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tyranny of examinations, many schools feel the need to offer their pupils the chance of measuring their standards of achievement by examinations of one kind or another. The teachers who believe that some kind of stimulus is needed are encouraged by those parents who refuse to keep their children at school beyond the age of fifteen unless an examination is in prospect. Many of the special courses in the modern schools are based on the syllabuses of the General Certificate of Education, although not usually on the academic subjects of the General Certificate. Nevertheless, it is generally agreed that the General Certificate of Education is an unsuitable examination for most modern school pupils. The examinations of a few professional bodies like the Royal Society of Arts or Pitman's College are suitable for those engaged in studies of a mainly vocational kind; but on the whole these are regarded as being too specialized.

In a recent circular* the Minister of Education has made it clear that he does not favour a new general examination for modern schools, nor the use of external examinations for any pupil under the age of sixteen. This does not mean that the Minister is against examinations in modern schools. He is rightly anxious that the interests of the majority are not sacrificed to the needs of the few. Experiments by groups of schools organizing their own examinations would be welcomed so long as the schools retain control over their own syllabuses. Here, surely, is an opportunity for university institutes of education to give a lead. Why should not regional panels representing academic staffs of modern schools, staffs of university education departments and training colleges and local industrialists be formed to devise courses and examinations suitable for the needs of secondary modern pupils, relevant to the requirements of local industries and acceptable to parents and employers? These could be related to the preliminary courses of further education institutions as well as the early stages of achievement required for the Duke of Edinburgh's Award in rescue and public service, training, expedition, pursuits and fitness, the details of which have recently been announced. These courses and examinations could form the bridge both between school and employment and the leisure-time pursuits of the schoolboy and those of the developing adolescent in industry and commerce. Such a proposal would do much to develop local pride in the modern school. Most important of all, it would give the modern schools something which so many of them appear to lack at the moment—faith in their ability to produce good citizens in an industrial society. For encouragement they should examine those schemes which are already in being in different parts of the country. They should also remember that discerning employers already prefer to select their apprentices from successful modern school children rather than from grammar school 'failures'.

SCIENCE AND MODERN LIFE

Science and Modern Life

By Sir E. John Russell. (Beckly Lecture for 1955.) Pp. iv+101. (London: Epworth Press, 1955.) 6*s*. 6*d*. net.

In this Beckly Lecture, presumably somewhat extended in published form, Sir John Russell has indicated some of the more difficult problems raised by the ever-increasing force of the impact of science and technology on our social life. Incidentally, he has touched on many other matters, currently discussed at several ranges of temperature. Through his long, very active life as chemist, agriculturist and man of affairs, he has travelled widely, met all kinds and conditions of men and, endowed with a sympathetic outlook, faculty of keen observation and retentive memory, has produced a most interesting, kaleidoscopic survey.

The large number of topics touched upon in a hundred short pages necessarily involves a cursory treatment of most of them, and no deep analysis of any one subject could be attempted. Nevertheless, the book is highly stimulating and can be warmly recommended to the general reader. At the outset the co-existence of a scientific and religious discipline in some early pioneers is noted, and at the end Sir John, for almost the first time in these pages, allows himself to express a definite personal view that hope for the future lies in the co-operation of science and religion in solving the serious and complex problems of human relationships. Again, he says "that the solution [of new social and ethical problems] lies in a more effective infusion into our lives of the spirit of Christianity". Taken quite literally the statement is unexceptionable, and the context shows that the emphasis is on the ethical system rather than on the dogmatic framework. An important question remains begged; but the author, as a scientist, probably wishes to see his own house in order and feels no urge to inquire into the lag period, differing according to the circumstances, in bringing religious dogma into line with knowledge of the natural world. Apart from this moral of the story, the bulk of the work is essentially a factual record, and only here and there will occasion be found to cavil at the statements made.

Many readers will think that the trend of the section on pp. 51–56 goes quite the wrong way. Contrary to the author's suggestion (p. 52), there seems no good reason to suppose that the existence of heredity involves the gradual deterioration of the race as an inevitable consequence. As Calverley said in another connexion, "we're not as pussies are", and surely we have more control over our destiny as a race than, say, carnation cuttings have over theirs. Admittedly it is hard to get a yard-stick in these matters; but the statements in regard to the quality of university students are contrary to the views of some teachers of long experience. In the opinion of many of us, the average calibre of present-day students is certainly no less than that of their predecessors. Nor is there any evidence of the shortening of the range of brilliance so as to produce a dead level of mediocrity.

A feature of the work which will be much appreciated is the references, which are valuable indications for further reading over a wide field.

In this little book there is sunshine and gloom, and perhaps rather more of the latter for the simple reason that the author has focused his attention chiefly on problems and difficulties. We should be most grateful for such a sincere expression of the thoughts and reactions of so eminent a scientist and administrator.

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* Examinations in Secondary Schools. Circular 289 (Ministry of Education.)

ROBERT ROBINSON

MODERN PHYSICS WITHOUT TEARS

Atoms and the Universe

An Account of Modern Views on the Structure of Matter and the Universe. By Prof. G. O. Jones, Prof. J. Rotblat and G. J. Whitrow. Pp. 254+31 plates. (London: Eyre and Spottiswoode (Publishers), Ltd., 1956.) 25*s.* net.

IN this book the authors have attempted an overall review of modern discoveries and ideas in physics and astronomy within the space of 250 pages. Though, in doing this, they have, as they say, had "to abandon one of the main characteristics of scientific method—its insistence on rigour in argument and explanation", the result is almost completely successful in giving the reader a convincing sketch-picture of recent achievements.

With my own specialized knowledge of atomic physics, I found the astronomical part of the book of greatest interest. This is extremely concise and close-packed with interesting facts and speculations. It is beautifully illustrated with a number of plates of planets and nebulæ. But it is quite possible to imagine an astronomer who would be more interested in the part of the book dealing with atomic physics.

The only unsatisfactory part of the book is that in which the authors try to explain very briefly the ideas of relativity and quantum mechanics. This was probably an impossible task; but I think that more than two pages might have been devoted to experiments and illustrations of the wave-properties of matter and that the considerations of the level-structure of atomic and molecular systems might have been amplified, since a great deal of the astronomical section involves knowledge of spectra and the shifting of spectral lines by the Doppler effect (beautifully illustrated, it is true, but nowhere explained).

But it would be surprising if one could not pick holes in such a book. It is very pleasant to see that the authors have found it possible to describe in simple, non-mathematical terms so much of modern physics and astronomy. There must, of course, be a limit to such an attempt. Quantum and general relativity ideas are not only less familiar than classical ideas, they are also more difficult to understand and to deal with. The Uncertainty Principle sets a limit to one's knowledge, especially to the knowledge one can express in familiar terms. Fortunately, much of physics is still 'classical', if we can tack on such fundamentally non-classical, but easily understood, developments as radioactivity. Astronomy is nearly 'classical' if one accepts the Einstein equivalence of mass and energy, and the motions of fundamental particles are mostly 'classical' until we have to deal with interactions, which involve various diffraction effects. Thus there is a large section of modern physics which can be visualized in more or less classical terms, and the authors have rightly exploited this. Indeed, the ordinary physicist should do just this in his experimental work—he should try to think things out for himself as simply as possible, if sometimes inaccurately, rather than wait for the pure mathematician to tell him all the answers.

I am sure that many of the simplified discussions in the book will prove of interest even to the professional in physics and astronomy. As a review of modern discoveries in these subjects, the book is excellent for the scientist who does not specialize in them. It certainly should be read by all students of physics or applied mathematics as a supplement to their formal text-books, and it can also be strongly recommended to the layman who has some background knowledge of physics.

H. W. B. SKINNER

CRYSTAL PHYSICS

Handbuch der Physik

Herausgegeben von S. Flugge. Band 7, Teil 1: Kristallphysik, 1. Pp. vii+687. (Berlin: Springer-Verlag, 1955.) 122.50 D. marks.

THIS book is one of the first parts to appear of the new "Handbuch der Physik"; together with Part 2 of Vol. 7, it will form a complete work on crystal physics. The necessity for two parts gives some idea of the importance of crystal physics to the other main branches of science. The book contains four sections: crystallography (102 pp., by H. Jagodzinski, in German); theory of the mechanical and thermal properties of crystals (221 pp., by G. Leibfried, in German); the specific heat of crystals (58 pp., by M. Blackman, in English); and the theory of lattice faults (283 pp., by A. Seeger, in German). There are two useful indexes giving the German–English and English–German equivalents of a large selection of technical terms. There is no name index.

Each paper is well documented by reference to works in German and English; relatively, there are few references to work in other languages. It is probable that these references will prove to be the most important part of the book, for in the space available some of the sections are rather cramped. Consider the section by Jagodzinski, for example; in one hundred pages it covers formal crystal symmetry, the relation between symmetry and physical properties, descriptions of some basic structures, and the relation between crystal structure and physical properties. The author has introduced several new ideas into the presentation of space-group theory, and I am particularly pleased to see that his treatment does not take the existence of the Bravais space-lattices for granted. On the other hand, there is a section entitled "Ein Weg zür luckenlosen Ableitung der 230 Raumgruppen" which disposes of the subject in four pages of text.

There is, unfortunately, a small degree of overlapping with the next section, by Leibfried, whose main object, however, is to give a general review of the theory of interatomic forces rather than to describe their effects in particular crystals. It is rather heavily mathematical, descending only occasionally to compare theoretical results with experiment, and omitting completely any descriptions of experimental methods. Experimentalists, however, should find this section useful in showing what type of experimental result is most useful in the general theoretical development of the subject.

Leibfried's and Blackman's sections again overlap appreciably; both discuss the Debye theory in some detail and its modification by Born and others. Blackman's account provides a very useful summary of the present state of the subject of the specific heats, and is of value to both theoretical and experimental physicists. It shows what an important part the characteristic temperature plays and also, unfortunately, what a complicated concept it has now become.

The final section, on lattice faults, is likely to be the least useful to the English-speaking world, solely because there are so many papers in English on the subject; about four-fifths of the papers in the bibliography are in English. For this same reason, it should be valuable to the Germans, and may give some incentive to them to apply their analytical powers to a new, fascinating and practically important branch of crystal physics.

The general impression remains of a thoroughly competent and able piece of work, rather ponderous perhaps, but of the general style that one expects in an encyclopædia. H. LIPSON

THE WREN IN BRITAIN

The Wren

By Edward A. Armstrong. (The New Naturalist Series.) Pp. viii+312+8 plates. (London: William Collins, Sons and Co., Ltd., 1955.) 30*s*. net.

IT is a sobering thought that, of the 280 species of bird which spend a substantial part of their lives in the British Isles, we still only have adequate and up-to-date monographs of a bare dozen. David Lack's "Life of the Robin" (1943) set a new standard, which has been well maintained by the seven books devoted to individual bird species that have appeared in the New Naturalist Series. The latest of these, by the leading British amateur worker in bird behaviour, is on the second smallest British bird, the wren (*Troglodytes troglodytes*). Though the book is formally devoted to the familiar European species, in fact, such is the wealth of comparative material presented that it almost becomes a treatise on the wrens of the world. This is an immensely valuable feature of the book, for students of British birds are more than usually prone to the myopic views engendered by insularity. Again and again, obscurities in the habits and biology of a British species can only be resolved by reference to the populations of the same bird in other parts of its range, or to quite different members of the same genus or family.

Ornithologists will all regret the author's statement in his preface that "the requirements of this series have necessitated drastic abbreviation and condensation", for it is always less convenient to have to turn to other sources for a complete conspectus. Thus, for extended information on parasites and nidicoles of the wren, one must now turn to the author's paper in Vol. 11 of the *Irish Naturalists' Journal*. However, authors must bow to economics, and ornithological readers must be thankful for being allowed to have as much between two covers as they are offered in this book. The work contains, in fact, a very adequate treatment of every important aspect of the life-history of the wren, largely based on the author's own field studies in a small wood near Cambridge. It is always dangerous to base a general study of a species on the particular circumstances in one locality, but in this book the author's wide reading, together with extensive field studies of wrens in other parts of the British Isles, and in Iceland, have obviated as far as possible any bias due to the quirks of Cambridge wrens.

If it were necessary to standardize monographs on birds (which Heaven forbid!), this would make a very satisfactory book on which to base the standard. There are twenty excellent photographs in black-and-white, by the author and others. R. S. R. FITTER

MALAYAN FERNS

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Ferns of Malaya

By Prof. R. E. Holttum. (A Revised Flora of Malaya: an Illustrated Systematic Account of the Malayan Flora, including Commonly Cultivated Plants—Vol. 2.) Pp. iv + 643 + 3 plates. (Singapore: Government Printing Office, 1954 [1955].) 20 Malayan dollars.

PROF. R. E. HOLTTUM'S book on Malayan ferns, the second volume of his revised "Flora of Malaya", maintains—even surpasses—the high standard set up by him in the first volume, devoted to the orchids. Van Alderverelt van Rosenburgh's account has long outgrown its usefulness, and an up-to-date and authoritative successor to it was much desired. Not only has the author described about five hundred species of ferns, but he has also provided 362 excellent line-drawings. The descriptive part of the volume is prefaced by chapters dealing with the nature, classification and nomenclature of ferns, followed by an interesting study of Malayan ferns in particular. Keys to identification are also provided.

Prof. Holttum naturally follows his own system of classification, which differs markedly in some respects from that of Copeland. This is no place to compare the two schemes; but mention must be made of the family Dennstaedtiaceae. The name was first proposed by Ching in 1940 for a small homogeneous group of genera centred around *Dennstaedtia*. When Prof. Holttum adopted the same name for a very much larger group of genera, he was doubtless unaware of Ching's work. Holttum's family comprises about seventy genera, as opposed to eight in Ching's scheme, and is so heterogeneous that the author has found it impossible to supply a family description. Subdivided into eleven subfamilies, it embraces such diverse elements as *Davallia*, *Acrostichum*, *Dryopteris* and *Pteris*, to mention but a few. Treated as families, these subfamilies would have invited little criticism since they are compact natural groups. Their amalgamation as a family will be regarded by some as far from natural. The treatment of the Hymenophyllaceae and Gleicheniaceae is frankly conservative, and the smaller segregate genera accepted by Copeland are not adopted. In the case of the Hymenophyllaceae, however, the corresponding segregate name of every species is given as an "alternative name".

A particularly interesting and novel feature of the book is an appendix, prepared by Prof. I. Manton, on the cytology of a hundred species of Malayan ferns. It is to be hoped that Prof. Manton's plea for further investigation of other species along the same lines by workers in Malaya will meet with a favourable response.

Prof. Holttum's book is well printed and commendably free from typographical errors. It should be pointed out, however, that *Ophioglossum pedunculosum* Desv. is now known as *O. reticulatum* L.

O. pedunculosum is a synonym of *O. costatum* R. Br. and is an entirely different species. Also, the varietal epithet '*alternans*' has been inadvertently omitted from the caption on the frontispiece.

It is to the observations accompanying the descriptions that the book largely owes its readability, and there is much to be learned by the specialist as well as by the less-informed reader. Apart from its value to the field-worker in Malaya, the book is essential for all those who have a genuine interest in ferns as a whole.

F. BALLARD.

CHEMISTRY AND PHYSICS OF RADIOACTIVE MATERIALS

Nuclear and Radiochemistry

By Gerhart Friedlander and Joseph W. Kennedy. (Revised version of "Introduction to Radiochemistry".) Pp. ix+468. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1955.) 60*s*. net.

IN the preface to their earlier work, "Introduction to Radiochemistry", the authors went to some trouble to define the subject. They have had second thoughts since then, and in the preface to this new volume they propose that the field which they previously defined as nuclear chemistry should no longer be regarded as a part of radiochemistry. Radiochemistry is now to be thought of as including chemical manipulations of radioactive sources and much of tracer chemistry. For these reasons, the title has been altered to "Nuclear and Radiochemistry". The old title may have been unsatisfactory and certainly did not please everybody; but, in the reviewer's opinion, the use of the term nuclear chemistry for describing certain parts of nuclear physics is not a happy one.

Whatever the meaning of the title, the book deals very largely with those parts of nuclear physics which are of interest to chemists. The authors have attempted to cover a wide field by selecting elegant and economical methods of presentation. They have, on the whole, succeeded admirably; only in a few instances has economy been carried too far. In Chapter 2, for example, the section on isotope separations has been reduced to a bare statement of techniques available.

The book is intended primarily for graduate or senior undergraduate students, and emphasis is very properly laid on ideas and principles. The research worker cannot, therefore, expect to find the degree of detail in chapters such as that on radiation detection and measurement, which he requires for his day-to-day work. On the other hand, few research workers in the field of radiochemistry will care to do without a book which contains such a wealth of carefully selected information on the physical background to the subject.

The authors have devoted rather a small fraction of their space to chemical aspects, and the treatment is often quite elementary. Radiation chemistry, which was excluded from "Introduction to Radiochemistry" as not strictly belonging to the subject, has been accorded a brief section in the new volume. This is probably desirable in order to round off a valuable chapter on interaction of radiations with matter. There is a statement, however, to the effect that "most organic systems are much too complex to encourage any detailed studies of the mechanism of their radiation decomposition", which is surely too pessimistic. The problem may be more difficult than that of organic pyrolysis, but modern analytical developments give grounds for better hopes. New chapters, on nuclear energy and on some cosmic problems, have been added in the new volume, and they make a useful addition. It is curious to note, however, that the section on chemical processing seems to be out of line with recent publication in this field. A coprecipitation process is chosen by way of example, and doubt is cast on the suitability of solvent extraction methods because of radiation effects; actually it has been common knowledge for some years that solvent extraction methods are in fact used.

Each chapter is followed by about a dozen well-chosen exercises, and there are about forty pages of appendixes devoted to a most useful compilation of nuclear data. This is an outstanding book, well conceived and well written. It can be strongly recommended to all radio (and nuclear ?) chemists.

THE FIRST HUNDRED YEARS OF THE CURTIS MUSEUM, ALTON

The Curtis Museum, Alton, Hampshire, 1855–1955

The First Hundred Years of a Small Museum. By William Hugh Curtis. Pp. vii+55+10 plates. (Alton: Curtis Museum, 1955.) 6*s*.

IT is now fully realized that much of the visible evidence of the heritage of Great Britain lies in the numerous small museums scattered unequally throughout the land. The consciences of the trusts, societies and public authorities owning these institutions have been awakened to their responsibility, and a very great amount of energy and enthusiasm is being expended into transforming these one-time hoards of junk into displays worthy of the best of modern trends in the museum world. A great deal of the credit for this must be given to the Carnegie United Kingdom Trust, which, with the Museums Association, has done much to stimulate and inspire the local museum.

The history of the Curtis Museum in Alton, Hampshire, during the past one hundred years is interesting and instructive not only for its own sake but also as an indication of the trend of development in so many of the museums of Britain. It is written in a clear, straightforward manner by Mr. W. H. Curtis (a grandson of the founder, Dr. William Curtis), who is probably the only one living who could write such a record of what has been so essentially a family concern.

It was in 1837 that William Curtis founded the Alton Mechanics Institute, which, like so many others, led to the establishment of a Museum in 1855. It started with about four thousand specimens, many of which were fossils and minerals, though in common with museums of that period included a quantity of foreign material of all sorts. In 1920 the Museum was transferred to the Alton Urban District Council, and Mr. W. H. Curtis was appointed honorary curator. It is interesting to note that in 1929 the acquisition of bygones was a definite feature in the policy of the Museum—the swing of interest from natural history had begun. At first efforts were concentrated on agricultural, domestic and personal objects, but eventually the search for the tools of rural craftsmen was actively pursued.

An important event in 1934 was the inaugural meeting of "The Friends of the Curtis Museum", a body which has done much for the Museum and continues to the present day. In 1946, the Museum was transferred to the Hampshire County Council under the terms of the Education Act, 1944. A grant from the Carnegie Trust was announced in 1949, and this helped the Museum to assume the modern aspect which characterizes it at the present day. In 1951 the appointment of a full-time curator brought the Museum into line with so many similar institutions up and down the country. The history concludes with an appreciation by Mr. C. P. Chatwin on the geological work of William Curtis.

This stimulating, almost year-by-year, record of the vicissitudes of a local museum is of interest not only to the community in Alton but also to the wider museum public, who see in it an epitome of what has happened at so many centres.

PATHOLOGY OF CANCER

The Genesis and Prevention of Cancer

Second Edition. By W. Sampson Handley. (London: John Murray (Publishers), Ltd., 1955.) 21s.

THE first edition of Mr. W. Sampson Handley's book appeared a quarter of a century ago. Although this new edition has recently been revised, the author's original ideas as to the cause of cancer remain unchanged. Many theories of the causation of malignancy are discussed and discarded. The virus theory is dismissed, and the author predicts "no specific organism of cancer will ever be discovered". Mr. Sampson Handley contends there is a definite correlation between the induction of cancer and lymph-statis. This theory was gradually built up over twenty-five years of clinical and histological study of the disease in all its many manifestations. He marshals evidence for his conclusion that precancerous lesions are areas in which the lymphatic vessels have either been blocked or else obliterated by chronic inflammation or congenital defect. He further argues that, as lymphatic obstruction always precedes cancer, it is therefore the main factor in causing the disease.

This view, although not universally accepted by pathologists as the cause of cancer, might hold for some types of malignancy. It would be an over-simplification to accept this theory as the universal cause of cancer. For example, it would be difficult to explain the origin of some forms of endocrine cancers, which depend on hormones both for their induction and maintenance, and which regress once the hormonal stimulus is withdrawn. Under such conditions, do accompanying changes first occur in the lymphatics before the onset of the disease, and can they be expected to disappear during regression? If so, they have not been adequately demonstrated.

Mr. Sampson Handley has done admirable pioneer work on the pathology of breast tumours, and has contributed greatly to our present knowledge of the spread of tumours via the lymphatic pathway. Although many might find his theories controversial, they will also find them stimulating. All who are interested in the histology of the early development of tumours should read this book.

There is also a chapter on cancer prophylaxis. Among the many preventive measures discussed, preputiotomy in children is recommended at birth in order to reduce the incidence of cancer both of the penis and the cervix. In this same chapter, when discussing constitutional factors such as hormones in the etiology of the disease, he contends that they "play only a subordinate part". This attitude is scarcely in accord with modern biological findings.

The book is well illustrated and has an appendix entitled "Tobacco and Cancer", in which some interesting statistics are given concerning lung cancer and other diseases occurring among heavy smokers.

CHROMOSOMES OF HIGHER PLANTS

Chromosome Botany

By Prof. C. D. Darlington. Pp. xii+186. (London: George Allen and Unwin, Ltd., 1956.) 16s. net.

IN this useful little book are summarized the important facts and points of view concerning the chromosome numbers and chromosome morphology of the higher plants (chiefly the Angiosperms), and the significance of their cytology in clarifying the taxonomy, phylogeny, geographical distribution and ultimately the evolution of the plants concerned. The facts and points of view are mainly those which have emerged during the period 1930–56; approximately the period since the publication of the first edition of the "Recent Advances in Cytology". Most of the topics dealt with in this epoch-making book have now received a revised treatment from the author in the several volumes written independently or in collaboration with Prof. K. Mather. The present volume brings to a considerable degree of completeness an achievement represented by books which are essentially challenging presentations of facts rather than dispassionate compilations. The reviewer does not forget that compilations and a practical handbook have been provided as well.

B-chromosomes, apomixis, microspecies, polyploidy and plant geography, ecological variation, change of basic chromosome number, change of chromosome morphology and chromosome size, centres of diversity, wheat, maize, *Rosa*, *Chrysanthemum*, are among the subjects treated, often with useful detail. On certain of them it has long been desirable to be able to quote the author's views. On the whole, these views do not differ markedly from those generally held, although, as always, it would be easy to quote sentences from this author with which few would agree. There are no complex diagrams. The sections dealing with basic numbers are particularly illuminating, although the bold assertion of 1949 in regard to the basic chromosome number of the ancestral Angiosperms is repeated here and their seven chromosomes appear on the dust-cover. Broadly, the book is an elaboration of the introduction to the first edition of the "Chromosome Atlas".

There is a separate bibliography for each chapter; but authors' names are also indexed. One feels that the names of some whose ideas have been assimilated, perhaps subconsciously, should not have been missing, for example, those of Huxley and Turrill; yet, of course, it is an advantage that the size of the volume has been kept down to that which a student can afford to buy. Every serious student of botany should be recommended to purchase this book, the only one of its kind published in Britain. There is an informative little appendix by E. B. Ford, on moths, butterflies and *Primula*.

M. B. E. GODWARD

AMEDEO AVOGADRO (1776–1856)

By PROF. J. R. PARTINGTON, M.B.E.

PROBABLY no name is better known to students, even the most elementary, of chemistry and physics than that of Avogadro; but this was not always so. He is not mentioned in the detailed histories of chemistry of Hoefer and Kopp, and in the biographical dictionary of Poggendorff he first appears in the third volume in 1898. The details of his life are to be found only in the very rare "Opere Scelte di Amedeo Avogadro", printed for private distribution by the Turin Academy of Sciences in 1911, the centenary of the publication (in French) of his famous hypothesis in the widely read *Journal de Physique*. The "Opere" has a long introduction by Prof. Icilio Guareschi and contains the first Italian translation of Avogadro's memoir of 1811. It also prints a letter from Faraday in 1842, thanking Avogadro for his last letter and saying (the letter is in Italian) that he had read the first two volumes of his great work with much profit, "sebbene io legga l'italiano con stento". This would be the "Fisica de' corpi ponderabili" (4 vols.; Turin, 1837–41), and Faraday says he had ordered the third volume from Paris.

A member of a distinguished Italian family, Amedeo Avogadro (to use his own contraction of his very long complete name) was born in Turin on August 9, 1776, and died a hundred years ago on July 9, 1856. He became bachelor of law in 1792, later doctor of eccelesiastical law (a family vocation), and practised for a time. He became interested in mathematics and physics, and in 1809 was appointed professor of philosophy in the Royal College of Vercelli. In 1820 he filled the first Italian chair of mathematical physics in Turin, which was suppressed for political reasons in 1822. The chair was restored in 1832 but was occupied for a year by Cauchy, the distinguished French mathematician, when it was re-occupied by Avogadro from 1834 until his retirement in 1850. The "Opere" lists more than fifty publications by Avogadro—all except the memoir of 1811 known only to specialists. He took an active part in public affairs and was a very cultured man with many friends among distinguished scientists in all countries; but he received no honours, partly because of his modesty and partly because he was so fully occupied with scientific work that he had no time to seek them.

Avogadro's famous memoir of 1811 is entitled "Essai d'une manière de déterminer les masses relatives des molécules élémentaires des corps, et les proportions selon lesquelles elles entrent dans ces combinaisons". He uses the names "molécule" and "molécule intégrante" for molecules in general, "molécule constituante" for a molecule of an elementary substance, and "molécule élémentaire" for the atom of an element. The title, therefore, shows that he is concerned, in fact, with atomic weights. The nomenclature and the clumsy and sometimes obscure French in which the paper is written make it difficult to understand. It announces the hypothesis that "le nombre des molécules dans les gaz quelconques est toujours le même à volume égal . . . les rapports des masses des molécules sont alors les mêmes que ceux des densités des différents gaz, à pression et température égales". A long supplement, which is little known, appeared in the *Journal de Physique* in 1814.

Avogadro makes it clear that the origin of his memoir was the publication in 1809 by Gay-Lussac of his law of volumes, in the form that gases "se combinent entre elles dans des rapports très-simples, et la contraction de volume qu'elles éprouvent par la combinaison suit aussi une loi régulière". This shows, said Avogadro, that "il y a aussi des rapports très-simples entre les volumes des substances gazeuses, et le nombre des molécules simples ou composées qui les forme". Gay-Lussac read his memoir to the Société d'Arcueil on December 31, 1808; it is purely experimental. In 1808 Dalton, in the first volume of his "New System of Chemical Philosophy", had said that "it is evident the number of ultimate particles or molecules in a given volume of one gas is not the same as in another", since one volume of nitrogen and one of oxygen form two volumes of nitric oxide, in which "the number of ultimate particles could at most be one half of that before the union".

This difficulty Avogadro resolved by the assumption that the molecules (a name which, it will be noticed, was used by Dalton) of elementary gases may contain two or more atoms and that the particles resulting from their union may divide. In modern symbols: $N_2 + O_2 = N_2O_2$; $N_2O_2 = 2NO$. In comparing the weights of molecules from the ratios of densities, Avogadro took the molecular weight of hydrogen as unity, so that his molecular weights are half the modern ones.

In 1814 Ampère published the same conclusions as Avogadro, mentioning him only in a footnote, so that Avogadro said in 1849: "Ampère a depuis adopté ce principe". Ampère suggested that the molecules of elementary gases contain four, not two, atoms, and made further obscure speculations about the geometrical forms of the particles. Dumas in 1826 is the only chemist to name Avogadro before 1850; others, when they refer to the hypothesis at all, credit it to Ampère, as did Gaudin, who in 1833 gave a detailed and clear exposition of it, which was favourably noticed by Berzelius.

Avogadro died on July 9, 1856, and his hypothesis was then in a state of full neglect. There were reasons for this. All attempts to construct a uniformly acceptable set of atomic weights had failed, and chemists had fallen back on the use of equivalent weights determined directly by experiment. Dumas in 1826 had found very abnormal vapour densities of sulphur and phosphorus, which had no clear relation to the accepted atomic weights; and, finally, the vapour densities of ammonium chloride, phosphorus pentachloride and sulphuric acid were only half those expected.

In 1858, Cannizzaro, then professor in Genoa, distributed a small pamphlet based on his lectures, in which he cleared up the difficulties of abnormal vapour densities by assuming that the sulphur and phosphorus molecules contain more than two atoms, and that ammonium chloride, etc., dissociate on heating and, thus occupying a larger volume, have abnormally low molecular weights. Cannizzaro showed that Avogadro's hypothesis, which was now restored to its rightful originator, could be applied without exception. He referred both atomic and molecular weights to the *atom* of hydrogen, instead of (as Avogadro did) to the molecule; the ratio of the molecular weight of any gas or vapour to that of hydrogen is the ratio of the densities, and since the hydrogen molecule is H_2, the molecular weight of the other substance, in terms of the atomic weight of hydrogen, is twice the relative density. The atomic weight of an element is then the smallest weight of it contained in a molecular weight of any of its compounds. These two features are important contributions by Cannizzaro.

Lothar Meyer was much impressed by Cannizzaro's pamphlet, and in his "Moderne Theorien der Chemie", published in 1864, he gave a clear account of the bearing of Avogadro's hypothesis on molecular and atomic weights. A similar service was rendered by Hofmann in his "Introduction to Modern Chemistry" in 1865. From that time the significance of the hypothesis came to be clearly perceived, and it now ranks next to Dalton's atomic theory in the structure of theoretical chemistry.

The kinetic theory of gases, developed by Clausius (1857) and Maxwell (1860), showed that Avogadro's hypothesis (they do not mention his name) follows from the assumption that the average kinetic energy of translation of gas molecules is proportional to the absolute temperature, and the significance of the hypothesis was thus seen by physicists. Avogadro was, in fact, a mathematical physicist, not a chemist in the proper sense. The hypothesis was seen to penetrate such diverse branches of physics as the kinetic theory, the Brownian movement, radiant heat, the scattering of light, the electronic charge, and the counting of α-particles. It became possible to determine the number of molecules in a molecular weight in grams of any substance, a constant of Nature now called Avogadro's number and equal to $6 \cdot 02 \times 10^{23}$. If it can be said with truth that the real existence of atoms and molecules has been experimentally demonstrated, it can be asserted with equal confidence that Avogadro's statement is no longer what he himself called it, a 'hypothesis'. A generation ago, students were warned by meticulous teachers not to call it Avogadro's 'law'; but this name would now seem to us much less objectionable.

Avogadro did not live to see the full recognition of his great service to chemistry and physics. Now, however, in commemorating the centenary of his death, no obscure name is rescued from oblivion but homage is paid to one long acknowledged as a master.

FINE STRUCTURE OF SOME CILIATE PROTOZOA

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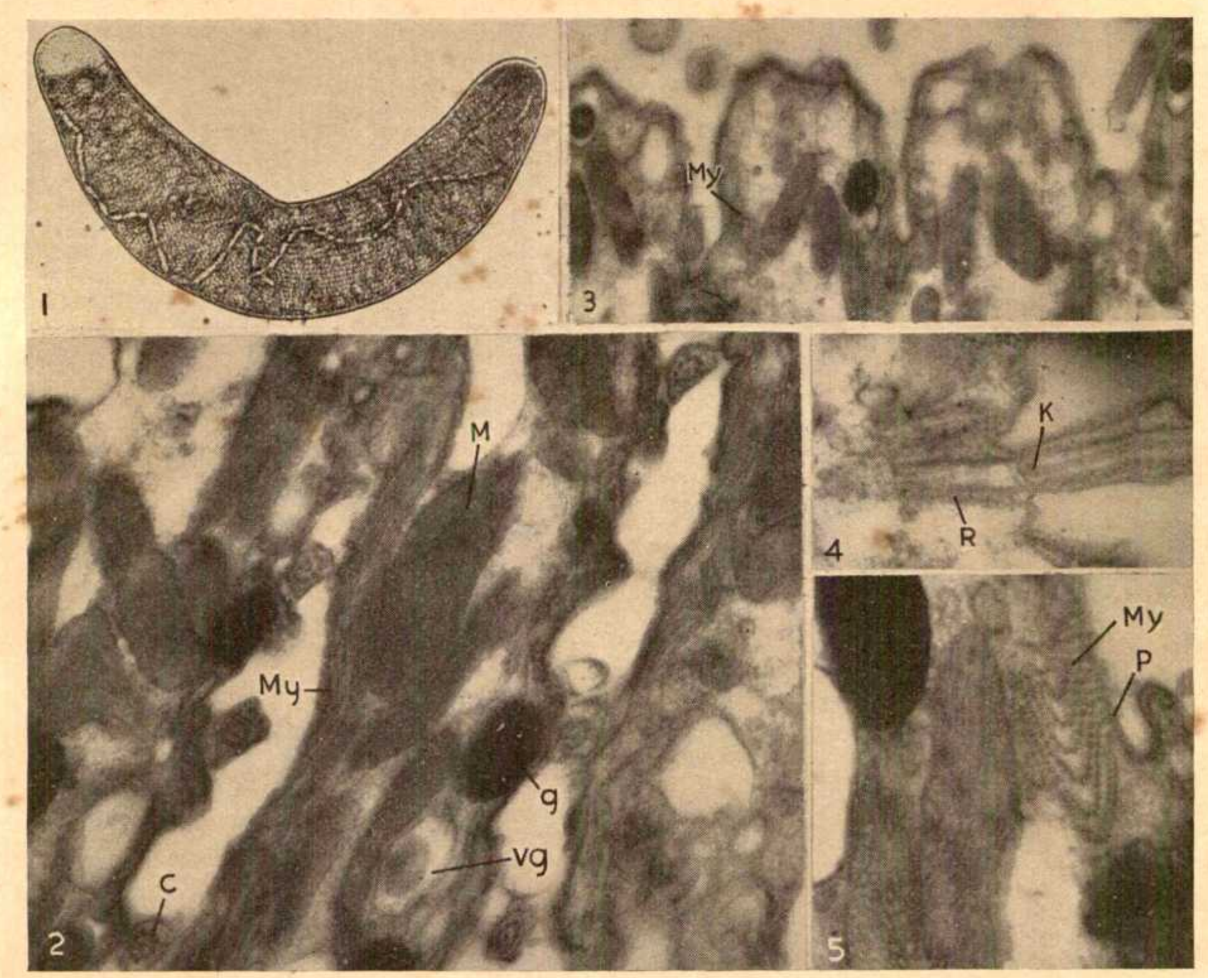
IN this article I wish to outline some of the more important features of the fine structure of certain ciliates which have been observed in the electron microscope. Most of the currently accepted information about Protozoa has been obtained with the help of the light microscope[1,2], and has clearly been restricted by the limited resolving power of this instrument. It is surprising that, in the ten or fifteen years during which the electron microscope has become an increasingly important and popular tool in the study of biological fine-structure, the study of Protozoa has been a comparatively neglected field. The start given to such investigations by Jakus and her collaborators[3-5] does not seem to have been followed, until very recently, to the extent that might have been expected. This is probably accounted for by the fact that Protozoa are in general rather large and thick organisms for study in the electron microscope without the aid of the thin-sectioning microtomes which have themselves only been developed in the past few years.

In the field of biological fine-structure, Protozoa offer many attractive possibilities. Among them may be mentioned: (1) structure of the nucleus, the nucleolus and the nuclear membrane; (2) protozoan cytoplasm with its many inclusions; (3) fine-structure of the protozoan pellicle and ectoplasm; Sedar and Porter[6,7] have recently made such investigations for *Paramecium multimicronucleatum* and Powers *et al.*[8,9] have studied mitochondrial structures in *Paramecium* species; (4) ciliary apparatus of the ciliates, including membranelles; (5) contractile structures or myonemata of the ciliates, to which I give special attention below; (6) sexual and asexual reproduction and the phenomena of mitosis in the Protozoa, which also suggest many interesting comparative studies with higher organisms. These are but a few of the approaches that may be made in this interesting field.

In this article I shall be concerned with three members of the Ciliophora: *Spirostomum ambiguum*, *Carchesium* sp. (probably *polypinum*) and *Stentor polymorphus*. The material has been fixed in a combination of osmium tetroxide and Zenker fluids and then embedded in a methacrylate medium. After appropriate polymerization of the plastic, thin-sectioning of the organisms was carried out on a microtome designed in this Laboratory. It has not been possible to illustrate all structural features to which reference has been made in the text, but fuller accounts will be made available as soon as possible; a more detailed description of the work on *Spirostomum* is already in course of publication[10].

Spirostomum ambiguum (Ehrenberg)

This heterotrich has a uniform body ciliation with a funnel-shaped pharynx and a long peristome roughly parallel to the body-axis. The surface of the body (see Fig. 1 for photomicrograph of the living animal) is crossed by perhaps as many as forty kinety along which the cilia are uniformly distributed. The kinety are separated by ectoplasmic ridges. Longitudinal sections through the ectoplasm which cut transversely through a number of cilia may be seen in Fig. 2. Fig. 3 is an electron micrograph of a transverse section through the ectoplasm, and the characteristic ridges and furrows may be seen



Spirostomum ambiguum

(1) Photomicrograph of a living animal showing the longitudinally arranged kinety, the beaded macronucleus, the contractile vacuole and the dorsal canal. × 120

(2) Electron micrograph of an oblique section through the ectoplasm which shows the ridges, transverse sections of cilia (*c*) lying in the furrows, mitochondria (*M*), two types of granular inclusion with — (*vg*) — and without — (*g*) — a vesicular membrane, and longitudinal sections of myonemes (*My*). × 32,000

(3) Transverse section through the ectoplasm showing the ridges and furrows (kinety) at the surface of *Spirostomum*. Myonemes (*My*) are localized asymmetrically at the left side of each ridge. × 16,000

(4) Longitudinal section of a cilium showing its kinetosome (*K*) and dependent root-like fibrils (*R*). × 35,000

(5) Transverse section through the fibrillar myoneme sheets (*My*) which are attached to the inner plasma membrane (*P*) at one end. Note the two types of mitochondrial structure. × 45,000

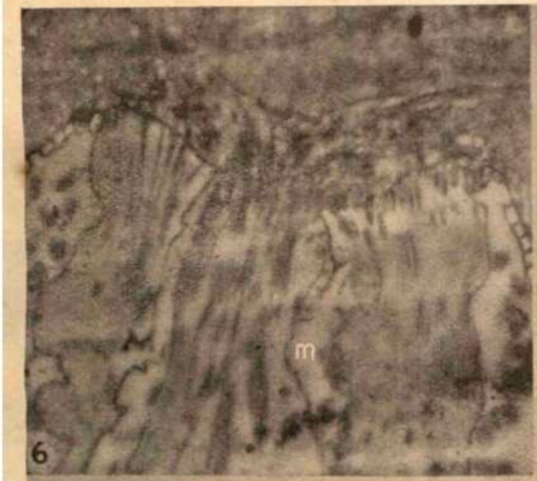
n this picture. The periplast of *Spirostomum ambiguum* has an overall thickness of about 500 A. and appears to be double. The inner component is referred to below as the plasma membrane.

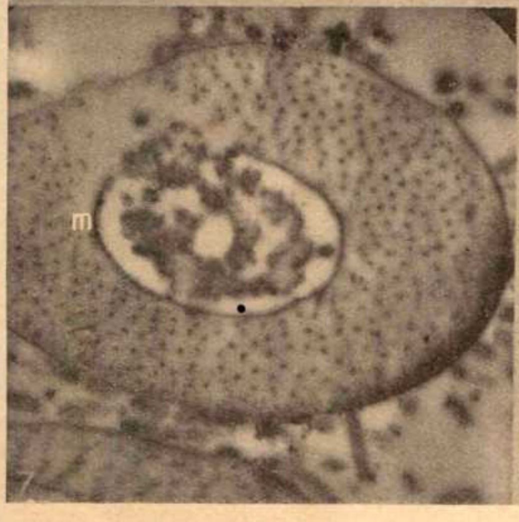
The external membrane of each cilium is continuous with the outer layer of the periplast. This membrane encloses a system of filaments, two of them approximately axial, and nine peripheral; each of the nine outer filaments is, in the best micrographs, resolved into two closely adjacent filaments. Each cilium is about 1500 A. in overall diameter. A longitudinal section through the basal apparatus (Fig. 4) clearly shows a granule, *K*, presumably the core of the kinetosome, which appears to be surrounded by twin septa. From the outer and lower part of the septum two rootlets, *R*, extend into the ectoplasm.

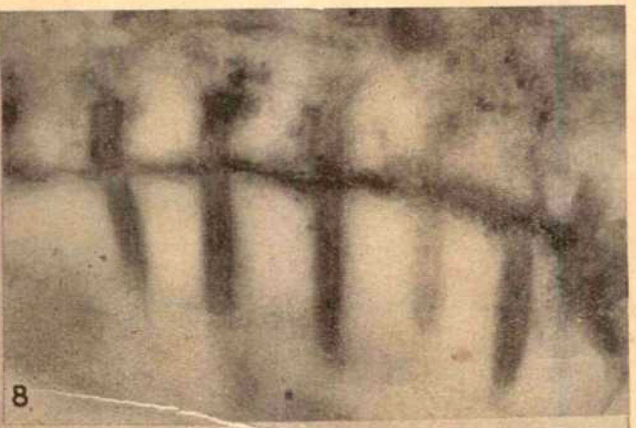
Earlier investigators with the light microscope have naturally given much attention to the problem of the detailed structure of the pharyngeal membranelles (for example, Bishop[11]). On the basis of the evidence I have obtained so far, the view that the motile portion of each membranelle in *Spirostomum* is composed of laterally joined cilia does not seem to be justified. I would, however, prefer to defer conclusions on this complex matter until I have made further observations.

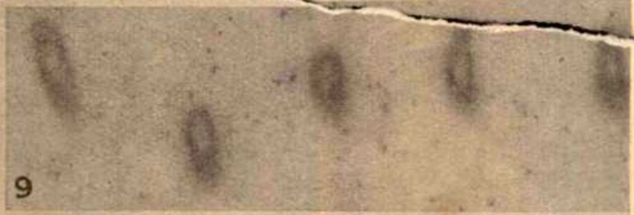
Long, slightly ovoid, bodies with fine structure characteristic of mitochondria have been observed in large numbers in the ectoplasm of *Spirostomum* (Fig. 2). Detailed examination of these bodies has led me to conclude that they may be separated into two distinct groups. In the first group (Fig. 5) the mitochondria are composed of sheets about 150 A. thick which are separated from each other by a layer of less dense—or possibly less osmiophilic—material of rather greater thickness. The total surface area of the sheets inside a mitochondrion represented by a cylinder 1 micron long and $\frac{1}{3}$ micron in diameter would be 1·25 cm.^{2}; each mitochondrion appears to be enclosed in a single membrane. Instead of this simple stratified structure, it is more usual, however, to find a modification in which the internal organization appears to consist partly of sheets (as above) and partly of small tubular vesicles which are typically elliptical in cross-section (see also Figs. 2 and 5). The lumen of the vesicles is often about 430 A. × 250 A. and the wall-thickness about 200 A. In the paper already referred to[10], it has been shown how such a vesicular structure may have been derived from a system of undulating sheets. The mitochondria that fall into the second group have so far been found only in small numbers in *Spirostomum*, but may be recognized as the type usually observed in metazoan tissues (see also Fig. 14 for *Carchesium*); such mitochondria contain a number of characteristic vesicular structures somewhat irregularly arranged. Without much more detailed investigation it is impossible to say whether the two groups into which I have divided the mitochondrial bodies of *Spirostomum* are really distinct, or whether the second group arises as a somewhat swollen or distended version of the first.

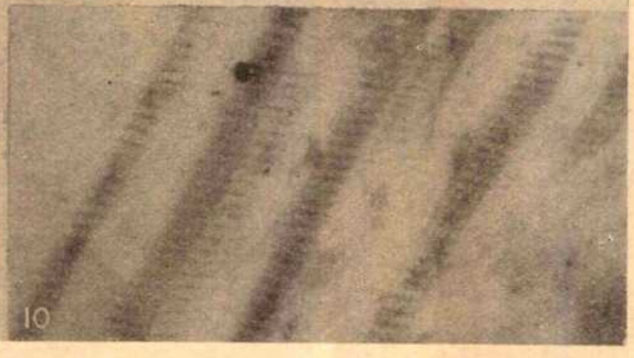
The most elementary observations of living *Spirostomum* show that the animal must possess some means of extremely rapid contraction. The history of the study of the myonemes of *Spirostomum* has been described in some detail[11]; such structures have in the past been inferred from examination by light microscopes of living and of fixed-and-stained material. The electron microscope observations show that the effective width of a myoneme is close to the limit of optical resolution. This accounts for the often conflicting observations which have been recorded. Fig. 3 is a transverse section of *Spirostomum* showing the pellicle and ectoplasm of two ridges and their neighbouring furrows. Attention is particularly directed to the structures, *My*, apparent on the left-hand side of each ridge. These structures are provisionally identified with the myonemes. Each myoneme appears to consist of a number of fibrillar ribbons or sheets, often about ten, which presumably extend the full length of the animal. Fig. 5 shows in greater detail a transverse section of a single myoneme. One side of each ribbon is attached longitudinally to the plasma mem-











Carchesium

(6) Longitudinal section of the junction of stalk and zooid which shows that the cytoplasm is continuous with the central canal; the junction is marked with a root-system, which may have a ciliary origin, and which may be attached to the longitudinal filaments of the annulus. × 3,000

(7) Transverse section of the stalk showing the central canal and the annulus which contains numerous filaments seen in cross-section. × 3,000

(8) Higher magnification of the root-system at the junction of the stalk and zooid. × 35,000

(9) An oblique section of the annulus which shows the tubular form of the filaments. × 32,000

(10) Longitudinal section of the striated filaments from the annulus of the stalk. Periodicity, 3[illegible]0–700 A.; diameter about 1400 A. × 35,000

brane, *P*, on one side of each ridge. There is apparently no permanent attachment of the distal ends of ribbons, each of which is simply embedded in the ectoplasm. The extended width of a ribbon is about 5000 A. The fibrils, which are the main feature of the ribbons, consist of an outer dense layer and an inner less dense core; the overall diameter of the fibrils is about 250 A. (Fig. 5). In longitudinal section the myoneme ribbons appear as narrow lines parallel to the plasma membrane (Fig. 2). The dimensions of the myonemes given above refer to contracted material.

The ectoplasm of *Spirostomum* contains in addition to the mitochondria two distinct forms of granular structure (*g* and *vg*) often about 0·5μ in diameter. The simpler structure (*g*) is composite and contains many small particles with no evidence of an enclosing membrane. The more complex structure (*vg*) consists of an apparently dense multigranular core which is enveloped in a well-formed membrane clearly separated from the inner structure. Both types of granule may be seen in Fig. 2. No such granular structures have so far been observed either in *Carchesium* or in *Stentor*.

In the electron micrographs of *Spirostomum* there is a fairly sharp transition from ectoplasm to endoplasm; no evidence of an intermediary membrane, however, has been found. The endoplasm is heavily vacuolated, and the ectoplasm is connected to the endoplasm through a widely spaced series of canaliculi which separate neighbouring vacuoles from each other. Although the vacuoles are often associated with a number of small vesicles, the features so far recognized by others as characteristic of contractile vacuoles have not been clearly observed. Food vacuoles have been found in many of the sections examined.

Carchesium

This peritrich may readily be distinguished from *Zoothamnium* on one hand and *Opercularia* and *Epistylis* on the other. In *Carchesium* each branch of the stalk is independently contractile; in *Zoothamnium* the whole colony contracts as one. *Opercularia* and *Epistylis* are non-contractile. I am not certain of the species of *Carchesium* examined; but it is probably *polypinum* (see Fig. 11 for a photograph of the animal under the light microscope). Fig. 12 gives a low magnification view of a transverse section through parts of the ciliary system near the mouth of the zooid; notable in the lower part of the micrograph is the triple row of cilia. In another section cut closer to the root system (Fig. 13) each cilium is joined laterally to its neighbours in the same row by short filaments about 1500 A. long and 200 A. wide. The endoplasm in both the above micrographs is filled with mitochondria which are of the vesicular type common to metazoan tissues and are similar to the Type II mitochondria of *Spirostomum*; Fig. 14 shows part of a *Carchesium* mitochondrion at higher magnification. Regions of the endoplasm near the cytostome in *Carchesium* have been found to be in a highly organized state (Fig. 15) reminiscent of the structures found in the mitochondria (Type I) of *Spirostomum*; the significance and extent of this elaborate system of sheets and vesicles, however, are not yet known.

The stalk consists of two distinct parts: an annulus, which is threaded by numerous longitudinal tubular filaments, marked with a periodic striation, and a central core or canal which appears to be continuous with the endoplasm of the zooid and is separated from the annulus by a single membrane, *m* (Figs. 6 and 7). The stalk, after fixing and embedding, generally appears elliptical in section, and the core is about half as wide as the annulus is thick (about 10^{-3} cm.) (Fig. 7). Bodies similar to mitochondria have frequently been observed in the core of the stalk and well removed from the stalk–zooid junction. A primitive type of root system occurs at the junction of the stalk and zooid (Figs. 6 and 8); but precise evidence of the nature of this connexion is so far lacking. The system does not appear to be related in any way to the basal ciliary wreath of a dividing zooid, although it seems extremely likely that it may have a modified ciliary origin. The striated longitudinal filaments of the stalk may be attached to the root system[12].

The filaments of the annulus are seen in longitudinal section in Fig. 10; the axial periodicity of their striations varies widely but generally lies in the range 300–700 A.; in transverse section the filaments are tubular and usually about 1400 A. in diameter. It is tempting to suggest that these striated longitudinal filaments are the contractile structures or spasmonemes of the stalk of *Carchesium*. On the other hand, Rouiller, Fauré-Fremiet and Gauchery[12] have very recently shown that the non-contractile stalk of the *Opercularia articulata* is also threaded with similar striated filaments.

The contractile mechanism of the stalks of such peritrichs as *Carchesium*, *Zoothamnium* and *Vorticella* has generally been associated with the central canal; this feature has not been observed in the non-contractile stalks of *Opercularia* and *Epistylis*. A careful search has therefore been made in *Carchesium* for the existence of possible contractile fibrils in the central canal of the stalk. Suggestive structures have been seen from time to time; but they have not been convincing and give the impression rather of stress regions in a comparatively uniform gel.

Thus in the present stage of knowledge it is possible only to speculate about the nature of the contractile mechanism. The striated filaments

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Figs. 11–16: *Carchesium*. Figs. 17–21: *Stentor polymorphus*

(11) Photomicrograph of living animal showing the zooid and attached stalk. × 350

(12) Low-magnification view of transverse section through the ciliary system close to the gullet. Note the three rows of ciliary roots in the lower left-hand side of the micrograph. × 6,500

(13) Higher magnification of a transverse section through the triple ciliary row seen in Fig. 12 but cut closer to the root system. Each cilium is laterally joined to its neighbour in the same row by short filaments about 1500 A. long and 200 A. in diameter. × 32,000

(14) Part of a mitochondrion of *Carchesium* showing the internal microvilli. × 45,000

(15) Structure of the highly organized part of the endoplasm usually found close to the gullet of the *Carchesium*. × 45,000

(16) A section through part of a nucleus. The dense bodies are positive to the Feulgen stain. × 32,000

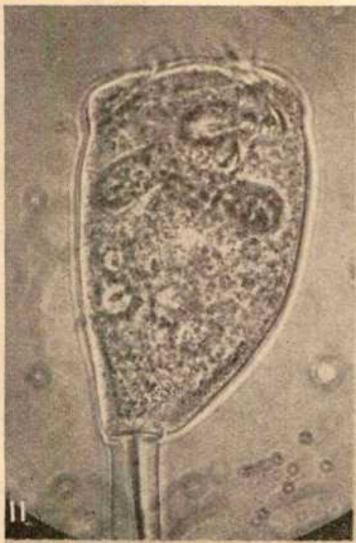
(17) Photomicrograph of living *Stentor polymorphus*. × 200

(18) Longitudinal view of the myoneme ribbons of *Stentor* which lie just beneath the pellicle (*P*). Each ribbon is about 130 A. thick. × 32,000

(19) Near transverse section of the ectoplasm showing groups of ribbon-like myonemes about 5000 A. wide; the myonemes are seen to converge into single dense structures in the lower part of the micrograph. × 32,000

(20) The dense structures of the myonemes terminate at the bases of the cilia and in this transverse section the point of attachment of the myonemes to ciliary roots can be seen. × 42,000

(21) A composite group of adoral cilia with a single extremely long (8–12μ) root system. × 32,000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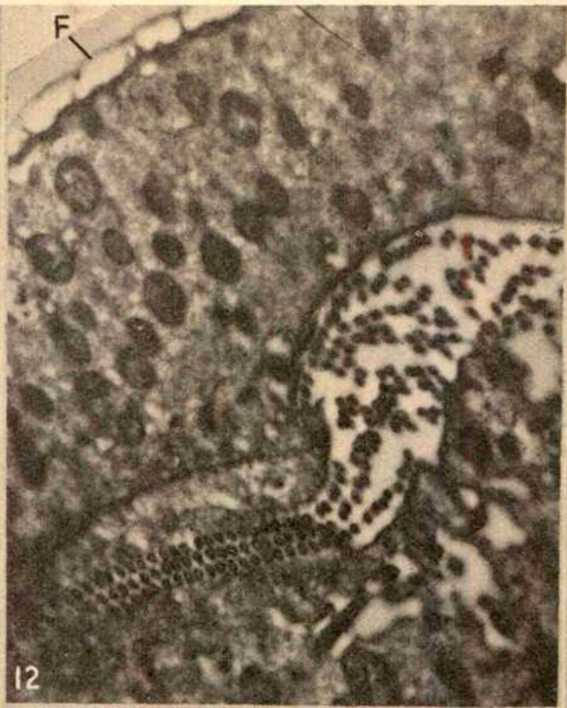

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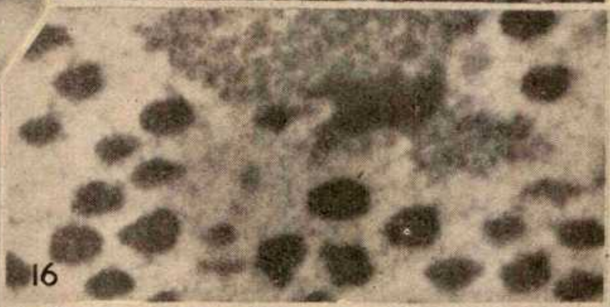
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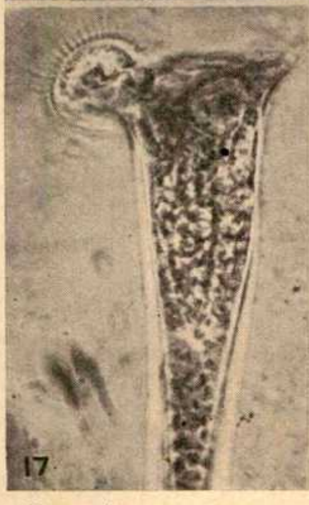
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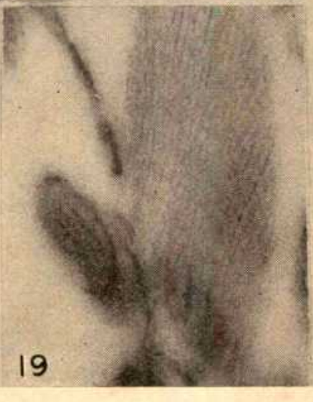
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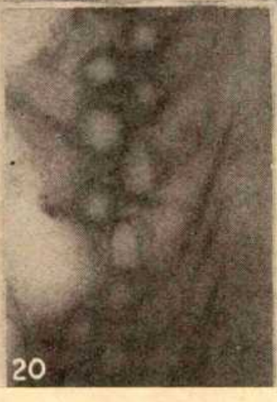
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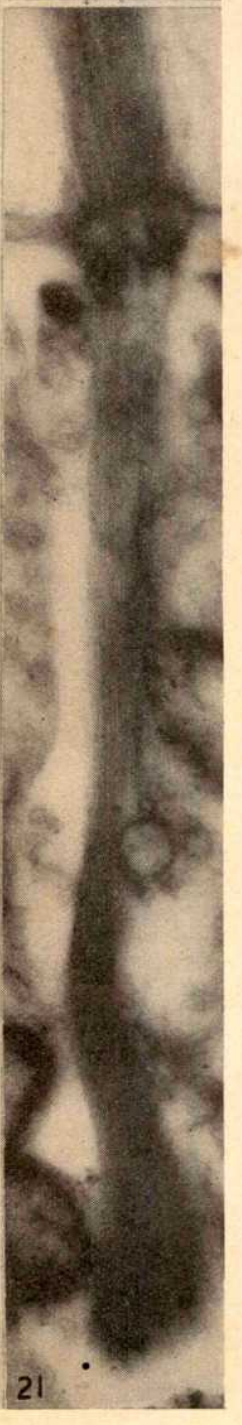
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[*See opposite*

observed in the stalks of the genera so far examined may all be potentially contractile. The function of the canal and its membrane in contractile species may be analogous to the function of the sarcoplasm and the sarcolemma in muscle fibres. Alternatively, the filaments may not themselves be contractile but may merely perform a strengthening or supporting function. Contractility may be achieved through an as yet unverified system of fibrils within the central canal, through the contractility of the canal membrane, or through the contraction of the amorphous gel surrounding the outer filaments. It is hoped that further comparative studies may help to solve this intriguing problem.

The outer boundary of the zooid of *Carchesium* is quite different from the periplast of *Stentor* or *Spirostomum* and may be seen in transverse section at *F* in Fig. 12. This boundary has a fluted appearance which may be caused by a longitudinally arranged series of tubular structures. The overall width of this system in the fixed material is about 5000 A.

Stentor polymorphus (*Müller*)

Stentor polymorphus (Fig. 17) is a heterotrich which is trumpet-shaped and, like *Spirostomum*, highly contractile. Only a limited number of the characteristic structures revealed by electron microscopy can be discussed here. In longitudinal sections of the body the most interesting structures are those probably associated with contractility; they are referred to below as myonemes, although it will be again obvious that electron micrographs do not in themselves provide evidence of contractility. Transverse views of the myonemes to be seen in Fig. 19 show them to be not unlike those shown in Fig. 5 for *Spirostomum*; the myonemes of *Stentor* are also situated asymmetrically in each ridge. Present evidence from many micrographs indicates that the myonemes are of indefinite length and in the form of closely associated narrow sheets or ribbons. The coarsely fibrillar structure of *Spirostomum* is not evident in *Stentor polymorphus*. In longitudinal section the sheets appear as a series of closely spaced parallel lines (Fig. 18). Comparison of micrographs suggests that each myoneme comprises about twenty to thirty such sheets (Fig. 18). The thickness of each sheet is about 130 A. and the width about 5000 A. A striking feature of Fig. 19 is the condensation of these sheets into thicker and denser objects; in this form these (presumably contractile) structures are apparently attached to the oral cilia (Fig. 20). In addition, the myonemes which lie in the ridges of the body appear to be attached to the locomotive cilia. This in turn suggests that the ciliary and contractile mechanisms are co-ordinated with one another, and that the contractile fibrils are identical with the kinetodesmata.

Some further remarks must be made about the adoral cilia. Fig. 21 shows that these are in small groups. From each such group an extremely long (8–12μ) root system depends into the body. This system is apparently highly organized; in longitudinal section it is filamentous; in oblique section a lattice-like arrangement is visible, the whole suggesting a regularly arranged system of interweaving sheets. Several very long bodies without clear structural characteristics have also been observed in sections of the endoplasm. It is not known what these are, although they may, of course, be another type or form of contractile structure. Fauré-Fremiet and Rouiller have very recently[13] reported a number of observations on the fine structure of *Stentor* species.

Even at this early stage, mention must be made of the nuclei observed in the three animals so far investigated. In all three the nuclei present a rather grossly granular appearance, and the large granular bodies are composite and react positively to the Feulgen stain. The whole of the space between the granules is filled with very small particles about 100 A. in diameter (Fig. 16). In view of the known difficulties of fixation of Protozoa, the possibility of nuclear artefact cannot by any means be excluded. The recent X-ray diffraction evidence for the long filamentous helical structure of nucleic acid (DNA) in certain intact nuclei makes it all the more necessary to study methods of nuclear fixation with extreme care; and it may be suggested that such methods should be based rather on the expected physical behaviour of polyelectrolytes under defined conditions than on earlier traditions of cytology.

I am indebted to the Botanical School, Cambridge, for the provision of specimens of *Spirostomum* from its collection, and to Dr. J. A. Kitching, of the University of Bristol, for the provision of *Carchesium* and *Stentor*. Dr. Kitching and Dr. Muriel Robertson have been most helpful in initiating me into this field and in the discussion of results. I wish to acknowledge valuable discussion with Prof. E. Fauré-Fremiet, who has simultaneously been investigating similar problems, and with Dr. Jean Hanson of this Laboratory.

It is a pleasure to record the invaluable help of Miss S. Fitton Jackson at all stages of the work.

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OBITUARIES

Prof. A. J. Kluyver, For.Mem.R.S.

DURING the night of May 13–14, 1956, Albert Jan Kluyver, professor of microbiology at the Technological University of Delft, Holland, suddenly died at his home of a heart attack, at the age of nearly sixty-eight years. The news of his death will deeply affect all who have known him, because they realize that it signifies the loss of a universally beloved personality and great scientist.

For almost thirty-five years he directed the work at his Institute in a manner that has made the Delft laboratory famous throughout the world as a centre of microbiological research. Under the leadership of M. W. Beijerinck from 1895 until 1921, it had already acquired an enviable reputation; and at the time of his succession to the chair, Kluyver was keenly aware of this and hence also of his great responsibilities, especially in view of the very limited training in microbiology he had received. But he possessed an excellent and highly perceptive mind, and an unrivalled capacity for work. By strenuous and undeviating application he rapidly succeeded in mastering the field, and in a few years he was ready to start developing a programme of his own that has resulted in some of the most far-reaching advances in biochemistry.

His chemical background inclined him from the start to a study of the biochemical activities of micro-organisms. Convinced by an early exhaustive review of the literature on this subject that the existing information did not reach much beyond providing a confusing picture of an almost endless variety of patterns, he began to look for unifying principles. How successful this search has been must be obvious to everyone who is conversant with the fundamental features of present-day biochemistry, which rests squarely on the concepts of the 'unity in biochemistry', and of 'comparative biochemistry' that Kluyver developed in the course of a very short time. These concepts have exerted a fertilizing influence on biochemical progress fully comparable to that which followed the introduction of the comparative anatomical and embryological approach into general biology. The foundation, inception and elaboration of these principles have been brilliantly presented by Kluyver in the series of lectures that he delivered in 1930 before the University of London, published in 1931 by the University of London Press under the title "The Chemical Activities of Micro-Organisms", and in the first two of the John M. Prather Lectures given in 1954 at Harvard University, and recently also published in book form ("The Microbe's Contribution to Biology", Harvard University Press, 1956). It is not too much to say that Kluyver's contributions have been instrumental in establishing the biochemical foundation for Darwin's concept of the monophyletic origin of living beings.

The recognition of the fundamental unity underlying the biochemical activities of extant living organisms should be attributed not only to Kluyver's philosophically inclined mind; equally significant for this development was his profound knowledge of the vast variety of microbes and his perception of their great biochemical potentialities. The possibility of using a particular bacterium, yeast or mould for the investigation of some specific biochemical process has been ably exploited in many studies carried out in his institute. During the first decade of his career as a microbiologist, Kluyver often expressed surprise and regret that this notion was not more prevalent, in spite of his ardent advocacy of its advantages in lectures and publications; he was too enthusiastic to be content with that form of mental inertia that impedes the speedy diffusion of novel ideas. But gradually his admonitions, supported by striking examples of fruitful applications, have had their effect, and developments during the past fifteen years have amply justified the high expectations he had for this type of approach, which has finally been used on a rapidly increasing scale. A consequence of this has been that general microbiology has come into its own as an important branch of biological science, and the reputation of the Delft laboratory has certainly not suffered from Beijerinck's retirement. In fact, the "Delft School" that has so strongly stimulated the rise of general microbiology is a term that properly refers to the period of Kluyver's leadership (see, for example, *Bact. Rev.*, 13, 161; 1949).

It is, however, not merely the scientific output that has made his laboratory one of the most sought-after institutions, to which microbiologists from all over the world have come to learn from the master. It has been the experience of all who have worked there that he contributed far more than his vast factual knowledge and the penetrating insight of a fine scientific mind. For they have also been exposed to a noble personality who had a deep understanding of human behaviour and a profound appreciation of the meaning of individuality. His whole demeanour was an inspiring example of a life radiating encouragement, tolerance and compassion. This attitude compelled much more than respect, and created in his institute a warm and conspicuous atmosphere of enthusiastic, generous and effective co-operation, of love for work, and of personal responsibility.

The same characteristics also made Kluyver a highly valued adviser, and his services were more and more frequently solicited on important national and international committees, where his wisdom usually led to finding genuine conciliatory solutions rather than compromises for difficult problems.

His outstanding significance as a scientist has been widely recognized. Only five years after his appointment to the Delft chair he was elected to membership in the Netherlands' Koninklijke Akademie van Wetenschappen; during 1947–52 he served as president of its section for natural sciences. He was also a member of many foreign scientific societies; his election as foreign associate of the U.S. National Academy of Sciences, as foreign honorary member of the American Academy of Arts and Sciences, and as foreign member of the Royal Society may be specifically mentioned. Microbiological societies, such as the British Society for General Microbiology and the Society of American Bacteriologists, were proud to count him among their honorary members. A recipient of several honorary degrees and other marks of distinction, he was perhaps most deeply touched when he was awarded the Copley Medal by the Royal Society.

Now his active and productive life has come to an end. Nevertheless, his contributions to science and society will continue through the work of his numerous pupils in various parts of the world. They will be aware of the great obligations which their association with A. J. Kluyver has engendered, and which implies the desire to perpetuate his way of life, to the benefit of humanity.

C. B. van Niel

Prof. J. M. D. Olmsted

James Montrose Duncan Olmsted was born of New England forbears at Lake City, Iowa, on May 21, 1886, and died at Berkeley, California, on May 26 just after his seventy-first birthday. Olmsted received an A.B. degree from Middlebury College (Vermont) in 1907 and four years later a B.A. from Oxford, where he was a Rhodes Scholar. He returned to the United States in 1911, served as professor of natural science at Shorter College, Rome, Virginia, and in 1912 became associate professor (later professor) of biology at Richmond College, also situated in Virginia, where he remained until 1915. During 1916–17 he held an Austin teaching fellowship (zoology) at Harvard, but he spent most of this period as a private in the U.S. Army, being demobilized in 1919 as a second lieutenant in the Sanitary Corps. After the War, J. J. R. Macleod made him assistant professor of physiology (later associate professor) in the University of Toronto. He remained there until 1927, when he went to the chair of physiology at the University of California, Berkeley. In 1931 he was appointed Senior Fellow to the Committee for the Relief of Belgium.

During his years as a Rhodes Scholar, Olmsted spent much of his time in France and became fluent in the language, and he also acquired an extensive knowledge of French literature and history. Being historically minded, it was natural that he should turn to historical writing in physiology; this resulted in a number of excellent papers and in three notable biographies: Claude Bernard (1939), François Magendie (1944), Charles-Edouard Brown-Séquard (1946), all three of which may be regarded as definitive, since no comparable studies of these important contributors to physiology have appeared in any language. Olmsted's scientific interests were wide and ranged from the special senses, the subject of his five excellent chapters in Macleod's "Physiology and Biochemistry of Modern Medicine" (fifth edition, 1927), to other aspects of neurophysiology and to carbohydrate metabolism, an interest inspired originally by Macleod. He published two of the pioneer papers on the action of insulin from the Toronto group—one under his own name on the effects of temperature, and another with A. C. Taylor on the action of insulin on oxygen saturation—both of which were submitted in April 1924 and appeared in the *American Journal of Physiology* for June of that year (69, 137 and 142).

Known as 'Olmie' to his closest friends, James Olmsted was by nature well poised but retiring, gentle in manner, the soul of kindness to students, and a quiet and most effective teacher. He took relaxation in music and painting, his medium in the latter having been chiefly water-colour. He was a member of the San Francisco Art Association, with which body he often exhibited. In a very real sense he was a physiologist in the best humanistic traditions of Foster and Sherrington. JOHN F. FULTON

NEWS and VIEWS

Pharmaceutics in the University of London: Prof. H. Berry

PROF. H. BERRY retires from his appointment as professor of pharmaceutics in the University of London and from his office as dean of the School of Pharmacy on September 30. He commenced his teaching career in 1919 after service in the Royal Fusiliers, Royal Engineers and Royal Garrison Artillery during the First World War. His first appointment was at the Robert Gordon's College, Aberdeen, but he soon transferred to the College of Technology, Birmingham, where he initiated and developed the Department of Pharmacy. In 1934 he joined the School of Pharmacy, University of London—then called the College of the Pharmaceutical Society—where he held a University readership in pharmaceutics and was appointed vice-dean. In 1937 he succeeded Prof. J. H. Burn as dean, and the title of professor of pharmaceutics in the University of London was conferred upon him in 1944.

It is in a large measure due to Prof. Berry's appreciation some twenty years ago of the impact of the advance of knowledge upon pharmacy that the new conception of pharmaceutics has been developed. He clearly saw that the day of empiricism was passing and that modern needs called for the application of science and engineering to the erstwhile pharmaceutical arts. Furthermore, he recognized that increasing costs and the development of the subjects of the degree to honours standards presented serious financial problems, and he succeeded in persuading the University of London and the University Grants Committee to accept the main burden of finance. This fundamental change was accompanied by a complete revision of the government of the School, which was consolidated when a Royal Charter was granted in April 1952. The new premises in Brunswick Square are, and will remain, a tribute to his work. His contributions to research have been mainly in the field of pharmaceutical microbiology, and many of the forty-five published papers will come to be regarded as classical contributions to the science. Prof. Berry, like all busy men, has found time to serve on many national and international committees, on the Pharmacopœia Commission and on the revision committee of the British Pharmaceutical Codex.

Prof. Edward Shotton

DR. EDWARD SHOTTON has been appointed to the chair of pharmaceutics at the School of Pharmacy, University of London, in succession to Prof. H. Berry. Dr. Shotton is a senior lecturer in pharmaceutics and a recognized teacher of the University. He qualified as a pharmaceutical chemist from the College of Technology, Birmingham, in 1933 and was appointed in 1934 as demonstrator in the College of the Pharmaceutical Society. In 1939 he joined the research staff of Burroughs Wellcome and Co. at Dartford, and later was appointed head of the Development Laboratories. In 1939 he obtained a London B.Sc. (Special) with first-class honours in chemistry, and in 1955 was awarded the degree of doctor of philosophy for a thesis entitled "Interfacial Tensions between Benzene and Sols of Arabic Acid and its Salts". He is a member of the University of London Board of Studies in pharmacy, and of the Boards of Examiners for the Pharmaceutical Society and the Universities of London and Manchester.

Dr. Shotton has made valuable contributions to the re-organization of the programme of training in pharmaceutics for the B.Pharm. degree along the lines envisaged by Prof. Berry, dividing the subject into three parts: general pharmaceutics, pharmaceutical microbiology and pharmaceutical engineering science. It is confidently expected that Dr. Shotton's long experience as a teacher and his experience in the pharmaceutical industry will enable him to weld these three parts into a living entity, and that he will continue to develop the scientific aspects of his subject and maintain it in correlation with the progress of pharmaceutical industry. Dr. Shotton's research interests have included problems of sterilization, the entrainment of liquid during distillation, the interfacial tension of solutions of arabic acid, the physical properties of granules which may affect adherence on compression, the stability of emulsions and emulsifying power, problems of formulation, etc.

Nuclear Power at the Imperial College, London : Prof. J. M. Kay

THE University of London has announced the appointment of Dr. J. M. Kay to the newly instituted chair of nuclear power at the Imperial College of Science and Technology. This will provide a focus in the College for study and interest in the fundamentals of nuclear power and in the engineering techniques involved. It will operate through post-graduate courses and research, and will maintain close liaison with all the Departments of Engineering and with those of Physics and Chemistry. Dr. Kay, who is thirty-five, graduated in the University of Cambridge, where he later held a University demonstratorship in chemical engineering. In 1952 he was appointed chief technical engineer of the Industrial Group of the Department of Atomic Energy at Risley, Lancashire ; since 1955 he has acted as a consultant in the field of nuclear power and in related industries.

University of Khartoum Bill

A BILL converting the University College of Khartoum into a University has been passed by both Houses of the Sudanese Parliament and submitted to the five Supreme Counsellors, in whom the presidential powers are vested, for their assent. The special relationship with the University of London, introduced in 1947, will cease, except in regard to students already registered, and the new University will award its own degrees and institute honours courses. Its budget for the next three years has been approved by the Sudanese Cabinet. When the Bill conferring university status comes into effect in the near future, Khartoum will be the first of the six overseas university colleges in special relationship with the University of London to assume university status. It will continue, however, to appoint external examiners from London as well as from other universities, and English will still be the language of instruction except in the Departments of Arabic and Sharia (Islamic) Law. The University will retain full autonomy, with executive powers vested in a council electing its own chairman and empowered to nominate a chancellor for appointment by the Supreme Council. Other Council members will include the vice-chancellor, treasurer, warden, members of the academic staff, nominees of Sudanese public and other bodies, and certain persons co-opted from the professions. The principal of the College, Prof. Michael Grant—on leave of absence from the chair of humanity in the University of Edinburgh—will become vice-chancellor. About three-quarters of the teaching staff are British, the remainder being mostly Sudanese (including three professors) and Egyptian. Appointments to twenty-four vacant posts have recently been offered. At the beginning of the new session there are expected to be 875 students in the University's seven faculties—an increase of about 170. It has developed from the former Gordon Memorial College, inaugurated in 1903 and extended to include the Higher Schools in various subjects (1945), and the Kitchener School of Medicine (1951), of which the final diploma is recognized by the Royal Colleges of Physicians and Surgeons.

Colonial Development Corporation

REPLYING for the Government in a debate on the Colonial Development Corporation in the House of Lords on June 20, Lord Lloyd, the Under-Secretary of State for the Colonies, said that there was no doubt that certain of the Corporation's activities, which the Secretary of State had been advised were *ultra vires* in relation to the Overseas Resources Development Act, 1948, were desirable from the point of view of the development of the Colonial territories. This legal opinion was disputed by the Corporation, and the Secretary of State for the Colonies accordingly proposed to introduce legislation to put the issue beyond legal doubt. A Bill had already been drafted, and the Government hoped to introduce such legislation before the end of the session. It was the Government's view that nothing should stand in the way of such legislation to validate actions which have been taken by the Corporation and are assumed to be *ultra vires*.

Atompraxis : New German Monthly Periodical on Atomic Energy

WITH the release at last year's Geneva Conference of much scientific and technical information concerning reactors and the peaceful uses of atomic energy, interest has been stimulated in many countries, and several new periodicals devoted to the study of individual branches of the subject have recently been launched. In Germany, where interest in nuclear science and engineering need no longer be purely academic, the new illustrated monthly periodical, *Atompraxis*, should prove most valuable in providing a medium for the dissemination and discussion of basic material and of new developments. The periodical is published by Verlag G. Braun, price DM 3.50 a number or DM 36 a year, and is obtainable in Britain through I. R. Maxwell and Co., Ltd., of London. The first number (pp. 40) contains articles on the use of radioactive isotopes in engineering, industry and hydraulics ; safety and protection problems arising in reactor projects ; the therapeutic use of the short-lived yttrium-90 isotope as a strong beta-emitter ; fundamentals, practice and problems of sterilization and preservation by gamma radiation ; and a review of the Geneva conference. One section is devoted to short summaries of important articles selected from other periodicals, and another to brief reports of the proceedings of conferences and society meetings. The editor, Dr. E. H. Graul, of Marburg, is assisted by Dr. K. Kamdl, of Linz, and Dr. A. Montens, of Essen.

Recent Donations to the Natural History Department of the Royal Scottish Museum, Edinburgh

DURING recent months the Natural History Department of the Royal Scottish Museum, Edinburgh, has been enriched by several important gifts. These include the large and important collection of cetacean remains formed by the late Sir William Turner, principal of the University of Edinburgh, which has been presented by the University ; the large collection of bird-skins, numbering nearly eight thousand, mainly from North Africa and Sicily, formed by the late Joseph I. S. Whitaker and containing Lord Lilford's collection, presented by Miss D. Whitaker, of Rome ; a small collection of bird-skins from Cyprus formed by Mr. G. F Wilson, of the Cyprus Secretariat, presented by Mr. H. F. Zetter on behalf of the English School, Nicosia ; the collection of bird eggs formed by the late Sir Maurice Denny and bequeathed by him to the Museum ; the collection of British Crustacea formed by the late Thomas Scott, of the former Fishery Board for Scotland, presented by Dr. C. E. Lucas, of the Scottish Home

Department; and a collection of marine shells from the New Hebrides and New Caledonia, made and presented by Mrs. Georgina Mills.

Electronic Computer for the Meteorological Office

APPROVAL has been given for the Meteorological Office to buy an electronic computer, and one has been ordered. The machine will be installed in the Napier Shaw Laboratory at the Central Forecast Office, Dunstable, and will be employed primarily on research into forecasting by numerical methods the space distribution of the height of selected isobaric surfaces which define the main features of the wind and temperature distribution up to some 10 km. above the Earth. On the basis of this information, the experienced forecaster can make the forecasts of wind and weather. Experience has shown the prediction of the future pattern of atmospheric structure to be one of the most difficult parts of forecasting; it is this part which electronic computers, by solving simplified forms of the dynamical equations of the atmosphere, can perform. Research into numerical forecasting has been conducted by the Forecast Research Division of the Meteorological Office for about eight years; but the Office has had to hire or borrow 'time' on the electronic computers belonging to others for actual trial of its methods. The computer will also be available for research into other complicated problems of meteorology, in which very heavy numerical work is involved.

Soaps as Polyelectrolytes

As a continuation of earlier seminars in the Chemistry Department of University College, London (*Nature*, 175, 670; 1955), Prof. J. J. Hermans, of the University of Leyden, gave a lecture on April 30 on polyelectrolyte properties of soaps. Debye's work (*Ann. New York Acad. Sci.*, 51, 575; 1949), dealing with the light-scattering of dilute soap solutions, was discussed, both the merits and the shortcomings of this treatment being demonstrated. Hutchinson's conclusions (*J. Colloid. Chem.*, 9, 191; 1954) neglect the fact that the system under consideration contains two solute components. Trap and Hermans (*Kon. Ned. Akad. Wet. Amsterdam*, B, 58, No. 2; 1955) carried out some accurate light-scattering measurements from which it follows that certain dilute soap solutions, in the presence of 0·05 *M* potassium chloride, contain rod-shaped micelles about 1000 A. long. This is consistent with earlier results of Debye and Anacker (*J. Phys. Coll. Chem.*, 55, 644; 1951). In the discussion, Dr. G. S. Hartley mentioned that the possibility of rod-shaped soap micelles had been considered by him in 1939, and Dr. J. H. Schulman referred to his recent work on surface tension. Other participants in the discussion directed attention to peculiar observations during the passage of soap solution through membranes. Finally, the question was discussed as to whether the intrinsic viscosity of soap solutions, determined at sufficiently low rates of shear with a Couette instrument, in conjunction with light-scattering experiments, might be helpful in estimating the size and shape of soap micelles. Such an approach would appear to be of interest, because of its success in the fields of other polyelectrolytes.

Rearing Locusts in the Laboratory

EVER since the days of T. H. Huxley, the standard introduction to the study of insect anatomy has been the dissection of the cockroach. Although large and easily obtainable, the cockroach is not an ideal insect for this purpose; the locust is better suited for teaching and for practice in elementary dissection. During recent years the locust has also proved increasingly useful for experimental work of many different kinds. The ease with which locusts can be reared in classroom or laboratory is not generally realized; it is therefore timely that the Anti-Locust Research Centre (1 Princes Gate, Kensington, London, S.W.7) should have produced a pamphlet, "Instructions for Rearing and Breeding Locusts in the Laboratory", by P. Hunter-Jones (pp. 9; 1956), which will be useful for both research workers and teachers. The easiest species to rear is the African migratory locust, *Locusta migratoria*, and most space is devoted to this; but the special requirements of the desert locust *Schistocerca gregaria*, the red locust *Nomadacris* and the Egyptian grasshopper *Anacridium* are briefly outlined. Copies of the pamphlet are obtainable on request from the Centre, which is often prepared to assist by supplying day-old hoppers for starting locust stocks.

Griseofulvin and Pathogenic Fungi

R. S. C. AYTOUN has contributed some interesting information on the effects of griseofulvin on actively growing hyphae of phytopathogenic species of *Botrytis*, *in vitro* and *in vivo* (*Ann. Bot.*, N.S., 20, 78, 297; 1956). *In vitro*, the reactions noted were slowing of the growth-rate, stimulation of branching, abnormal appearance of hyphal protoplasm, and loss of rigidity of the hyphal membrane in the region of the tip. The antibiotic is not translocated within the mycelium. *In vivo*, *Botrytis tulipae* was incapable of penetrating cell membranes in the stem of tulips watered with griseofulvin. The antibiotic was shown to delay or to prohibit the penetration of onion epithelium by *B. allii*, depending on concentration. The characteristic curling and stunting of hyphae caused by griseofulvin have both been observed to occur in plant cells.

Forestry Commission: Report for 1953–54

THE annual report of the Forestry Commission for the year ending March 1954 (pp. 177+8 plates. London: H.M.S.O., 1955; 6*s*. net) contains an introduction by Mr. James Macdonald, director of research and education, outlining the three sections in which forestry research is considered in the report. The first section deals with brief summaries of the main trend of work proceeding in the Research Branch of the Commission; the second deals with projects under investigation by universities and other institutions; and the third, a new section, comprises a series of papers by members of the research staff on subjects which have yielded sufficient information to be made public in this form, although often the importance of the inquiry must be considered as provisional. This is a most useful departure; so often during a piece of research work being undertaken a point is reached at which it would be useful for both the research worker and others to know exactly how far the investigation has gone, and yet this cannot be made available in a research report since the knowledge available is not of sufficient detail. A list is added to the report of the more important experimental areas in Great Britain, classified under subjects. As the report shows, contact has been maintained with universities and institutions engaged on research in forestry and related subjects, such as the Rothamsted Experimental Station and the Macaulay Institute for Soil Research. The Nature Conservancy, which is concerned with woodlands, has also been of great assistance. In order to secure liaison in fields of common interest, a small informal committee of representatives of the Nature Conservancy and the Forestry Commission has been established to discuss matters of research and investigation. The Research Branch of the Commission also takes an active part in the affairs of the International Union of Forest Research Organizations.

Rhizomorph Behaviour in *Armillaria*

S. D. GARRETT has investigated some of the factors which determine the vigour of the infection of potato tubers by the rhizomorphs of *Armillaria mellea* (*Ann. Bot.*, N.S., **20**, 78, 194; 1956). The growth of rhizomorphs of *Armillaria mellea* from small woody inocula through tubes of soil was characterized by a progressive decline in weekly growth increments. The initial growth-rate was related to the size of the inoculum food-base; the subsequent decline is attributed partly to depletion of nutrient reserves in the inoculum through fungal respiration and growth, and partly to competition for nutrients between the main growing apex of the rhizomorph and its subordinate branch apices. The vigour of infection of potato tubers by rhizomorphs from such small woody inocula increased with size of the inoculum, and decreased with increasing distance between inoculum and tuber. When the inoculum potential of *A. mellea* was low, the fungus was generally overtaken in the tuber tissues by soft-rotting bacteria, which prevented its further advance.

Zoological Nomenclature

As from November 9, 1956, the International Commission on Zoological Nomenclature will start to vote on the following cases involving the possible use of its plenary powers for the purposes specified against each entry. Full details have already been published (*Bull. Zool. Nom.*, 11, Pt. 11, 1956). (1) *Turbinella* Lamarck, 1799 (Cl. Pelecypoda), validation; (2) *Terrakea* Booker (F. W.), 1930, designation of type species for, and *brachythaerus* Morris, 1845 (*Productus*), validation of (Cl. Brachiopoda); (3) *Unio* Philipsson, 1788 (Cl. Pelecypoda), designation of type species for; (4) *Elaphe* Fitzinger, 1833 (Cl. Reptilia), validation; (5) *daea* Dampf, 1910 (*Palaeopsylla*) (Cl. Insecta), determination; (6) *Torquesia* Douvillé, 1929 (Cl. Gastropoda), designation of type species for; (7) Horniman (R. B.), January 1940, "Preliminary Descriptions of some new Birds", suppression. Comments should be sent as soon as possible to the secretary to the Commission, Mr. Francis Hemming, 28 Park Village East, Regent's Park, London, N.W.1.

Equal-Loudness Contours for Pure Tones

THE equal-loudness contours for pure tones heard binaurally have been redetermined at the Acoustics Section of the National Physical Laboratory, Teddington, by D. W. Robinson and R. S. Dadson (*Brit. J. App. Phys.*, **7**, 166; May 1956). Loudness is one of the few concepts which can be correlated with several aspects of the complicated subjective reaction to a sound and therefore provides a starting-point for measurement in such work. The relation between the loudness of a sound and its root-mean-square pressure and frequency for various waveforms and for binaural and monaural hearing is of interest not only in the understanding of the hearing mechanism and its reaction to pure and complex sounds, but also in the design of frequency-weighting circuits for such instruments as the 'sound-level meter' and in the calculation of loudness-levels from the spectrum analysis of sounds. Discrepancies exist between the previously published pure tone equal-loudness contours for free-field conditions (Fletcher, H., and Munson, W. A., *J. Acous. Soc. Amer.*, 5, 82 (1933), and Churcher, B. G., and King, A. J., *J. Inst. Elec. Eng.*, 81, 57 (1937)), and it was not possible to derive an acceptable standard. The new work reported by the National Physical Laboratory, which covers increased ranges of frequency and sound pressure and the effect of age and sex of otologically normal subjects, is a welcome redetermination. Although these results differ by up to 10 phons from the previous determinations, they are more regular with sound pressure and frequency, and the errors are estimated to be only about ±1 phon over the greater part of the work.

Royal Commission for the Exhibition of 1851: Awards for 1955

THE Royal Commission for the Exhibition of 1851 has awarded the following senior studentships for 1956 for research at the universities indicated: C. M. P. Johnson (Cambridge), nuclear physics at Cambridge; C. B. Reese (Cambridge), organic chemistry at Cambridge; Dr. M. W. Windsor (Cambridge), physical chemistry at Sheffield; A. J. Smith (Wales), geology at the University College of Wales, Aberystwyth. The Commission has also awarded the following overseas scholarships for 1956: Canada: C. B. M. Bailey (British Columbia), animal growth; C. Crowe (Western Ontario), physics at Cambridge. Australia: Dr. (Miss) B. I. H. Hall (Adelaide), physics at University College, London; A. L. Hunt (Adelaide), biochemistry at Oxford; S. P. H. Mandel (Sydney), mathematics at Cambridge; D. A. Levy (Sydney), theoretical chemistry at Cambridge. New Zealand: G. G. Pritchard (New Zealand), botany at Cambridge; W. D. Twose (New Zealand), physics at Cambridge. India: Dr. J. Jacob (Annamalai), zoology at Queen's College, Dundee, University of St. Andrews. Pakistan: F. Aziz (Lahore), radiochemistry at Cambridge.

University of Nottingham: Gifts

THE following gifts have been received by the University of Nottingham: £2,000 a year for five years from Imperial Chemical Industries, Ltd., towards the cost of building up a school of colloid science in the Physical Chemistry Laboratory; a research scholarship of £600 a year from W. Canning and Co., Ltd., of Birmingham, to be held in the Department of Metallurgy, for research in the field of metal finishing; £300 a year for three years from the Electro-Chemical Engineering Co., Ltd., of Woking, to the Department of Metallurgy towards the cost of a scholarship for research in metal finishing.

Physics of Nuclear Reactors

A CONFERENCE on "The Physics of Nuclear Reactors" arranged by the Institute of Physics was held in the Institution of Electrical Engineers during July 3–6. The programme opened with an address by Sir John Cockcroft, president of the Institute, on "Scientific Problems in the Development of Nuclear

Power". This was followed by lectures on the physics of advanced reactors, the zero-energy fast breeder reactor, effects of irradiation on the physical properties of solids, shielding, control, instrumentation, chemistry and metallurgy in a nuclear energy project, and the uses of reactors; Prof. R. E. Peierls gave an evening discourse on "Recent Developments in Nuclear Theory". Speakers came from Britain, the United States and Canada. An informal dinner was arranged for overseas visitors, who were also entertained at a Government reception. During the meeting there was an exhibition of books and of apparatus. The lectures, with the exception of that by Prof. Peierls, will be published as a supplement to the *British Journal of Applied Physics*; the programme of the conference includes full abstracts of the lectures.

Commonwealth–American Universities Conference

THE Commonwealth–American Universities Conference, at which university presidents from the United States representing the Association of American Universities will participate with vice-chancellors of United Kingdom and Commonwealth Universities, will be held this year in London and Birmingham during July 10–17 under the auspices of the Association of Universities of the British Commonwealth. The sessions in London will be opened by a reception on the evening of July 10 in the Senate House of the University of London at which H.M. the Queen Mother will be present as Chancellor of the University. Discussions will be held in London on the general question of "University Expansion in relation to Population Trends", with particular emphasis on the effect of the approaching 'bulge' in the university age-group in the United States and in various countries of the Commonwealth. The members of the Conference will visit Exeter on July 13 for the ceremony of installation of Mary, Duchess of Devonshire, as first chancellor of the new University. On the following day members will meet in Birmingham, where discussions will be held on a series of problems common to universities in Britain and the United States, such as the adequacy of school preparation for college and university students, the need for an expanding curriculum to meet new world needs, and the relationships of university administration to students, faculties and governing boards.

Royal Meteorological Society: Officers for 1956–7

THE following have been elected officers of the Royal Meteorological Society for the year 1956–57: *President*, Dr. R. C. Sutcliffe; *Vice-Presidents*, Prof. G. Manley, Sir Graham Sutton, R. G. Veryard and Dr. T. W. Wormell; *Vice-President for Canada*, Dr. D. P. McIntyre; *Vice-President for Scotland*, J. R. Atkinson; *Treasurer*, Dr. J. S. Farquharson; *Secretaries*, P. J. Meade, Dr. H. L. Penman, Dr. A. G. Forsdyke (*Librarian*) and Dr. G. D. Robinson (*Editor*).

Announcements

THE gold Albert Medal of the Royal Society of Arts has been awarded for 1956 to Sir Henry Dale, "for eminent service to science, particularly physiology".

AT the annual general meeting of the Marine Biological Association of the United Kingdom, held on June 27, Mr. E. H. E. Havelock, Dr. A. G. Huntsman and Dr. A. C. Redfield were elected honorary members of the Association.

THE Council of the Royal Society has awarded the Tropical Research Fellowship (Medical Sciences) to Dr. D. G. Jamison, of Corpus Christi College, Oxford, for his work on the histopathology of leprosy with particular reference to the relationship of the mycobacteria to cutaneous nerve fibres.

DAME CAROLINE HASLETT is resigning from the post of director of the Electrical Association for Women, which she has held since its inception thirty-two years ago.

DR. GERARD KLEIN, lecturer in theoretical physics in the Royal Holloway College, London, has been appointed senior lecturer in mathematics in the Royal Technical College, Glasgow.

THE following have been appointed to lectureships in The Queen's University of Belfast: L. J. Symons (geography), Dr. F. A. Lewis (inorganic chemistry) and R. Taggart (mechanical engineering).

THE following have been appointed to lectureships in the University of Birmingham: Dr. J. G. Valatin (mathematical physics), Dr. G. A. Doran and Dr. P. M. Rolph (physics), Dr. L. W. Poel (botany), Dr. G. T. Wright (electrical engineering) and Dr. J. J. Pick (industrial metallurgy).

THE British Iron and Steel Research Association will hold two 'open days' at its Sheffield Laboratories on September 6 and 7, for representatives of member firms.

THE United Nations Food and Agriculture Organization is holding an international meeting of inland fisheries workers in Helsinki during July 24–26, at which inland fisheries in relation to world food economy will be reviewed. The European member nations of the Organization will be sending representatives and, at the same time, biologists at the Thirteenth International Limnological Congress, which is being held in Helsinki during July 27–August 7, have also been invited to attend as observers.

A RESIDENTIAL course on rural studies, organized by the Institute of Rural Life at Home and Overseas, will be held at the Essex Institute of Agriculture, Writtle, near Chelmsford, Essex, during September 2–15. The course will be of a general nature, but tropical conditions will be included and the course should appeal to workers and students from overseas. The fee is £14. Application should be made not later than July 27 to the Secretary of the Institute, 59 Bryanston Street, Marble Arch, London, W.1, from whom further information can be obtained.

A SYMPOSIUM on "Recent Studies in Yeast and their Significance for Industry", arranged jointly by the Dublin Section and the Food and Microbiology Groups of the Society of Chemical Industry, will be held in Dublin at the Rupert Guinness Hall during September 17–18 (and possibly 19). The Biochemical Society, which is meeting in Dublin during September 14–16, is arranging sightseeing tours for the afternoon of September 15 and for the whole of the succeeding day; members attending the symposium can join these tours. Further information can be obtained from the honorary secretary of the Dublin Section of the Society of Chemical Industry, Dr. A. K. Mills, Arthur Guinness Son and Co. (Dublin), Ltd., Chemists' Laboratories, St. James's Gate, Dublin.

THE H. H. WILLS PHYSICAL LABORATORY

UNIVERSITY OF BRISTOL

DURING March 26–28 the Physics Department of the University of Bristol entertained several hundred guests with the object of showing both the teaching and the research work of the Laboratory to them. The guests included the Lord Mayor and Lady Mayoress of Bristol, professors of physics from other universities, industrial and government scientists, schoolmasters, and members of the academic staff of other departments of the University.

Apart from the numerous scientific conferences held in Bristol, including the British Association which met there last year, the Laboratory has not been on display in this way since its opening in 1927. The L-shaped building came into existence through the generosity of Henry Herbert Wills, and was designed by Sir George Oatley with the advice of Prof. A. M. Tyndall. Built on the hill where the old Royal Fort once stood, its extremely solid structure and embattled top well preserve the tradition of its name. It was originally intended to be only the first instalment of a group of University buildings, and with this in mind the north-western end was left unfaced, as it remains to-day. Grave doubts were, however, expressed at the time as to the wisdom of constructing so large a building with its two large lecture theatres, several smaller lecture rooms, library, workshops and research rooms, and all with ample provision for expansion. Three years after its opening the teaching and research staff numbered only eighteen, and many of the rooms were unoccupied. To-day, the staff number no less than seventy, and space is at a premium. Many research rooms have had galleries put in them (easily done because of the very generous ceiling heights) and special huts have been built to house both working low-temperature equipment and the mass of discarded apparatus characteristic of physics laboratories, which the occupants are not very likely to use again, but cannot bear to dispose of.

Throughout its existence, the Laboratory has been notable for the wide range of interest of its schools of research, and important contributions have been made in such different fields as magnetism, the electrical conductivity of gases, including accurate measurements of the mobility of gaseous ions, the spectroscopy of metals, the emission of soft X-rays, X-ray studies of long-chain hydrocarbons, and low temperatures. The result has been the development of a correspondingly wide range of experimental techniques and resources, and the work in progress to-day shows no less diversity. Most of the current research work, except that in theoretical physics, was displayed either by demonstrations of the working of the actual apparatus or by photographs and diagrams.

In optics, the interest is centred on high-aperture systems and interferometers for testing. A reflexion microscope of N.A. 0·95 (dry) and a meniscus Schmidt meteor camera of focal ratio *f*./0·78 and field diameter 56° were shown, both these instruments having already attracted considerable interest outside the Laboratory. The Laboratory also houses a commercial electron microscope which is available to all departments of the University, and is occasionally used also for work on problems encountered by local industries.

The early work of the Laboratory on low temperatures has already been mentioned, and the group engaged on this study is now one of the largest in the Department. Liquid oxygen and helium are purchased in bulk, and the Laboratory also has its own apparatus for producing liquid hydrogen and helium. The main subjects at present studied are paramagnetism of crystals at low temperatures, the superconductivity and thermodynamic properties of metals, the mechanical properties of solid argon, and properties of the liquid helium film.

The Department is well known for its work, both theoretical and experimental, on the solid state, and this interest was manifested in the exhibits of several different groups. Work on the growth of both metallic and non-metallic crystals was shown, and also on the structure of macromolecular substances such as polythene and nylon. Techniques for handling single crystals of silver halides have also resulted in the elucidation of many problems connected with photographic materials, and have also enabled the dislocation structure of a solid to be studied in a particularly direct manner.

The crystalline structure of thin evaporated metal films has been studied by X-ray techniques, and the effect of conditions of deposition and adsorbed gases on the electrical properties of these films has also been the subject of considerable experimental investigation. The mechanical properties of metals, particularly the mechanism of the development of fatigue cracks, and the investigation of the creep of strained single crystals, constitute the work of another group, the aim in this case being to produce results capable of theoretical interpretation rather than of immediate technical use.

Techniques for the electronic measurement of very small strains were also in evidence in work on ferroelectrics, in which hysteresis loops not only of polarization against field but also of mechanical strain against either could be displayed oscillographically. Attempts are also being made to produce an 'artificial' dielectric material of extremely high permittivity. In all these solid-state studies the Laboratory is fortunate in being well equipped with X-ray diffraction apparatus, including single-crystal and powder cameras, a stabilized X-ray unit with an output constant to better than 1 per cent, and a Geiger-counter diffractometer for X-ray fluoroscopy.

A comparatively recently developed interest in the Department is the study of mineral separation, which centres mainly on the flow properties of fine sands or slimes suspended in water. Apparatus for bulk separation has been devised, and also an analytical tool, the 'mechanized vanning shovel', which reproduces some of the movements used by Cornish miners in assessing the separable mineral content of ores.

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The largest research group, and probably the best known, is devoted to the study of cosmic rays and is housed at the top of the building. The two most important techniques demonstrated were the production and flying of high-altitude balloons, and the processing and examination of nuclear emulsions, both of which have been greatly advanced as a result of work by the Bristol group. The importance of this work both in the study of the nature of cosmic-ray primaries, and in the investigation of nuclear events at energies higher than can be obtained even with the largest accelerators, is too well known to require elaboration here.

The more routine activities of the Laboratory, such as in the teaching laboratories, workshop and glass shop, were on view and excited considerable interest, and in these matters the Department can congratulate itself on being very well staffed and equipped. As a further diversion to visitors, films were exhibited periodically in the large lecture theatre. These films were made by members of the Laboratory and illustrated work on cosmic rays, glass blowing and crystal growth.

For its growth from small beginnings to its present state, the Laboratory owes an enormous debt of gratitude to Prof. A. M. Tyndall, first holder of the Henry Overton Wills chair of physics (1919–48). In this office he was succeeded by Prof. N. F. Mott (1948–54) and then by Prof. M. H. L. Pryce (1954–). The second professorship, the Melville Wills chair, has been held by the late Sir J. E. Lennard-Jones (1927–32) and Prof. N. F. Mott (1933–48), and the present incumbent is Prof. C. F. Powell (1948–). From time to time a third professor of physics has been appointed—Prof. S. H. Piper (1951–53) and Prof. F. C. Frank (1954–). A recent addition to the distinctions of the academic staff was the election this year of Dr. J. W. Mitchell to the fellowship of the Royal Society.

Comments and letters received from the visitors by the organizers seemed to confirm that the open days, although involving a considerable amount of work, have been successful in bringing the activities of the Laboratory to the attention of its guests in an interesting and agreeable way. D. F. GIBBS

CARNEGIE INSTITUTION OF WASHINGTON

REPORT FOR 1954–55

YEARBOOK No. 54 of the Carnegie Institution of Washington* covers the year July 1, 1954–June 30, 1955, including Dr. Vannevar Bush's final report as president and the reports of departmental activities and co-operative studies, with a bibliography of publications of the Institution and of the president in addition to those appended to the departmental reports. At the Mount Wilson and Palomar Observatories two major studies of the Andromeda nebula were completed during the year: an intensive study of the high-luminosity variables, including the cepheid, the long-period, the semi-regular and the irregular types; and a systematic search for novæ during two observing seasons, in which the detailed light curves of thirty novæ were measured and, for the first time, definitive statistical information was obtained on the absolute luminosities at maximum, types of light curve and the frequency of these novæ. A third major project was the establishment of a precise, photoelectrically determined magnitude-scale, extending down to the faintest observable stars in several areas distributed in such a way that at least one of the areas is always visible in the night sky for comparison. The project has now provided standards for use throughout the range of the Hale telescope. The programme concerned with setting up photoelectric standard-magnitude sequences has also been completed, and the study of the internal motions in planetary nebulæ continued, as well as spectroscopic observations of the Cassiopeia radio source and a spectroscopic observation of the colliding pair *NGC* 1275 in the Perseus cluster of galaxies. A new grating spectrograph was put into service at the Cassegrain focus of the 60-in. telescope, and a new stellar template magnetometer is being developed to increase the efficiency of observations of stellar magnetic fields, depending on the use of a template of the spectrum of the star to be investigated.

The Joint Committee on Image Tubes for Telescopes is attempting to develop a promising type of image converter for mass production, in which a very thin film is stretched across the end where the phosphorescent screen would otherwise be located; this film permits the electronic image to be formed astride the tube while the high-quality vacuum is preserved. An attempt is also being made to develop a special type of thin-film converter capable of withstanding full atmospheric pressure, thus avoiding the complications of the vacuum charger required in the first converter.

The Department of Terrestrial Magnetism, using the 'Mills cross' array of antennæ, has made the interesting and unexpected discovery of a variable 22-Mc./s. source of small dimensions in the constellation Taurus. A comprehensive series of measurements on the distribution of hydrogen clouds in several sectors of our galaxy indicates that our solar system is near the inner edge of a local arm, and that this arm is not circular about the centre of the galaxy but is strongly inclined. Observations have also been made on the intensity distribution of the emission from the 'quiet' Sun and on the low-frequency radio emission from several of the most intense sources in the sky, with the view of differentiating between thermal and other possible mechanisms producing these radiations. In a seismic expedition to the Rocky Mountains in the summer of 1954, unequivocal evidence was obtained that the sharp boundary between the crust and mantle of the Earth lies at the same depth under the Colorado Plateau in Arizona and New Mexico as under the coastal plain in Maryland and Virginia, and later in the summer the same result was obtained under the mountains of Utah. Encouraging progress was made in determining the extent to which the history of the changes in the Earth's magnetic field can be traced in geological time, and an expedition to Arizona and New Mexico showed that the rocks of the south-west of the United States give about the same location for the magnetic pole in Permian time as is indicated by the rocks of Great Britain. In the programme of isotope dating for ancient minerals, age studies of minerals in the Quartz Creek (Colorado) area have demonstrated a pattern of consistency among the rubidium–strontium ages and also among the potassium–argon ages of the micas from this region. Studies have also been made of toroidal magnetic fields in the ionosphere, of the daytime enhancement of the initial phase of magnetic storms at Huancayo, and the investigation of nuclear energy-levels by the method of Coulomb excitation with alpha-particles was continued.

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* Carnegie Institution of Washington. Year Book No 54 (July 1, 1954–June 30, 1955), with Administrative Reports through December 9, 1955. Pp. xxxix+9+311+3 plates. (Washington, D.C.: Carnegie Institution of Washington, 1956.) Cloth, 1.50 dollars; paper, 1 dollar.

A major shift in biophysical work was made from the study of the synthesis by cells of small units like amino-acids to the organization of these units into the biologically active molecules of protein and nucleic acid. The kinetics of protein formation in bacteria and yeast have been studied and the specific adsorption of amino-acids as a first step in their incorporation into proteins observed, while experiments have also been made on the role of peptides in protein synthesis.

The Geophysical Laboratory has completed a broad study of the system copper–iron–sulphur and has discovered a strong dependence of (solid state) inversion temperatures on very slight excesses of silver or tellurium in the compounds Ag_2Te and Ag_5Te_3. Extensive X-ray studies of single crystals of digenite have been completed, and preliminary experiments made on methods of dissolving sulphide ores *in situ*. In the hydrothermal synthesis of albite, small but significant variations in lattice parameters have been discovered as a function of temperature of crystallization alone. In statistical petrography the emphasis has been primarily on the theory and technique of modal analysis, while a systematic investigation has been made of the effect of cæsium and thallium on the system $K_2O.Al_2O_3.6SiO_2—H_2O$, using special radioactive tracer techniques with the view of obtaining the fundamental data needed on the distribution of trace elements. Much attention has been given to all three amphibole groups as well as to feldspars and micas.

The Department of Plant Biology has further developed a new way of measuring the absorption of light of different colours by the functional pigments in living plant material and in solutions of the extracted pigments, and the method has already been utilized in studying the photochemistry of chlorophyll. Progress is being made in the isolation of the protochlorophyll holochrome in increasingly smaller units. Experiments on the transformation of protochlorophyll to chlorophyll have continued in aqueous and glycerol extracts of various etiolated plants, all the extracts so far prepared showing particles in a dark-field microscope. Studies of the rate of re-formation of protochlorophyll in leaves illuminated and then returned to darkness have shown that the rate of re-formation accounts for the rate of formation of chlorophyll in illuminated plants for the first two hours. Investigations in etiolated barley seedlings of the precursors of protochlorophyll which contain magnesium have indicated that the extra magnesium accumulated in illuminated plants is contained in an acidic fraction and that from one-third to two-thirds of the total protochlorophyll in barley is of the phytol-free form. The range-grass programme has continued. and the chromosome numbers of all but one of the hybrid *Poa* lines used in the regional tests are now known. The study of the biosystematic structure of the aquatic plant family Lemnaceae has continued, and experiments in general taxonomy have been designed to elucidate the complex genetic and environmental relations between and within wild species of plants. A new planting of the second generation of yarrow from coastal and alpine environments is providing information about the hereditary constitution of the parental races. Studies on the rate of growth under laboratory conditions of different species and strains of the miniature *Lemna* have indicated little difference in the optimum temperature for growth between strains of the same species from different climatic regions, the differences being between species rather than between races of the same species. This lack of distinct racial differences within the species is strikingly at variance with the findings in species of other plants grown in soil.

The report of the Department of Embryology includes a brief survey of the work of the Department during 1913–55 whereby the description of the human embryo has now been completed by the definitive description of those representing the first four or five days of development. A comprehensive investigation of the development of the human diaphragm has clarified the anatomical defects underlying diaphragmatic hernia. Studies continued of the uterine lining, especially of its blood vessels, in relation to the phenomena of menstruation, and a preliminary account has been published of work on the passage of the sugars across the monkey placenta, using a method which promises to be very useful in studying fœtal physiology.

In the Department of Genetics electron-microscope studies of third-instar salivary-gland cells of *Drosophila* have afforded evidence of the polytone nature of the chromosomes, the subsidiary strands having a diameter of about 500 A. and being arranged in a hierarchical assembly of intertwined pairs of pairs. Investigations of the action of cytochrome *c* in reducing basophilia of tissue sections indicate that basicity *per se* is not the determining factor since lysozyme, another basic protein, does not reduce basophilia of tissue sections, whereas hæmoglobin, another hæmoprotein, does. All three proteins increase staining with acidic dyes. Although a considerable degree of purification of calf-spleen deoxyribonuclease has been effected, crystallization has not yet been achieved, and the marked changes in the mode of action with purification suggest that several enzymes capable of degrading deoxyribonucleic acid may be present.

Chemical studies of bacteriophage have provided further evidence of the genetic role of viral nucleic acid. The substance that initiates viral infection is at least 95 per cent pure nucleic acid, and this increases in infected cells before viral-precursor protein begins to form. Substances such as chloramphenicol that inhibit protein synthesis do not interfere with the formation of nucleic acid, and nucleic acid 'purified' in this way behaves like normal virus precursor. Accordingly, nucleic acid is not synthesized inside a viral membrane and can function without associated protein. New evidence has been obtained that, in the transduction of *Salmonella* clones, incorporation of the genetic specificity of the donor strain into the genotype of the recipient usually occurs in the single daughter cells within one or two divisions after infection. Genetical analysis of short regions of the chromosome complex of *Salmonella typhimurium* have shown that all the known tryptophan, cystine and methionine loci are closely linked. A high concentration of amino-acids during the critical period corresponding to the first third of the first division after irradiation appears to be a major requirement for the production of induced mutants, and evidence has been obtained in the transformation of genetic markers in *Salmonella* that mutations are frequently induced during the preparation of the donor material. Other work on controlled mutation in maize and the organization of cellular materials is reported in some detail.

ITALIAN SOCIETY FOR GEOPHYSICS AND METEOROLOGY

FOURTH GENERAL ASSEMBLY

THE fourth General Assembly of the Società Italiana di Geofisica e Meteorologia (Genova) was held at the University of Genoa during April 5–8. The convention was opened by the president, Prof. M. Bossolasco, who welcomed the delegates to the Assembly. A large number of papers ranging over a wide number of topics was presented.

Prof. A. Defant (Innsbruck) delivered the opening lecture, on "Recent Developments in the Theory of Ocean Currents". Referring to the classical theory due to V. Ekman for a homogeneous ocean, he gave an account of the recent contribution due to H. Stommel and W. Munk, pointing out the objections directed to it and its limitation. He then discussed the theory of ocean currents due to G. Neumann, which uses as surface of reference that deduced for the Atlantic from the observations of the expedition *Meteor*. Prof. Defant showed that this new theory gives a possible explanation of the intensification of ocean currents on their west coasts. Reference was also made to some work by Charney on the formation of narrow currents on these coasts.

Prof. Perri (Turin) spoke on "The Slow Surface Wave and its Seismological Significance in a Limiting Case". This referred to a slow surface which was discovered by the author, the theory of which he developed in 1954. Prof. Perri recalled its main features and attributed the fact that the velocity of the wave is intermediate between that of the Rayleigh waves and Love waves to an abnormal dispersion.

Prof. A. Giao (Paris) presented a paper on "The Behaviour of the Advection Vector of the Perturbations of the Vertical Vorticity in the Free Atmosphere". After discussing the definition of the advection vector, Prof. Giao went on to consider applications to the atmosphere. By means of the observed temperature fields and wind between the equator and the poles (from sea-level to the 20-km. level) one can deduce the mean field of the advection vector of the perturbations and compare it with the mean wind in the field. This leads to the explanation of many empirical facts and gives the limits of the region of 'long waves'. The second part of the paper dealt with the derivation of a generalized equation for the vertical vorticity by a simple transformation of the equation of pressure variation in Prof. Giao's theory of perturbation.

"The Oscillations of the Natural Radioactivity of the Air in the Northern Alps, and Their Significance" was the title of a paper by Dr. R. Reiter (Munich). Dr. Reiter has found from many measurements of the air of the Zugspitze (2,600 m. above sea-level) that the greatest radioactivity is associated with southerly currents. This is considered to point to a dependence on the nature of the geological formations traversed by these winds, the formations containing granite and orthogneiss. Dr. Reiter also discussed the variations of the radioactivity of the air as a function of other meteorological factors.

A paper by Dr. C. Mennella (Naples) dealt with "The Reliability of the Presumed Normal Values of the Rainfall in Italy". Considering various series of rainfall measurements for the past hundred years or so, Dr. Mennella attempted to appraise the reliability of the mean values relative to quinquennial, decennial and longer periods. This enables one to estimate the degree of variability and instability and to deduce to what extent they are inadequate to represent the specific characteristics of the phenomena.

Dr. W. Hesse (Leipzig) spoke on "The Hydrogenic Balance of Plants" and on "The Results of Measurements made on Various Plants as Functions of Meteorological Factors". Dr. Hesse pointed out that the water system of cultivated plants is very complicated and is influenced by various external factors; on the meteorological side, several methods have been evolved to assess evaporation and transpiration of plants. In the vegetation period 1950, 1953, 1954 and 1955, Dr. Hesse used the newly developed Klein lysimeter in Leipzig, and from 1954 onwards a transpirograph and a measuring apparatus consisting of six different Klein lysimeters with which it was possible to assess the water content of plants.

Prof. O. Burkard (Graz) proposed a formula for the moving ionization of the F_2 layer in Europe. He showed that the squares of the critical frequencies $(f_0F_2)^2$ measured at European stations in the morning may be represented by the empirical formula:

$$(f_0F_2)^2 = K\left(\frac{\cos\chi}{\cos^2\varphi}\right)^x \cos^2\varphi$$

where χ is the zenith angle of the Sun, φ the geographical latitude of the station, x depends on locality, K is a constant depending on the locality and probably on the intensity of the solar ionizing radiation.

The communications from Prof. P. G. Piccardi and Dr. R. Cini (Florence) were presented by Prof. Bossolasco. These related to "The Action of an Electromagnetic Field of Frequency 10 kHz. on a Chemical Test" and "The Problem of the Influence of Atmospherics". Experiments showed that Prof. Piccardi's chemical test is influenced by an electromagnetic field of frequency 10 kHz. (kc./s.) and that it is probable that the variations observed during this test are due to variation in solar electromagnetic radiation as well as atmospherics due to lightning discharges.

Prof. V. Ferraro (London) gave an account of the present state of theories of magnetic storms. He pointed out that an atmospheric-current theory such as has been proposed by Vestine is unlikely to prove correct since on this theory it seems difficult to account for such distinctive phenomena as sudden commencements, auroral zones and other features which point rather to an influx of solar corpuscular streams in the upper atmosphere as the cause of these phenomena.

Dr. K. Rawer (Neuershausen b. Freiburg) gave an introductory talk to the general discussion on the International Geophysical Year. Dr. Rawer discussed in particular preparations made for the study of ionospheric recordings, absorption, 'winds', back scatter and whistlers. The discussion that followed related particularly to questions of interest to the Italian participants of the International Geophysical Year.

In a paper on "The Harmonic and Anharmonic Constants for the Tides at Palermo, Milazzo, Lipari and Cagliari", Dr. S. Polli (Trieste) said these are determined for periods of 26 months in the case of Palermo, and shorter periods for the other stations, by using the British Admiralty method developed by Doodson. The monthly and seasonal variations in the tides are determined separately, so as to examine any seasonal variations of the constants. A second paper dealt with wind-bores in the ports of Trieste and Venice; it appears that this wind-bore traverses the gulf of Venice without change of direction, lateral expansion and with little loss of speed.

Prof. H. Berg (Cologne) dealt first with "The Velocity Profile in Rivers"—an attempt to express the vertical velocity gradient of rivers by a logarithmic law using certain ideas of Prandt concerning turbulent flow over rough surfaces. In a second paper, on "Examples of Trivial Correlations in Solar Terrestrial Relationships", Prof. Berg examined two such examples: Farthing's experiment, which led him to conclude that a period of intense coronal radiation is followed by a penetration of cold air over the Earth; and an investigation by Abbott, who claimed that the solar constant is considerably lowered on days of intense geomagnetic storms. Prof. Berg showed that the results in both cases are only the outcome of faulty mathematical reasoning.

Prof. G. Berbesconi (Genoa) considered the "Partial and Total Representation of an Ellipsoid on the Sphere". Starting from the principle of the minimum energy of deformation of an elastic ellipsoidal geographical network, Prof. Berbesconi determines a relationship between the ellipsoid of gyration and the local spherical surface in the neighbourhood of the oscillation point up to a radius of 250 km. He next examines various functions the extremals of which give a good representation of the whole ellipsoid on the sphere and define a new latitude which he considers useful for the construction of geographical globes.

Dr. I. Dagnino (Genoa) considered the "Frequency of Cyclones and the Distribution of Cloud in the Mediterranean", using the synoptic charts for all the days during the period 1946–55. For the case of the region of maximum frequency, Dr. Dagnino has examined and discussed the principal atmospheric and meteorological factors giving rise to these cyclones—in addition to the seasonal factors.

Prof. Bossolasco (Genoa) spoke on some work he has done with collaborators on "The Atmospheric Electric Potential in the Layers close to the Ground". The result of a series of observations (with Drs. Dagnino and Romagnone) to determine the variation of the atmospheric electric field near ground-level showed a decrease of the potential gradient from a height of 1 m. to 2 m., and a further decrease at a height of 3 m. The variation at discrete potential-levels confirms electrically the presence of a boundary layer near the ground. A second communication dealt with the "Measurement and Continuous Recording of the Salinity of the Atmosphere". The apparatus used for the purpose is one developed by F. Meda, based on the principle of collecting the radioactivity by passing the air through water.

Prof. M. Cutolo (Naples) spoke on "The Measurement and Behaviour of the Geomagnetic Field at the Lower Border of the E-layer". He described how this can be effected by taking the mean of the frequencies of the two maxima in the gyro-interaction curve and pointed out that the measurements of the geomagnetic field would be very accurate. Prof. Cutolo also spoke on "The Effects of Demodulation in the Ionosphere"; this method also provides an alternative method of measuring the geomagnetic field in the E-layer.

"Micropulsation in the Geomagnetic Horizontal Force and in Telluric Currents" was the subject of a paper by Dr. K. Burkhat (Munich). Dr. Burkhat pointed out that although the close connexion between geomagnetic variations and telluric currents has been known for more than a century, it has only recently been possible to decide which of the two phenomena is the cause and which the effect. At large distances from the electrodes, and in the case of small periods, the respective phases are in good accord. But for small periods (diurnal variation) and close to the electrodes, one finds a definite difference in the phase of the currents with respect to the geomagnetic variations. The difference in phase can be explained as due to the effect of resistance and reactance, since we now know that every telluric current connected with geomagnetic variation is due to induced currents. Dr. Burkhat then considered the statistics of pulsations and noted that the frequency curve for pulsations with periods of about 30 sec. coincides very nearly with the variation of maximum electron density in the E- and F_1-layers.

Prof. M. Matschinski (Paris) next spoke on "Problems of Geochemistry". He confined himself to what he described as the geographical aspects of geochemistry—which problem he formulated as that of finding the relationship between the chemical and geographical traits of given regions. As an example, he considered volcanic regions in the form of arcs; he recalled that he has already found a relationship between the density and the radius of curvature of the arcs. Prof. Matschinski showed several graphs with the view of demonstrating a statistical interdependence between geographical traits and certain chemical characteristics of rocks of the regions considered; for example, the mean percentages of the oxides of silicon, aluminium, calcium, magnesium, sodium, potassium and iron. These results were obtained from more than two thousand analyses.

The prize for meteorology offered by the Society was awarded to Prof. A. Giao and M. Ferreira for their paper "Introduzione alla climatologia dinamica dell'America Settendrionale, del Nord-Atlantico e dell'Europa". The following officers were elected for the period 1956–59: *President*, Prof. M. Bossolasco, *Council*, Profs. Aliverti, Lovera and Ranzi; *Secretary*, Dr. I. Dagnino.

V. C. A. FERRARO

MEMBRANE PHENOMENA

FARADAY SOCIETY DISCUSSION

THE Faraday Society held a general discussion on "Membrane Phenomena" in the University of Nottingham during April 10–12. Nearly two hundred scientific workers attended the discussion, the first of its kind to be held in Nottingham. The president, Mr. R. P. Bell, took the chair for the whole of the meeting, and the proceedings were opened by the sending of a message of greeting to Prof. F. G. Donnan, a founder-member and past-president of the Society, who is well known for his work in the field of membrane equilibria.

The discussion proper was preceded by the Spiers Memorial Lecture, given on this occasion by Prof. T. Teorell (Upsala), whose subject was "Transport Phenomena in Membranes". Prof. Teorell indicated how his own interest sprang originally from biochemical studies on hydrochloric acid in the stomach. He outlined structural studies on cell membranes, showing slides of striking electron micrographs taken by F. S. Sjöstrand. He stated that theories must explain the five phenomena of ionic transport, membrane potential, electrical conductivity, ionic distribution equilibria, and the potential gradient and spatial distribution of ions within the membrane. In this connexion he discussed the achievements of four theories: those of the porous membrane, the homogeneous membrane, the energy-barrier model, and the fixed-charged membrane model. He pointed out how concentration gradients within a membrane may be in the reverse direction to the overall gradient between the two bulk solutions on each side of the membrane, leading to anomalous transport. He surveyed most ably the whole range of phenomena from the collodion membranes of Michaelis to the recent results of the Cambridge physiology school, concluding with reference to his own recent model which shows rhythmic variations of potential.

The general introduction was given by Prof. G. Scatchard (Massachusetts), who briefly outlined the programme to be followed, emphasizing the key part to be played by the thermodynamics of irreversible processes. T. L. Hill's (Bethesda) paper showed how the McMillan–Mayer solution theory, applied to the membrane equilibrium problem, leads directly to a value for the osmotic pressure. A combination of this theory with the classical Donnan method in certain instances leads to the membrane potential. R. Schlögl (Göttingen) divided total particle fluxes into those relative to the local centre of gravity, and a convection common to all particles, and showed that the latter may play an important part in membranes with an appreciable water permeability.

M. Nagasawa and I. Kagawa (Nagoya) found that the slope of the straight line connecting membrane potential and the logarithm of the ion activity for an ion-exchange membrane is less than RT/F, which they explained by abnormal ion activities within the membrane. F. Bergsma and A. J. Staverman (Delft), discussing a similar discrepancy for bi-ionic potentials, have found it particularly marked for hydrophile membranes and suggested water transport as the cause. G. Scatchard and F. Helfferich (Massachusetts and Göttingen) have found the abnormally high potentials observed in various cells with cation exchange membranes to be most marked when ions of different valence are present and to be markedly reduced by suitable stirring. They attribute the observations to a preference of the membrane surface for divalent ions. F. Helfferich (Göttingen) discussed the effects of Nernst diffusion films adherent to the membrane on its permeability. R. Neihof and K. Sollner (Upsala and Bethesda) have calculated rates of exchange of ions from membrane potentials of bi-ionic systems, demonstrating ionic selectivities approaching those observed in biological systems.

G. Manecke and H. Heller (Berlin-Dahlem) discussed the separation of non-electrolytes from electrolytes using an ion-exchange membrane, a problem also of interest to T. S. Mackie and P. Meares (Aberdeen), who compared sorption isotherms and diffusion-rates of ethanol in 'Zeocarb 315'. The ethanol is salted-in to the membrane, and it appears that two-thirds is in solution in the water swelling the membrane and free to diffuse, the remainder being adsorbed on the polymer chains.

J. W. Lorimer, E. I. Boterenbrood and J. J. Hermans (Leyden) have investigated membranes of viscose and sodium carboxymethyl cellulose, carrying out six measurements—specific conductivity, two transport numbers, two diffusion coefficients, and permeability—in order to permit evaluation of the six phenomenological coefficients of the thermodynamic theory. A. Despic and G. J. Hills (London), using membranes of cross-linked polymethacrylic acid, have subtracted electrosmotic flow from total flow, thus obtaining the flow due to solvated counter-ions. The latter quantity leads to a value of 9 ± 1 for the solvation number of sodium ion within the membrane. H. P. Gregor and D. M. Wetstone (Brooklyn) dealt with selective transport across sulphonic and carboxylic cationic membranes.

K. S. Spiegler, R. L. Yoest and M. R. J. Wyllie (Pittsburgh) considered the electrical potentials arising across porous plugs of ion-exchange materials, separating two solutions of the same electrolyte. In dilute solutions such plugs give almost perfect membrane potentials; but in concentrated solutions, conductance occurs largely through liquid in the pores, and the potential difference approaches the liquid-junction potential. The results are shown to be relevant to the suspension effect observed in pH measurements on suspensions and gels using a combination of glass and calomel electrodes. T. R. E. Kressman and F. L. Tye (London) showed how the transport numbers of sodium and chlorine ions in certain ion-exchange membranes decrease with increase in current density, an effect attributable to concentration diffusion. D. Hutchings and R. J. P. Williams (Oxford) considered how far cation-exchange membranes are suitable for analytical use. They have found conditions on the whole to be unfavourable, equilibrium potentials being reached only slowly, and in any case being often lower than those expected on thermodynamic grounds.

The last session was devoted to the properties of biological membranes. D. D. Eley and D. G. Hedge (Nottingham) examined the interaction of protein solutions with lipoid monolayers by a development of the Schulman–Rideal technique. Increases in surface pressure were interpreted to show the formation of a first sublayer of fully uncoiled protein chains, and a secondary layer consisting possibly of native protein. A. Rothstein (Rochester, N.Y.) concluded from studies of yeast cells that the cell surface is a "multimembrane compartmentalized structure". There is an outer barrier impermeable to proteins and holding enzymes such as saccharase and phosphatase. Within this there is a second membrane impermeable to anions and bivalent cations but permeable to potassium and hydrogen ions. Finally, there is a barrier impermeable to potassium and hydrogen ions, and containing metabolic pumps for phosphate and potassium ions. Dr. Rothstein outlined the evidence supporting this model: exchange reactions with radioisotopes are playing a big part in this kind of work.

W. D. Stein and J. F. Danielli (London) defined 'facilitated diffusion' as involving a specific structural relationship between the membrane and the diffusing species. As a model for the permeability of red-blood cells to glycerol, they consider a pore, possibly of protein, containing hydrogen-bonding groups that complex with the glycerol and lead to the observed kinetics, which are of the saturation or Michaelis–Menten type. Various glycols and alcohols were shown to be competitive inhibitors for the diffusion, and copper a non-competitive inhibitor. Freda Bowyer and W. F. Widdas (London) discussed the same problem for glucose and red-blood cells, considering in particular the kinetics of inhibition by dinitrofluorobenzene, which appears to be a fourth-order reaction. P. Mitchell and J. Moyle (Edinburgh) have found the specificity and kinetics of phosphate transport in *Staphylococcus aureus* to resemble those for enzyme-linked reactions, and suggested that the enzyme-substrate complex forms the carrier for the facilitated diffusion. In the closing paper, R. D. Keynes and R. H. Adrian (Cambridge) described how in resting nerve or muscle the membrane is 25–100 times more permeable to potassium ion than sodium ion, the inside of the fibre being negative to the outside. As the action potential arrives, the membrane changes so that sodium ion becomes the more permeable ion, the inside of the fibre now becoming positive. There is no model to date which will account for the observation that the ratio of the permeability of sodium ion to that of potassium ion is linked to the electrical polarization of the adjacent membrane.

There was a lively discussion on many of the papers, and a number of contributors sought to show how ion-exchange systems can lead to a selective action on different cations. On the whole, it seemed that there is still something of a gap between the achievements of the physical chemist and the needs of the biologist with his complex systems; but it seems clear that this general discussion, and the published account which will appear in due course, should do much towards the further closing of this gap in the future. It is clear that the Faraday Society continues to provide a unique forum for the development of the border-line sciences.

D. D. ELEY

ROYAL COMMISSION ON AWARDS TO INVENTORS

FINAL REPORT

THE fourth and final report of the Royal Commission on Awards to Inventors* concludes the record of the Commission's work. Besides listing decisions of the Commission since November 9, 1952, it discusses certain aspects of the more important of the 115 claims considered since the issue of the previous report. Only nine claims were dealt with under Head 1 of the Warrant during the period, and the Commission from the outset indicated its reluctance to deal with patent claims where the validity of the patent was seriously challenged. Several claims have consequently been referred to the Courts and other claimants have elected to have their claims considered under Head 3, that is, under the exercise of the Crown's bounty in granting an *ex gratia* award. By far the majority of claims heard by the Commission have been brought by such claimants, who have waived, or have not possessed, legal rights to support their claims. This procedure cannot be applied to claimants possessing patent rights who, after the period to which their claim relates, have assigned their patents to a third party. Normally, at the request of the Crown, the Commission has taken into account, in estimating the utility of the invention, its possible future use by the Crown as well as the past use. In a claim by J. R. Geigy S.A. and the Geigy Co., Ltd., relating to dichlorodiphenyltrichlorоethane, the patents covering the invention had, at the date of hearing, been transferred to a newly formed company which was not a party to the claim, and the claimants undertook either to amend the claim by joining the patentees or to obtain an undertaking safeguarding the Crown from any further claim.

From time to time it has been urged on the Commission that exceptionally large use of an invention should be taken not merely as an important factor but as the predominant factor in determining the quantum of an award. It was on this principle that, in view of evidence showing the highly effective use of rockets in the later stage of the War, both in regard to material and to morale, the Commission, notwithstanding the heavy discount which the status of the claimants involved, recommended an award of £5,000 for the invention of a loose-charge rocket motor. In regard to novelty and originality of invention, the material question which has weighed with the Commission has been whether it has been the earlier or later publication or communication which has in fact led to the practical use of the invention by the Crown; nor has the fact that the claimant has patented his invention abroad, and thereby knowledge of the invention has been made available to an enemy country, necessarily disqualified the claimant from receiving an *ex gratia* award. Accordingly, the Swiss firm of J. R. Geigy S.A. was not disqualified from receiving an award in respect of the exceptional usefulness of DDT as a means of safeguarding the health of British troops; in the same way, notwithstanding the fact that the information contained in the late Prof. N. A. V. Piercy's earlier papers dealing with the mathematical basis of the design of aerofoil sections had become common knowledge among aeroplane constructors, the Commission, in view of evidence that his subsequent confidential communications to the Air Ministry were of permanent value for the construction of aerofoils, recommended an award.

The Commission has occasionally, as in connexion with the Pritchard principle for constructing bomb-sights, recommended an award where the inventive merit of the contribution consisted mainly of mathematical or theoretical calculations. Claims by employees of Crown contractors have generally been treated on the principle that, if the invention was made in fulfilment of the employee's duty to his employers, he should look to the firm he serves for an *ex gratia* reward for such services. The Commission was, however, able to treat the status of the claimants in the project known as Pluto and the inventors of the cavity magnetron as substantially the same as that of research workers directly paid by the Crown, since at the time they were lent or seconded to a government department for carrying out the experimental work which led to the invention. An award could be recommended to the inventor of the winged target or pilotless aircraft for towing behind aircraft because the company employing the inventor had waived its claim as patentees against the Crown in favour of the inventor. An award of £2,500 was recommended in respect of the disk seal triode in spite of some dubiety as to the validity of the claim, in view of some ambiguity in the contract in force and of the merit and extensive usefulness of the technique, particularly in blind firing from ships.

The gratuitous offer to the Crown and its contractors of the free user of a patented invention does not necessarily disqualify the owner of the patent from afterwards qualifying for an *ex gratia* award; but the Commission has held that surgical or medical discoveries, in accordance with the recognized practice of the medical profession, become available for use of the Crown in the same way as for any members of the public. The only award recommended under Head 4 of the Warrant was for a claim in respect of the Sommerfeld track.

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* Royal Commission on Awards to Inventors—Fourth and Final Report. Pp. 20. (Cmd. 9744.) (London: H.M.S.O., 1956.) 9d. net.

THE CATTLE EGRET

AN Old World bird which is a constant companion of cows has become established in the United States in the past fifteen years. Unknown there before its first appearance in Florida in 1942, there are now approximately two thousand birds in that State, according to Alexander Sprunt, jun., of the National Audubon Society (Smithsonian Institution News Release, April 13).

The bird is *Bubulcus ibis*, the cattle egret, which has been well known for many years in southern Europe, Africa and the Middle East. It is a small white egret with dark-brown feet and yellow legs and bill and is most remarkable for its strange, constant association with cattle. The close proximity to cattle is little short of astonishing. It keeps pace with the animal continually, usually close by the head, but sometimes near the fore or hind feet and occasionally under the abdomen. When an insect is disturbed, the bird darts out, catches it and returns. Now and then it reaches up and takes something from the body of the cow, or its legs. At times, the cow may be seen to push the bird aside with its muzzle, but appears not to object otherwise to the immediate closeness of its satellite.

A peculiar and unexplained characteristic of the bird is its habit of weaving the head and neck from side to side. A bird will suddenly stop feeding, stand perfectly upright, and weave the upper part of the body.

It feeds chiefly on grasshoppers and crickets. This may explain its fondness for cattle, which disturb these insects in the grass while grazing.

How the cattle egret got to the New World, especially the United States, is difficult to explain. It was first observed in British Guiana in 1937, but did not appear in the United States until five years later.

The cattle egret population is concentrated in Florida; but stray specimens have been observed as far north as Maine, and even Newfoundland, and inland to Chicago. Sprunt believes that a few pairs may have been blown over the Atlantic by wind currents.

SEA-BIRDS IN SWEDEN

IN 1950, regulations came into force in Sweden prohibiting the shooting of sea-birds during the early months of the year. The Swedish Institute of Forest Zoology has now completed investigations to show the effects of these regulations (Bull. Roy. Sch. Forestry, Stockholm, Sweden, No. 22; 1956). These show that everywhere the eider has increased substantially in numbers, while stocks of the velvet scoter were generally unchanged. This species usually arrives at the breeding places so late that it is scarcely affected by the legal spring shooting. There is, accordingly, a substantial difference between the eider and the velvet scoter in this respect, which supports the assumption that the prohibition of spring shooting—which applied only to the eider—had a salutary effect on the stock of that species.

The general trend regarding the stocks of Swedish sea birds since the new regulations were introduced has led to the following conclusions.

There is little possibility of distinguishing between male and female birds. Even if differentiation were possible, the male bird in the spring would still be essential for breeding. The risks of wounding birds in the large spring flocks are greater than those in the autumn shooting of migratory birds.

Birds are being shot which have been produced at other places and, at this time of the year, are returning to their production areas. This shooting cannot be motivated by game protection.

Although the amended regulations of 1950 have been of some benefit—indeed, of very appreciable benefit in the case of the eider—further review of the problems of spring shooting is now required.

The question of restricting spring shooting rights to the coastal population should be carefully considered, regardless of whether the shooting is done in public or private waters.

Should this prove impracticable, it is recommended that a general ban on spring shooting be introduced and that the coastal population be compensated by granting them prolonged autumn and winter shooting rights.

Permission might also be given for the limited shooting of male birds in production zones having well-ordered sea-bird protection. A certain amount of spring shooting along the migratory routes beyond the skerries but outside the production zones proper might be permitted as a transitional measure.

EVENING INSTITUTES IN BRITAIN

THE most popular studies pursued at evening institutes are those offering instruction in household handicrafts. More than a quarter of the student body registered, totalling nearly one and three-quarter million, are women taking classes in cooking, catering, home-furnishings, needlework and similar subjects for the improvement and decoration of the home.

This significant change in the character of evening classes is revealed by a Ministry of Education survey designed to help local education authorities, principals of institutes and teachers to meet the changing needs of young people and adults for purposeful leisure-time study and occupation*.

The change in public taste, and also in social conditions over a period of twenty years or so, is reflected in subject and attendance figures given. Between 1930 and 1952, the numbers of students studying vocational subjects in evening institutes declined considerably, while the numbers taking non-vocational subjects, such as art, music, handicrafts, dancing, and so on, increased. During this period vocational studies have to a great extent been transferred from evening to day work, largely as a consequence of the increasing readiness of employers to give young people time off during the day for study. The full-time work in technical colleges also increased greatly over the period.

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* Evening Institutes. Ministry of Education Pamphlet No. 29. (London: H.M.S.O.) 3s. net.

The new emphasis on 'do-it-yourself' subjects has been accompanied by a change of character in the student body as a whole. Formerly, there were more men and women between the ages of eighteen and twenty-one attending senior vocational courses than any others. Now, the preponderant group is composed of students attending leisure-time classes, the majority of them women over the age of twenty-one.

Besides purely domestic subjects, older housewives and recently married couples take leatherwork, weaving, lace-making and basketry. So popular is the demand that the scope of subjects is steadily being extended to cover health, household management, parentcraft, and those aspects of sociology and psychology which affect the well-being of the family.

The number of young people between fifteen and eighteen attending evening classes is higher than it has ever been, though fewer now enrol in 'grouped' vocational courses. This feature is more noticeable in the south than in the industrial midlands and the north-west, where family tradition and pressure by employers still encourage attendance. Over the country as a whole the predominant type of class is the recreational one in which young people and grown men and women are to be found working together. Most of the work consists of making furniture for the home.

Full-time teachers are rare. Of 41,834 teachers engaged in 1952, only 67 were full-time assistants, and only about a third of them were professional teachers by day. The bulk of staff engaged were non-professional people with special knowledge or skill who became teachers in the evenings. The number of such instructors is increasing.

In addition to the expected kinds of instruction, classes dealing with local industries are not uncommon. There is a class on boat-building in a Thames-side town, for example; navigation is studied in a Devonshire fishing town; and welding courses are provided in a small midland town remote from a technical college. In urban evening institutes a common class is the owner-driver and car maintenance class. The instructor is often the proprietor of a local garage. A similar type of specialized class is radio and wireless, generally taken by a local radio trader.

The provision of classes in prisons and Borstal institutions is a development which has taken place since the Second World War. There are now classes in sixty-four establishments in England and Wales. In large establishments a separate institute can be formed; for smaller places the classes are usually attached to the nearest evening institute. Subjects of instruction are much the same as in the normal evening institute.

The survey examines in detail current practice in the organization and teaching of the arts, vocational courses, physical activities and subjects in the more formal curriculum provided by every evening institute. A suggestion is offered that courses and groups might with advantage be started in 'popular' science. Though it is not certain that teachers could be found for such an innovation, or that the public response would make it worth while, it is thought to be an experiment well worth trying.

HIGH-VOLTAGE PAPER ELECTROPHORESIS OF NON-VOLATILE ORGANIC ACIDS AND THEIR MIXTURES WITH AMINO-ACIDS

By Dr. D. GROSS

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SURPRISINGLY few results of successful separations of organic acids (excluding fatty acids) by electrophoresis have been published, although on theoretical grounds the utilization of the variation of mobilities with dissociation constants would appear to be promising.

Earlier attempts[1] were limited in scope and success, and the separations of only a few free acids or derivatives of acids have been described so far. Recently, Berbalk and Schier[2] reported on a more elaborate investigation of the mobilities of a series of acids under the conditions of paper electrophoresis. In a study in this laboratory of the electrophoretic behaviour of organic acids at high potential gradients, we have found that, under the conditions chosen, even small existing differences in mobilities could be exploited for clean, rapid and reproducible separations, which, as the positions taken up by the various acids are mostly different from those on chromatograms, affords a useful complementary method for the detection and identification of many acids. In general agreement with Berbalk and Schier, we found a fairly good correlation between dissociation constants and migration rates, that is, mobility being directly proportional to K, and electrolyte solutions of about pH 2 to be most suitable for separations. Raising the pH of the solution increased the mobilities of some acids but also led to multiple spots. To effect a separation between two acids, their dissociation constants must vary by a factor of, at least, 2, although several exceptions have been found.

In further development of the technique[3], the cooling system has been improved by the introduction of aluminium alloy cooling plates of 1 in. thickness, with water flowing through grooves in the precision-ground, closely fitting plates, thus ensuring a better contact and heat transfer. With cooling water (tap water) of 9° C., energy of up to 3 W./cm.^{2} has been satisfactorily dissipated. The construction of a bigger power unit capable of delivering up to 150 m.amp. at up to 12,000 V. has made the application of potential gradients of up to 240 V./cm. to a strip of an effective length of 50 cm. possible. The dielectric strength of insulating films of polythene ('Telcothene') of a thickness of 0·015 in. has been found sufficient under these conditions. The exact measurement of voltages greater than 3,000 V. proved difficult, and certain corrections for lack of precision had to be made. A pneumatic uniform pressure device added since has greatly improved the evenness of migration.

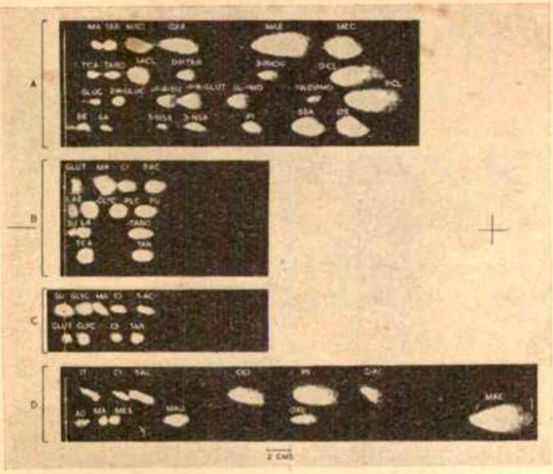

Fig. 1. Electrophoresis of non-volatile organic acids

Organic acids: *AD*, adipic acid; *BE*, benzoic acid; *C-AC*, *cis*-aconitic acid anhydride; *CI*, citric acid; *CIO*, citraconic acid; *D-CL*, dichloracetic acid; *D-HTAR*, dihydroxytartaric acid; *FR-DIPHO*, fructose-1-6-diphosphate (barium salt); *FU*, fumaric acid; *GL-PHO*, D-glucose-1-phosphate (potassium salt); *GLUC*, gluconic acid; *GLUT*, glutaric acid; *GLYC*, glycollic acid; *I-CL*, *iso*citric acid lactone; *IT*, itaconic acid; *α-K-BU*, α-keto-butyric acid; *2-K-GLUC*, 2-keto-gluconic acid; *α-K-GLUT*, α-keto-glutaric acid; *LA*, lactic acid; *LAE*, lævulinic acid; *MA*, malic acid; *MAE*, maleic acid; *MAO*, malonic acid; *M-CL*, monochloracetic acid; *MEC*, meconic acid; *MES*, mesaconic acid; 3-*NSA*, 3-nitro-salicylic acid (2-hydroxy-3-nitro-benzoic; 5-*NSA*, 5-nitro-salicylic acid (2-hydroxy-5-nitro-benzoic); *OX*, oxalic acid; *OXA*, oxalacetic acid; *OXU*, oxalsuccinic acid; 3-*PHOG*, 3-phosphoglyceric acid (barium salt); *PI*, picric acid; *PLC*, pyrrolidone-carboxylic acid; *PY*, pyruvic acid; *SA*, salicylic acid; *SSA*, sulphosalicylic acid; *SU*, succinic acid; *T-AC*, trans-aconitic acid; *TAR*, tartaric acid; *TARO*, tartronic acid; *TCA*, tricarballylic acid; *T-CL*, trichloracetic acid

Conditions: (*A*) 120 V./cm., 7·4 m.amp./cm., Whatman No. 3 *MM*. 4 × 22½ in. strip, 0·75 *M* formic acid, *p*H 2·0, mean temperature of cooling water 10° C., 20–50 μgm. of each compound (according to strength of acid) applied 3 in. from cathode end, ½ hr. (*B*) 100 V./cm., 5·2 m.amp./cm., 0·75 *M* formic acid + 1 *M* acetic acid (1 : 1) mixture, *p*H 2·25, 1½ hr. (*C*) 180 V./cm., 7·2 m.amp./cm., *p*H 2·25, ¾ hr. (*D*) 200 V./cm., 13 m.amp./cm., *p*H 2·0, ½ hr.

The results obtained are illustrated by Fig. 1, which shows the position of forty-two organic acids after electrophoresis at various potential gradients for varying periods of time. Both solutions of formic acid and of mixtures of formic acid and acetic acid were used. To remove the volatile acids, the strips were dried at about 90° C. for 5 min. and then exposed to a stream of cold air for 1–3 hr., depending on the grade of paper used. The thicker Whatman No. 3 *MM* paper usually required 2½–3 hr. for removal of residual acid, whereas for Whatman No. 1 1 hr. was sufficient. Removal is essential when a *p*H indicator is used to reveal the separated non-volatile acids. A 0·1 per cent solution of bromo-phenol blue in 96 per cent ethanol saturated with sodium carbonate proved to be satisfactory, showing the acids as yellow spots or bands on a blue background. In general, there are four main groups of acids: (1) those with high dissociation constants (values at 25° C.) and thus moving fastest in the electrical field, typically represented by oxalic acid ($6{\cdot}5 \times 10^{-2}$); (2) those moving at a slightly slower rate, represented by maleic acid ($1{\cdot}5 \times 10^{-2}$); (3) those moving at somewhat less than half the speed of oxalic acid, represented by pyruvic acid (3×10^{-3}); and (4) the slow-moving acids, of which the fastest is represented by fumaric acid ($1{\cdot}0 \times 10^{-3}$) and the slowest by succinic acid ($6{\cdot}6 \times 10^{-5}$). In the latter group, glyoxylic acid ($4{\cdot}6 \times 10^{-4}$) can be cleanly separated from glycollic acid ($1{\cdot}49 \times 10^{-4}$). The alkaline hydrolysate of *iso*citric acid lactone yielded one major constituent, possibly *iso*citric acid, separable from citric acid. The time required for separations was ½–1½ hr., depending on voltage applied and types of acids present.

It was noticed that at *p*H 2 all amino-acids examined, being below their iso-electric point and thus positively charged, moved well away to the cathode, whereas the organic acids, being still negatively charged, moved to the anode. This offered a possibility of dealing with both groups of compounds, which very often occur together, on a single electrogram. The procedure adopted was to spray one half of the strip with ninhydrin, heat it and reveal the amino-acids present, and then spray the other half with bromo-phenol blue to reveal the non-volatile organic acids. Only taurine moved too short a distance away from the starting line and had, in case of doubt, to be checked by another run. The displacement of the weaker organic acids towards the cathode is, of course, due to electro-endosmotic and electrolyte flow effects and is mainly a function of voltage applied, time of run and original position of sample. Various mixtures of twenty different organic acids and twenty-one amino-acids were distinctly separated into their individual components at potential gradients of 160–240 V./cm. and within short periods of time, ranging from 13 to 30 min. per run. Some of the results are shown in Fig. 2.

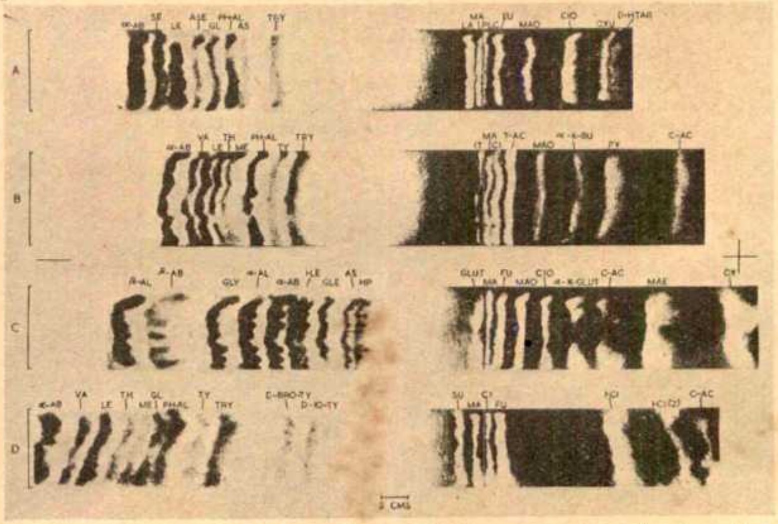

Fig. 2. Electrophoresis of mixtures of non-volatile organic acids and amino-acids

Organic acids as in Fig. 1. Amino-acids: *α-AB*, α-amino-butyric acid; *β-AB*, β-amino-butyric acid; *α-AL*, α-alanine; *β-AL*, β-alanine; *AS*, aspartic acid; *ASE*, asparagine; *D-BRO-TY*, di-bromo-tyrosine; *D-IO-TY*, di-iodo-tyrosine; *GL*, glutamic acid; *GLE*-glutamine; *GLY*, glycine; *HP*, hydroxyproline; *I-LE*, *iso*leucine; *LE*, leucine; *ME*, methionine; *PH*, phenylalanine; *SE*, serine; *TH*, threonine; *TRY*, tryptophan; *TY*, tyrosine; *VA*, valine

Conditions: (*A*) 160 V./cm., 10·5 m.amp./cm., Whatman No. 3 *MM*. 2½ × 22½ in. strip, 0·75 *M* formic acid, *p*H 2·0, 20 μgm. of amino-acids and 50 μgm. of organic acids applied 8–10 in. from anode end, mean temperature of cooling water 12° C., ½ hr. (*B*) 160 V./cm., 10·2 m.amp./cm., *p*H 2·0, 27 min. (*C*) 200 V./cm., 13·8 m.amp./cm., *p*H 2·0, 13 min. (*D*) about 240 V./cm., 13·7 m.amp./cm., *p*H 2·0, water temperature 9° C., 24 min.

The range of acids applied is limited only by the length of the paper strip. The full range of acids requires a strip of a length of 80–100 cm. *Iso*leucine contained a well-separated contaminant of slightly lower mobility, and *iso*citric acid lactone had a contaminant of higher mobility. Tentative experiments have been started in connexion with an investigation into the possibilities of two-dimensional electrophoresis by extraction of the bands after the first run, concentration and re-application as spots for the second run. In this conjunction it was found that the position of glutamine in borate buffer of *p*H 9·2 is not as shown before[3], presumably due to decomposition of sample, but between starting line and asparagine. The separation of aspartic acid, glutamic acid, asparagine and glutamine is thus made possible.

Thanks are due to Mr. H. C. S. de Whalley, director of research, for encouragement, Dr. F. A. Isherwood for the gift of a sample of *iso*citric acid lactone, Mr. R. W. Butters for technical assistance, Mr. S. D. Gardiner for help in the design of the electrical power unit, and to the directors of Tate and Lyle, Ltd., for permission to publish this communication. [Feb. 2

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[1] Wieland, T., and Feld, U., *Angew. Chem.*, **63**, 258 (1951). Michl, H., *Monatsh. Chem.*, **82**, 489 (1951). Neish, W. J. P., *Rec. Trav. Chim.*, 72, 105, 1098 (1953). Smolarek, W., and Dlugosch, G., *Naturwiss.*, **41**, 18 (1954). Wieland, T., and Pfleiderer, G., *Angew. Chem.*, **67**, 257 (1955).

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[3] Gross, D., *Nature*, **176**, 72 (1955).

NATURE OF "CHALK HEATH" SOILS

By R. M. S. PERRIN
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IN certain areas on the Chalk of Great Britain, particularly on the South Downs, there are found shallow, strongly acid soils with *Erica cinerea* or *Calluna vulgaris* as invading or locally dominant species. Co-existing with these typical calcifuges are calcicoles, such as *Poterium sanguisorba*, which are mainly rooted in the underlying chalk. These unusual associations have been described by Tansley[1], who refers to them as "Chalk Heaths".

In a study of weathering and soil-formation on the English Chalk, briefly reported elsewhere[2], it was found important to decide whether these "Chalk Heath" soils consisted of decalcified and highly leached residues from chalk or whether they represented thin drift deposits. This question cannot be answered by field-examination alone. The soils are usually full of angular and nodular flints, as would be expected in a true chalk soil, and pass sharply into the underlying chalk. Further, their depth is generally consistent with the probable rate of accumulation of chalk insoluble residues since the cessation of solifluxion at the end of the Pleistocene. On the other hand, in some cases the soils appear to be too deep and too deficient in flints to be truly residual from chalk.

The mechanical and mineralogical compositions of several representative "Chalk Heath" soils were therefore compared with those of the acetic acid–insoluble residues from a number of chalks. Special attention was paid to soils from Manor Farm Down, Cocking, West Sussex, and Lullington Heath, East Sussex, where particularly good examples of "Chalk Heath" vegetation occur.

The mechanical composition of the small amount of insoluble residue from Upper and Middle Chalks varies little from place to place and is typified by the summation curve in Fig. 1 (I). Clay is invariably the dominant component, and there is no evidence of sorting in the sand grades. A soil truly derived from the residue of such chalk is typically found to give a mechanical composition curve as shown in Fig. 1 (II), the shape of this curve being mainly determined by the mechanical weathering of flint in the sand fractions. If, however, the amount of flint in each grade is estimated by microscopic examination, the curve can be re-drawn on a flint-free basis and is then of the form shown in Fig. 1 (III). These curves illustrate the fact that in soils truly derived from chalk some destruction of clay takes place as well as comminution of flint. As would be expected, there is no evidence of any sorting in the sand grades.

The "Chalk Heath" soils, on the other hand, give summation curves, typified by Fig. 2 (I), which indicate a high degree of sorting with a predominance of particles with diameters in the region of 0·03–0·04 mm. Comparison of these curves with those of loesses and 'brickearths' of recognized aeolian origin (for example, Fig. 2 (II) and (III)) strongly suggests that these soils are mainly derived from wind-blown material. Sorting and deposition by water would appear to be ruled out by the topographical situations of the heaths on the crests or slopes of escarpments.

On the other hand, while the soils correspond closely to some British brickearths, they differ from typical North American or European loesses in carrying higher proportions of clay and sometimes,

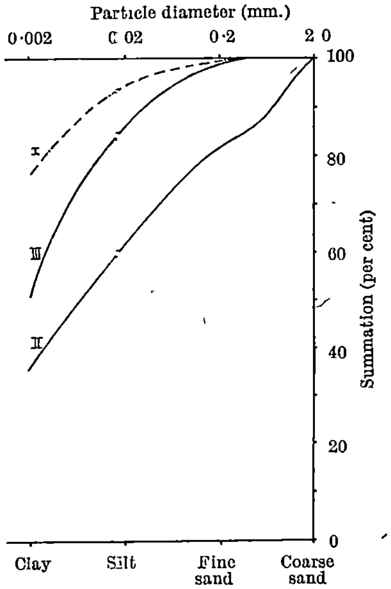

Fig. 1. Insoluble residues from a chalk and from its derived soil. (I), Upper Chalk, Hambledon Hill, Dorset; (II), Upper Chalk soil, Hambledon Hill, Dorset; (III), Upper Chalk soil, Hambledon Hill, Dorset, curve redrawn on flint-free basis

In accordance with common usage in pedology, the summation curves only show the composition of material less than 2 mm. in diameter. Larger particles are collectively referred to as 'stones' but not invariably, of sand grains greater than 0·066 mm. in diameter. This extra sand, however, always consists of flint, which is apparently weathering *in situ*, since it occurs only in the coarser sand grades and as stones. In soils where the flint content is appreciable, a composition curve is obtained as in Fig. 3 (I); but if this is replotted on a flint-free basis, it assumes the form of (II), the upper part of which corresponds closely to that for a loess. The high clay contents of the soils can be explained in various ways. The most likely explanation is that the local wind-blown dusts carried appreciable amounts of clay in the form of soil aggregates of fine-sand dimensions and that this clay has been re-dispersed during the process of mechanical analysis.

The sand fractions contain very rich assemblages of heavy minerals, including green and blue amphiboles, zircon, rutile, anatase, ilmenite, tourmaline, garnet, apatite, kyanite, epidote, sillimanite and zoisite, together with a few grains of a variety of other minerals. Such assemblages are far too rich to have been derived from the insoluble residue of chalk, and the presence of blue amphibole strongly suggests that the material is derived from Pleistocene deposits. It must therefore be considered to be of Pleistocene or Post-Pleistocene age.

The clay fraction of a "Chalk Heath" soil is made up of kaolinite and dioctahedral vermiculite. This differs markedly from the clay in the insoluble residue of chalk, which consists of illite and dioctahedral montmorillonoid. However, experience with soils truly derived from chalk and from various tills in East Anglia has shown that it is usual for montmorillonoid to weather to kaolinite and for illite to alter to dioctahedral vermiculite. The kaolinite–vermiculite assemblage appears, in fact, to be a typical weathering product in free-draining soils in Britain. The mineralogy of the clay fraction thus unfortunately provides no evidence as to the origin of the soil.

From the available evidence it thus seems likely that the "Chalk Heath" soils originate from the deposition of wind-blown material on flinty pavements, produced by the local weathering of chalk, on sites from which Clay-with-flints and other Tertiary deposits had previously been stripped by peri-glacial or normal erosion. This hypothesis is supported by the practically identical shapes of summation curves (on a flint-free basis) for soils from widely separated localities and by the occasional presence adjacent to "Chalk Heaths" of deeper deposits, again with the same mechanical composition but with a lower proportion of flint stones.

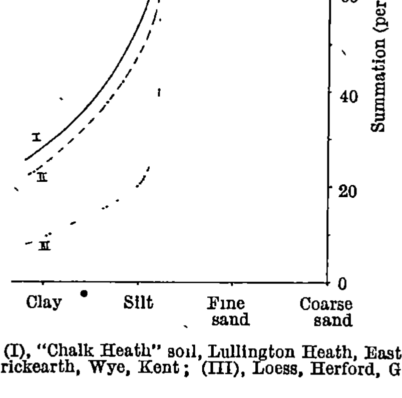

Fig. 2. (I), "Chalk Heath" soil, Lullington Heath, East Sussex; (II), Brickearth, Wye, Kent; (III), Loess, Herford, Germany

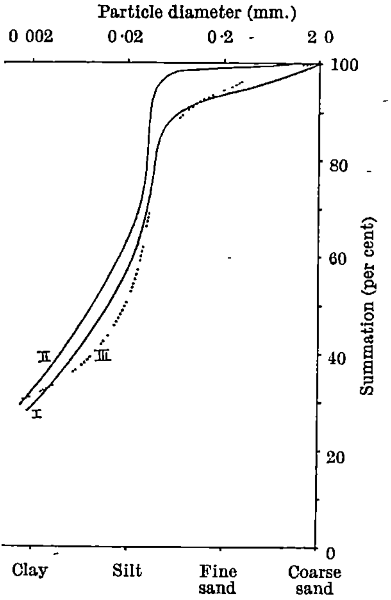

Fig. 3. (I), "Chalk Heath" soil, Manor Farm Down, West Sussex; (II), "Chalk Heath" soil, Manor Farm Down, West Sussex, curve redrawn on flint-free basis; (III), Topsoil overlying Clay-with-flints, Combe Hill, south-west of Wendover, Bucks

If this suggested origin be correct, it would be expected that topsoils giving composition curves of the same type would be widespread and would occur on various geological formations. Such soils have now, in fact, been located on the Chalk in the Yorkshire Wolds and on Clay-with-flints in Savernake Forest, Berkshire. Deposits of a slightly different type but also with a marked concentration of particle diameters in the region 0·03–0·04 mm. have been found overlying the Chalk on the Berkshire Downs, red Clay-with-flints on the Chilterns (see Fig. 3 (III)) and Carboniferous Limestone in Derbyshire. It therefore seems likely that careful mechanical analysis might reveal thin deposits of similar loess-like material in many soils in Britain which have not been too greatly disturbed by long-continued agriculture.

It would clearly be of great interest to know when the material was laid down. Cornwall[3] has recently shown from archæological evidence that loess was probably deposited in England as late as the Bronze Age. It is hoped that in due course it will be possible to date the deposits on the "Chalk Heaths" using similar methods.

The assistance of Dr. M. Black, of the Sedgwick Museum, Cambridge, in the execution and interpretation of heavy mineral analyses is gratefully acknowledged. Details of the complete investigation will be published elsewhere.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Impulsive Radio Signals from the Planet Venus

RADIO signals of an impulsive or burst-like nature which appear to come from the planet Venus have been detected at the Ohio State University at a wave-length of 11 metres. The observations were made with an interferometer antenna consisting of two colinear arrays of six horizontal half-wave-length elements one-quarter wave-length above ground. Each array is backed up by a reflector element, which, with the ground, forms a corner reflector. The arrays are separated by 426 ft. along an east–west axis. The receiver operates a pen recorder with a time constant of about one-quarter second.

Twice on May 23 and once on May 30, 1956, intense signals were observed when Venus drifted through the main antenna beam. On each occasion the signals were recorded for a period of two to three hours. They appear on the recorder tape as a succession of randomly spaced sharp spikes each representing a burst of short duration (1 sec. or less). The appearance somewhat resembles records of signals received from Jupiter[1]. On each of the three records the envelope of the spikes shows an interferometer lobe pattern in close agreement with one to be expected for a radio source at the position of Venus. The likelihood of confusion with the Sun or other planets is remote, since these were well separated in angle from Venus. Radio sources such as Cygnus *A*, Cassiopeia *A* and Taurus *A* were also well removed. Furthermore, they exhibit a different appearance on the tape and have fixed, instead of changing, celestial co-ordinates.

On all the three records the bursts are observed to pass through peaks spaced about 90 min. apart, at which times they are most frequent and intense. The record of May 23 is of particular interest in this respect since a period of activity was observed between 1300 and 1500 E.S.T. and again between 1900 and 2100, both periods showing similar peaks of activity 90 min. apart. The Sun set at 1947 E.S.T. There is some indication of activity between 1500 and 1900, but Venus was near the edge of the main beam during this period.

In about three months of searching for signals from Venus since February 1, 1956 (no observations were made during April), the only periods of intense activity observed were on May 23 and 30. Possible indications of activity from Venus were noted on February 15 and March 6 but with less certainty. It may or may not be significant, but on May 17 and 26 there were large solar flares. These dates are six and four days, respectively, in advance of May 23 and 30, on which days signals from Venus were observed.

The peak power flux-density of the bursts of signals from Venus have often been recorded at several times the value of the Cygnus *A* radio source at the same frequency (26·7 Mc./sec.). Assuming that Cygnus *A* has a power spectrum proportional to the wave-length, the peak radiated radio-power flux-density of a burst from Venus is:

$$38 \times 10^{-24} \times 9{\cdot}4 \times 2{\cdot}5 = 8{\cdot}9 \times 10^{-22} \text{ W. m.}^{-2} \text{ (c./s.)}^{-1}$$

where 38×10^{-24} W. m.$^{-2}$(c./s.)$^{-1}$ is the value for Cygnus *A* observed[2] at 250 Mc./sec., 9·4 is the spectrum ratio, and 2·5 is taken as the Venus to Cygnus *A* ratio at 26·7 Mc./sec. on May 23. Actually, the Cygnus *A* spectrum may be flatter than assumed, but compensating this effect the peak burst of power may be higher than recorded since the receiver time constant is one-quarter second and the burst may be of considerably shorter duration. The distance of Venus on May 23 was 0·4 astronomical unit. Assuming that the Venus source radiates isotropically and neglecting the loss through any ionosphere which the planet may have, the peak power in a burst from Venus is about 40 watts per cycle per second of band-width. This is about 0·003 of the value observed for a burst from Jupiter.

If one assumes, in the absence of information about the spectrum of the signal, that the power is constant over a 10-Mc./sec. band-width, the integrated peak radiated radio power of a burst from Venus is 4×10^8 watts (or 400 megawatts). However, if the spectrum is more like that for terrestrial lightning, this may be too low by a factor of about 10, making the value 4×10^9 watts. The total peak power in a terrestrial lightning stroke has been estimated at 10^{13} watts or more[3]. Assuming a conversion efficiency to radiated radio power of 0·001 yields 10^{10} watts of radiated radio power for a terrestrial lightning stroke. This is somewhat larger than the probable value for Venus. Thus, it would appear that a lightning discharge phenomenon on Venus of the intensity of the terrestrial variety (or weaker) would have sufficient power to be the mechanism involved.

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Columbus 10, Ohio. June 4.

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Interpretation of Ionospheric Measurements made during Solar Eclipses

Hunaerts and Nicolet[1] have pointed out that the interpretation of *E*-layer measurements made during solar eclipses is very sensitive to the value of the effective recombination coefficient ($\alpha \times 10^{-8}$ cm.^{3} s.$^{-1}$) in the range $\alpha = 1$–8. For the eclipse of February 25, 1952, at points in the belt of totality, a value of α near the lower end of this range implies, in general, that the west limb of the Sun must have been much brighter than the east limb, and also that there can have been no source of ionizing radiation outside the visible disk. Conversely, a higher value of α requires the existence, in the corona, of sources which remained unobscured during totality, and only a small difference between the brightness of the west and east limbs. At Khartoum, for example, the intensity of the coronal component (I_c) and the difference between the intensities of the sources near the west and east limbs ($I_w - I_e$), both expressed as a percentage of the total radiation, are given by $I_c = 12 - 18/\alpha$ and $I_w - I_e = 2 + 39/\alpha$. The arbitrary assumption that there was no coronal radiation thus leads to the result: $\alpha = 1{\cdot}5$.

Fortunately the interdependence of I and α suggests the possibility of using a method of finding α which makes no arbitrary assumptions about I. If ionospheric measurements are made during the same eclipse at two stations, it ought to be possible, in principle, to express the intensity of a given source in terms of two different functions of α; equating these functions would then allow α to be determined. This technique has proved to be practicable using data obtained at Khartoum and Ibadan in 1952; the resulting expressions for the intensity (per cent) of the west limb source are $I_k = 15 + 18/\alpha$ and $I_i = 29 + 2/\alpha$, and similar expressions have been derived for the uniform disk and east limb components. The solution of the equations for the three sources allows the values of α at the two stations to be determined simultaneously; it is found that the difference between them is not significant and that the most probable value is $\alpha = 1{\cdot}2$.

This low value for α and the implied absence of any coronal radiation are at variance with the conclusions reached by Hunaerts and Nicolet, who find that $\alpha = 4$ and that 15 per cent of the total radiation originates in the corona. A valuable check would be provided if similar determinations of α could be carried out using the measurements made in other parts of Africa during the 1952 eclipse, and a fuller account of the method used, including numerical data for Khartoum and Ibadan, will appear elsewhere[2].

Hunaerts and Nicolet have also referred to the observation that ionospheric measurements made during the 1954 eclipse imply equatorial brightening and polar darkening of the Sun's disk[3]. This conclusion is independent of the assumed value of α, a change in which leads only to a change in the relative brightness of the west and east limbs; the amount of polar darkening and the magnitude of the uniform disk component are very insensitive to changes in α. As the 1954 measurements were not made in the belt of totality, no information on the possible existence of coronal radiation can be given.

This work was carried out as part of the programme of the Radio Research Board, and this communication is published by permission of the Director of Radio Research of the Department of Scientific and Industrial Research.

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Slough, Bucks. Feb. 27.

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Atomic Time and the Definition of the Second

THE experience gained[1] with the cæsium resonator has shown that it can be used for establishing a unit of time interval with great ease and accuracy, and it is now important to decide how this new facility can best be incorporated into the general framework of time measurements. It is necessary first to outline the present position with rather more practical detail than has been given in the recent correspondence in these columns[2,3].

The unit provided by the present time signals is based on the diurnal rotation of the Earth, the astronomical observations being corrected for known irregularities and also smoothed over long intervals by means of quartz clocks. It is known in Britain as the second of provisional uniform time and in America as that of U.T.2. Corrections to the signals are published by the observatories responsible for them after some delay, about six months in the case of the Royal Greenwich Observatory. These corrections are obtained from a statistical study of the observations and of clock performances and thus give the most probable value of the unit. It is important to realize that the corrected assessment of the unit involves certain assumptions being made about the behaviour of the clocks and of the Earth, but there is good evidence that it is in general uniform to ± 4 parts in 10^9 during a year.

It is internationally recommended[4] that, in view of the known variations, amounting to ± 4 parts in 10^8 during the last century, in the period of rotation of the Earth relative to other periodicities of the solar system, the second of ephemeris time should be used for precise work. This is based on the length of the tropical year[5], which is subject to a small secular change and is therefore referred to the particular epoch 1 900·0, the definition of the second being 1/31 556 925·975 of the tropical year for 1 900·0. The accuracy with which this new unit can be given is governed by the accuracy with which the current tropical year can be determined. This determination is made in practice from observations of the Moon, and W. Markowitz, using the dual-rate camera which he has recently developed[6], estimates the probable error to be ± 5 parts in 10^9 for measurements extending over one year[7]. To obtain the accuracy of ± 5 parts in 10^{10} (as an outside limit, not probable error), already being used in frequency measurements, the observations would thus have to be extended over more than ten years, and this long interval would have to be subdivided into equal seconds. It appears, therefore, that the second of ephemeris time can be made available with the required accuracy only by using an atomic standard for interpolation purposes.

The correlation of the two units is thus not easy and, moreover, there may be a gradual departure between the two as pointed out by Bullard[8]. There may be some point, therefore, in the suggestion made by Clemence[2] that they should be defined independently, and that a separate name should be given to the atomic unit; but it would almost certainly give rise to confusion, because the physicist who usually obtains his time from time signals would have to inquire into the precise nature of those signals. It is surely preferable for the responsible authorities to make available a single unit of time, as is strongly advocated by Pérard[3]. Pérard states that this unit should be defined in terms of the astronomical second, the frequency N of an atomic standard being given by the relationship:

$$Nt = \frac{\text{tropical year for } 1\ 900{\cdot}0}{31\ 556\ 925{\cdot}974\ 74}$$

The difficulty here is that, in spite of the number of figures with which the denominator apparently can be given, the tropical year is unlikely to be determined more closely than to ± 5 parts in 10^{10} in ten years, which means that the full accuracy of the atomic standard would remain latent for that time. Physicists and radio engineers would have no alternative but to adopt some value and use it as an independent atomic unit.

The following tentative proposals are put forward in an attempt to overcome this difficulty: to make the atomic standard immediately available but to preserve a single unit of time closely linked with, although not defined by, that given by astronomical observations.

(1) The provisional unit of time should be the time of 9 192 631 830 cycles of the cæsium $Fm,(4,0) \leftrightarrow (3,0)$ resonance at zero field, and named 1 provisional second. This is the frequency obtained[9] in terms of the provisional uniform second in June 1955, but it turns out to be very near the value expressed in the average provisional uniform second for the period June 1955–June 1956, and no alteration is therefore recommended.

(2) The joint work of the National Physical Laboratory and the U.S. Naval Observatory at present in progress should be continued to obtain the value of the cæsium frequency in terms of the second of ephemeris time for a period of, say, five years, when the precision should approach 1 part in 10^9. As the length of the tropical year is varying by 2 parts in 10^{10} per year[10], there is little point in relating the two units more closely than this. Indeed, it may be sufficient to accept the relationship with a lower accuracy which will be available in a shorter time.

(3) This new frequency should ultimately be adopted for the definition of the second. It is expected that the value will not differ by an amount which is significant for most purposes from the provisional value, as the difference between the units of provisional uniform time and of ephemeris time is believed to be small during the present period. A step adjustment could also be made to bring actual time (epoch) to the ephemeris time-scale.

For the purpose of the definition the frequency will be given to 1 part in 10^{10}, as it will certainly be possible in the near future to calibrate the working standards in terms of the resonance with that precision.

(4) The closest relationship should be maintained by the appropriate authorities between atomic time and astronomical time in order to determine any departure between the two systems and also to preserve the continuity of time determinations over long periods. Quartz clocks and astronomical observations would be used for integrating atomic time just as quartz clocks are now used to subdivide astronomical time.

(5) As other atomic standards come into use, their frequencies should be expressed in terms of the provisional second defined in (1), and, later, in terms of the second as defined in (3). The provisional second is already available through the *MSF* standard-frequency transmissions[11,12].

In making these proposals, the understandable reluctance to break with a practice as old as civilization is fully appreciated; but a consideration of the precision of measurement alone shows that the astronomical unit of time is no longer sufficiently accurate for modern measurements of frequency and time interval.

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Teddington, Middlesex. May 23.

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Terrestrial Heat-Flow in Hungary

Numerous borehole temperature measurements have been made in the Carpathian Basin during the past seven decades. It has been found that the value of the geothermal gradient lies between 40 and 70 deg. C./km. The causes of this high value have not yet been established, since the thermal conductivity of the rocks has not yet been measured.

In the Liassic coal basin of South Transdanubia at Zobák and Hosszuhetény, the sinking of four big shafts offered a favourable opportunity of determining terrestrial heat-flow The shafts have at present reached depths of 550 and 600 metres respectively, and have been sunk throughout in the same Liassic calcareous shale. In order to determine heat-flow, several measurements of the virgin rock temperature were taken in the course of sinking the shafts. The thermal conductivity of rock samples was measured by a method very similar to that of Benfield[1] and Bullard[2].

The heat flow was computed according to the following formula:

$$q = \frac{T_2 - T_1}{\sum_{i=1}^{n} \frac{\Delta h_i}{\lambda_i}}$$

where Δh_i is the thickness of stratum with thermal conductivity of λ_i. According to measurements taken in shafts at a distance of 90 metres, the mean value and probable error of the terrestrial heat-flow is:

$$10^6 q = 3 \cdot 035 \pm 0 \cdot 010 \text{ cal./cm.}^2 \text{ sec.}$$

Our measurements taken in shafts are more direct and reliable than those performed in boreholes, as the virgin rock temperature at the bottom of the shaft is affected by not more than 0·02 deg. C. by ventilation. In boreholes it is the temperature of the drilling fluid that is measured, and this differs, often considerably, from the virgin rock temperature.

It is believed that the present measurements are the first ever attempted in continental Europe[3], and that the high value obtained may be of interest for the geophysicist and geologist. This high value affects mining operations rather unfavourably. Since at a depth of 570 metres the virgin rock temperature is 36° C., it may be assumed to rise to 60° C. at 1,000 metres to which it is planned to sink the shafts. Such high temperatures will present special problems in mine ventilation.

A detailed account of this work will soon be published elsewhere.

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Effect of Altitude on the Position of the Magnetic Pole

In the most recent analysis of the Earth's magnetic field (for the epoch 1942), Spencer Jones and Melotte[1] evaluated forty-eight coefficients in the spherical harmonic expansion of the magnetic potential. Using their values for a spheroidal Earth, the X (northerly) and Y (easterly) components of the Earth's magnetic field were calculated at heights of 100 km. and 250 km. above the Earth's surface for $\theta = 5°$, $10°$, $15°$, $20°$ and $25°$ and for $\varphi = 240°$, $250°$ and $260°$ E., where θ and φ are the co-latitude and longitude respectively. The heights 100 and 250 km. were chosen to correspond to the E- and F-layers of the ionosphere. For the purpose of comparison, X and Y were also evaluated at the Earth's surface and in every case the value of $H = (X^2 + Y^2)^{1/2}$ was computed.

In order to trace any movement of the magnetic pole with increasing height, the above calculations were repeated on a much finer grid in the vicinity of the pole. Thus X, Y and H were computed for values of $\cos \theta = 0{\cdot}958$, $0{\cdot}962$, $0{\cdot}966$, $0{\cdot}970$, $0{\cdot}974$ and $0{\cdot}978$, and $\varphi = 256°$, $257°$, $258°$, $259°$ and $260°$ E. The results were plotted graphically, and the position of the pole at different altitudes is given in Table 1.

Table 1

Height	$\cos \theta$	φ
Ground-level	0·970	258° E.
100 km.	0·972	258°
250 km.	0·975	258(½)°

The position of the pole at ground-level is thus 76° N., 258° E., that is, 102° W., which agrees with the position given by Spencer Jones and Melotte[1]. It may be noted that for a spherical Earth, instead of a spheroidal Earth, they obtained the position as 77° N., 103½° W. It should be remembered that this is the position for the epoch 1942. For the year 1956, the latitude must be increased by approximately one degree with no appreciable change in longitude.

Table 1 shows that there is a gradual shift in the position of the pole with increasing altitude, the relation between $\cos \theta$ and altitude being linear. At a height of 250 km. the pole has moved northwards one degree, there being no measurable change in longitude. This trend cannot continue far, since, with increasing altitude, the effects of the higher harmonics in the expansion of the magnetic potential become less and less important. If the trend did continue, the magnetic pole would be directly above the geographical pole at a height of 1,500 km. It has been shown, however, that for $\theta = 0°$ the horizontal field cannot vanish at any altitude.

An interesting feature of the calculations was that in certain cases the value of H increased with height, due mainly to an increase in the X-component. This is not likely to be significant, however, and most probably reflects small errors in the coefficients of the harmonic expansion. Although the increase could be accounted for by currents in the ionosphere, this explanation can scarcely be true, since it was assumed from the outset that there was no external component of the Earth's magnetic field.

The work was supported by the Geophysical Division of the Air Force Cambridge Research Center, Mass, U.S.A.

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Harmonics in a Multi-Story Structure

THE design of structures to withstand earthquakes is largely empirical. It is found, from experience, that, if the structure is designed to withstand a horizontal acceleration of one-tenth that of gravity, the building suffers no more than superficial damage even in a major earthquake. Spectra of earthquakes prepared by Housner[1] would appear to indicate that accelerations much greater than this design value are reached. If any tall building is postulated, the lack of a theoretical basis for the accepted design criterion causes considerable hesitation, particularly where one or more of the harmonic frequencies of the building may coincide with partial frequency components of the earthquake. This uncertainty is largely responsible for structure design in New Zealand, and in some American areas, being limited to a maximum height. (In New Zealand this maximum height is 100 ft.) Prof. L. Jacobsen and Robert S. Ayre[2] commented on a uniform building (mass and rigidity constant at each story): "Current design-rules give reasonable results for the fundamental mode shears only and the higher mode shears require considerable increases in the proportionality or percentage factor, especially in the upper part of the building".

The possibility of excitation in the higher modes either being serious in itself or adding to the fundamental excitation in such a way that inter-story shear may become excessive has been one of the major uncertainties in the subject. Recent work at the Dominion Physical Laboratory, where an electrical analogue of a ten-storied building has been built and excited by earthquake accelograms, has shown that excitation of the harmonics for the case of a uniform building may be ignored. However, if the building is designed to the current design code (inter-story stiffness proportional to total mass above the inter-story section), then the harmonics do have a small effect on the upper two storys. The effect is shown in Figs. 1, 2 and 3 in the form of spectra of one particular earthquake.

These spectra are a plot of the fundamental period of a uniform ten-story building against the maximum equivalent static acceleration producing the same stress which occurs during the passage of the particular earthquake. The single-story spectrum shows the major peak at 0·4 sec. period. Fig. 2 and 3,

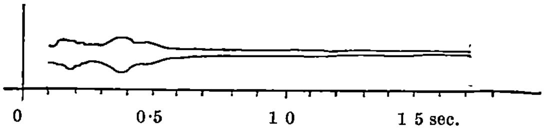

Fig. 1

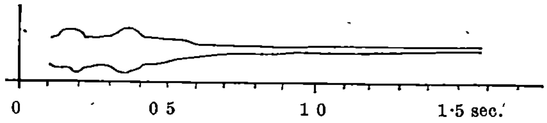

Fig. 2

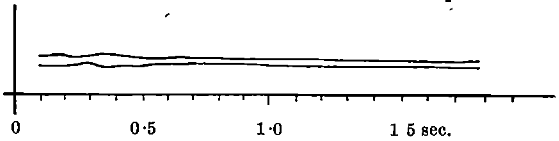

Fig. 3

Spectra for a uniform building: (1) single degree of freedom; (2) first story; (3) tenth story

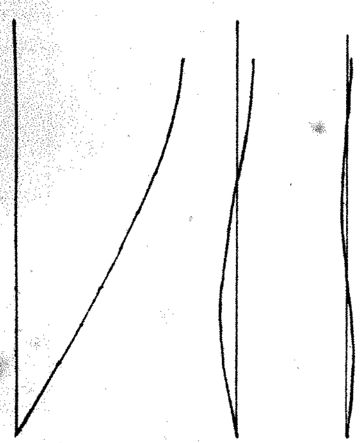

Fig. 4. Resonant amplitudes of the first three modes of oscillation for a fixed exciting acceleration

taken at the ground floor and top floor of a ten-story structure, show no peak at 1·2 sec., although the second harmonic of a structure of 1·2 sec. fundamental is 0·4 sec.

Fig. 4 shows the amplitudes developed throughout a ten-story structure when the ground undergoes a sinusoidal displacement at a constant value of peak acceleration and the frequency is made that of the various harmonics. The percentage damping is arranged to be the same for each mode.

It is concluded that, in a tall building, modes of oscillation other than the fundamental have far less effect than previously supposed. It is hoped that further work on the analogue machine may provide a theoretical basis for a more exact building code.

The work is to be published in detail elsewhere.

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Mobility of π-Electrons in Heterogeneous Linear Molecules

THE observation that the lowest energy singlet transition in the electronic absorption spectrum of *trans*-chalcone (compound 8 in Table 1) had the same oscillator strength as that for *trans*-stilbene[1] led us to investigate other compounds of the type Ph—X and Ph—X—Ph, where —X— stands for a conjugated chain containing hetero groups such as —CO—, —N=N— and —CH : N.N : CH—.

In the majority of these compounds, a considerable part of the total absorption intensity is found in the lowest energy $\pi \rightarrow \pi^*$ transition, the oscillator strength ($f = 4{\cdot}32 \times 10^{-9}\int\varepsilon\, d\nu$) generally being measurable with accuracy, since the absorption band is well separated from the remainder of the spectrum[2].

Kuhn, in a semi-theoretical treatment of polyene chains as a system of coupled linear oscillators[3], concluded that the electrons were about 90 per cent mobile and that, among other things, the oscillator strength of the lowest singlet–singlet transition could be calculated from the equation

$$f = 0{\cdot}178n \qquad (1)$$

where n is the number of —CH : CH— groups in the chain. For the diphenyl-polyenes he calculated that a phenyl group was equivalent to 1·5 double bonds.

In particular, for *trans*-stilbene, our observed f-value for the $\pi \rightarrow \pi^*$ transition is 0·755 and $n = 4$, which leads to the empirical equation

$$f_{\text{obs.}} = 0{\cdot}189n \qquad (2)$$

If equation (2) is extended to include hetero compounds such as those in Table 1, it may be re-written more generally as

$$f_{\text{obs.}} = 0{\cdot}189(1{\cdot}5a + b + n_{\text{het.}}) \qquad (3)$$

where a is the number of phenyl and b the number of vinyl groups; in any molecule, n_{het}, the double-bond equivalent for each hetero group, may then readily be calculated.

The results are listed in Table 1. They show that the carbonyl group makes virtually no contribution to the $\pi \rightarrow \pi^*$ transition intensity; acetone itself exhibits very weak absorption in the near ultra-violet region of the spectrum (compound 2). The azo group also appears not to make an intensity contribution to the $\pi \rightarrow \pi^*$ transition in azobenzene, although it gives rise to a lower-energy weak $n \rightarrow \pi^*$ absorption. On the other hand, the alazine group (compounds 11 and 12) is equivalent to at least two double bonds, that is, to two conjugated vinyl groups.

The exception among the ketones is cinnamaldehyde, for the behaviour of which there is no obvious explanation on the basis of the present discussion, especially since benzaldehyde behaves in the same way as the remaining ketones. For di-cinnamalazine, and to a less extent for di-benzalazine,

Table 1

No.	Compound	Structural formula	$f_{\text{obs.}}$	Hetero group	$n_{\text{het.}}$	$\varepsilon_{\text{max.}}$	$\nu_{\text{max.}} \times 10^{-3}$ cm.$^{-1}$
1	Acetoneazine*	$Me_2C : N.N : CMe_2$	0·045	—	—	~3,000	~46·0
			—			8,000	50·0†
2	Acetone*	MeCOMe	$5{\cdot}0 \times 10^{-4}$	—CO—	0	17·4	37·8
3	Benzaldehyde	PhCHO	0·28	—CHO—	0	13,300	40·0
4	Cinnamaldehyde	PhCH : CH.CHO	0·615	—CHO	0·75	25,000	34·3
5	Stilbene	PhCH : CHPh	0·755	—	—	29,000	33·8
6	Benzil	PhCOCOPh	0·55	—CO.CO—	0	21,200	38·5
7	Azobenzene	PhN : NPh	0·56	—N : N—	0	20,800	31·4
8	Chalcone	PhCH : CHCOPh	1·755*	—CO—	0	24,400*	32·2*
			0·750			23,500	31·9
9	Benzalacetone	$(PhCH : CH.)_2CO$	0·930	—CO—	0	35,800	30·2
10	Cinnamalacetone	$(PhCH : CHCH : CH.)_2CO$	1·35	—CO—	0	54,900	26·6
11	Benzalazine	$(PhCH : N.)_2$	0·970	—CH:N.N:CH—	2·2	37,500	33·3
12	Cinnamalazine	$(PhCH : CHCH : N.)_2$	1·53	—CH:N.N:CH—	3·2	65,900	28·9

* In water; all other spectra measured in 95 per cent ethanol. † Absorption still rising.

the situation is complicated by the fact that a further transition moderately intense in acetone-azine and possibly $n \rightarrow \pi^*$ in character, appears to have been shifted and intensified so as to overlap the strong absorption at low frequencies, giving apparently high values to n_{het}.

The conclusion from this work is that conjugated hetero groups in the chain of elongated planar molecules cause no decrease in mobility of the carbon π-electrons, even though such groups possess different types of orbitals from those in homogeneous conjugated molecules. This appears to be true whether or not the hetero groups themselves make a contribution to the intensity of the transition under consideration. Any such decrease in mobility would result not only in a marked decrease in intensity of the absorption band, but also in changes in its shape and location, with a consequent tendency for the band to overlap the remaining absorption at higher frequencies. On the contrary, a separate intense low-energy band is observed for the compounds containing one or two phenyl groups. These compounds must be in their fully extended 'all-*trans*' form, since it is well known that the corresponding stereoisomers containing one or more *cis*-bonds give rise to less intense absorption at the low-frequency end of their spectra[1,4].

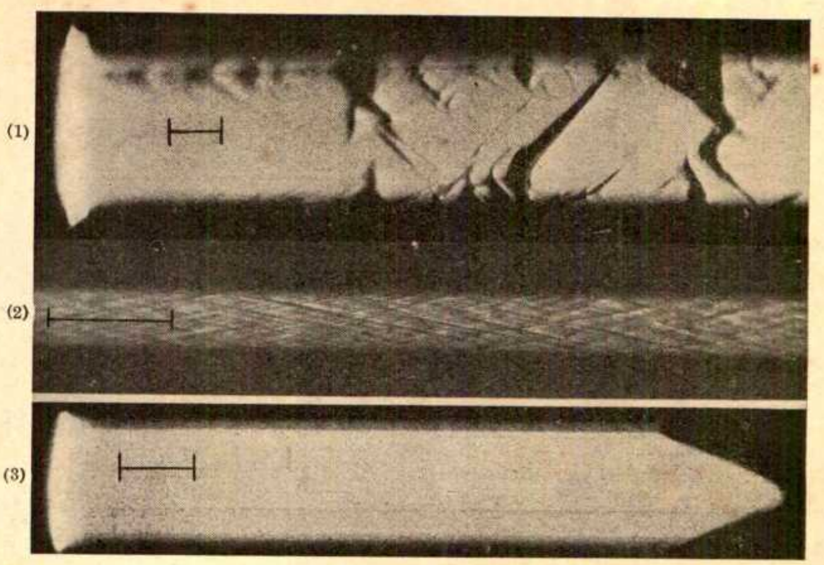

Fig. 1. End-on view. Dark-waves in nitromethane. Length of horizontal line corresponds to 1 microsecond

Fig. 2. End-on view. Dark-waves in nitromethane–acetone. Length of horizontal line corresponds to 1 microsecond

Fig. 3. End-on view. Nitromethane detonation running beyond foil lining and failing. Length of horizontal line corresponds to 1 microsecond

On the basis of the free-electron model, Bayliss has shown[5] that the intensity of the lowest-energy transition in a homogeneous conjugated polyene should be independent of its overall length and dependent only on the number of carbon π-orbitals. The present results indicate that this theory may be extended to include at least some types of conjugated heterogeneous molecules.

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Detonation Phenomena in Homogeneous Explosives

We have observed in this laboratory that the manner in which a detonation proceeds in a homogeneous explosive is more complex than had previously been thought. Regions of relatively low luminosity have been observed in the detonation fronts of homogeneous solid and liquid explosives under certain conditions of diameter and confinement. Although these regions of low luminosity, which we call 'dark-waves', are larger and more numerous under conditions close to failure, they have also been observed under conditions in which the detonation is apparently proceeding at normal, constant velocity.

Fig. 1 shows the camera trace obtained with a rotating-mirror camera[1] looking end-on at a cylindrical tube of detonating nitromethane as the front advanced toward the camera. The nitromethane was confined in a glass tube, 0·642-in. internal diameter, and was at an initial temperature of 24° C. The rotating mirror was operating at 1,000 rev./sec., which corresponded to a writing speed of 1·8 mm./µsec. on the recording film. A 0·05-mm. slit was used in the camera. Fig. 1, then, is essentially a time-history of that portion of the detonation front seen by the fine slit as the front proceeded up the tube. The trace starts at the left with a band of high luminosity caused by the initiating explosive (composition *B*), and numerous dark-waves can be seen later in time as the detonation front approaches the region of good focus. The detonation continued for 6 in., which was the full length of the tube, in spite of the dark-waves.

Fig. 2 shows a similar trace obtained from a detonating mixture of 84 per cent nitromethane – 16 per cent acetone (percentage by volume) confined in a brass tube of 0·500-in. internal diameter. Initially, the liquid explosive was at a temperature of 23° C. The rotating mirror was operating here at 5,000 rev./sec., which corresponds to a writing speed of 9 mm./µsec., and a 0·2 mm. slit was used. The dark-waves seen in this weakened explosive are characteristically finer and more numerous. They appear to originate at the tube walls and to advance into the detonating liquid at a lateral velocity of about 4 mm./µsec. Again, this detonation is a stable one which will proceed indefinitely at a constant velocity.

Dark-waves have also been observed in detonating diethylene glycol dinitrate, ethyl nitrate, and single crystals of PETN. It is very likely that they are characteristic of finite-diameter, detonating, homogeneous explosives. They appear to be more prevalent at smaller diameters, weaker confinement and lower initial temperatures. The dark-waves can become so numerous and large as to cause abrupt failure of detonation. The evidence as a whole suggests that dark-waves are closely associated with hydrodynamic rarefactions originating at charge boundaries.

An interesting effect observed in connexion with dark-waves is that very thin metal foils can considerably reduce the diameter at which failure of detonation of nitromethane occurs and often completely prevent the occurrence of large dark-waves. Fig. 3 shows a camera trace obtained from a glass tube of less than failure-diameter, the first 2 in. of which have been lined with 0·002-in. stainless steel foil. The rotating mirror was operating at 1,000 rev./sec. and a 0·05-mm. slit was used. It can be seen that the detonation is propagated in the foil-lined region and then cut off sharply as it travels beyond the foil. Other experiments have shown that tungsten foil is more effective than steel, and steel is more effective than 'Dural' in reducing the failure diameter of nitromethane in glass. The denser foils are effective in thicknesses less than 0·001 in. The fact that these very thin foils can prevent dark-waves and failure suggests that either the reaction zone in nitromethane is extraordinarily thin or that the foils are effective in allowing the important first step of the reaction to start (and perhaps proceed for a short time) undisturbed by edge effects. Other experiments do, indeed, suggest that the detonation reaction in nitromethane proceeds in several distinct steps[2].

Further work is in progress on these subjects and we plan to publish additional details shortly. The work was done under the auspices of the U.S. Atomic Energy Commission.

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The Cubic Form of Ice

Electron diffraction experiments have been carried out on deposits formed by water vapour on a base at low temperatures. The water vapour is produced in a separate injection unit outside the camera. The object of the experiments was to study, in particular, the diamond-type cubic form of ice observed by König[1] in deposits formed at low temperatures from the residual vapour in an electron-diffraction camera.

The cubic form was found by König to transform on heating into the normal hexagonal structure of ice at about − 80° C. These experiments were of the transmission type, which means that the ice layers can scarcely have been more than a few thousand angstroms in thickness. Experiments by Tschudin[2] on the free evaporation of massive ice in vacuum show, however, that at − 80° C. a layer of ice should be diminishing in thickness at a rate of at least three thousand angstroms a second. It would appear, therefore, that there is some form of contamination which effectively prevents evaporation. In view of the theoretical importance of a new form of ice at zero pressure, it was thought worth while to check the existence of this structure, using a method which allowed the supply of water vapour to be controlled. This was achieved by immersing the water in the injection unit in a bath, the temperature of which could be varied but was usually set at − 78° C.

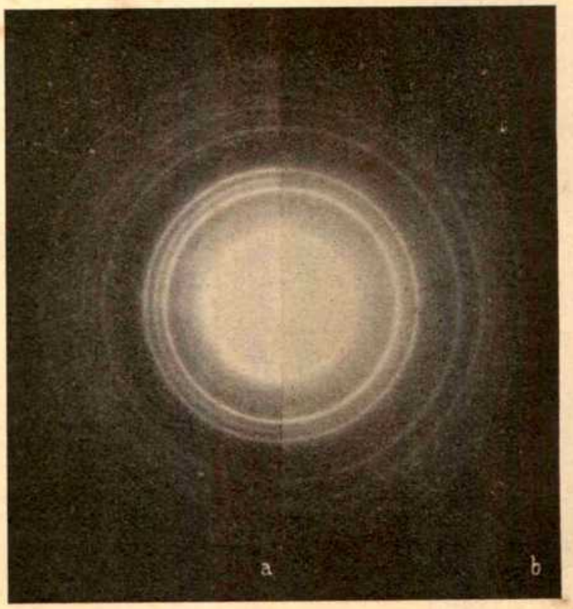

Fig. 1. Transmission patterns of ice: (*a*) hexagonal ice; (*b*) cubic ice

The deposits were formed on a base in a special low-temperature unit which fitted into an existing electron-diffraction apparatus. The unit is essentially a liquid-air jacket containing channels for the electron beam and for the water vapour from the injection unit. The specimen carrier is mounted on a brass disk which is connected both to a heater unit and to the liquid-air container. The temperature of the specimen can be varied from − 180° C. to room temperature.

Three types of diffraction patterns were found with the injection technique depending on the temperature of the base (see Table 1 and Fig. 1). The bases used in transmission experiments were: 'Formvar', collodion, silica, amorphous germanium. In reflexion experiments, cleaved galena was sometimes employed; the usual bases were, however, films of silver formed by evaporation on to heated mica. These have flat surfaces and give a diffraction pattern characteristic of a single crystal.

The same types of deposit were obtained as those found by König, though the characteristic temperature ranges are considerably different. This is in part due to the fact that the deposits in König's work were formed at very low temperatures and then heated. When similar experiments are carried out using the injection technique, the diffuse ring pattern changes on heating into the diamond-type cubic pattern at about − 115° C., the transition taking

Table 1. Injected Water Vapour

Temperature of base	Diffraction pattern	Comments
− 180° to − 140° C.	Diffuse rings	—
− 140° to − 120° C.	Sharp rings	Diamond-type cubic
> − 100° C.	Sharp rings	Hexagonal ice
> − 105° C.		Rapid evaporation

place in a temperature range of about 2 deg. C. The deposit evaporates completely at − 105° C. These results differ from those found by König in two respects. The transition point is substantially higher and better defined, and the layer evaporates completely at a much lower temperature.

To examine this point, deposits were formed from residual vapour in the camera, this being possible if the pumping period is not as prolonged as usual. When 'Formvar' or collodion was used as a base, results were obtained similar to those of König, including the transition from the cubic to the hexagonal form at − 80° C. With other bases, the layers evaporated completely at about − 105° C.; these bases were silica and amorphous germanium in the transmission work and silver in reflexion experiments. These and other experiments suggest strongly that the tenacious character of the deposits is associated with some contamination, which in its turn is associated with the organic bases.

The spacing of the cubic ice was measured at − 120° C., using thallium chloride and rocksalt as standards, the known spacings at room temperature being extrapolated to − 120° C., using expansion data at room temperature, Grüneisen's law and specific heat data.

The cube spacing of the diamond-type form of ice is found to be 6·351 ± 0·007 angstroms, at − 130° C., a value which is slightly lower than that found by König.

Experiments were also carried out using heavy water (of purity 99·72 per cent). The same three types of deposit were found as for ordinary water, the temperatures involved being only a few degrees higher than those characteristic of ordinary water.

The work described above has been made possible by grants from the Department of Scientific and Industrial Research and the Rockefeller Foundation. It is part of an interdepartmental programme organized by Dr. B. J. Mason, of the Meteorology Department of this College.

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Symmetry of Azulene Crystals

The problem of the symmetry of azulene crystals was first put to me by Dr. H. H. Günthard[1] in 1949. He gave me some of the material from which I prepared, by sublimation, extremely pleochroic crystals.

The crystals showed the forms {001} and {110}, but in addition every crystal showed one, and only one, form of the plane (100). In other words, one acute corner of every diamond-shaped crystal was truncated. This seemed to me a strong indication that there was no axis of symmetry and that the space group was Pa and not $P2_1/a$. It is interesting to find from the communication of Prof. J. M. Robertson and Dr. H. M. M. Shearer[2] that X-ray statistical tests confirm the indications of classical crystallography.

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Geometrical Isomerism of some Nitrophenylhydrazones of Benzoyl Formic Acid and their Infra-red Spectra

Recently, papers[1,2] have appeared describing *cis*- and *trans*-2 : 4-dinitrophenylhydrazones of some aliphatic α-keto acids. The structural assignment of the hydrazones as geometrical isomers was confirmed by means of infra-red spectra. Previously[3] we separated 2 : 4-dinitrophenylhydrazone of benzoyl formic acid into two forms, using a salting-out process, and found that the *trans*-form is changed into the *cis*-form by sunlight.

We have now investigated further this hydrazone, as well as mono nitrophenylhydrazones of the acid; it was found in each case that the *cis*-form sodium salt, from the isomeric mixture, could also be precipitated by salting-out with sodium carbonate. Each *cis*-isomer had a higher R_F value (on a silica gel chromato-strip[4] buffered by sodium phosphate), a longer $\lambda_{max.}$ and a lower melting point (except for the 2 : 4-compound). These constants and infrared data agree well with Isherwood's results[1] (Table 1). All these isomers were isomerized in carbonate solution, or by sunlight or heat.

Separation of the geometrical isomers. Well-powdered hydrazones (2 gm.) were suspended in about 80 ml. of $N/2$ carbonate solution, and various amounts of anhydrous sodium carbonate (0, 1·5, 3, 7 gm.) were then added for the 2 : 4-dinitro-, *o*-, *p*- and *m*-nitro compounds respectively. The precipitated salt (*cis*-form) was washed with carbonate solution. The filtrate was promptly precipitated with hydrochloric acid, and a pure *trans*-form was obtained by recrystallization from methanol with a small amount of acetone. To obtain a pure *cis*-form, the precipitated salt was dissolved in luke-warm water, and again precipitated by the addition of carbonate, and freed from sodium. Purification was by recrystallization from a mixture of methanol and benzene. The 2 : 4-dinitro compound was the most sharply separated. Solubilities of sodium salt of this *cis*-form (having 3·5 moles of water) in water and in normal sodium carbonate solution were 0·82 gm./l. and 0·01 gm./l., respectively. The isomer is sensitive to both light and heat.

Isomerization of the isomers. Isomerization was carried out in alcoholic aqueous solution, with or without addition of carbonate. Such solutions were either left in the sunlight or in the dark. Isomerization and decomposition were traced by studying, spectrophotometrically, the variations of $\lambda_{max.}$ and extinction. In carbonate solution, *m*-isomers were isomerized more distinctly, and accompanied by distinct decomposition. The transformation equilibria (starting from both forms) occurred at two different points according to whether the solutions were in the dark or in the light. This may indicate that isomerization occurs in ionic and in photochemical radical processes concurrently. Other isomers, however, isomerized rather slowly under the same conditions. Contrary to the *m*-isomer, the equilibria of the *o*- and *p*-isomers were at nearly the same respective points. The dinitro-compound, on the other hand, was completely converted into a *cis*-form, without decomposition. After exposure to sunlight, from a concentrated solution of the pure *trans*-form of this compound with carbonate, both forms were actually obtained almost quantitatively. Reverse isomerization could not be effected under alkaline or acidic conditions.

Table 1. CONSTANTS OF SOME PHENYLHYDRAZONES OF BENZOYL FORMIC ACID AND SOME INFRA-RED SPECTRAL BANDS

Hydrazones of benzoyl formic acid		Melting point (° C.)	R_F	λmax.* (mμ)	εmax.* ($\times 10^3$)	Infra-red spectral bands (microns)† Finger print region	CO-stretching bands	NH-stretching bands
2 : 4-Dinitro-	*cis*	202	0·6	393	26	9·99w	5·96s	—
	trans	197	0·4	372	24	9·80m	5·91s	3·07w
o-Nitro-	*cis*	180	0·4	451	9·2	9·94w	5·96s	3·13–3·16w
	trans	203–204	0·2	436	6·8	9·79m	5·85s, 5·95s	3·07w
p-Nitro-	*cis*	183	0·4	412	33	9·97w	5·98s	—
	trans	191	0·2	393	25	9·79m	5·93s	3·07w
m-Nitro-	*cis*	181	0·4	329	21	9·93w	6·01s	3·09w
	trans	192	0·2	308	22	9·79m	6·02s	3·08w
Phenyl-hydrazone of benzoyl formic acid (*cis*)						9·96w	6·05s	—
2 : 4-Dinitro-phenyl-hydrazone of meso-oxalic acid						—	5·81s, 5·86s, 5·99m	—

* In alcoholic aqueous solution. † s, strong ; m, medium ; w, weak.

Infra-red spectra of various phenylhydrazones of benzoyl formic acid and of mesoxalic acid. The infra-red spectra were all obtained with the substances in a paraffin mull. A Perkin–Elmer Model 21 spectrometer fitted with a rocksalt prism was used.

The spectra of all *trans*-forms of the four nitrophenylhydrazones of benzoyl formic acid were characterized by the appearance of weak and sharp absorption bands in the region 9·79–9·80μ. On the other hand, all *cis*-forms of these compounds showed medium bands in the 9·93–9·99μ region. With the phenylhydrazone (which is not separable into two forms), a band appeared in the same region as that of the *cis*-form. In the case of the 2 : 4-dinitrophenylhydrazones of mesoxalic acid, as well as of pyruvic acid (observed by T. Moriwaki[2]), there were no distinct bands in these regions.

In the case of the chelated *cis*-isomers, with the exception of the *m*-nitrophenylhydrazones, the strong carbonyl bands appeared in the longer wave-length region as with those of aliphatic acid derivatives, the original shorter wave-length bands of which almost disappeared. The obscure imino bands became more obscure (Table 1).

I am grateful to Profs. R. Nodzu and R. Gotō, of Kyoto University, for their helpful suggestions. The use of the Perkin–Elmer instrument was made possible through the courtesy of the Sumitomo Chemical Co., Ltd., in Osaka.

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Formation of Free Radicals in Polymer Films on Irradiation

It is known that free radicals may be formed in rigid solvents[1–3], and that during the polymerization of acrylonitrile they may become trapped in the polymer[4]. The relative stability of the radicals under these conditions probably accounts for the instability of cellulose observed[5] after exposure to ultra-violet radiation. We have recently been studying the action of light on dyed and undyed films and some of our results are of interest in connexion with the recent observations of Ford[6]. In the course of our work, undyed films of cellulose acetate (deplasticized, British Celanese), nylon (no plasticizer, hexamethylene diamine – adipic acid, 0·004 in. thick, Du Pont de Nemours) and methylmethoxy nylon (no plasticizer, Imperial Chemical Industries) have been exposed to the effect of heat and/or radiation.

Our results with these films can be summarized briefly : (1) The absorption spectra of the unexposed films are not appreciably changed on heating in either oxygen or nitrogen in the dark at 50° C. for 150 hr. (2) After prolonged exposure in either gas to a high-pressure mercury-vapour lamp (G.E.C., Osram) only slight changes in absorption spectra are found either immediately after exposure or after storage in the dark at room temperature or at 50° C. (3) On exposure to a low-pressure mercury lamp emitting mainly at 2537 A., profound changes are produced in the films. These changes are (*a*) an effect shown immediately after exposure, and (*b*) a post-irradiation effect, which appears on storage in the dark and is greater on storage at higher temperatures.

The latter experiments were carried out in quartz absorption cells, and streams of dry nitrogen (oxygen-free) or oxygen were passed through them continuously throughout the experiment. Fig. 1 illustrates the changes with nylon film. After exposure for 20 hr. the peak in the unexposed film at 2800 A. is displaced to 2900 A. and is considerably increased. On heating in the dark at 50° C. for 300 hr. the peak reverts to about 2850 A. and is further augmented. This change occurs in both oxygen and nitrogen, and would seem to exclude the suggestion made by Ford[6] that the change in nylon films on irradiation is due to combination with oxygen. This may possibly occur to some extent during irradiation in oxygen ; but the similarity of the results in oxygen and nitrogen suggests that the full explanation is likely to be much more complex. Other workers[7,8] have observed the development of a band in the region of 2800–2900 A. on the heating of nylon at high temperatures in a vacuum, and it may be that the products formed on irradiation and on pyrolysis resemble one another.

After an exposure of 5 hr. it was observed that in nitrogen (but not in oxygen) the peak at 2800 A. in the unexposed nylon film was depressed and flattened immediately after irradiation, although after heating in the dark for 300 hr. at 50° C. the curves in both oxygen and nitrogen were beginning to show the trend displayed prominently in Fig. 1, that is, peaks in the region of 2850 A. It seems likely that the changes in absorption spectra are due to slow recombination of trapped free radicals formed by photolysis either with themselves or by a series of complex reactions with the polymer chain itself.

The results obtained with cellulose acetate film show one very interesting feature. Immediately after irradiation the increase in optical density of film exposed

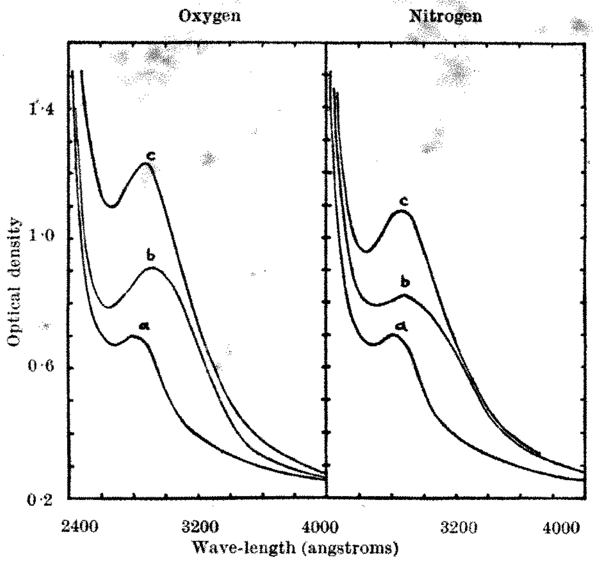

Fig. 1. Nylon film exposed to low-pressure mercury-vapour lamp: (*a*) unexposed; (*b*) immediately after 20 hr. exposure; (*c*) heated for 300 hr. at 50° C. after exposure

in dry nitrogen is greater than that exposed in oxygen, the difference apparently being greater the longer the period of exposure. It is thus not possible to ascribe such changes purely to reaction with oxygen. Methylmethoxy nylon films, which have no absorption peaks before exposure, are highly unstable to short-wave ultra-violet radiation. Although the changes are greater in oxygen than in nitrogen, there is some evidence in both gases of the formation of a peak around 2800 A., suggesting that the methylmethoxy group may possibly be split off the polymer chain on irradiation. Substantial changes occurred with these exposed films on heating at 50° C. for 300 hr.

There seems to be one important conclusion from this work which has a bearing on the related subject of the action of near ultra-violet and visible light, such as is present in sunlight, on textile materials. There is substantial evidence[9] that this phenomenon is completely different in mechanism from the photolytic effect of 2537 A. radiation. The results with the undyed films suggest that on irradiation with near ultra-violet and visible light no trapped free radicals are produced in the polymer material. It thus appears doubtful whether free radicals play any part in the degradation of textile materials which are exposed to sunlight behind glass.

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A Complement-fixing Antigen from Egg-adapted Canine Distemper Virus

THE distemper complement fixation test, first used by Laidlaw and Dunkin[1] for measuring the antibody content of hyperimmune dog serum, has not been extensively employed in studies on this disease. These authors, together with Pyle and Brown[2], Mansi[3,4] and Hudson and Mansi[5], have all used relatively crude suspensions of infected dog tissue as antigen. The one attempt to demonstrate complement fixation antigen in various chick embryo tissues subsequent to infection with egg-adapted viruses was unsuccessful (Mansi[4]).

Preliminary experiments with the Onderstepoort egg-adapted distemper strain (190th chorioallantoic membrane passage) showed that virus-rich chorioallantoic membrane was able to fix complement in the presence of both distemper-immune and normal dog sera. This latter non-specific reaction was, however, greatly reduced following adsorption of the crude chorioallantoic membrane material with a strongly basic anion-exchange resin, 'Dowex-1'. A subsequent period of heating at 56° C. for 15 min. completely abolished non-specific activity without adversely affecting antigenicity. The procedure now to be described repeatedly yielded satisfactory complement fixation antigens.

Five days after inoculation of chorioallantoic membrane with a high concentration of seed-virus, grossly infected areas were removed and ground in a blender to form a 50 per cent (w/v) suspension in Kolmer saline (100 mgm. $MgCl_2.6H_2O$ in 0·85 per cent NaCl). The crude suspension was clarified by slow-speed centrifugation and then adsorbed for 30 min. at room temperature with an equal volume of 'Dowex 1*x*–10' resin (the adsorbant previously being converted to the sodium form with 10 per cent disodium hydrogen phosphate and repeatedly washed in distilled water). Following centrifugation, the supernatant fluid was removed and heated at 56° C. for 15 min. and finally titrated against immune dog serum by the 'chessboard' method to determine the optimal antigen concentration for routine use (usually a 1 : 2 or 1 : 4 dilution of stock material).

Antigens prepared by the above method were not anticomplementary, did not produce a precipitate when stored in the fluid state at 4° C., and when used with a 'short' fixation time (1 hr. at 37° C. prior to the addition of sensitized red cells) did not show the false positive reactions which often occurred following overnight ice-box fixation. Contrary to the observation of Mansi[4], it was found essential to inactivate at 56° C. for 30 min. all dog and ferret sera prior to testing, since unheated sera were invariably procomplementary and yielded false negative results. Using the above method, distemper-immune dog sera complement fixation titres of the order of 1 : 32 to 1 : 48 (50 per cent fixation end-point) were regularly obtained, while sera from young 'normal' puppies failed to react in a dilution of 1 : 5. It is of interest to record that these former sera when diluted 1 : 250 to 1 : 500 and mixed with approximately one hundred egg-infective doses of virus completely suppressed lesion formation on the chorioallantoic membrane. The negative sera in the lowest dilution tested (1 : 10) did not prevent virus growth.

Incidental observations made on the distemper antigen produced from chorioallantoic membrane suspensions showed the 'Dowex'-adsorbed material to be virtually inactive after heating for 30 min. at

56° C. Antigenicity was, however, completely retained at this temperature during the 15 min. necessary for the abolition of non-specific reactions with normal dog sera. Several unsuccessful attempts were made to prepare satisfactory antigens from crude chorio-allantoic membrane suspensions by precipitation either with methanol (30 per cent final concentration) or with protamine sulphate (0·5 per cent). These results will be reported on in detail at a later date.

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Influence of Ionizing Radiation on the Appearance in the Serum of Rabbits of Humoral Factors slowing down Cell Division

WORK was undertaken to study certain physiological mechanisms which play a part in the reaction of higher organisms to ionizing radiations. I wish to record the finding in the serum of irradiated animals of a humoral factor that influences the rate of cell division. Experiments of a similar nature have been reported by other workers[1], who found, however, no or uncertain effects of humoral factors.

Rabbits received a single dose of whole-body X-irradiation of 900 r. (focal skin distance 90 cm., 190 kV., 12 m.amp., 0·5 mm. copper, dose-rate 20 r./min.). Blood was obtained by cardiac puncture 24 hr. after irradiation of the animals. Simultaneously and by the same procedure, blood was obtained from controls. Heart fibroblasts of chicken embryos were cultured quantitatively in roller tubes, using, with minor adjustments, the method described by Hull *et al.*[2]. 4 ml. of serum of irradiated rabbits or controls with the addition of 50–100 μc. of radiophosphorus as acid sodium phosphate dissolved in 0·1 ml. saline were used as culture medium. Growth, as indicated by the daily increment of the radioactivity of the culture, was determined daily for periods of about ten days; in later experiments, cultivation was discontinued after five daily measurements.

The reproducibility of growth-curves, as determined by the above-mentioned technique, was established in forty experiments, using identical serum in duplicate or triplicate cultures. The probable error in these experiments was about 10 per cent. The significance of the difference in growth-rate observed between tissue cultures grown on serum of irradiated rabbits and on serum of controls was tested by Fisher's *t*-test using the results of thirty-one experiments (fifteen irradiated, sixteen controls). The results show that tissue cultures grow more slowly on the sera of irradiated rabbits than on the sera of controls, the difference being about 30 per cent. This difference was statistically highly significant ($P < 0\cdot01$).

In further experiments, serum of irradiated or control sabbits respectively was added to the standard fluid medium and infected with a standardized suspension of *E. coli* (9 ml. standard medium + 3 ml. serum + 0·1 ml. standard suspension of *E. coli* in saline). Growth of the culture was evaluated by the turbidimetric method, using in early experiments a Coleman Junior spectrophotometer. Measurements were carried out at 650 mμ. In later experiments, the automatic recording photocolorimeter described by Marha and Jenšovský[3] was used.

To compare growth-rates, the values of $t_{1/4}$, $t_{1/2}$ and $t_{3/4}$ were determined. These values indicate the time necessary for the number of organisms, and so the turbidity of the culture, to reach one-quarter, one-half and three-quarters of the maximal value.

As in the case of our experiments with quantitative tissue cultures, the reproducibility of results using identical sera in duplicate or triplicate experiments served as a measure of the error of the method. A probable error of 2 per cent was obtained in our experiments, indicating that the method is well reproducible.

Table 1 shows the mean relative $t_{1/4}$, $t_{1/2}$ and $t_{3/4}$ for *E. coli* cultures using standard medium, standard medium with the addition of serum of controls and standard medium with the addition of serum of irradiated rabbits.

Table 1

Medium	Relative $t_{1/4}$	Relative $t_{1/2}$	Relative $t_{3/4}$
Standard medium	1·0	1·0	1·0
Standard medium + serum of controls	1·32	1·33	1·31
Standard medium + serum of irradiated rabbits	1·64	1·63	1·58

All the differences shown in Table 1 are statistically highly significant ($P < 0\cdot01$).

These experiments lead to the conclusion that the addition of rabbit serum to the standard medium decreases the growth-rate of *E. coli*. On addition of serum of irradiated rabbits, the growth-rate decreases still further. On analysing the growth curves, we find that the decreased growth-rates are caused by the prolongation of the initial stationary phase of the cultures.

In further experiments we have shown that when rabbit blood or rabbit serum is irradiated *in vitro*, it does not influence the growth-rate of *E. coli*, if added to standard culture medium. In order to produce this effect, the whole organism has to be irradiated.

In addition it was found that the factor responsible for hampering cell division is thermolabile, that it can be inactivated by heating to 56° C. for 30 min.; further, it was found that it does not pass through ultrafilters. On coagulation of the serum proteins at low temperature with an ether–alcohol mixture, the humoral factor stays in the coagulum. On dialysing the serum, the dialysate and the euglobulin fraction showed no influence on the growth-rate of *E. coli*. The pseudoglobulin and albumin fraction, however, prolonged the initial stationary phase of *E. coli*. On incubation of the serum for 1 hr. at 37° C. with *E. coli* killed by heating to 65° C. for 1 hr., the serum loses most of its depressing effect. Similar results are obtained on incubating the serum with a cellular suspension of calf thymus. Incubation of the serum with dead micrococci without toxic components typical of staphylococci, or with dead air-borne bacilli anthracoides, causes loss of ability of the serum to depress the growth of *E. coli*.

The experiments described prove, therefore, the existence of a humoral factor slowing down cell division on the serum of rabbits. The effect of this factor increases after irradiation of the rabbit. The fact that irradiation of blood or serum *in vitro* with doses of irradiation used in these experiments does not increase the ability of the serum to slow down growth of tissue cultures or *E. coli* indicates that this effect is not due to physico-chemical changes caused directly by the effect of ionizing radiation on the serum proteins, as assumed by Woenckhaus[4] and Žáček[5]. The whole organism must be irradiated to achieve this effect.

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Probable Identity of an Antibiotic produced by a Spore-bearing Bacillus of the *B. pumilus* Group with Micrococcin

THE production of an antibiotic by a species of *Micrococcus*, isolated from Oxford sewage, was reported by Su[1], who named the substance micrococcin. Later, Heatley and Doery[2] gave an account of the preparation and some of the properties of purified micrococcin. They showed it to be relatively insoluble in water, to darken and sinter at 222–28° without having a sharp melting-point, to show a maximum in its ultra-violet light absorption spectrum in ethanol at 345 mμ (E 1%, 1 cm., 180), to have $[\alpha]^{21}_{D}$ + 116° (c, 5·0) in 90 per cent ethanol, molecular weight greater than 2,000, and to give the following elementary analysis: C, 49–49·5; H, 4·6; N, 13·9; S, 15·9 per cent. They also stated that "it gives a positive ninhydrin reaction only after acid hydrolysis, but this seems to be due to ammonia, not amino-acids. Nothing is known of its chemical nature". Still later, Fuller[3] isolated from cultures of a spore-bearing bacillus of the *B. pumilus* group, originating in soil collected in East Africa, an antibiotic, sparingly soluble in water, which became discoloured at 232°, sintered at 238°, and appeared to melt at 252°; it gave the following elementary analysis: C, 48·9; H, 4·7; N, 13·7; S, 16·0 per cent. It did not appear to give a ninhydrin test even after hydrolysis with hydrochloric acid and was thought to be of non-peptide nature.

The similarity in the properties of the antibiotics from these two widely divergent sources suggested that they might indeed be related in structure, and, in the interval, some progress[4] had been made with the study of the chemistry of the antibiotic obtained from *B. pumilus*, which had been found to have a maximum in its ultra-violet light absorption spectrum in 95 per cent ethanol at 345 mμ (E 1%, 1 cm., 210) and to have $[\alpha]^{21}_{D}$ + 63·7° (c, 1·19) in 90 per cent ethanol. On acid hydrolysis it broke down to give a series of compounds, conveniently considered in two groups, (i) soluble, and (ii) insoluble, in the cold diluted hydrolysis mixture. Continuous ether extraction of the acid-soluble fraction afforded a substance, $C_7H_7O_3NS$, and propionic acid, leaving still a complex mixture of substances, while treatment of the insoluble material with methanolic hydrogen chloride gave a non-basic substance, $C_{24}H_{23}O_5N_5S_4$, and a substance, $C_{16}H_{19}O_3N_3S_3$ (?), isolated as the picrate. Further examination of the water-soluble fraction left after removal of the substance $C_7H_7O_3NS$ showed it to contain ammonia in amount corresponding to about 23 per cent of the total nitrogen present in the antibiotic (micrococcin, 24·2 per cent[2]), and paper chromatography in butanol/acetic acid/water (63 : 10 : 27) revealed the presence of four ninhydrin-reacting substances giving spots of R_F about 0·20 (violet), 0·26 (yellow) forming a cap to another spot of R_F 0·32 (violet), and 0·52 (violet). Ion-exchange chromatography on 'Amberlite *IR*-120(H)' afforded the first and fourth of these ninhydrin-reacting substances in pure form. The slowest-running substance in the paper chromatography came off the resin first in N hydrochloric acid and proved to be L-threonine, while the fastest-moving substance in the paper chromatography left the resin last in 3 N hydrochloric acid and was a substance, $C_8H_{12}O_2N_2S$, isolated as the hydrochloride.

After acid hydrolysis of micrococcin, earlier carried out in Oxford, the same pattern of ninhydrin-reacting substances was shown on paper chromatography as that observed for the antibiotic from *B. pumilus*, and the two antibiotics have now been found to possess very similar infra-red absorption spectra and comparable fluorescence characteristics. In addition, redetermination of the optical rotatory power of micrococcin at lower concentration than that previously used[2] has given $[\alpha]^{21}_{D}$ + 62·2° (c, 1·10) in 90 per cent ethanol, and the substances $C_7H_7O_3NS$ and $C_{24}H_{23}O_5N_5S_4$ have now both been isolated after acid hydrolysis of micrococcin, so that a considerable degree of identity, or near-identity, between the antibiotics from the two sources has been demonstrated. However, with substances of such a degree of complexity as these one cannot be confident that they are identical in every detail, and it is still possible that, as in other cases among antibiotics, we have in these two substances two members of a group of closely related compounds. As the name 'micrococcin' is already established in the literature, it may be undesirable to apply a specific trivial name to the antibiotic produced by *B. pumilus* in view of the

Table 1

Test organism	Minimal inhibitory concentrations (μgm./ml.) in nutrient broth	
	Micrococcin	Micrococcin *P*
Bacillus cereus	0·05	0·05
Bacillus laterosporus	0·03	0·01
Bacillus firmus	0·4	0·4
Bacillus mycoides	0·02	0·02
Streptococcus haemolyticus, Group *C*	0·2	0·2
Streptococcus faecalis	0·05	0·05
Staphylococcus, Group *B*	0·07	0·07
Staphylococcus aureus "13"	2·0	2·0
,, ,, "21"	0·2	0·5
,, ,, "23"	0·5	1·0
,, ,, "24"	5·0	5·0
Leuconostoc citrovorum	0·02	0·01

The strains of *Staphylococcus aureus* had been isolated from hospital cases and were kindly provided by Dr. Mary Barber, Department of Bacteriology, St. Thomas's Hospital. Strains "13" and "21" were resistant to penicillin, streptomycin and oxytetracycline, while strain "23" was resistant to penicillin; strain "24" was sensitive to penicillin, streptomycin and oxytetracycline.

relationship between the two antibiotics that has emerged. On taxonomic grounds, however, the term 'micrococcin' is too narrowly suggestive of source to be satisfactory as a name for the antibiotic from *B. pumilus*; but, in the circumstances, it may serve as a chemically generic name, and we propose to refer to the antibiotic obtained from *B. pumilus* as 'micrococcin *P*', in the absence of evidence to show that the two substances are completely identical. As Table 1 shows, the antibacterial 'spectra' of the two substances were very similar, and organisms made resistant to one antibiotic were resistant to the other in comparable degree.

An account of the chemistry of micrococcin *P* will appear elsewhere[4].

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Intra-cellular Identification of the Rous Virus

It has recently been established by an electron microscopical survey that the incidence of tumour cells with virus-like particles 70 mμ in diameter varied widely in the tumour-cell populations of different examples of Rous ascites tumours[1]. In view of the manifest impossibility of equating unknown particles with virus on morphological grounds alone, further experiments have been made in which morphological studies were combined with biological tests.

A sample of ascitic fluid was taken from each of five Rous ascites tumours and the number of tumour cells in it was determined using a hæmocytometer. Each sample was divided into two portions. The first portion was used to make electron microscope preparations by the method employed in the earlier work[2]. This method allows all the cells in a sample to be examined as well as the whole of each cell, and thus makes it possible to establish the incidence of tumour cells with particles in the total tumour-cell population. To do this, 3,000 cells from each tumour were searched in the electron microscope.

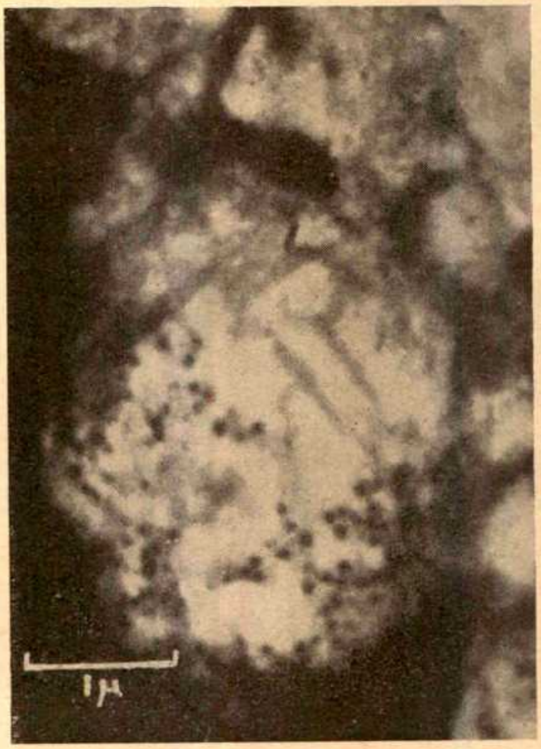

Fig. 1. Vacuole from a Rous ascites tumour cell showing a group of Rous virus particles; the limiting membrane of the vacuole can also be distinguished, particularly where it has become folded. Fixation over osmium oxide vapour was started after the cell had been *in vitro* for 21 min. and was continued for 30 hr. Electron micrograph, × 20,000

The cells in the second portion of each sample were collected by centrifugation, washed six times by centrifugation and then disrupted under standard conditions in a mechanically driven Ten Broek disintegrator. The virus released from the broken cells was titrated by diluting in serial tenfold steps and inoculating samples of each dilution intradermally in four young pullets. From the number of tumours which developed following the inoculations, that dilution of the virus suspension which would have caused tumours in 50 per cent of the birds was calculated[3]; the result has been expressed in terms of 1 ml. of ascitic fluid containing the cells from which the virus suspension was made and is shown in Table 1 as the 'tumour dilution 50 per cent' (*TD*50).

It can be seen from Table 1 that where few tumour cells with particles were found (Exp. 12) the tumour-producing activity of the virus extractable from the cells was low, while where many cells with particles were found (Exps. 10 and 11) this activity was high. The figures between these extremes (Exps. 9 and 13) also show close agreement. Statistically, the correlation is highly significant and $P = 0{\cdot}002$; taken in conjunction with the size of the particles and their appearance, this correlation makes it possible definitely to identify the particles as the Rous virus. From the results obtained it has also been possible to show that something of the order of 50 virus particles were the average minimum number needed

Table 1. CORRELATION BETWEEN INCIDENCE OF ROUS ASCITES TUMOUR CELLS WITH PARTICLES IN TOTAL TUMOUR-CELL POPULATION AND INFECTIVITY OF VIRUS EXTRACTABLE FROM THE CELLS

Exp. No.	Tumour cells per c.mm. ascitic fluid	No. of cells examined in electron microscope	No. of cells containing particles	Incidence of cells with particles	No. of cells with particles per ml. ascitic fluid	*TD*50 per ml. ascitic fluid
9	23,000	2,997	6	1/500	46,000	$10^{-5 \cdot 3}$
10	24,000	3,003	40	1/75	320,000	$10^{-6 \cdot 4}$
11	26,000	3,000	52	1/57	456,000	$10^{-6 \cdot 1}$
12	18,000	3,000	1	1/3,000	6,000	$10^{-4 \cdot 1}$
13	29,000	3,000	16	1/187	155,000	$10^{-5 \cdot 8}$

to cause a tumour under the experimental conditions used.

As in the earlier work[1], the virus particles have only been observed grouped together in association with the vacuoles which are commonly found in Rous ascites tumour cells. So far, 27,637 such cells, with their fine structure well preserved, have been examined in the electron microscope, and 168 of them have contained virus particles. In no single instance has the virus been observed lying free in the cytoplasm. The vacuoles have been found to have a limiting membrane; such a membrane can be seen around the vacuole shown in Fig. 1, particularly where it has become folded. A group of virus particles is also present.

A detailed account of this work is to be given elsewhere[4], together with a discussion of its significance and its relation to reports of unidentified particles in fowl cells, both from normal chick embryos[5] and from Rous tumours[6].

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Effect on the Growth-rate of Weanling Rats of supplementing the Protein of White Bread with *l*-Lysine

WE have recently re-investigated the rates of growth of rats, of both sexes and at various ages, on diets in which all the protein was derived from white flour (70 per cent extraction) or from wholemeal. The stimulus for this re-examination was provided by the publication by Widdowson and McCance[1] of their results of the growth of both children and animals on diets containing a large proportion of wheaten flour. Our experiments have shown[2] that the superior growth-rate of male weanling rats on the protein of wholemeal, compared with that of white flour, is due to the higher lysine content of the wholemeal protein. This work also demonstrated the extreme sensitivity of the weanling rat to small changes in the lysine content of the diet, when wheaten flour is providing the protein. We have accordingly now investigated the growth response of male weanling rats when small increments of *l*-lysine were added to a diet in which the protein was provided by white bread. Similar experiments have been carried out by Rosenberg and Rohdenburg[3], Rosenberg, Rohdenburg and Baldini[4] in the United States; but the bread used contained 3 per cent non-fat milk solids.

This type of experiment was of additional interest since it is known that, with certain diets, an increase in the content of a single amino-acid may lead to a reduced rate of growth through inducing an amino-acid imbalance. This effect, and the related problem of antagonism between certain individual amino-acids, have been extensively investigated by Elvehjem and co-workers, and a paper[5] by the Wisconsin workers gives a comprehensive list of references to earlier work. The results we have obtained are given in Table 1.

Table 1. RESPONSE TO THE ADDITION OF *l*-LYSINE TO A DIET IN WHICH THE PROTEIN WAS SUPPLIED BY WHITE BREAD CRUMB
(Growth of male rats measured over 28 days from weaning)

Lysine addition (per cent)	Nitrogen in diet (per cent)	Mean weight gain per rat per day (with 95 per cent fiducial limits)	Mean food intake per rat per day (with 95 per cent fiducial limits)	Ratio of weight gain to intake of nitrogen
0·0	2·15	1·2 gm. ± 0·2	7·4 gm. ± 0·5	7·8
0·06	2·16	1·9 gm. ± 0·2	9·1 gm. ± 0·5	9·5
0·12	2·17	2·3 gm. ± 0·2	9·2 gm. ± 0·5	11·4
0·18	2·19	3·0 gm. ± 0·2	11·0 gm. ± 0·5	12·4
0·24	2·20	3·4 gm. ± 0·2	11·3 gm. ± 0·5	13·7
0·30	2·20	3·3 gm. ± 0·2	11·1 gm. ± 0·5	13·6

The diet was adequately supplemented with vitamins and minerals. It contained 80 per cent by weight of white bread, 5 per cent arachis oil and the balance sucrose.

From Table 1 it will be noted that the optimum response was provided by the addition of about 0·25 per cent *l*-lysine. The lysine content of the unsupplemented diet measured by the Moore and Stein technique[6], using the ion-exchange resin, 'Zeocarb 225', was 0·25 per cent. Thus the best growth-rate was obtained at a lysine content of about 0·5 per cent.

An earlier experiment, with five lysine supplements increasing from 0·2 per cent, by increments of 0·1 per cent to 0·6 per cent, had also shown that the optimum response in growth-rate (again 3·4 gm./rat/day) was reached with a lysine addition between 0·2 and 0·3 per cent. There was an indication of a slight fall (only just significant at $p = 5$ per cent), in food consumption and in gain in weight, with the lysine addition of 0·6 per cent. It was therefore of interest to ascertain whether the addition of a still greater quantity of lysine would depress the growth-rate by inducing an amino-acid imbalance. To test this point the growth-rate with an addition of 0·3 per cent lysine (a level where the plateau for growth-rate had been reached) was compared with that when the supplement was 1·2 per cent lysine. In the first week of this experiment the growth-rate was significantly less at the higher lysine-level (2·8 gm./day as against 3·6 gm./day at the 0·3 per cent lysine-level). But the food consumption was also less. During the following two weeks the difference in rate of gain in weight narrowed, and the results for growth over 21 days are given in Table 2.

At the higher lysine-level the rate of gain was less, but so also was the food intake. The use of a highly significant ($p \sim 0·1$ per cent) linear regression of weight-gain on food-intake indicates that the reduced rate of gain may be wholly accounted for by the reduced food consumption.

One of the most interesting features of these observations is the good rate of growth (3·4–3·6 gm. per rat per day) which is obtained when wheat protein is supplemented by a small addition of lysine.

Table 2

Lysine addition (per cent)	Nitrogen in diet (per cent)	Mean weight gain per rat per day	Mean food intake per rat per day	Ratio of weight gain to intake of nitrogen
0·3	2·36	3·6 gm. ± 0·3	11·2 gm. ± 0·5	13·7
1·2	2·54	3·2 gm. ± 0·3	10·2 gm. ± 0·5	12·5

In this experiment white bread crumb provided 90 per cent by weight of the diet.

The growth-rate is almost trebled compared with that obtained in the unsupplemented bread ; an observation which is closely similar to those made by Rosenberg, Rohdenburg and Baldini[4]. It should be emphasized that our observations have only been concerned with growth, and the effect on other aspects of development needs to be investigated.

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Anticoagulant Action of Neodymium 3-Sulpho-*iso*nicotinate

ALTHOUGH it has long been known that the rare-earth metals interfere with blood clotting both *in vitro* and *in vivo*, it was not until 1950 that Vincke and Sucker[1] described, in neodymium 3-sulpho-*iso*nicotinate, a compound that was sufficiently soluble and free of toxic effects for clinical use. It is given by intravenous injection in 2·5 per cent solution and was at first regarded as a prothrombinopenic agent on the basis of a prolonged one-stage 'prothrombin' time. Recently, using newer techniques, Beller and Mammen[2] have reported that neodymium acts by reducing factor VII and factor X, leaving prothrombin normal. We have meantime been studying, independently, the mode of action of this salt, using in particular the blood thromboplastin generation test[3], with the following results.

In intravenous doses of the order of 5 mgm./kgm. in man and rabbits, it led to impairment of intrinsic blood thromboplastin generation by inhibiting, in the circulating blood, two thromboplastin constituents normally present in serum, namely, Christmas factor (*PTC*, factor IX) and factor X[4,5]—and also to reduction in factor VII (*SPCA*, stable factor) activity. It is this action on factor VII (which, it is now recognized, plays no part in blood thromboplastin formation) that is responsible for the prolonged one-stage 'prothrombin' time. These effects were demonstrable in four hours and lasted for twenty-four hours or slightly longer. With this dosage there was no alteration in the antihæmophilic globulin activity of the plasma, and the whole-blood clotting time in glass remained normal. With larger doses of 50 mgm./kgm. in animals, however, in addition to the above effects, the whole-blood clotting time was greatly prolonged and the activity of antihæmophilic globulin was reduced. In neither case was there any interference with prothrombin measured by the two-stage method, or with the thrombin–fibrinogen reaction. The action on factor VII and the serum thromboplastin factors was not prevented by oral premedication in humans with vitamin K_1 in 50-mgm. doses. In fifty-four injections in twenty patients no toxic effects were encountered.

Bergsagel[6] has shown that calcium interacts with Christmas factor at an early stage in the formation of blood thromboplastin. Since calcium and neodymium are similar in their chemical properties but are not, of course, biologically interchangeable, it is possible that neodymium acts as an antimetabolite of calcium by displacing it from combination with one or more of the protein factors in coagulation, although to date we have no evidence that excess of calcium will prevent the action of neodymium *in vitro*.

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Trans-Synaptic Atrophy in the Cerebral Cortex

THE disappearance of neurones from the primate lateral geniculate body after de-afferentation has been clearly demonstrated[1], and less dramatic trans-synaptic degenerative changes have been described elsewhere in the central nervous system, for example, in the cortex of the piriform lobe after degeneration of the olfactory tract[2]. Hitherto, however, attention has been focused on the perikaryon, and the role of afferent input in preserving the normal dendritic organization of neurones has apparently never been studied.

We have examined the pyramidal cells in the pre-piriform cortex of the rat after removal of the olfactory bulb, which is known to be the main source of afferent fibres to this region[3]. Comparison of the two sides of rat brains subjected to unilateral olfactory bulb resection has revealed no obvious differences in the nuclei or perikarya of the pyramidal cells, apart from a slight reduction in size, in material stained with buffered thionin, or in the fibre plexuses in material prepared by the Holmes–Silver impregnation technique. In Golgi–Cox preparations, however, a marked reduction in the number of dendritic branches arising from the pyramidal cells on the operated side has been consistently observed during the examination of a large number of neurones in three brains.

This change is very conspicuous a hundred days after operation on forty-day old rats. It is readily observed in the plexiform layer, the second of the five layers into which the pre-piriform cortex has been subdivided[4]. This layer contains the dendrites of the pyramidal cells as they pass to synapse with the axons of the lateral olfactory tract, which spread out over the surface of the piriform lobe. Typical examples of normal and atrophic pyramidal cells that appeared to be completely stained are shown in Fig. 1 ; their silhouettes were traced under the micro-projector. We conclude that the normal pattern of dendritic organization of the pyramidal cells in the pre-piriform cortex is dependent upon the integrity of their afferent input.

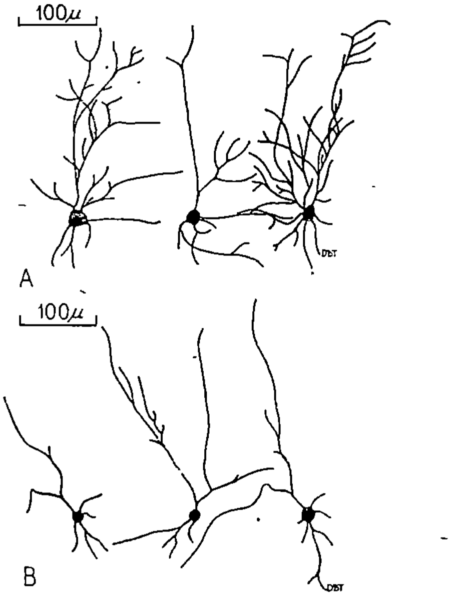

Fig. 1. Pyramidal cell bodies in the pre-piriform cortex of a rat killed a hundred days after unilateral olfactory bulb resection at the age of forty days: *A*, normal side; *B*, side of operation (Golgi–Cox preparation, micro-projector tracing)

Further work is in progress and will be reported elsewhere. We are indebted to Prof. J. Z. Young, who placed the facilities for this investigation at our disposal, for his advice and encouragement.

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The Longevity Function: Some Additional Data from Domestic Animals

In 1825, Benjamin Gompertz[1] analysed the function expressing the law of human mortality and suggested that the rate of mortality increased in a logarithmic manner with the age of the population. Recently, Kershaw, Chalmers and Lavoipierre[2], analysing the pattern of mosquito survival in laboratory conditions, showed that, for a cohort of 1,200, the Gompertz function was linear for both male and female.

Unfortunately, only figures of percentage survival were available for this cohort, and it was desirable to check the function by constructing a life-table. An appeal was therefore made for information on other survival data, published or unpublished, and information was obtained by one of us (J. O. L. K.) on cohorts of 167 draught horses, 63 breeding sows, and on 79 Ayrshire and 82 British Friesian cows. The criterion in these cohorts was economic—the working-life of the horse, the breeding-life of the sow and the milking-life of the cow.

The cohorts, when analysed by the graphic method introduced by Kershaw *et al.*, for numbers near or less than 100, yield a linear Gompertz function. The data on the horses and on the sows, when plotted as a frequency distribution curve of the number of animals against the economic life, show a normal probability curve, and similar curves for each herd of cows show a log-normal distribution.

We have analysed all the data available to us, including information published by the United States Atomic Energy Commission[3], on the survival of mice, guinea pigs and rabbits (the results will shortly be published in detail in the *Annals of Tropical Medicine and Parasitology*); but we have so far been unable to determine why some distributions are normal whereas others are log-normal; nor have we been able to correlate the type of curve with any feature of the biological system involved or with the criterion of survival.

It would appear that the determination of the pattern of mortality of biological systems is of such fundamental importance that all available information should be analysed; we therefore reiterate our appeal for information on survival data.

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Relation between Genetic Constitution of an Offspring and Weight of its Litter-mates

Rabbit does, drawn from a single stock, were artificially inseminated, either from one large buck of the same stock or from one small one of a different strain[1]. The two types of offspring were distinguishable by pre-arranged genetic factors. Offspring of the large buck averaged 2·7 gm. heavier at birth than offspring of the small buck. When they were raised in the same litters, after heterospermic insemination with mixed semen, the difference in birth-weight increased to 6·1 gm. The increase may be called the 'enhancement effect' in relative birth-weight.

This result prompted investigation of a naturally occurring analogue of the experiment. In mammalian dizygotic twin births, there are again two recognizable types of offspring, male and female, whose genetic constitutions carry with them a weight difference, the males being the heavier in most species. Also, the two types of offspring are born either in litters of one type (like-sexed twins), or are born together in the same litters (unlike-sexed twins). Is the difference in birth-weight of the sexes greater in unlike-sexed twins? As shown in Table 1, there is, in fact, an apparent enhancement effect in six sets of data for sheep twins. In the first two sets of data[2], which are unweighted averages, the effect was not found statistically significant by the authors. The small third group, a combination of the control data of three experiments[3-5], also shows an enhancement effect, though not significantly. This group was obtained by listing the four series of births that

Table 1. Birth-weight in Like- and Unlike-sexed Twins

	No. of twin offspring	Mean birth-weights per offspring in lb.				Difference in birth-weight of sexes		Measure of enhancement effect (*a–b*)
		Unlike-sexed twins		Like-sexed twins		Unlike-sexed twins (*a*)	Like-sexed twins (*b*)	
		♂	♀	♂	♀			
Sheep								
Cheviot (ref. 2)	*c.* 2,200	7·48	7·06	7·28	7·02	+ 0·42	+ 0·26	+ 0·16
Shropshire (ref. 2)	*c.* 2,200	9·37	8·78	9·33	9·04	+ 0·59	+ 0·29	+ 0·30
Various (refs. 3, 4 and 5)	46	9·27	8·16	9·04	8·50	+ 1·11	+ 0·54	+ 0·57
Langhe (ref. 6) (from record abstracts)	212	10·06	9·05	9·36	8·96	+ 1·01	+ 0·40	+ 0·61
Welsh Mountain, 1951–53 } from N.A.A.S.	276	5·78	5·34	5·84	5·45	+ 0·44	+ 0·39	+ 0·05
Welsh Mountain, etc., 1954 } records	150	7·39	6·87	7·07	7·77	+ 0·52	− 0·70	+ 1·22
Man (ref. 7)	72	5·74	5·48	5·53	5·44	+ 0·26	+ 0·09	+ 0·17

contained figures for all four types of offspring; birth-weights were then averaged successively within and between series. The material on the Langhe sheep was calculated from the original record abstracts of Mason and Dassat[6]; birth-weights of the four types of offspring were averaged first within and then between the nine flocks for which complete data were available. Again, an enhancement effect resulted. A fifth and sixth set of unweighted data, each showing an enhancement effect, were calculated from the records of the Trawscoed Experimental Farm. Finally, an enhancement effect is apparent in human twins[7]. In all these comparisons, a small incidence of identical twins might affect relative numbers in the classes of offspring, but would not be expected to bias the average weights.

Individually, the sources of information may not show a statistically significant enhancement effect. But it is rather striking that the effect should be apparent in eight successive sets of data (one for rabbit, six for sheep, one for man). A *t* test indicated that the chance of such a regularity being due merely to sampling error was less than the conventional significance limit of one in twenty. It may also be calculated that the unweighted mean of the last column in Table 1 (+ 0·44) is significant in comparison with its standard error (± 0·152).

These eight sets of data all point towards the same conclusion; when genetically large and small offspring are born together in mixed litters, their difference in weight at birth is greater than when the offspring are born in litters of one type only. This may be ascribed provisionally to embryonic competition, in the sense that the large offspring grows unduly large at the expense of the small offspring. As may be seen in Table 1, increased weight of the male offspring contributes fairly regularly to the enhancement effect; but until more data are available, it cannot be said how regular is the contribution of decreased weight of the female offspring.

In the literature of mammalian genetics and animal breeding, there seems to be little or no recognition of an enhancement effect. If it should prove to be of general occurrence, it could have significance in several contexts. For example, in the rabbit experiment mentioned above, the estimate of superiority of one sire over another, in terms of birth-weight of offspring, varied according to the method of progeny testing; insemination with mixed semen gave a greater superiority than that obtained after the more usual type of progeny-testing with semen from one sire at a time. Enhancement is a relative term, and it might equally well be said that ordinary progeny-testing has a minimizing effect. Which test gives the correct measure of genetic superiority between the two males?

A wider possibility for multiple births in general, and not only twins, is that an enhancement effect may occur when one embryo of a litter becomes larger than a litter-mate for any reason, not necessarily genetical; for example, owing to some local uterine condition. Something like an autocatalytic process may occur; once an embryo has become large, it may have a competitive advantage and become unduly large while growth of the smaller one will be retarded. Thus, differences in weight between embryos would become exaggerated during gestation. Studies of the origin of variation in birth-weight within the mammalian litter are liable to be biased unless this source of variation is taken into account. Moreover, further evidence from the rabbit experiment suggests that the enhancement effect measured at birth is still evident after weaning.

This work, which will be published in full, was carried out with financial support from the Agricultural Research Council. I am indebted to Prof. C. H. Waddington for interest and facilities. For access to records, I am indebted to I. L. Mason and P. Dassat, and to the Director and Staff of the National Agricultural Advisory Service Experimental Husbandry Farm, Trawscoed, Aberystwyth.

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Dominance Order for Red–Green Defective Alleles

On the theory of Franceschetti[1,2] there are two series of multiple alleles for defective colour vision, one series responsible for deuteranopia (*D*), extreme deuteranomaly (*EDA*) and deuteranomaly (*DA*), and the other for protanopia (*P*), extreme protanomaly (*EPA*) and protanomaly (*PA*). His theory suggests that there is a dominance order for each series, such that the genes producing the lesser defects are dominant to those producing the greater, and that the two normal genes are most dominant.

This theory is supported by many pedigrees[3-7]; but it is possible to test it statistically by comparing the frequencies of defective men with those of defective women. On the theory, since the less defective genes are more dominant, and defective women are those who carry two defective genes, there should be more of the lesser defective women in proportion than of the lesser defective men.

In a group of 126 red-green defective men and women, all tested with the Rayleigh equation, in one or other form of anomaloscope test, the following frequencies were found.

	PA	*EPA*	*P*	Total
Men	15	28	20	63
Women	4	4	2	10
	DA	*EDA*	*D*	Total
Men	53	66	12	131
Women	15	7	0	22

Some of these subjects were included by chance, and others were invited as being suspected defectives, because they had made errors in daily life, or on the Ishihara or lantern tests. Since there was a special interest in defective women, more in proportion of these were invited, and there are probably three times as many as would be expected if all subjects had been found purely by chance. The fact that some subjects were invited does not affect the relative frequencies of the different types. The subjects were sometimes related; but this was not more frequent in one group than another, and does not affect relative frequencies.

Owing to the small frequencies in some of the cells it is convenient to combine the protan and deutan groups, and it is necessary to use Yates's correction. Chi-squared for the resulting table, in which we compare the relative frequencies of women with men defectives, is 9·70, and is significant on the less than 0·01 level for two degrees of freedom. It is to be inferred that there are relatively fewer *P* and *D* women than men, relatively fewer *EPA* and *EDA* and more *PA* and *DA*, as predicted by the theory being tested, which is therefore supported by the data.

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Photoperiodic Promotion of Vegetative Growth in the Cultivated Strawberry Plant

The strawberry variety Royal Sovereign is a short-day plant, flower initiation being promoted by short photoperiods, whereas stolon formation and increased petiole length are promoted by long photoperiods[1]. Hartmann[2] has shown that in short photoperiods parent plants of the variety Missionary are able to induce flower formation in attached runner plants growing in long photoperiods. This he interpreted as evidence of the transmission of a hypothetical flower-forming substance along the stolon in an acropetal direction.

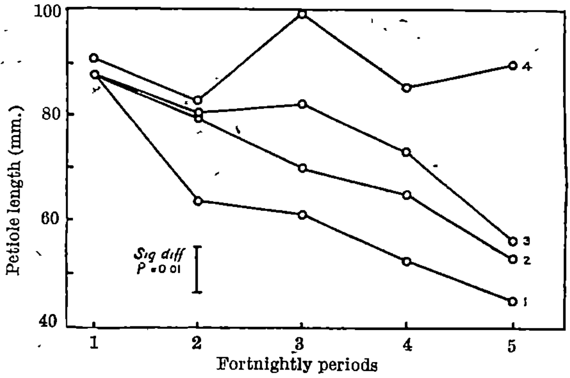

Fig. 1. Mean petiole lengths (mm.) of leaves emerging from the bud during five successive fortnightly periods

Evidence is now presented for the transmission in the opposite direction along the stolon of a substance or substances promoting stolon formation, increased petiole-length, and antagonizing the processes leading to flower formation.

Pairs of runner plants of the variety Royal Sovereign were rooted singly in pots in the field in summer. Each pair consisted of adjacent plants in a runner train. On August 11 the pairs were lifted in their pots, and the stolon, joining members of a pair, was retained intact. From this date the older of each pair of plants, described as the 'parent' plant, was grown under a 9-hr. photoperiod in the glasshouse. The attached runner plant received continuous illumination by supplementing natural light with light from incandescent lamps, initially at 15–20 ft. candles, but later increased to 30–35 ft. candles. Four defoliation treatments, with four-fold replication, were imposed. Treatments consisted of the removal of (1) all leaves, (2) all but the youngest fully expanded leaf, and (3) all but the youngest two fully expanded leaves from the runner plants. Unfolding leaves were retained in all except treatment 1. Plants of treatment 4 were not defoliated. The leaf status in treatments 1–3 was maintained by weekly removal of the oldest leaf where necessary, so that plants of treatments 1, 2 and 3 had 0–1, 1–2 and 2–3 fully expanded leaves respectively during the experiment. Parent plants were left intact. Control pairs, two in each defoliation treatment, were grown with both parent and runner plants in continuous light.

After prolonged treatment two of the four runner plants of treatment 1 (all leaves removed) initiated

Table 1. RESPONSE OF PARENT PLANT TO LONG-DAY TREATMENT OF ATTACHED-RUNNER PLANTS

Treatment No.	No of leaves retained	Mean No. of leaves formed before inflorescence initiation*		Mean No. of stolons produced	
		Parent plants in short days	Parent plants in long days (controls)	Parent plants in short days	Parent plants in long days (controls)
1	0–1	3·0 (1·86)	No infl.	0 0 (0 71)	1 5
2	1–2	5·5 (2 39)	,,	1 0 (1·14)	3 5
3	2–3	6·0 (2 55)	,,	1 5 (1·35)	4 0
4	All	12 25 (3 55)†	,,	3 75 (2 04)	4·0
Sig. diff. *P* = 0 5 *P* = 0·01		(0 47)		(0 20) (0 52)	

* Assuming six developing leaves in the bud.
† One plant had not initiated an inflorescence by the time the experiment was terminated. Figures in brackets are $\sqrt{n + \frac{1}{2}}$ transformations.

inflorescences, after initiating a mean number of 11·0 leaves. This alone is in support of Hartmann's experimental results with the variety Missionary. No other runner plants produced inflorescences.

The purpose of this communication is to direct attention to the results given in Table 1 and Fig. 1. The presence of leaves on runner plants in continuous light was associated with delayed inflorescence initiation, increased stolon production and increased petiole length in the parent plants growing in short photoperiods. Moreover, the effect was proportional to the number of leaves retained on the runner plants. All these responses are characteristic of the effect of long photoperiods on the strawberry.

It is suggested that the runner plants acted as donors and the parent plants as receptors of a quantitatively active stimulus promoting vegetative as opposed to reproductive growth.

The experiment was designed as a preliminary study of the influence of leaves on the runner plant in long photoperiods upon the response of the runner plant to a flower-inducing stimulus received via the stolon from the parent plant. The control layout, while adequate for the original purpose, does not preclude an explanation in terms of nutritional factors. However, the appearance of the critical parent plants, which made vigorous growth, typical of short-day responses in the variety, suggests that formative rather than nutritional factors were operating.

Further work is in progress.

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Seed Vernalization and Flowering in Lettuce (*Lactuca sativa*)

Temperature, photoperiod, and chemical regulators, separately and interacting, markedly influence seed-stalk development in lettuce[1]. Conflicting reports have, however, appeared as to the effectiveness of seed vernalization in accelerating flowering in this crop[2]. In order to resolve these differences, leaf number preceding the visible inflorescence has been used as a 'physiological index' of flowering[3], and the effects of seed vernalization, in combination with temperature, day-length, and chemical regulators, have been evaluated.

A standard procedure was used for the vernalization of head lettuce seed (*Lactuca sativa*, variety Great Lakes), consisting of pre-germinating moist seed at 60–70° F. for 24–48 hr. and then subjecting to 40° F. for at least thirteen days. Periodical temperature interruptions of 60–90° F. for 2 hr. daily, or at three-day intervals, did not nullify the vernalizing effect of cold exposure. Seed which was pre-germinated for three days or more at 60° F. was not effectively vernalized by subsequent exposure to 40° F. Plants from lettuce seed which had been soaked at 60–70° F. and air-dried 6–12 hr. prior to chilling at 32° or 40° F. were delayed in flowering as compared with those vernalized according to the standard procedure. When maleic hydrazide (20 and 40 p.p.m.) was added to the water which was used in moistening the seed during vernalization, plants afterwards produced visible flower parts at a lower node than did plants from seed vernalized in water alone. (The maleic hydrazide was formulated as the water-soluble diethanolamine salt of 1,2-dihydro-3,6-pyridazinedione and applied as 'MH-40' by the U.S. Rubber Company, Naugatuck Division, Naugatuck, Conn.)

When lettuce plants were grown at night temperatures above 65° F. subsequent to seed vernalization, seed-stalk development was accelerated without preceding head formation. At temperatures below 65° F., plants grown from vernalized seed first produced a high percentage of firm, vegetative heads and then flowered. Non-vernalized plants flowered only at night temperatures above 65° F. The potential for flowering was decidedly greater following seed vernalization, but flowering was afterwards delayed by continuous night temperatures below 65° F. and was completely absent at 50° F. Much of the disparity in results obtained with seed vernalization of lettuce by various workers may be resolved on this basis.

Soil temperatures influenced the rate of seed-stalk development (days to anthesis), but not the vernalization stimulus *per se* (leaf numbers preceding the inflorescence). At the higher soil temperatures (64° and 70° F.) flowering was promoted, whereas at lower temperatures (50° and 57° F.) flowering was delayed. A decrease in the percentage of plants which produced seed-stalks occurred as soil temperatures declined from 71° to 50° F.

Likewise, photoperiod markedly affected flowering of vernalized head lettuce. The minimum night temperature following vernalization which favoured earlier flowering was reduced from 65° to 60° F. when plants were grown at a day-length of 16 hr. At 60° F. with a nine-hour day, both vernalized and non-vernalized plants formed firm vegetative heads which flowered simultaneously. Thus the flower-promoting effects of seed vernalization in lettuce may be nullified by short photoperiods as well as cool growing temperatures.

The delaying effect of cool (below 65° C.) temperatures (both soil and air) combined with relatively short days on seed-stalk development in greenhouse studies was verified in the field. Plants grown in the early spring, when night temperatures were less than 60° F., formed heads and remained vegetative irrespective of prior seed vernalization or treatment with chemical growth regulators.

This communication is based on a thesis submitted by one of us (L. R.) in partial fulfilment of the requirements for the Ph.D., Michigan State University.

Lawrence Rappaport
S. H. Wittwer
H. B. Tukey

Department of Horticulture,
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East Lansing.
Feb. 6.

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FORTHCOMING EVENTS

Monday, July 9—Saturday, July 14

Society of Chemical Industry (at the Imperial Institute, Exhibition Road, London, S.W.7)—75th Annual Meeting.

Thursday, July 12—Saturday, July 14

Institute of Physics, Non-Destructive Testing Group (at the H. H. Wills Physical Laboratory, Bristol)—Meeting on "Physics of Some New Aspects of Non-Destructive Testing".

Friday, July 13

Biochemical Society (in the Department of Biochemistry, The University, Leeds), at 11 a.m —Symposium on "Metals and Enzyme Activity".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Lecturer, Grade B (graduate, preferably with teaching experience), in the Mathematics Department—The Registrar, Technical College, Sunderland (July 13).

Lecturer or Assistant Lecturer (with qualifications in physical or inorganic chemistry, and preferably with experience in radiochemistry) in Chemistry—The Registrar, The University, Hull (July 16).

Lecturer (preferably with special interests in entomology, physiology or protozoology) in Zoology at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (July 16).

Research Assistant (honours graduate in botany) at the Department of Agriculture's Cereal Station at Ballincurra, Midleton, Co. Cork, Ireland—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (July 17).

Assistant Lecturer in the Department of Philosophy—The Registrar, The University, Manchester 13 (July 21).

Lecturer in Geology—The Head of the Department of Geology, Imperial College of Science and Technology, South Kensington, London, S W.7 (July 21).

Fellows (men or women graduates of any university) in Carbohydrate Chemistry—The Principal, Royal Holloway College, Englefield Green, Surrey (July 23).

Lecturer (with training or experience in one of the following fields: (*a*) hydraulics; (*b*) aerodynamics; or (*c*) hydrodynamics) in the Department of Fluid Mechanics—The Registrar, The University, Liverpool (July 23).

Lecturer/Senior Lecturer in Electrical Engineering at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, July 27).

Lecturer in the Department of Mechanical Engineering—The Registrar, The University, Liverpool (July 28).

Soil Microbiologist (with a good honours degree and practical experience)—The Secretary, Glasshouse Crops Research Institute, Worthing Road, Rustington, Littlehampton, Sussex (July 29).

Assistant (graduate in medicine, biology, psychology, sociology, or any other social science) in the Department of Public Health and Social Medicine—The Secretary, The University, Edinburgh, (July 31).

Assistant Lecturer (with special qualifications or interests in radio astronomy) in Physics—The Registrar, The University, Manchester 13 (July 31).

Lecturer in Anatomy—The Registrar, The University, Manchester 13 (August 7).

Lecturer in Education, at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C.1 (New Zealand, August 15).

Lecturer in the Department of Botany, Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, August 15).

Chair of Electrical Engineering at the University of Tasmania—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, August 31).

Lecturer in the Department of Zoology, University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, September 1).

Assistant Chemist (with a degree in chemistry, agricultural chemistry or A.R.I.C., or about to qualify) for analytical work on crops and soils—The Secretary, Rothamsted Experimental Station, Harpenden, Herts, quoting Ref. 1052/7.

Assistant Experimental Officer (male, with G.C.E. advanced level in science subjects, including mathematics and chemistry, or equivalent qualifications) in the Analytical Section, Medical Division, for work involving the analysis of radioactive and other toxic agents in biological specimens and in air—The Establishment Officer, Atomic Energy Research Establishment, Harwell, Didcot, Berks. quoting Ref. 541/34.

Assistant Professor in the Department of Anatomy—Prof. R. L. de C. H. Saunders, Dalhousie University, Halifax, Nova Scotia, Canada.

Biochemist (with a first- or second-class honours degree in biochemistry or equivalent qualification, with postgraduate research experience), to study the chemical properties of cervical mucus in relation to the action of sex hormones—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, quoting Ref. 56/3.

Biochemist (with Ph.D., M Sc., or equivalent qualification) to engage in research on the biosynthesis of proteins—The Secretary, Courtauld Institute of Biochemistry, Middlesex Hospital Medical School, London, W.1.

Chemistry Master, to teach to advanced level—The Headmaster, The Hall, Repton, Derbyshire.

Head of the Chemistry Department—The Director of Research, British Cotton Industry Research Association, Shirley Institute, Manchester 20.

Lecturer (with an honours degree in metallurgy and preferably with industrial and research experience) in Metallurgy—The Secretary, Sir John Cass College, Jewry Street, London, E.C.3

Principal Lecturer (with research experience, and preferably industrial experience) in Ceramic Materials in the Department of Metallurgy—The Secretary-Treasurer, Royal Technical College, George Street, Glasgow, C.1.

Research Assistant (with Inter. B.Sc. or equivalent qualification in chemistry or metallurgy) to assist in the general work of the Corrosion Section of the Chemistry Department, and in particular to assist in research on rust resisting steels for aircraft—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting "C.R.1".

Senior Lecturer in Inorganic Chemistry; and an Assistant Lecturer, Grade B, in the Physics Department—The Acting Principal, Royal Technical College, Salford 5,

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Department of Scientific and Industrial Research. Food Investigation Special Report No. 62. Dehydration of Fish—British Experiments (1939–54) and the Development of a Warm Air Drying Process. By Dr. C. L. Cutting, Dr. C. A. Reay, and Dr. J. M. Shewan. Pp. iii+160+8 plates. (London: H.M. Stationery Office, 1956.) 7*s*. 6*d*. net. [274

Universities Council for Adult Education. Report on the year 1954–1955. Pp. 24. (Bristol: The University (W. E. Salt, Hon. Secretary and Treasurer), 1956.) [274

British Non-Ferrous Metals Research Association. Thirty-sixth Annual Report. Pp. 48. (London: British Non-Ferrous Metals Research Association, 1956.) [274

Bulletin of the British Museum (Natural History). Entomology. Vol. 4, No. 3: The Mosquitoes of Arabia, I. By P. F. Mattingly and K. L. Knight. Pp. 89–141. 15*s*. Vol. 4, No. 4: Records and Descriptions of Microlepidoptera from Lord Howe Island and Norfolk Island collected by the British Museum (Natural History) Rennell Island Expedition, 1953. By J. D. Bradley. Pp. 143–164. 6*s*. Vol 4, No. 5: Sphecidae (Hym.) Récoltés en Libye et au Tibesti par M. Kenneth M Guichard. Par Jacques de Beaumont. Pp. 165–215. 15*s*. Geology. Vol. 3, No. 1: The Structure, Evolution and Nomenclature of the Ostracod Hinge. By Peter C Sylvester-Bradley. Pp. 1–21+plates 1–4. 12*s*. 6*d*. Vol. 3. No. 10: Birds Collected by Mr. F. Shaw-Mayer in the Central Highlands of New Guinea, 1950–1951. By R. W. Sims. Pp. 387–438+plates 13–14. 15*s*. Vol. 4, No 1: British Mites of the Subfamily *Macrochelinae* Trägårdh (*Gamasina-Macrochelidae*). By G. Owen Evans and E Browning. Pp. 1–55+plates 1–4. 17*s*. 6*d*. Title-page and Index to the Bulletin of the British Museum (Natural History). Entomology, Vol. 3, 1953–1954. Pp. iv+523–529. (London: British Museum (Natural History), 1956.) [274

Other Countries

Aligarh Muslim University Publications. (Zoological Series.) On Indian Insect Types. Edited by Prof. M. B. Mirza. 4: The Early Embryology of *Pyrilla perpusilla* Walker (Homoptera), including some Observations on the Later Development. By Dr. Klaus Sander Pp. ii+61+12 plates. (Aligarh: Aligarh Muslim University, 1956.) Rs. 5. [15

Dominion Museum, Wellington. Records in Ethnology. Vol. 1, No. 4: Notes with Illustrations of Maori Material Culture. By W. J. Phillips. Pp. 1+123–182. (Wellington: Dominion Museum, 1955.) [15

Bibliography of Scientific Publications of South Asia (India, Burma, Ceylon). No. 12: July–December, 1954. Pp. iv+130. (New Delhi: Insdoc, National Physical Laboratory.) [15

Forty-Third Indian Science Congress, Agra, 1956 Section of Agricultural Sciences. Survey and Classification of Indian Soils. (Presidential Address.) By Dr. S. P. Raychaudhuri. Pp. 16. (Calcutta: Indian Science Congress Association, 1956.) [15

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Annual subscription £6, payable in advance,
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CHEMICAL LABORATORY
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GOVERNMENT RESEARCH IN GREAT BRITAIN

THE debate in the House of Commons on the second reading of the Department of Scientific and Industrial Research Bill on June 20 ranged over numerous aspects of the organization of research in Britain, though without pressing home the vital questions more than had been done earlier in the House of Lords. The proposal to change the Advisory Council into an executive body met with a lukewarm reception, nor was the financial clause debated at that stage. Mr. F. Willey's reference to the quinquennial principle drew from Mr. J. R. Bevins a reminder that there is an agreement about expenditure on a five-year basis between the Department and the Treasury; but there was no searching discussion of the problem of Parliamentary control in relation to the efficient conduct of research.

No more than in the House of Lords was there any serious criticism of the work of the Department of Scientific and Industrial Research, though there was some criticism of the Advisory Council for Scientific Policy, Mr. J. Callaghan suggesting that its reports were virtually ignored by the Lord President of the Council. Mr. Callaghan asked for a statement of Government policy, including a review by the Government of the organization and co-ordination of our scientific effort. He suggested also that a survey should be made of research projects, so that it would be possible to see what needs to be done but is not being undertaken either by industry, the universities or by other institutions. He also pressed once again for a Minister in the House of Commons bearing some responsibility for the scientific effort of Britain and able to deal with questions from his own experience and first-hand knowledge.

Sir Hugh Linstead supported much that Mr. Callaghan advocated, though he pointed out that finance alone will not assure effective research or provide the conditions in which research is most fruitful, and he uttered a warning both against undue Government co-ordination and excessive preoccupation in Parliament with the financial aspect, since the limiting factor in the scientific and technological spheres may well be men. Sir Hugh emphasized, moreover, that it is virtually impossible for major research to be undertaken in Britain without Government direction, and whether it liked it or not, the Government is bound to take a much closer interest in what is going on and to have an increasing say in the selection of projects and the places and the men who do the work. He appeared to look rather to the quality of the men who serve on the Council than to any formal change in organization to secure the necessary co-ordination, and he suggested that the relative distribution of the energy and resources of the Department requires reconsideration. Sir Hugh recognized, and indeed stressed, the importance of disseminating information, but suggested that forty-five per cent is too high a proportion of the Department's effort to be devoted to advisory and like services, and that the responsibility for disseminating information might well be shared with other organizations.

That is certainly a matter for examination. A large part of the value of the industrial research associations is derived from their educational influence on the industries they serve, and it would not be easy to separate sharply their advisory and educational work from research work in the usual sense of the word, whether pure or applied. The estimate of the Advisory Council quoted in the debate relates to the work of the Department as a whole: for the research associations it could well be different, and Mr. J. H. Dunning's study in the June issue of the *District Bank Review*, which was quoted in the debate, suggests that a major part of their effort, as against the 30 per cent estimated by the Advisory Council for the Department as a whole, is devoted to basic research. Moreover, as Mr. Austen Albu pointed out, in referring to the work of the Intelligence Division of the Department, which is responsible for the dissemination of the results of research, the National Reference Library of Science and Invention and the National Science Lending Library could play an important part here. The failure of the Government to take any steps to implement these recommendations of the Advisory Council on Scientific Policy or to establish the National Science Centre not only hinders the work of the Department but also tends to perpetuate existing waste and overlapping of effort. Indeed, the conversion of the former Advisory Council into an executive body, if it means anything at all, would seem to make the provision of such means for informal contact the more important if we are to avoid the rigidity of control which all participants in the debate recognized as one of the great dangers attending Government direction of research. The early establishment of a National Science Centre would contribute not merely to the more efficient dissemination of existing knowledge, but also to the establishment of the right climate for the encouragement of science and scientific research.

Mr. Herbert Morrison made no comments on this matter, but was convinced that the Lord President of the Council could make a most important contribution to the work of the Research Council, though he attached little importance to the change of function from advisory to executive. Clearly, though Mr. Morrison implied rather than stated this, the Lord President's other responsibilities should not be such as to encroach on this prime responsibility for watching over the scientific work of the Government and the research effort of the nation in general. Given the time and interest, the Lord President could, without exercising executive responsibility, do much to keep the research effort in balance, to see that projects are discontinued when no longer of real significance, and generally provide the encouragement and stimulus needed for effective research.

Mr. Morrison's experience led him to lean rather to the advisory committee system of securing expert advice as to the selection and discontinuance of projects. Nor did he press the point about representation in the House of Commons. That was, however, put forcibly by Mr. Eric Fletcher, who, recognizing that it may not always be practicable for the Lord President to sit in the House of Commons, argued convincingly that, when this happened, some other senior Minister, such as the Lord Privy Seal, should be entrusted with the responsibility for answering for scientific matters from his own knowledge and place in the Cabinet.

The debate thus ranged far outside the work of the Department of Scientific and Industrial Research, and was indeed a discussion of the adequacy of the research effort of Britain. Misgivings were expressed as to the extent and balance of that effort; but there were few positive suggestions for improvement, though its close connexion with technological education was clearly appreciated. Sir Hugh Linstead, for example, referred to the part which the technical colleges could play in research if they received adequate grants, and suggested that this is a matter to which the new Research Council should turn its attention.

It is obvious that members of Parliament took a very wide view of the responsibilities of the new Research Council, and at times seemed to stretch them to overlap with the responsibilities of the Advisory Council for Scientific Policy. Admittedly, the Bill does not limit the responsibilities of the Research Council to the work of the Department of Scientific and Industrial Research, nor does it offer any contribution to the prevention of duplication of research effort or research grants through other Departments of State. The need persists for a closer look at the whole Government organization, for at present research grants for the universities may come through the University Grants Committee as well as the Department of Scientific and Industrial Research, research grants for the technical colleges from the latter and through the Ministry of Education, while, as the Select Committee on Estimates has stressed, research in defence departments such as the Admiralty is liable to involve risk of duplication on a large scale.

This matter of overlapping was emphasized by Mr. M. Philips Price, who, recognizing that it cannot be dealt with by the Bill and that it is not entirely a matter for the Lord President of the Council, suggested an investigation of the whole question of overlapping of research in Civil Departments, in the Service Departments and in the field of nuclear energy. This need to reduce overlapping and obsolete research was one of the main points reiterated in the debate, and two aspects of it were particularly stressed: our lack of information as to the extent of our research effort or even as to the gaps in that effort, and, less prominently, as a corollary of eliminating waste, the possibility of more co-operation and pooling of effort. The importance of a clear system of priorities was also stressed, and Mr. J. Idwal Jones also advocated more independent research institutes, besides extending research at the universities and technological and technical colleges. Apart from an indirect reference by Mr. H. Brooke, the Financial Secretary to the Treasury, in concluding the debate, to the importance of safeguarding university autonomy, however, little reference was made to the problems of financing research in universities by outside bodies which were discussed at the last Home Universities Conference.

Mr. Callaghan quoted a recent reply from the Treasury giving Government expenditure on scientific research and development as £235 million, of which only £31 million is on civil research, and he asserted that of 10,000 scientists employed by the Government about 7,500 are engaged on defence research and development. Mr. Albu estimated the total expenditure on research in Britain as about £300 million, of which between £50 million and £70 million is by industry. A recent lecture to the Institute of Physics by Sir John Cockcroft put the expenditure of industry on research for its own purposes as more than £40 million. As between fundamental research, civil applied research and defence research, he estimated that as against £200 million on defence research and more than £60 million on civil applied research, £5 million is expended on fundamental research at the universities and another £5 million in fundamental research in government and semi-government institutions, about ten per cent of the total graduates engaged on research being occupied with fundamental research.

This expenditure of rather less than five per cent of research effort of Britain on fundamental research compares with 7 per cent in the United States; and while per head of population the research and development labour force works out at about the same in the two countries, as also, allowing for differences in the value of money, do the costs of research, Mr. Dunning in his article referred to above estimates that, discounting the difference in money values, the average American firm carries out 2·5–3·5 times more research than the average United Kingdom firm. The United States are also outstripping Britain in the rate at which they are adding to their scientists and technicians, the output of graduates in engineering and applied sciences in 1954 being 136 per million of the population compared with 57 in the United Kingdom. Mr. Dunning also estimates that the parent companies of the hundred most important American subsidiaries manufacturing in Britain spend more each year, in real terms, on research and development than the whole of British industry combined, and that the size of the average parent company is five to ten times that of the subsidiary, in terms of labour force.

Such comparisons were not given undue weight in the debate in the House of Commons; they were used rather for emphasizing the relevance of technical education to the research potential of Britain. Moreover, it was also recognized that a part of the shortage of scientific man-power arises from failure to use it to the best advantage. Even if the shortage is not eliminated in this way, as Mrs. M. Jeger suggested, it would undoubtedly be alleviated by making sure that existing resources are used wisely and with the planned forethought that is appropriate for any scarce commodity. The main point is the lack of accurate and full information on which to form sound judgments of the magnitude and disposition of the existing effort of Britain: even in regard to the alleged loss of scientific man-power overseas, information seems to be incomplete.

None the less, the absence of such information, while it restrained criticisms in the debate and particularly suggestions as to neglected fields of research, does not invalidate Mr. Dunning's broad conclusion that for sheer volume of research expenditure, and without considering the question of research efficiency, the United States command a lead over the United Kingdom which, because the results of research are cumulative, is likely to grow. The concern expressed in the debate as to the balance of research effort did not reflect any desire to curtail expenditure on fundamental research, either by the Department of Scientific and Industrial Research or at the universities, or to increase the total expenditure without due consideration of the objectives. Concern was obviously entertained as to the proportion of resources going into nuclear research. Sir John Cockcroft has estimated the number of scientists and technologists working on nuclear power as about 1,000 out of the 58,600 which Sir Harold Hartley gives as the total employed in Britain on research and development. Nor, while it was recognized as necessary that particular projects should be terminated and that research programmes should be continuously re-examined, was any real uneasiness expressed about overlapping. As Mr. Brooke remarked, a certain amount of overlapping may be fruitful: it is much more important to close any serious gaps in the advancing front of research, and we must have the knowledge that enables us to do so.

While, however, Mr. Dunning's article was quoted in the debate, his suggestions regarding co-operation in research and the pooling of results received no comment. Mr. Dunning regards the structures of the United States and the United Kingdom as complementary rather than competitive, and considers that the chief source of anxiety so far as Britain is concerned is likely to be over Continental and Asiatic competitors. To make the best use of the limited resources of Britain and so meet the demands of the future, he suggests that we should specialize in those stages of manufacturing and research to which our productive resources are comparatively the most suited, and exchange the knowledge and expertize acquired in these fields for that attained in fields to which the productive resources of the country are less well suited. Industrial development in Britain already benefits directly from the competitiveness and dynamic quality of the American system, and Mr. Dunning indicates how the gap between the discovery of a new product, process or material and its full acceptance and marketing is being bridged by the presence in Britain of firms financed from the United States.

There is an important point here bearing on the research organization and potential of Britain which was missed in the debate. If, in the way just noted, British industrial achievement is linked with an economic environment more favourable to exploitation, while the American economy benefits from the fundamental research carried out in Britain which the United States can often apply to their great advantage, we cannot be content for British firms to concentrate on fundamental research while their American associates develop and commercialize the results. Nevertheless, research co-operation in this way does offer mutual advantages in specialization, and in time the production and selling technique will be made available to British firms.

What needs to be remembered is that Britain cannot afford to rely entirely on such co-operation. There are fields in which it is vital to prosecute research independently; and in any event, undue reliance on American facilities may tend to stifle initiative and development. Co-operation will always be easiest and most fruitful when there is the right climate of opinion on both sides; and, in Mr. Dunning's opinion, while a freer exchange of knowledge between United Kingdom firms, regular visits by industrialists to the United States, and better publicity may all help, it is even more important to reconsider features of the economic and fiscal policy of Britain which tend to discourage initiative and enterprise.

That is one, but not the only, reason for taking the discussion of the Government organization of and support for research, whether fundamental or applied, out of party politics; and though this relation of research to fiscal policy was not mentioned in the debate, the discussion was refreshingly free from political partisanship. Mr. Brooke remarked in concluding the debate that we must seek a system which can preserve the freedom of the universities, the freedom of the scientist, and allow the Government to apply its resources so as to fill the gaps and stimulate the best possible work in the right directions for the whole of the industrial and scientific field. From that there would appear to have been no real dissent in the House. Only Mrs. Jeger appeared to recognize that we have still to learn much about the most economical and fruitful way of financing research in the universities, where it is now estimated that some 14 per cent of the university budget, or nearly £4·5 million in that for 1953–54, is represented by external support for research, half of which comes from the Government. Of this total, some 20 per cent of the resources of the departments of science and technology are devoted to work of direct interest to industry; and as both Dr. V. E. Cosslett and Prof. H. W. Melville pointed out at the Home Universities Conference last winter, we are only at the beginning of discussions on how best to regulate the impact on the universities of the growing interest of industrial and other external organizations in project research and to secure that there is not excessive concentration in particular fields, such as nuclear research, to the neglect of others.

The debate in the House of Commons has accordingly demonstrated the wide opportunities open to the new Research Council, although it may not have made clear how far its functions may overlap those of the Advisory Council on Scientific Policy. The Government, moreover, should have been left in no doubt as to the urgent need to take the steps required to fill the gaps in public knowledge of the present disposition of the research effort of Britain, and particularly as regards defence research. Parliament and the scientific and technological world must be given the information essential for a sound judgment as to the way in which resources of the country are distributed in research in order to ensure that wise decisions are taken as to the gaps to be filled or the overlapping to be eliminated. Such information is essential for effective co-operation within Britain itself and also in active partnership with the United States, as Mr. Dunning suggests. The continuing debates on the Bill afford further opportunities which should be utilized to promote public understanding of what is required and to supply the goodwill and esteem which the new Research Council—and also the Advisory Council for Scientific Policy—requires to enable it to carry out its work effectively; and to ensure support for the recommendations and decisions in regard to the Department of Scientific and Industrial Research for the furtherance of research in Britain generally needed for firm action and sustained results. The debate on the second reading of the Bill at least warrants the hope that further discussions on it will proceed in an atmosphere which will facilitate and not obstruct the appointment to the new Research Council of scientists and industrialists of outstanding qualifications and abilities, and not simply representatives of particular interests.

GEOLOGICAL RECORDS OF RADIOACTIVE EVENTS

Nuclear Geology

A Symposium on Nuclear Phenomena in the Earth Sciences. Edited by H. Faul. Pp. xvii+414. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1954.) 56*s.* net.

THE new subject of radioactivity has influenced many older branches of science; but no discipline—with the obvious exceptions of physics and chemistry—was more profoundly changed by it than geology. It may suffice to recall how fundamentally its whole time-scale has been altered; when, in the second half of the past century, Lord Kelvin declared that "as an abode fitted for life" the Earth cannot have served for more than 20 to 40 million years, it was very hard for geologists to oppose him, since he was in possession of all the relevant scientific facts—except those concerning the liberation of nuclear energy. This almost unlimited source of heat was discovered only towards the end of his life through the study of radioactive elements. Now the time which the astrophysicist can grant to the geologist has been increased more than a hundredfold and, more important still, several methods based on radioactivity have been put in his hand by which he may try to determine this figure experimentally with an accuracy never hoped for previously.

It is only natural that in the present volume, with its rather unusual title of "Nuclear Geology", considerable space is devoted to these determinations of geological age; but, to do justice to the ambitious title, an attempt is made to discuss also many other geological problems which appear now in a new light after radioactive data have been applied to geology. As the book is mainly meant for geologists and not for nuclear physicists, the first chapter, on fundamental considerations, instruments, and techniques of detection and measurement, will be found useful. It is preceded by a historical introduction which enumerates the early discoveries by radioactive workers which were of importance to geologists. (It is not quite correct to say (p. 5) that the work of Richards and Lembert on the atomic weight of radiogenic lead "first *proved* the theory of radioactive decay"; besides the fact that Hönigschmid's identical work was carried out quite independently and made public at the same meeting, the considerably earlier experiment by Ramsay and Soddy on the production of helium from radium has obviously greater claim to that description.)

The introductory paragraphs are followed by chapters on the occurrence of uranium, thorium, potassium and the inert gases in Nature, on the production of heat inside the Earth by radioactive processes and the help nuclear methods may give to geophysical exploration; also the subjects of radiation damage in minerals and of the influence of radioactivity on the formation of petroleum are discussed.

The subjects mentioned cover such a wide field that the editor was well advised to enlist the help of a great number of experts (twenty-six, in fact); he was prepared to sacrifice "uniformity of view, coverage and style" in order to gain "intangible freshness and clarity which are preserved only in first-hand accounts". This is admittedly the right procedure so long as isolated chapters are concerned which can stand by themselves. However, that such divided work cannot hope to achieve everything is convincingly explained by the author of the last chapter, on the origin of the Earth. Here Prof. Harold C. Urey begins with the assertion: "It is not possible to discuss the origin of a chondritic meteorite without attempting to understand the origin of the entire solar system; in fact, the latter subject cannot be discussed separately from the problem of the evolution of stars". He deplores the fact that astronomers and physicists have attempted to explain the origin of the solar system without possessing the necessary chemical knowledge, and then presents the relevant facts about the widely varying abundances of the chemical elements. He discusses possible explanations based on the volatilities of the elements (which are known) and the temperatures prevailing at certain stages of the Earth's history (which must be conjectured); and he concludes that "much more" must be learned before a "definite and lasting model of the origin of the solar system and of the Earth is devised". It is apparently Prof. Urey's opinion that one man will have to study and digest this vast amount of facts, before any effort to solve the riddles of the solar system can succeed. We may remember that, guided by a similar ideal, near the end of his life Alexander von Humboldt wrote the encyclopædic "Kosmos", and that Goethe, too, had the ambitious aim, neatly expressed by the scholar and poet Friedrich Ruckert:

> Eh es sich rundet in einen Kreis,
> Ist kein Wissen vorhanden;
> Solang nicht Einer Alles weiss,
> Ist die Welt nicht verstanden.

F. A. PANETH

AMMONITES AND CHRONOLOGY OF THE JURASSIC

Jurassic Geology of the World

By Dr. W. J. Arkell. Pp. xiv+806+46 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1956.) 105s. net.

THE author of "The Jurassic System in Great Britain" (1933) has capped that notable work with this equally substantial volume. Starting with Great Britain, where the succession of Jurassic formations was first determined, Dr. W. J. Arkell conducts his reader on a world tour, continent by continent, giving for each region a concise account of the rocks of this system and a critical review of the evidence as to the exact stages which they represent. Ammonite assemblages are the dominant theme throughout the work, the object of which, Dr. Arkell states, is in "no small part . . . to test the principles and performance of palæontological correlation on a world scale, to establish its capabilities and limitations". Bibliographies are given for each region, and Jurassic outcrops are indicated in numerous sketch maps. Some previously unpublished matter has been incorporated. The work is a mine of information and will be indispensable for reference.

Many will remember the controversies which, thirty years or more ago, centred around S. S. Buckman, who taught that ever-increasing precision was possible in the correlation of Jurassic rocks throughout the world on the basis of the distribution of ammonites, if only specimens were accurately collected and very critically examined. His culminating effort was to produce a scheme of about 370 'hemerae' into which, he alleged, it was practicable to divide Jurassic time. Ammonite evolution and the universal dispersal of new forms were, he maintained, so rapid that, if marine rocks deposited during any one of these hemerae were present in any region, the ammonite assemblage which then flourished everywhere would be found in them; and the absence of any such assemblage would indicate a local gap in the rock succession. A few thought that Buckman's scheme was entirely based on careful field-work (he certainly knew the Middle Jurassics of the Cotswolds thoroughly), others regarded him as a prophet who had divined the truth; but there were unbelievers who pointed out that his ideas were contrary to present-day experience of faunal provinces and the dependence of distribution on ecological factors. His doctrines were, at least, a stimulus to accurate collecting. Time has now put them to the test, and we turn with interest to Dr. Arkell's pronouncements on the subject.

That the rapidly evolving, prolific and (apparently) mostly very mobile ammonites afford the most reliable basis at present known to us for the correlation of marine Mesozoic rocks is a universally accepted fact. In the Lias, moreover, there is very little evidence of the existence of faunal provinces, the distribution of many genera being world-wide. As we ascend in the Jurassic succession, however, three faunal provinces (Tethyan, Pacific and Boreal) become distinguishable, contesting for certain regions. In the most favourable circumstances, where rocks of suitable lithology occur, a considerable degree of precision in correlation within a restricted area is possible with the aid of ammonites. Over any wide area, however, zonal schemes, much less detailed than those of Buckman, break down, and the original series of zones promulgated by Oppel in 1856–58 (amounting to about one-tenth the number of Buckman's hemerae) lies at about the limit of practical utility. Further, Dr. Arkell's considered view is that the original eleven stages into which d'Orbigny divided the Jurassic system in 1850 form "by far the best scheme yet devised for classification on a world scale". Even these are not applicable universally for the uppermost Jurassic; here we still have no means of exact correlation between d'Orbigny's Portlandian and Purbeckian in north-west Europe, the Volgian of Russia, and the Tithonian of the rest of the world. These conclusions are both a testimony to the acumen of the pioneers and a reminder that applied palæontology cannot be expected to progress on the same lines as a mathematical science. An interesting episode in the history of palæontological theory must be considered finally closed.

The concluding chapters of the work deal with other matters of general interest. Dr. Arkell is on the side of those who advocate the permanence of the main ocean basins. He has no use for palæogeographical maps, especially those showing continental masses occupying the present North Atlantic and Pacific basins in Jurassic times. Of continental drift since the Jurassic, he finds no evidence.

L. R. Cox

PROGRESS IN NUCLEAR SCIENCE

Annual Review of Nuclear Science

Vol. 5, 1955. Edited by James G. Beckerley, in association with Martin D. Kamen and Leonard I. Schiff. Pp. x+448. (Stanford, Calif.: Annual Reviews, Inc., in co-operation with the National Research Council of the National Academy of Sciences, 1955.) 7 dollars.

THIS is the fifth volume to appear in this series. The individual articles range widely from theoretical nuclear physics through nuclear engineering and radiation chemistry to radiobiology. Such publications must eschew the ephemeral progress report, the too-specialized description of experimental work or the very general treatment which properly belongs in a text-book. This volume generally avoids these hazards. The literature surveys are up to date to within about a year ago.

In a review of present knowledge of electromagnetic transitions in nuclei, Goldhaber and Weneser discuss the relative success of various nuclear models in explaining the regularities observed experimentally. Ford and Hill discuss the recent experimental information that has led to a detailed and consistent picture of the charge distribution in the nucleus. Theoretical explanations of this distribution, however, still seem inadequate. Peaslee contributes a survey of a field which has been receiving much attention recently—that of nuclear reactions in the intermediate energy-range up to 20 MeV. Here the compound nucleus model is ceasing to be applicable, and the more direct knock-on processes familiar at high energy have not yet become predominant. Two extreme models, the optical model and the statistical model, have each had some success. However, the experimental information available so far is rather incomplete.

Fretter supplies a useful article of the handbook type on the cloud chambers and bubble chambers being exploited in high-energy physics. Blizard discusses radiation shielding, a vexing technical problem for reactor or accelerator designers since the shielding represents such a large fraction of the cost. Borst compares designs of reactors intended for research purposes. Much of his discussion is of particular installations in the United States, but some of his remarks have general application. A few recent industrial problems where the mass-spectrometer has been used are reviewed by Berry and Walker.

Three articles are on radiation chemistry: a review of recent work by Dainton; a discussion of chemical effects of low-energy electrons by Krauss, Wahrhaftig and Eyring; and a useful compilation of radiochemical separation procedures by Finston and Miskel. Four articles on radiobiology complete the volume: cellular radiobiology, by Mortimer and Beam; removal of radioelements from the mammalian body, by Schubert; vertebrate radiobiology (physiology), by Edelmann; and a technical survey of radioautographic methods, by Norris and Woodruff.

The large amount of new data reviewed in these articles indicates the rapid growth and complexity of this field. The book is well produced and fully indexed. E. B. PAUL

UNIVERSITY OF SHEFFIELD

The Story of a Modern University

A History of the University of Sheffield. By Arthur W. Chapman. Pp. xvi+551+38 plates. (London: Oxford University Press, 1955.) 50*s*. net.

TO the student of higher education in Great Britain the past decade has been a period of great significance, for it has seen, among other developments, the creation of four new universities. Despite the great social, economic and political changes which have followed upon two World Wars, these years resemble, at least in the creation of universities, the first decade of this century, when a number of the civic universities of Britain were founded.

In "The Story of a Modern University", Dr. Artuhr W. Chapman recounts the growth of one of these—the University of Sheffield—which received its royal charter in 1905, and which to-day has some two thousand students in six faculties. Dr. Chapman has traced, with meticulous care and skill, the development of the University and its forerunners over a period of more than three-quarters of a century. Such an achievement has required from him an intimate knowledge, not only of the University, but also of local aspirations, and those national trends which contributed to its creation, as well as an appraisal of the personalities of the stalwarts who led the movement for a university in Sheffield.

The University has indeed been fortunate in its historian, for Dr. Chapman brings to his task an unusually long and varied experience of it. He has been a member of the staff for more than thirty-five years, and has served the University with rare devotion and enthusiasm. For two decades he taught in its laboratories and lecture rooms, for almost a decade he was warden of its largest hall of residence, and for the past twelve years he has been its registrar. With this rich experience he has been able to deal sympathetically with both the academic and administrative sides of its development.

Dr. Chapman's book is, however, more than a history of a particular university. It epitomizes a movement which, during the past hundred years, has revolutionized higher education in Britain. An outstanding feature of this work is an admirable collection of pen-portraits of such leaders as Mark Firth, Henry Stephenson and W. H. Hicks, "the academic founder of the University".

This is a scholarly work, beautifully produced, with many excellent reproductions of portraits of the University's leading personalities over the years. It will be read with real pleasure and satisfaction by all who cherish and support our universities, and it might, with advantage, be read by many students to-day, who do not always appreciate the wealth of their inheritance. BRYNMOR JONES

CHEMISTRY IN THE PETROLEUM INDUSTRY

The Chemistry of Petroleum Hydrocarbons

Edited by Benjamin R. Brooks, Cecil E. Boord, Stewart S. Kurtz, Jr., and Louis Schmerling. Vol. 2: Pp. vi+448. 108*s*. net. Vol. 3: Pp. vii+690. 144*s*. net. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1955.)

THESE two volumes now follow Vol. 1, published in 1954, and present an extensive body of information and ideas on a wide range of topics, which can more or less be included under the general title of "The Chemistry of Petroleum Hydrocarbons". The title is, in fact, interpreted liberally, and these are far from being text-books of pure chemistry. In many cases the subject-matter is treated largely from the point of view of current practice in the petroleum industry. Vol. 3, for example, begins with a short chapter on the oxidation of *ortho*xylene to phthalic anhydride. This particular section, which might well be glossed over in a text-book on chemistry, is introduced because of the uncertain supply of naphthalene in the United States and the consequent importance of this alternative route to phthalic anhydride. These two volumes are the work of forty-four contributors, and the coverage is thus comprehensive.

The specialized contributor to volumes such as these must be allowed freedom to follow his own ideas on the important current trends in his own field, since only in this way can each author contribute his detailed knowledge to the total presented. The editors of the volumes, on the other hand, must inevitably seek to achieve some unity of style and treatment, in addition to seeing that the whole field is adequately covered: they will seldom be in a position to criticize specialized detail. In the same way, the reviewer will focus his attention on the overall picture presented by these volumes, which must then be judged on the success achieved in selecting and unifying the contributions of the many authors. In justice, one might claim that multi-author volumes such as these should have multi-reviewers!

It need scarcely be said that the general presentation is excellent. Printing and paper are of high quality and printing errors are almost non-existent. There is, however, a certain unevenness in the individual chapters. Considering the form of the book in the preface, the editors conclude that "it would be necessary to limit its scope to scientific fundamentals". Many of the chapters conform to this idea. Yet the chapter on conditions and results of thermal cracking, though excellent in itself, ends with details of the design calculations illustrating "the adaptation of an existing furnace to a Visbreaking operation". An extensive chapter on the theory and mechanism of aromatic substitution forms a splendid digest of this much-studied subject. A later chapter deals further with the theory of nitration, but surely the information that nitrobenzene is also called oil of mirbane and smells of bitter almonds could be left to the junior text-books.

The subjects dealt with in the two volumes cover a wide range. Vol. 2 deals mainly with pyrolysis (including catalytic cracking) and oxidation of hydrocarbons and includes, among others, excellent sections on pyrolytic reactions of aromatic hydrocarbons, the theory of catalytic cracking, mechanisms of the reactions of non-benzenoid hydrocarbons and the theory of hydrocarbon oxidation. In Vol. 3, the chapter on fluorination of paraffins and cycloparaffins seems rather brief, and it is surprising at first sight to see a chapter on the chemistry of natural and synthetic rubbers: this is logical, however, when the present trend towards synthetic rubber is considered. This volume includes also excellent chapters on vinyl polymerization and on catalytic hydrogenation.

These volumes can be recommended as a valuable and convenient source of information on petroleum chemistry, particularly from the industrial point of view. In addition, they include excellent survey chapters on a good deal of fundamental chemistry. If one must regret that the great bulk and pace of modern development make it difficult for any one man to collate and present the published knowledge in this field, the present editors and authors are to be congratulated on producing this much order out of the vast mass of available information.

LEIBNIZ AND NEWTON

The Leibniz–Clarke Correspondence

Together with extracts from Newton's "Principia" and "Opticks". Edited with Introduction and Notes by H. G. Alexander. (Philosophical Classics.) Pp. lvi + 200. (Manchester: Manchester University Press, 1956.) 16*s*. net.

THE beginnings of modern science are rightly located in the seventeenth century, not only because of the positive achievements of that time, but also because it was then that the kinds of explanation which have come to be regarded as scientific were first thrashed out in philosophical discussion. Now that the broad principles of what constitutes a scientific explanation have come to be taken for granted, it is easy to forget that they emerged only after prolonged debate in which theologian, metaphysician and natural philosopher all took part, and in which indeed the major protagonists were well able to play all three parts at once. The correspondence between Leibniz and Clarke, now reprinted for the first time in English since 1738, represents the last phase of the battle. Leibniz died in 1716, only two weeks after Clarke's fifth letter had been dispatched, and no subsequent philosopher followed him in contesting the theoretical basis of science on purely metaphysical grounds.

It would be a mistake, however, to regard Clarke as the champion of enlightened science and Leibniz as the reactionary metaphysician. Much of the argument in this correspondence is of the kind that would now be called, in a pejorative sense, metaphysical, and neither Clarke nor Leibniz is concerned to make a distinction between questions of science and questions of metaphysics. With regard to theology, indeed, it is Leibniz who is the prophet of the new age, for he wishes to assert its distinction from and independence of science, but he sees this distinction as a safeguard for the doctrine of the uniqueness and transcendence of God rather than as a declaration of independence by science. This was the point upon which the controversy began. In 1715 Leibniz wrote to Caroline, then Princess of Wales, that the philosophy of Sir Isaac Newton was contributing to the decay of natural religion in England, for Newton had said that space is an organ by which God perceives things, thereby making things independent of God who created them, and also that God needs to intervene in the universe from time to time to maintain its order, like an unskilful workman who has made a machine which constantly needs repairing. This provoked Clarke to reply, as a churchman and disciple of Newton, and the correspondence continued through Princess Caroline for a year, five letters passing on either side. Its subject-matter was soon extended to include Leibniz's own metaphysical principles, and scientific topics such as the nature of space and time, the existence of vacuum, and the theory of gravitation.

On these scientific questions the argument turns upon what kind of theory is to be admitted in science, and in each case it is Leibniz who insists that theoretical explanations must conform to what he regards as self-evident metaphysical principles. There is no disagreement about the facts—Leibniz knows as well as Clarke that space void of air is produced in Torricelli's barometer and Guericke's air-pump, and that the planets move around the Sun in curved paths—it is the Newtonian explanation of these phenomena in terms of material atoms exerting forces upon each other across a void that he contests. There cannot, he says, be indistinguishable atoms because there would have been no sufficient reason for God to have arranged them in one order rather than any other, and God does not act without sufficient reason; and there cannot be a void because the universe would be imperfect if it did not contain as much matter as possible. Clarke disputes these arguments on theological grounds. He agrees with Leibniz, however, that nothing can act where it is not present, only maintaining, as Newton had done, that gravitational attraction is a fact, however it may be explained. If Leibniz can explain it by the laws of mechanism, he says, he will "have the abundant thanks of the learned world". Clarke's tendency throughout is to allow no restriction on the kind of explanation which may be given, and he is prepared to contemplate the direct action upon matter of immaterial, insensible substances as well as the direct intervention of God.

If there is any moral to be drawn, perhaps it is that science needs both Leibniz and Clarke. There is always some limitation on the kind of theory which is useful at any particular stage, and in 1716 Leibniz was right to question Clarke's immaterial substances and non-mechanical explanations. But preconceived ideas about what kinds of theory are proper can become too rigid, as physics learned again in the nineteenth century.

Mr. H. G. Alexander contributes notes and a critical introduction which contains an excellent account of the controversy on the nature of space and time as it appears in Newton, in the Correspondence, and afterwards, concluding with some remarks on the theory of relativity.

MARY B. HESSE

TUBE INVESTMENTS RESEARCH LABORATORIES

NEW HIGH-ENERGY RADIATION DEPARTMENT

By DR. A. CHARLESBY

IN recent years, interest in the civil aspects of the atomic energy programme has been mainly centred in the use of atomic energy for power production; radioisotopes produced in atomic plants have also found widespread application as tracers in industry, medicine and agriculture. A new and rapidly developing subject concerns the use of high-energy radiation to promote chemical changes, such radiation being available in atomic reactors.

Although the effects on materials of ionizing radiation in the form of alpha-, beta- and X-rays have been studied for a number of decades, the subject has received a sudden impetus in the past few years and considerable scientific and technical effort is now being devoted to it in a number of countries. This greatly increased interest arises from two main causes—the availability of powerful sources of radiation in the form of atomic piles or high-voltage generators, and the discovery of important applications of the knowledge gained from such studies. Information on the effect of atomic radiation on potential pile materials is essential in the design of high-power reactors. Moreover, recent research has shown that some of the changes induced by radiation, particularly in organic materials, may be of considerable industrial value.

The fields of potential application are extremely varied and include such diverse subjects as the sterilization of pharmaceuticals and foodstuffs, the production of mutations in plants, the initiation of chemical reactions as, for example, in the petroleum industry, and the production and modification of plastic materials. It is a measure of the rapid rate of progress in this field that although some of the basic discoveries were published only a few years ago, processes based on these have already reached the industrial stage. The field of application will undoubtedly extend with further research. Eventually, high-energy radiation may indeed supersede certain chemical treatments involving heat or chemical reagents. It has already been found that some processes which cannot at present be carried out by conventional chemical techniques become feasible by the use of high-energy radiation which can be applied in solids, liquids or gases at any desirable temperature.

Although the development of the subject is closely bound up with atomic energy, it should perhaps be emphasized that this relationship is largely of a historical character. The observed changes in physical and chemical properties arise from disturbances in the electronic structure and not from any changes in the nucleus. Of the sources available to produce such modifications, only a certain number rely directly or indirectly on nuclear transformations. These include the atomic pile itself, radioactive uranium rods withdrawn from atomic piles after use, or fission products which would otherwise be wasted. Naturally occurring radioactive elements or radioactive isotopes produced in the pile, such as cobalt or cæsium, may also be used for producing the required radiations. Chemical changes may be caused by alpha-, beta- or gamma-rays produced by such sources, either alone or together with the slow and fast neutrons present in atomic piles.

For most applications of radiation, beta- and gamma-rays appear to be most useful and convenient. Alternative sources of radiation are, however, available which do not rely in any way on nuclear changes, but instead depend on electrical high-voltage equipment, including linear accelerators, Van de Graaff machines, cyclotrons and X-ray equipment. It has been found that many of the effects obtained depend only on the energy absorbed within the material being irradiated and not on the type of radiation or its energy, which determines the penetration within the specimen. Thus, results obtained under certain experimental procedures can often be readily translated into those for very different radiation conditions. Experiments carried out with low-intensity fission products can be used for determining the feasibility of using radiations from high-power accelerators and, conversely, information obtained from the use of such accelerators can eventually be applied when fission products of high intensity become available with the growth of the atomic energy programme.

Until recently, work on the changes which can be produced by radiation have been largely confined to the use of low-intensity sources in universities and atomic energy laboratories; but the stage has now been reached where British industry is entering into the field. The equipment installed at the Tube Investments Research Laboratories, Hinxton Hall, Cambridge, is the first industrial installation designed specifically to pursue this work on a larger scale and with a greater degree of control of radiation conditions. To permit treatment with various types of radiation of different penetration and ionizing power, a number of radiation sources are available; these comprise a high-voltage accelerator giving 2 million volts, several X-ray machines and a large radioactive cobalt source.

The radiation building has been designed primarily to provide accommodation for the radiation sources and operating personnel; the preparation of specimens and the subsequent studying of the changes produced will normally be carried out in a separate laboratory building now under construction. The radiation building itself comprises a tower flanked by two small wings, one of which houses the smaller sources and the control gear for the main 2-million volt accelerator. This is installed in the upper of the two stories of the central tower and projects vertically downwards into the radiation treatment room on the lower story. The second wing of the building is used at present as a test laboratory, but is arranged for conversion to accommodate longer specimens which can be fed from one wing to the other through the radiation chamber. To protect personnel in the two wings against the intense radiation present in the radiation chamber, the walls consist of 3 ft. of concrete, while the heavy steel door is lined with lead. The radiation-level in the control room is constantly monitored and recorded. Specimens are

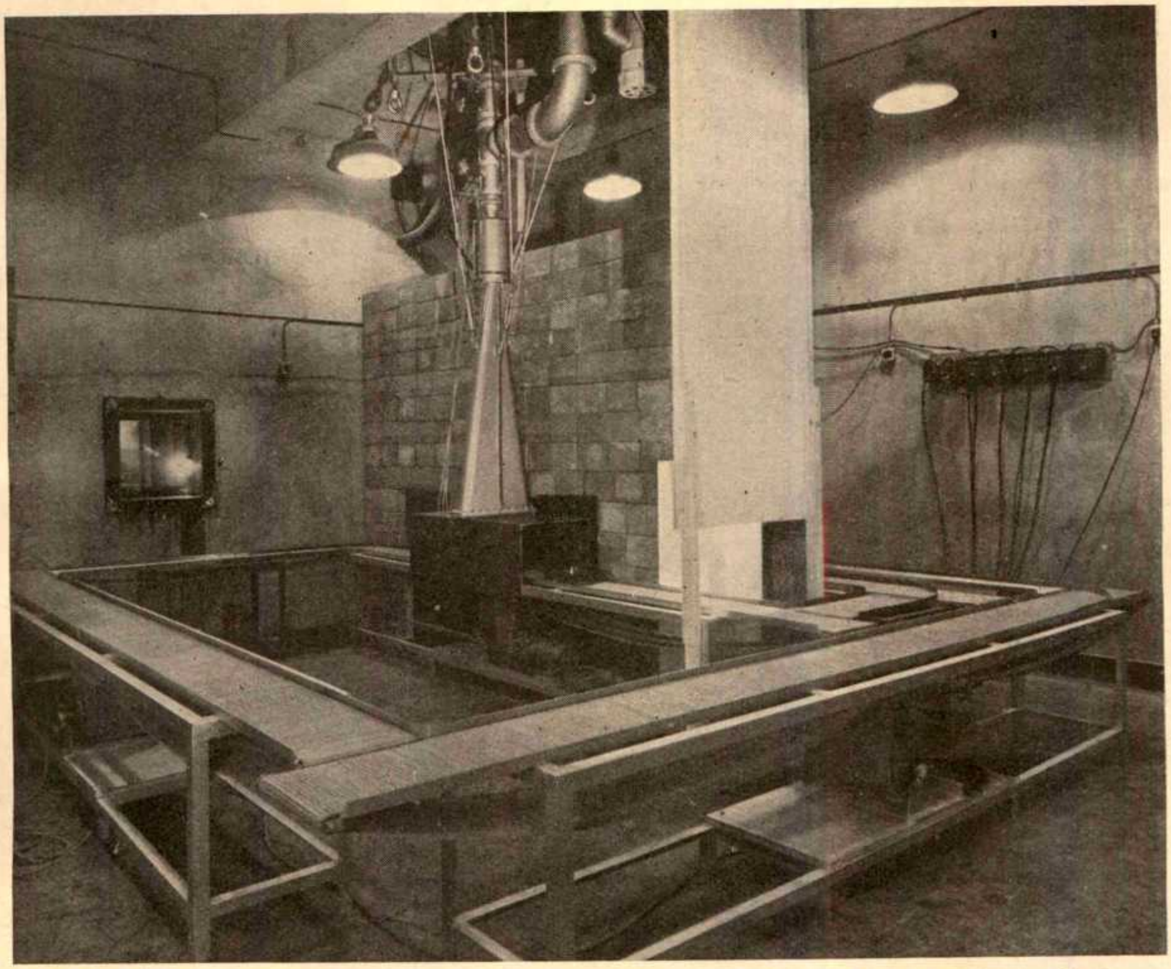

Fig. 1. General layout of the conveyor system within the irradiation chamber. The output tube for 2-MeV. electrons, showing the electromagnetic beam scanner, Faraday cage and viewing window can also be seen

led into the radiation chamber by a conveyor system passing through a labyrinth. A glass viewing-window approximately 1 ft. across allows specimens to be observed during treatment. This window consists of forty-one sheets of ¾-in. glass separated by medicinal paraffin oil to prevent multiple reflexions which would otherwise make direct vision impossible. A separate chamber houses the necessary ventilation and heating equipment.

The Van de Graaff electro-static generator supplied by the High Voltage Corporation, of Cambridge, Mass., is capable of producing an electron or ion beam of 2 million volts and of high intensity. By operating under a gas pressure of some thirty atmospheres, the total size of the installation has been considerably reduced. Under normal operation, it can generate 500 watts of electron-beam power, equivalent to the total radiation power available from many tens of thousands of curies of radioactive cobalt. By using an electron beam, the equivalent radiation intensity is even greater, since substantially all the energy emitted can be directed on to and absorbed within the specimen. Although most efficiently used for electrons, the generator can be converted to produce gamma radiation, fast protons or neutron radiation should these be required for special purposes.

Articles for radiation can either be placed immediately under the beam or fed from the control room by means of a flexible system of conveyor belts. The electron beam is scanned across each specimen by electromagnetic means controlled externally by the operator. The speed of the conveyor belt under the beam can also be varied over a wide range, and reversing mechanisms are available in the control room to enable specimens to be passed back and forth across the beam. Thus, a very wide range of radiation conditions can be readily obtained. After radiation, specimens may be taken out of the radiation chamber on the conveyor system and can then be handled immediately, since no induced radioactivity is produced with electron beams or gamma radiation of this energy-level.

In addition to the high-voltage accelerator, an X-ray machine operating at about 200,000 volts is available; this produces a radiation flux of higher penetration than from the 2-million volt electron beam, but the intensity is much lower. A second X-ray machine produces an intense beam of X-rays of up to 50,000 volts. Penetration of this radiation is very low and the equipment is mainly intended for surface treatment.

A high-intensity radioactive cobalt source gives highly penetrating gamma radiation of 1·3 million volts. This equipment has been designed to allow specimens to be irradiated at varying dosage-rates and at different temperatures. During the loading process, the cobalt source sinks into the base. To protect personnel during this operation, a number of interlocking devices are incorporated so that the container cannot be opened until the source is retracted into the safe position.

The programme of work envisaged with the radiation equipment includes both research and development. In the first instance, the effects of irradiating plastic materials are being studied in detail because it has already been shown that very useful changes can be produced in materials such as polyethylene, rubber and silicones.

At the same time, fundamental research is being undertaken into the mechanism by which radiation interacts with matter, and includes such problems as the irradiation of solutions, effects of inhibitors or protective agents, and the dependence on temperature of radiation-induced chemical changes. The investigation of radiation effects in materials may be considered as a new branch of scientific study involving close collaboration between chemists, physicists and biologists. Many of the effects observed are very novel, and their elucidation should provide not only a basis for further advances in radiation techniques and applications but also may well throw light on basic chemical reactions. The number of problems open for investigation is embarrassingly large, and collaboration with other organizations and research associations interested in the study or application of radiation methods is essential if rapid advances are to be made in this exciting new field.

THE MINISTRY OF AGRICULTURE, FISHERIES AND FOOD

WILSON REPORT

IN December 1954 an independent Committee, that is, not an inter-departmental one, was set up to review the ex-Headquarters organization of the Ministry of Agriculture and Fisheries, to which has now been added the remnants of the Ministry of Food, making it the M.A.F.F. The report of this Committee has recently been published* and, from the name of its chairman, Sir Ayrton Wilson, is being referred to as the Wilson Report. Anyone desirous of forming a clear view of the multitudinous activities of this Ministry and how they impinge on the farmer cannot do better than read this report. Although conforming to the usual style of such reports, with short numbered paragraphs, it is extremely lucid and readable and displays throughout its hundred pages the extreme thoroughness with which the members of the Committee have carried out their difficult task.

The Committee was asked "to consider generally whether the organization is best adapted to secure efficient and economical performance of the functions of the Ministry", to which the Committee's reply is summarized as, "It could certainly be better adapted"; whether "there was undue complexity, over-specialization, or overlapping", to which the reply is, "Yes! there is"; and whether "there was duplication and unnecessary interference with the work of local authorities", to which the reply is, "Little or no evidence of this". In addition to these three questions, the Committee was asked to survey the remaining organizations of the Ministry of Food and also to examine carefully the methods for dealing with the acquisition, management and disposal of land by the Minister and with the preparation of cases for consideration under the Agricultural Act of 1947 and the Agricultural Holdings Act of 1948. Because these cases impinge so directly on the rights and livelihood of individual citizens, the Minister evidently felt it necessary, in view of public criticism, to have existing procedures reviewed by an independent body. Comparatively minor improvements are put forward.

The report concludes with no less than seventy-eight main recommendations which, if put into effect, would result in savings approaching a thousand in staff and £1,000,000 in salaries, travelling expenses and general overheads. There would be additional savings on premises difficult to estimate accurately in advance. With the present Government committed to some reduction in national expenditure, it is evident that many of the recommendations of the Wilson Committee are likely to be implemented and they are now being considered by the County Agricultural Executive Committees as well as by the organizations concerned. Clearly it is not possible here to give an adequate summary of the voluminous report and its many findings; but an attempt will be made to select some of the major points.

Apart from its headquarters staff, the Ministry has no less than thirty-two organizations which can be divided into six major groups, with a staff of 8,500, and twenty-six smaller groups with about 1,500. The total annual cost is just under £10 million. The major groups are the County Agricultural Executive Committees, the National Agricultural Advisory Service, the Agricultural Land Service, the State Veterinary Service, Fatstock-Marketing, and the National Milk Testing Service. Examples of the minor groups are the Agricultural Lime Department, Land Drainage and Water Supply, the Rodent Inspectorate and the Insect Inspectorate. The organizations work within twenty-two different sets of boundaries—a fact which, in itself, indicates the probability of frequent lack of co-ordination.

Before planning some pruning, streamlining and regrouping of these numerous bodies the Committee first pointed to certain weaknesses, abnormalities and dangerous tendencies, and then laid down some desirable principles. Unlike most government departments, the Ministry of Agriculture and Fisheries has created its own local authority in the form of the County Agricultural Executive Committees and invested them with both advisory and executive duties. For the executive work, the Ministry has made much use of technical and professional staff instead of keeping to the usual practice of using administrative staff. The numerous separate organizations had the dangerous tendency of getting away from team-work altogether. "The Ministry's local organization is riddled with divided loyalties and dual control." The basic principles which, in the opinion of the Committee, ought to be followed are: first, the operations and methods of a Ministry should be supported by a broad body of public consent; second, that clear ("clean" is printed in the report) lines of command should flow from the centre to the farthest out-station, leaving no officer in doubt about his responsibilities or about who is his superior officer; third, the insidious growth of "perfectionism" must be avoided, for example, the tendency to develop a function beyond reasonable limits and regardless of cost; fourth, the organization and procedure must permit effective control of finance —not merely precise audit but provision for thorough preview of proposed outlay.

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* Report of the Committee appointed to review the Provincial and Local Organization and Procedures of the Ministry of Agriculture, Fisheries and Food. Pp. vi+108. (Cmd. 9732.) (London: H.M. Stationery Office, 1956.) 4*s.* 6*d.* net.

The most important local body is the County Agricultural Executive Committee, particularly as the National Agricultural Advisory Service county staff is closely associated with it. The proposals of the Wilson Committee regarding the County Agricultural Executive Committees can be taken as illustrative of the lines along which reorganization is envisaged. At the time of the Ryan Committee set up in 1949 with somewhat similar terms of reference, four of the main jobs of the County Agricultural Executive Committees were their responsibility for production targets, conduct of the Farm Survey, supervision of backward farmers, administration of trading services and subsidies. Since then, however, targets have gone, the survey has practically ceased, supervision cases are trivial in number; on the other hand, the country has continued to pay large sums in grants and subsidies. It is clear, therefore, that there must now be concentration on technical development to ensure higher and higher efficiency if the subsidies are to be justified. Technical development must in future be the first and primary duty of the County Agricultural Executive Committees, working in close co-operation with the National Agricultural Advisory Service. A second function would be to act as local adviser to the Minister.

Where State action affects the liberty and livelihood of the individual farmer, there is also need for local consideration of appeals against decisions of Civil servants dealing with routine work such as grants and subsidies. Other local problems, such as the completion of rabbit clearance and the use of land for particular purposes, can be dealt with by the same body. The Wilson Committee accordingly recommends that the future structure of a County Agricultural Executive Committee should be a Main Committee to concentrate on technical work and advice to the Minister, but delegating the other functions mentioned to a tributary body called the Executive Panel. The delegation of duties should be complete, the Main Committee merely receiving a regular report from the Panel. The word 'Executive' would in future be omitted from the name of the County Committee so that it would become the County Agricultural Committee. The chairmen of these Committees, preferably younger men than at present and with a broad outlook and constructive ideas, would meet regularly in the different regions and also have close links with the Minister through liaison officers. With a few exceptions, such as East and West Suffolk which would probably be made into one unit, the County Agricultural Committees would remain on the present county basis.

The report next deals with the routine executive and trading work no longer to be done by the County Agricultural Committee. For these the unit of area suggested is again the administrative county, except that there would be more amalgamations of smaller counties, for example, combining Cumberland with Westmorland, and Bedfordshire with Hertfordshire. In this way the existing sixty county units would be reduced to not more than forty, each with its "Divisional Executive Office". Besides doing the routine work mentioned, the Divisional Executive Office would provide clerical staff for the County Agricultural Committee and have attached to it the Area Milk Organization, the Lime Inspectorate, Pest Officers, etc. The office would be under the control of a senior member of the Civil Service Executive Class. The executive divisions (= counties or amalgamated small counties) would be grouped into Regions with boundaries, for the most part, coinciding with the present Standard Government Regions. In the north and in the south-east, combinations of two regions would reduce the ten Government Regions to eight Agricultural Regions. Wherever possible, the Ministry's Regional Staff would be centred in the standard regional "capital", such as Cambridge. Here there would be in command an administrative, not a technical, officer with the rank of Assistant Secretary. He would be the Ministry's chief official and representative in the region, and would supervise all regional staff comprising twelve separate services such as the National Agricultural Advisory Service, Fatstock Marketing, Defence. The technical staff at regional level, though under the general direction of the Controller, would retain the right of direct access to their superiors at the Ministry on technical matters.

Regarding the twelve services at the regional centre (four of them at county-level also), numerous recommendations are made, some of considerable importance. The National Agricultural Advisory Service would have lost most of, but not quite all, its non-advisory functions. It is also proposed that it should hand over to the Veterinary Service its Milk Production Officers who, "for all practical purposes are not advisory officers nor does the present nature of their work require them to be milk production specialists—they are scarcely concerned until the milk is in the pail". The number of Farm Machinery Specialists is also thought excessive and it is recommended that there should be one at each regional centre and one in large arable counties. In the case of horticulture, the recommendation is that the regional specialists should be reduced in number and sent to front-line work in the counties, where they should be able to do more effective advisory work. The Wilson Committee very pertinently and rightly directs attention to an outstanding weakness of the National Agricultural Advisory Service's structure (which some, including the present writer, pointed out even before it had started to function), that the 'key' man of the service, the District Officer, could only get promotion by "being withdrawn from front line work". An important addition to the Service is recommended owing to the proposed reorganization of the present Agricultural Land Service: it is that a specialist estate management section should be formed at regional level. The land service, it is suggested, should shed its extraneous non-professional duties and become a compact body of highly qualified land agents. Its local organization would be based on the new divisions and obtain its clerical staffs and common services from the Divisional Executive Offices. A somewhat similar reorganization is proposed for the Veterinary Services.

A long chapter of the report deals with "Milk Administration". "We have found it fascinating but extremely complicated." The main recommendation is that the National Milk Testing Service with its 350 staff should be disbanded and its work handed over to the Milk Marketing Board and the Veterinary Inspectorate. It was always difficult to see any real justification for the existence of the National Milk Testing Service.

In conclusion, one feature of the reorganization planned by the Wilson Committee may be pointed out which will please those who, like the writer, continue to maintain that the advisory and educational services should never have been divorced and should be 'remarried' as soon as possible. The County Agricultural Committees will remain based, in general, on existing counties and will have, as their chief concern, technical development and advisory work. It would be a small and comparatively easy step to add to these duties the responsibility for agricultural education in the counties. A great accession of strength would accrue to both services and further large economies in man-power and expenditure could be achieved together with greatly increased efficiency.

H. W. Gardner

STRUCTURE OF VITAMIN B_{12}

By Dr. DOROTHY CROWFOOT HODGKIN, F.R.S., JENNIFER KAMPER, MAUREEN MACKAY and JENNY PICKWORTH

Oxford

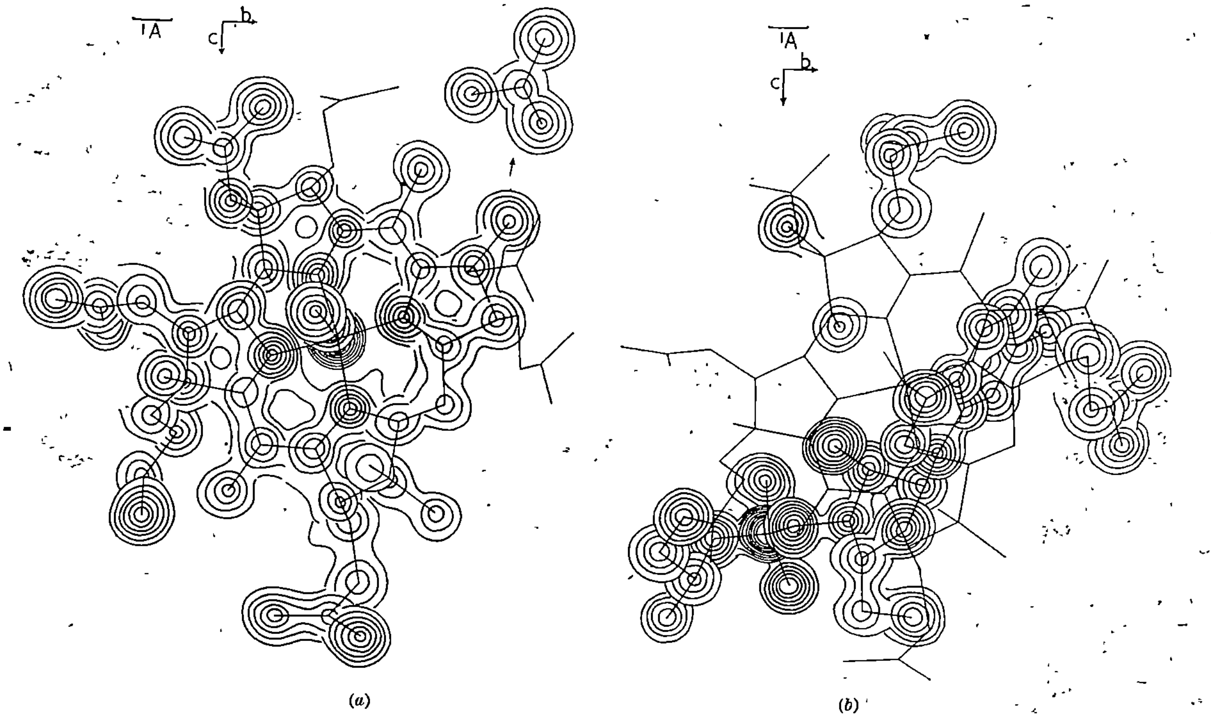
KENNETH N. TRUEBLOOD
Los Angeles

AND

JOHN G. WHITE
Princeton

Since our communication in August 1955[1], we have carried our refinement of the structure of vitamin B_{12} a critical stage further. Four more calculations of the electron density distribution have been made, one for the wet B_{12} crystals, two for air-dried B_{12} crystals and one for the hexacarboxylic acid.

In Fig. 1 are shown the electron density peaks over all the atoms of the B_{12} molecule as it appears from our present calculations in the wet crystals. These peaks are rather lower than those observed for the hexacarboxylic acid owing to the smaller number of X-ray reflexions given by the larger molecule in proportion to its size. But they serve to show the relative positions of all the atoms in space of this very complex molecule within probably as little as 0·3 A. Similar evidence has been obtained for air-dried B_{12}; for both crystals the reliability indices in the latest structure factor calculations, 36·1 and 30·6 per cent, respectively, are now low



(a) (b)

Fig. 1. Electron density-levels from the three-dimensional electron density-distribution for wet B_{12} crystals, calculated with terms phased on 93 atoms

Here, and in Fig. 4, the contours are drawn in the sections of the calculated distribution parallel with the *a* plane, passing at or near the atomic positions. Owing to the complexity of the molecule, complete contours for every atom are not given and the figure is divided into two parts. (*a*) shows the cobalt-containing nucleus and cyanide group; (*b*) the benziminazole, sugar, phosphate and propanolamine groups, the side chains being divided between the two. The acetamide chain on ring *B* is inset. The contour interval is 1 e/A^3.

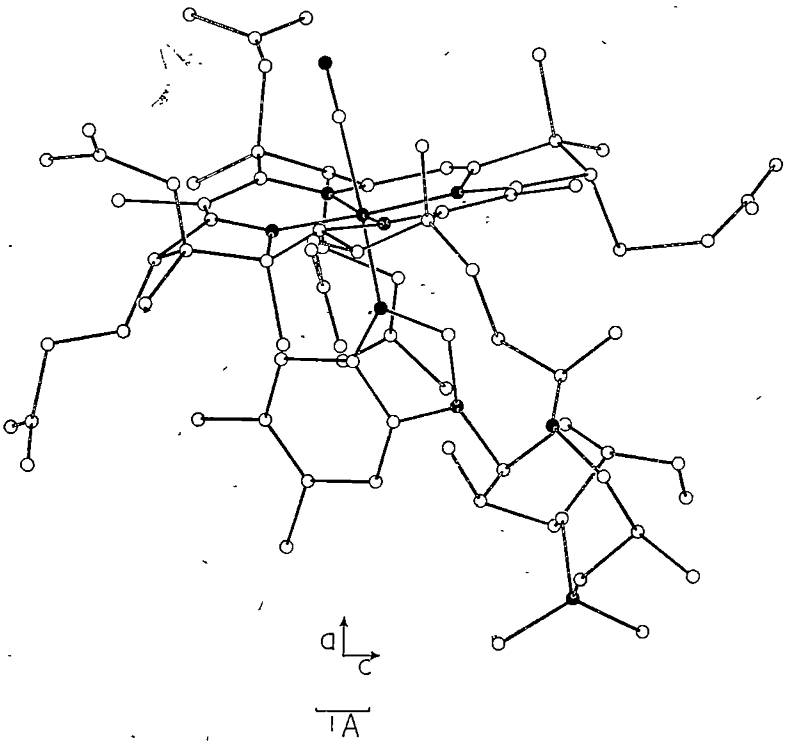
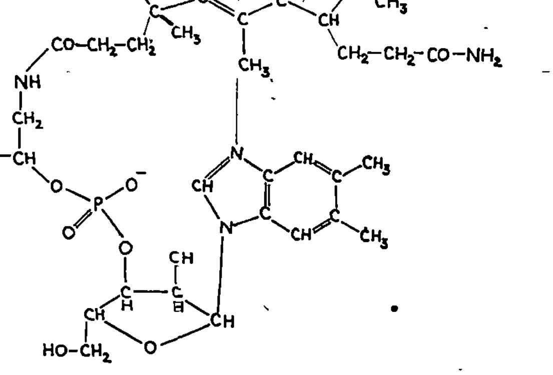


Fig. 2. The atomic positions found in the molecule of vitamin B_{12}. These are shown as derived in the wet crystals, projected on the *b* plane. To distinguish different parts of the molecule, bonds within the cobalt containing nucleus, benziminazole and cyanide groups are shown in black, together with the cobalt and phosphorus atoms and the nitrogen atoms of the nucleus, benziminazole, propanolamine and cyanide groups

enough to indicate that the solution we have reached is likely to be essentially correct.

The molecule that appears is very beautifully composed, not far from spherical in form, with all the more chemically reactive groups on its surface. It is drawn in projection in Fig. 2. It is built around the two planes of the benziminazole nucleus and the central cobalt-containing nucleus, which are nearly at right angles to each other. The ribose ring turns in a position nearly normal to the benziminazole group, which permits its easy linking through the phosphate, propanolamine, and propionic acid residues to ring *D* of the planar group. The benziminazole nucleus is packed in on either side by the propionamide side-chains in the extended, staggered configuration, attached to rings *A* and *B*; the side-chain on ring *C*, in the gauche configuration, lies above the ribose ring. All the acetamide residues project from the opposite side of the nucleus to the propionamide residues, towards the cyanide group. It is an interesting point that one of them—that on ring *B*—swings round the carbon–carbon single bond from a position directed away from, to one in contact with, the cyanide group, when the crystals are removed from their mother liquor; this permits the rather closer packing of the molecules found in the air-dried crystals. Throughout the molecule, as shown by Figs. 1 and 2, the atomic positions found conform in a most convincing way with the stereochemical rules established by the study of simpler molecules.

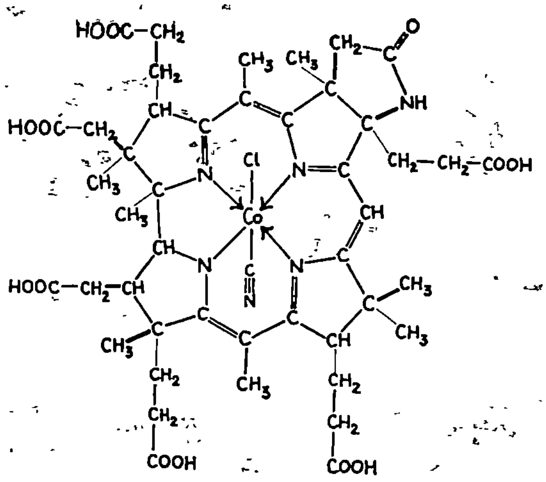
It now seems reasonably certain that we should formulate vitamin B_{12}, $C_{63}H_{88}O_{14}N_{14}PCo$, as in I, and the hexacarboxylic acid as in II, with six double bonds in the inner ring of the central nucleus; these can form a resonating system by intervention of the cobalt atom as illustrated by III. Some evidence in support of this has been obtained by theoretical calculations[2], by spectroscopic measurements[3] and from further chemical studies[4]. Our own evidence for this formulation is the geometrical form of the nucleus, which is illustrated by Fig. 3, and which is closely similar in all three crystals studied. The interatomic distances shown in this figure are derived from the latest calculations on the hexacarboxylic acid and are not individually very precise; in other parts of the molecule distances differing by as much as 0·16 A. from accepted bond-lengths have been found. But it is notable that in the region N_6–N_{18} *all* the bond-lengths are shorter than normal single bond distances; their average value, 1·36 A., is similar to that found in the phthalocyanines[5]. The positions of C_{29} and C_{30}, one or other of which would be expected to be out of the plane of the central ring system if only five double bonds were present, are even more significant. In the hexacarboxylic acid they appeared at all stages of the refinement to be within 0·2 A. of this plane, but in the B_{12} crystals themselves their positions were at first more confused, particularly C_{29}. As a critical test, accordingly, this atom was omitted from the phasing calculations used for the latest electron distribution calculated for air-dried B_{12}. It has now appeared, as Fig. 4 shows, as a small but clearly defined peak at a site which is closely equivalent to that found in the hexacarboxylic



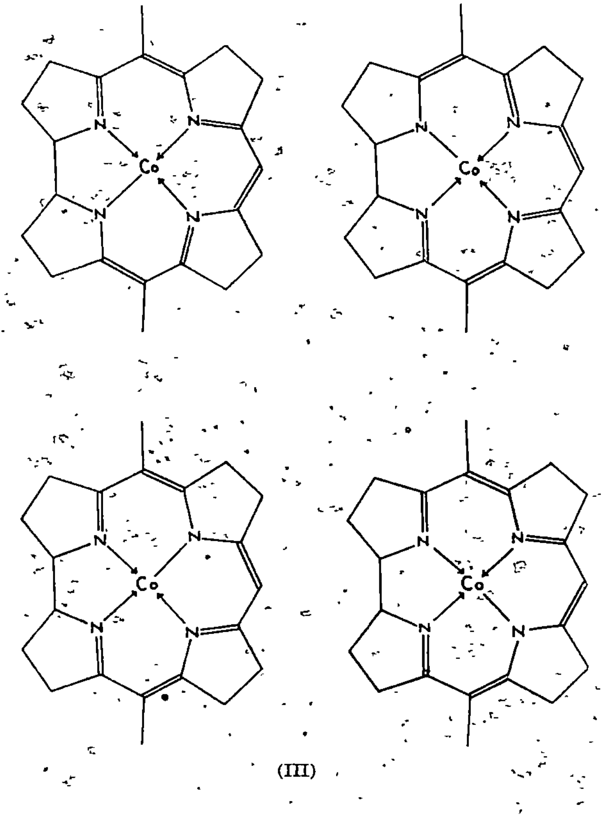
(I)

acid along the line Co to C_8. There is still some departure from planar character in this region of the inner nucleus in both wet and air-dried crystals, but this seems to affect N_{10}, C_9 and C_8 as much as C_{29}. If real, it may be a consequence of a small amount of compression from the benziminazole nucleus, which is in contact with these atoms. It is, in any event, not of the geometrical form that would be expected if C_8 were reduced.

The crystal structures of the different B_{12} compounds are still not completely solved; many of the water molecules which occupy space between the vitamin molecules have been placed, but not all. Still further small adjustments are to be expected on continued refinement of the atomic positions observed. We hope that future calculations will add still greater precision and certainty to our knowledge of the structure of the molecule.



(II)



(III)

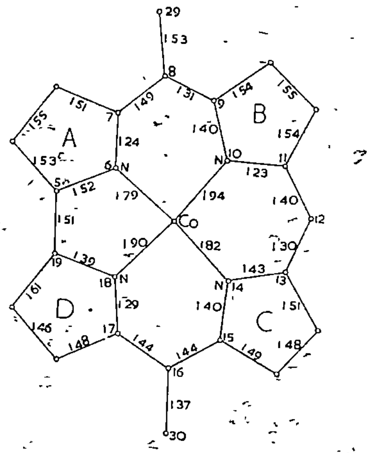


Fig. 3. Interatomic distances found in the inner nucleus of the hexacarboxylic acid, derived from nine refinements of the calculated electron density distribution

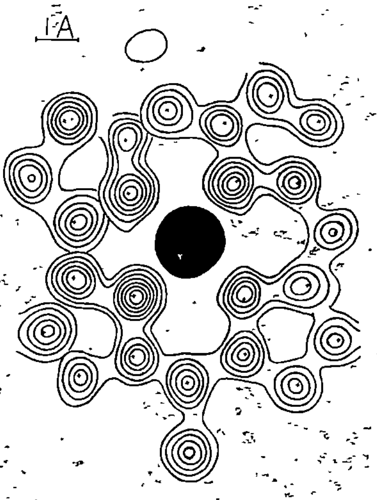


Fig. 4. Electron density peaks over the nucleus in air-dried vitamin B_{12}, derived from the three-dimensional electron density distribution calculated with terms phased on 95 atoms (Princeton data)

The latest series of calculations on wet B_{12} were carried out on the University of Manchester electronic computer through the generous co-operation of Dr. D. W. J. Cruickshank, Miss Diana Pilling and Mr. J. F. P. Donavan, of the University of Leeds. Those on air-dried B_{12} and on the hexacarboxylic acid were made on the National Bureau of Standards automatic computer in Los Angeles, supported by the United States Office of Naval Research.

Again we acknowledge the very generous support given this research by the Nuffield Foundation, and materials and help given us by Dr. E. Lester Smith, Glaxo Laboratories, Ltd., and Dr. K. Folkers, Merck Laboratories. Two of us (J. P. and J. K.) received grants from the Department of Scientific and Industrial Research.

[1] *Nature*, **176**, 325 (1955).

[2] Orgel, L. E. (private communication).

[3] Beaven, G. H., and Johnson, E. A., *Nature*, **176**, 1264 (1955).

[4] Todd, A. R. (private communication).

[5] Robertson, J. M., *J. Chem. Soc.*, 1195 (1936). Robertson, J. M., and Woodward, I., *ibid.*, 219 (1937).

OBITUARIES

Prof. George Sarton

It has been my privilege to enjoy the friendship of George Sarton for forty-three years. He was, in my judgment, one of the great teachers of our age. This was not because he was in the ordinary sense eminent in science, nor because he was an acute investigator, nor on account of anything startlingly original in his outlook. It was because he was a superb organizer of knowledge and an unrivalled integrator, and because these powers came to him with an extraordinary devotion to learning, a uniquely clear vision of its object, an Olympian firmness of purpose, and a quite exceptional industry and linguistic equipment. For about the last twenty years of his life, he was one of the most widely learned scholars in the world. Though he long held a post as historian of science at the Carnegie Institution and a chair of the history of science at Harvard University for many years and was a good, clear, allusive lecturer, he was not a great academic success in the sense of attracting a large following of students. He was, nevertheless, one of the most important intellectual influences of our time, for he defined, illustrated and developed as a new discipline the study of the history, principles and method of science. This he called 'The New Humanism'. The title is not ideal, but it denotes an approach that bids fair, in the New World at least, largely to displace the old humanism.

Apart from the width and depth of his learning, his literary output was very impressive both for its bulk and quality. He edited and largely contributed to fifty-five solid volumes of the journals that he founded—*Isis* and *Osiris*. Many of these volumes contain an introduction by himself which I am tempted to call a sermon. These provide a body of moral and scientific philosophy. It would be worth while putting together the best of them, for they would form a good guide to anyone proposing to devote his life to scientific research. No one can write on ancient or medieval science without often consulting the five enormous volumes of Sarton's monumental and mistitled "Introduction to the History of Science". Its title is wrong because it has become more a court of appeal than an introduction and is seldom consulted in vain. He was the author of many other works, but his great "History of Science", which was to be the crown of his old age, is alas! a torso. He produced the first volume, which is on the science of the Ancient Empires—not the period on which he was strongest—and the second volume is in the press. The remaining half-dozen will never see the light.

Sarton was a very human figure with a Gallic wit, a not unpleasant sense of his own greatness, and a few foibles. Among the latter was an odd aversion to Plato and an incapacity—which grew on him with the years—for writing without adding notes to his text. Even his reviews had notes, and even notes to the notes. But he was always a good, clear and simple writer and one may search many pages of his innumerable works without finding an obscure passage.

His linguistic attainments were astonishing. He was brought up trilingual—French, Flemish and German. He had a good classical education and graduated in the physical and mathematical sciences in his native Belgium. He married an English lady in 1912 and before settling in the United States acquired fluent and perfect English which was, however, never quite freed from a delightful Gallic tang. He could use all the major European languages freely and obtained facility in Hebrew and Arabic. He knew some Chinese and was led to its study by something more than an inkling of the great technological and scientific treasures in that language that are now being unearthed by Dr. Joseph Needham. To all the vast stores of learning that these accomplishments imply, he added a very wide knowledge of modern science. In his later years he had become particularly attracted by biology and, though without early training in that department, it is remarkable how much he wrote on it and how seldom he stumbled for lack of understanding. He was a master of those who know, and it is therefore not entirely fanciful to compare him to his own master, Aristotle.

What influence did Sarton exert on our age? I can only put the matter as it appears to me. Among 'humanists' surprisingly little, and in Great Britain scarcely any at all. By most English students of the classical, literary and historical disciplines in Britain his massive works are, I imagine, scarcely ever consulted and remain almost unknown. In the United States he had become something of a national figure, and there, even among humanists, his influence was certainly greater. This partial eclipse of his genius is, I believe, temporary. On both sides of the Atlantic the overwhelming need for scientific and technological training and the corresponding earlier specialization is producing a novel situation. A new humanism is needed, and several universities in England and a larger number in the United States have instituted departments of the philosophy and history of science. In these the work of Sarton is given a place accorded to that of no other man, and his influence in all that concerns the humanization of science is bound to increase in the near future.

Lastly, what were the intellectual influences that were instrumental in moulding Sarton's own thought? There can be no doubt that, of those who lived into the twentieth century, Tannery and Duhem affected him most deeply. More distantly he was evidently a follower of August Comte, and his greatest works bear the authentic Comtian mould. He accomplished the task which Comte suggested. The key to Sarton's thought is that true knowledge is a unity and that to divide it into categories—scientific, literary, religious, æsthetic, etc.—for any but practical purposes, is to mistake its nature.

All his work was helped by a serenely happy domestic life. Sarton died in April of this year at the age of seventy-two. Mrs. Sarton—who was an artist in her own right—died some years ago. He is survived by a daughter, May Sarton, a distinguished novelist and poet.

CHARLES SINGER

Dr. G. Liebmann

GERHARD LIEBMANN, who died suddenly on June 18, was born on June 29, 1906, in Berlin. In 1925, he matriculated at the Falk Realgymnasium, Berlin, and proceeded to read physics in the University of Berlin under such teachers as Planck, Von Laue, Schrödinger, Wehnelt and Nernst. He graduated with honours in 1928. Continuing as a postgraduate research student, he was awarded his doctorate of philosophy in 1930. Following this, he was awarded a German national research fellowship in physics which he served under Prof. Nernst, at the same time assisting Prof. Wehnelt as demonstrator. After six further years research in German industrial laboratories, he came to Britain because of the adverse conditions in Germany under the Nazis in 1936. Shortly after his arrival in Britain, he was appointed chief physicist and head of the Vacuum Physics Section of Cathodeon, Ltd., in Cambridge, where he served until 1947, when he took a senior appointment in the Research Laboratory of the Associated Electrical Industries, Ltd., at Aldermaston in Berkshire.

His earlier researches in Germany were concerned with high-temperature physics, infra-red spectra and electronic valves. In Great Britain, he made important contributions in the development of television cathode-ray tubes, valves and image converters. He became interested in the electron microscope while in Cambridge, and built an instrument there.

Already he had published many papers, and taken out more than forty patents. He later developed his interest in the electron microscope, and put to good use his innate mathematical ability and ingenuity. His development of the resistance-network analogue calculating method, and his use of this in calculating the properties of electron lenses, contributed largely towards the development of greatly improved electron microscopes. His scientific papers were then appearing in many scientific journals, and were being read in European countries, in the United States and in Britain. He latterly extended his reputation in the computational field by the development of resistance-network analogue methods for the solution of the transient heat flow equations, fourth-order differential equations, and the more complicated equations occurring in thermal stress and neutron diffusion problems. He lectured by invitation in the United States in 1955, and in Brussels early in 1956, and was appointed vice-chairman of the International Analogue Computation Association. He had long been a Fellow of the Institute of Physics, and several times lectured at the Institute, and was a member of the American Institute of Radio Engineers.

Liebmann was a kindly and loyal man. He was a great lover of family, of science, and the mountain peaks. His interest in science was wide, and his advice to colleagues and assistants has contributed greatly to their success. His powers of concentration were great. He was liked and admired by all. His memory will live with his friends because of his understanding and his sincerity, with his colleagues because of his example and guidance, and with his fellow scientists because of his scientific achievements.

He leaves a widow, a son and a daughter.

M. E. HAINE

NEWS and VIEWS

Chancellorship of the Massachusetts Institute of Technology: Dr. J. A. Stratton

A NEW post, that of chancellor, has been established at the Massachusetts Institute of Technology, and Dr. Julius A. Stratton, at present vice-president and provost, has been appointed as the first holder. As chancellor, Dr. Stratton will be directly responsible for administering the academic side, including staff, of the Institute's affairs and will be deputy to the president, Dr. James R. Killian, jun., who is the Institute's chief executive officer; the chancellor will act as president in the latter's absence. The other principal officers of the Institute are Admiral Edward L. Cochrane, vice-president in charge of relations with industry and government, and Mr. Joseph J. Snyder, vice-president and treasurer. Dr. Stratton graduated from the Institute in 1923 and, after study in Grenoble and Toulouse, gained the D.Sc. of the Federal Institute of Technology, Zurich, in 1927. He became assistant professor of electrical engineering in the Massachusetts Institute in 1928 and then assistant professor of physics (1930), associate professor of physics (1935) and professor of physics (1941). He was on the staff of the Radiation Laboratory at the Institute from its inception in 1940 until the end of the Second World War. During the War he was at first engaged on communication surveys and other problems over the North Atlantic and in North Africa and Italy; later he advised on problems of ground radar, radar fire control and radar bombing, and assisted in the establishment of aids for all-weather flying. For these services he was awarded the Medal for Merit. After the War Dr. Stratton became director of the Research Laboratory of Electronics at the Institute, the peace-time successor to the Radiation Laboratory. He was made provost of the Institute in 1939, with the primary responsibility for co-ordinating inter-school educational and research facilities, and two years later he became vice-president as well.

Mechanical Engineering at Swansea: Prof. R. H. Macmillan

MR. R. H. MACMILLAN has been appointed to the newly created chair of mechanical engineering at the University College of Swansea. Mr. Macmillan, who has been on the staff of the Department of Engineering at Cambridge for the past ten years, was educated at Felsted School and Emmanuel College, Cambridge, where he took the Mechanical Sciences Tripos in 1941. He was then commissioned in the Technical Branch of the R.A.F., where he was concerned mainly with automatic equipment for gunsights and with rockets. Since returning to Cambridge, he has published several papers on problems of automatic control, and his textbook, "An Introduction to the Theory of Control", first appeared in 1951. He spent the academic year of 1950–51 working as a visiting assistant professor in the Mechanical Engineering Department of the Massachusetts Institute of Technology, and on a later visit to the United States contributed to the Frequency Response Symposium of the American Society of Mechanical Engineers: on this occasion he also lectured on aspects of automatic control at the Universities of Pennsylvania and Minnesota. Mr. Macmillan's particular interest is in explaining engineering developments to other scientists and to the general public, and in considering their social implications; in this connexion the B.B.C. has broadcast a number of his talks, and last autumn he gave a popular series of afternoon lectures at the Royal Institution. His book, "Automation: Friend or Foe", has just been published by the Cambridge University Press.

Royal Society and Nuffield Foundation Commonwealth Bursaries

AWARDS under the Royal Society and Nuffield Foundation Commonwealth Bursaries Scheme have been made as follows: A. B. Acton, assistant lecturer in genetics, University of Glasgow, to work in Toronto on the comparison of the chromosome conditions of Canadian populations of Chironomid flies with those in Britain (July–September 1956); Dr. W. R. Adey, senior lecturer in anatomy in the University of Melbourne, to visit neurological centres in Great Britain in order to extend his studies on temporal lobe epilepsy (December 1956–February 1957); Dr. L. Davies, lecturer in zoology, Durham Colleges in the University of Durham, to study blackflies and other biting insects, at Ottawa and Hamilton, Ontario (July 1956 for three months); J. Harley-Mason, lecturer in chemistry in the University of Cambridge, to investigate in Jamaica some West Indian plant products of potential chemical and medicinal interest (December 1956–April 1957); Dr. N. E. Hickin, of Leatherhead, Surrey, to visit Uganda during October 1956 to collect material for continuation of his studies of caddis flies (October 1956); Dr. A. Mohiuddin, reader in zoology in the University of Karachi, to study parasitic protozoa at the London School of Hygiene and Tropical Medicine (September 1956 for about twelve months); Dr. R. P. Rastogi, lecturer in chemistry in the University of Lucknow, to study at Reading and Edinburgh thermodynamic properties of mixtures (July 1956 for twelve months); Dr. W. M. Smith, associate professor of chemistry in Queen's University, Kingston, Ontario, to study at Oxford the kinetics of reactions in the liquid phase, with particular emphasis on fast reactions and the influence of the solvent (July 1956–June 1957); Prof. H. Waring, professor of zoology in the University of Western Australia, to investigate at Cardiff the influence of melanophore hormone preparations on carbohydrate metabolism, and particularly on the hyperglycæmia induced by adrenaline (October 1956–January 1957).

Ramsay Memorial Fellowships: Awards

THE Ramsay Memorial Fellowships Trustees have made the following awards for 1956–57: Dr. M. J. Stephen, a general fellowship at the University of Oxford; a Glasgow fellowship to Mr. G. S. Harris, at the University of Cambridge; a Canadian fellowship to Mr. A. H. Webster, at the University of Cambridge; a Netherlands fellowship to Dr. C. H. Stam, at the University of Leeds; and a United States fellowship to Mr. P. B. Sherry, at the University of Oxford. The Trustees have renewed the following fellowships for 1956–57: Mr. B. R. Hammond (general fellowship) at the National Institute for Research in Dairying, Reading; Mr. E. Haslam (general fellowship) at the University of Cambridge; Mr. H. Inokuchi (Japanese fellowship) at the University of Nottingham; Dr. R. Vicente and Mr. F. Garcia-Moliner (Spanish fellowships) at the University of Cambridge.

New Veterinary Building at Cambridge

A NEW building to house the Veterinary Investigation Officer and his staff of the Ministry of Agriculture, Fisheries and Food is to be constructed on the site of the School of Veterinary Medicine of the University of Cambridge. This was only made possible as a result of a gift of £10,000 by Lady Brigid von Preussen and her husband towards the cost of the scheme. The Veterinary Investigation Officer is responsible for investigating outbreaks of diseases among herds and flocks of the eastern counties of England. A great deal of clinical and pathological material is continually being sent to the centre for diagnostic purposes, and pressure of routine work not infrequently prevents the fullest use being made of this valuable material for research purposes. It was considered that contiguity of the centre with the School would help to overcome this and would facilitate collaborative research between the clinicians and pathologists of the School, on one hand, and with the veterinary staff of the Ministry's centre, on the other. Besides the value of the pathological material for teaching purposes, the student will inevitably be more likely to be introduced to the herd and flock problems of the surrounding counties by being continually brought into contact with the work of the Ministry's veterinary officers.

Westonbirt Arboretum

THE Forestry Commissioners have appointed the following as members of the Westonbirt Arboretum Advisory Committee: The Hon. L. Palmer (*chairman*), Sir Edward Salisbury, Sir Harry Champion, Mr. C. M. Floyd, The Duke of Beaufort, Sir Eric Savill, Prof. E. W. Yemm, Mr. Hiram Winterbotham and Mr. J. S. L. Gilmour. This arboretum, with some neighbouring woodland, was acquired recently by the Commissioners. It is situated to the south-west of Tetbury. It covers more than a hundred acres and is a unique collection of trees and shrubs; it was founded in about 1820 by the ancestors of the late Sir George Holford, by whom it was afterwards developed, the work being continued by the late Lord Morley. Oaks, yews and conifers form a background to numerous rare specimens of trees and shrubs collected from many parts of the world, particularly Japan, China and the western States of America, and including, notably, varieties of maple and rhododendron. The Committee will consider means of facilitating public access to the arboretum.

U.S. National Science Board

ON May 25 the United States Senate confirmed President Eisenhower's nomination of the following as members of the National Science Board of the U.S. National Science Foundation. Drs. L. M. Gould, P. M. Gross, G. D. Humphrey and F. A. Middlebush are charter members of the Board and have been re-appointed. Dr. Warren Weaver, of the Rockefeller Foundation, has been appointed to succeed the late Rev. J. B. Macelwane, and he will retire in 1960. The following have been appointed to serve a term of six years: Prof. E. J. McShane, professor of mathematics in the University of Virginia; Prof. S. M. Nabrit, professor of zoology, Atlanta University; Dr. J. A. Stratton, chancellor, Massachusetts Institute of Technology; Prof. E. L. Tatum, professor of biology, Stanford University.

Paris Academy of Sciences: Elections

THE following have been elected *correspondants* for the Botany Section of the Paris Academy of Sciences: Prof. P. Martens, professor of palæobotany in the University of Louvain, in succession to Prof. E. Gäumann, recently elected a foreign associate of the Academy; and Prof. A. Fernandes, professor of botany in the University of Coimbra, in succession to the late Prof. E. D. Merrill. The following have been elected *correspondants* for the Zoology Section of the Academy: Prof. U. d'Ancona, professor of zoology in the University of Padua, in succession to Prof. D. Keilin, recently elected a foreign associate of the Academy; and Prof. P. Brien, professor of zoology in the University of Brussels, in succession to Prof. A. Vandel, recently elected a non-resident member of the Academy.

Recent Economies in Government Expenditure

THE Chancellor of the Exchequer, Mr. H. Macmillan, made a statement about economies in government expenditure on June 26, in which he said that the estimated savings in defence (£36·5 million on the defence programme and £14 million on defence expenditure) do not reflect any change in the size or shape of the Armed Services and that any major decisions in this field would only be taken after consultation with Britain's allies. The savings of £25·5 million on other Civil Estimates, details of which are given in a paper afterwards circulated, include £810,000 in grants for Colonial development and welfare, including research, £70,000 in economies in capital expenditure by the Agricultural Research Council, £53,000 in economies in training and research and reduction in purchases of equipment by the Forestry Commission, £180,000 in economies in maintenance expenditure on roads and £150,000 in general economy by the Department of Scientific and Industrial Research. Economies of £265,000 by the Ministry of Housing and Local Government are to fall in part on National Parks. From the public point of view, it would seem that, where departments have been efficiently run in the past or have been short of adequate resources, the cuts though small will do real, if only marginal, harm.

Factory Inspectorate of Great Britain

REPLYING to questions in the House of Commons on June 26, the Minister of Labour and National Service, Mr. Iain Macleod, said that, of the ninety-six districts of the Factory Inspectorate, thirty-six have no inspectors possessing university degrees in engineering or chemistry and physics, and only eleven have more than one such inspector. For 1939, when there were ninety-two districts, the corresponding figures were twenty-four and twenty-three. Mr. Macleod said that the question of the technical strength of the Inspectorate is the most important matter now before him as a result of the departmental committee's report, and the problems are being considered whether the establishment of inspectors should be increased and whether more technically qualified people are needed.

National Science Foundation Russian Translation Programme

EXPANSION of the U.S. National Science Foundation programme for the translation into English of Russian research literature has recently been made through a grant of 76,500 dollars for this purpose to the American Institute of Physics. The expanded programme will include the *Zhurnal Teknicheskoi Fiziki* (*Journal of Technical Physics*), *Akusticheskii Zhurnal* (*Acoustics Journal*), and physics articles from the *Doklady Akademii Nauk SSSR* (*Proceedings of the USSR Academy of Sciences*). First issues of the translated journals will appear soon. The Foundation and the American Institute of Physics have already successfully collaborated in the publication of *Soviet Physics—JETP*, a bi-monthly translation of *Zhurnal Eksperimental noi i Teoreticheskoi Fiziki* (*Journal of Experimental and Theoretical Physics*), six issues of which have now appeared. In addition to the programme in physics, the Foundation is supporting translations of Russian papers in mathematics and biology; and plans for the fiscal year 1957 include the earth sciences and the engineering sciences. The American Mathematical Society publishes about 1,000 pages annually of Russian work in mathematics, under the title, *American Mathematical Society Translations*. The Foundation has just awarded a small grant to *Biological Abstracts* for the translation and publication of abstracts from the Russian journal, *Referativnyi Zhurnal: Biologiia* (*Abstract Journal: Biology*). During the last half of 1956 some 1,200 abstracts from Russian journals covered by *Referativnyi Zhurnal: Biologiia* will be translated by Consultants Bureau, Inc., of New York and reprinted in *Biological Abstracts*. The abstracts will be drawn from thirty-one primary journals covering a wide range in the field of biology.

Science Museum Collection of Time-Measuring Instruments

THE interest shown in the collection of exhibits at the Science Museum, London, illustrating the measurement of time has called for a third, revised and expanded, edition of the descriptive catalogue of the objects exhibited in the Time Measurement Section of the Museum (pp. 102+10 plates. London: H.M.S.O., 1955; 6*s*. 6*d*. net). The second edition was published in June 1950. Part 1 of the handbook, entitled "Historical Review", which is published separately and which in its third edition was reprinted last in 1952, consists of a brief review of the history of time measurement together with notes on the principles employed in measuring time. Part 2, the "Descriptive Catalogue", contains the substance of the descriptive labels exhibited with the various objects in the Museum. The collection is classified into twelve large groups, which are further divided into sub-groups, and 463 exhibits are listed (compared with 390 in the second edition), together with some eighty other objects not on exhibition. A new section deals with time recorders, that is, instruments which make a printed record of the time of day at which a certain event takes place. Many of the collection of more than seventy sand-glasses, presented to the Museum in 1952 by the Rt. Rev. Abbot Horne, of Downside Abbey, are now included in the Museum exhibition, in addition to several new exhibits in almost every section. The illustrations in the handbook are the same as in the previous edition, but the illustration on the cover has been changed from a reproduction of a sixteenth-century weight-driven domestic clock to that of a 1718 garden sundial. The price is double that of the previous edition.

Rapid Analysis of Silicate Rocks

DURING recent years the United States Geological Survey has been faced with the problem of achieving a greatly increased output of chemical analyses at a time when the demand for analytical chemists much exceeded the supply. To circumvent this impasse, rapid analytical methods have had to be devised. The procedures described in Bulletin 1036-C of the Survey, "Rapid Analysis of Silicate Rocks", by Leonard Shapiro and W. W. Brannock (pp. 56. Washington, D.C.: U.S. Government Printing Office, 1956; 20 cents), provide for the analysis of the thirteen oxides most commonly determined in silicate rocks by simple direct methods which can readily be learned by relatively untrained personnel and which give results several times faster than formerly. Most of the determinations depend upon the use of a spectrophotometer, flame photometer, or automatic photometric titration equipment. The booklet will be welcomed by geologists and mineral chemists with experience of the tedious and time-consuming routine of conventional rock analysis.

Ethnographic and Archæological Survey in Angola

AN ethnographic survey in the Kioko (Bachioko) region of Angola, made by José Redinha, curator of the Dundo Museum, has been published by the Diamond Company of Angola under the title of "Campanha Ethnográfica au Tchiboco (Alto-Tchicapa)" : Pt. 1, "Notas de Viagam" (pp. 175+5 plates) ; Pt. 2, "Aratacoes e Documentacao Gráfica" (pp. 214) (Museu do Dundo, Publicaçoes Culturais No. 19. Lisbon : Companhia de Diamantes de Angola). The first volume contains the itinerary of the expedition, with ethnographic and archæological details on the people and their country. The second volume is a magnificently illustrated catalogue of the objects collected, together with supporting notes on the arts and crafts of the region. This volume, with its wealth of illustrated detail, should be of considerable value to curators of ethnographical museums and to those interested in the comparative study of the material culture of Negro Africa.

University of Sheffield

THE following appointments have been made in the University of Sheffield : J. P. Duncan (lecturer in mechanical engineering in the University of Manchester), professor of mechanical engineering ; Dr. G. Weber, senior lecturer in biochemistry ; Dr. I. C. Browne, lecturer in physics ; Dr. D. J. Harris, lecturer in electrical engineering. The following resignations have been announced : Dr. J. Lewis, lecturer in chemistry ; Mrs. H. G. Knowles, map curator and librarian in the Department of Geography.

The Council of the University has accepted an offer by Boots Pure Drug Co., Ltd., to provide a medical research fellowship of the annual value of £1,000 for a number of years. The London Tin Corporation, Ltd., is providing a research fellowship in metallurgy, which has been awarded to Dr. B. B. Argent. Other research fellowships have been awarded as follows : Owens-Illinois Research Fellowship in glass technology to Dr. N. E. Richards ; Oldham Research Fellowship in mining to A. G. Neill.

The Council has approved a proposal by the Medical Research Council to establish a Unit for Epidemiological Research on Respiratory Diseases (Air Pollution) in the University. The Unit will be under the direction of Dr. J. Pemberton, senior lecturer in social and industrial medicine.

Announcements

MR. G. H. GREENHALGH has been appointed British scientific attaché in Scandinavia, in succession to Mr. R. G. Silversides, who is returning to the headquarters staff of the Department of Scientific and Industrial Research. Mr. Greenhalgh is on loan to the Department from the Atomic Energy Research Establishment, Harwell.

To commemorate the occasion of the diamond jubilee of the *British Journal of Radiology*, the following have been elected to honorary membership of the British Institute of Radiology: Mr. Cuthbert Andrews ; Sir Russell Brain ; Dr. Russell J. Reynolds ; Dr. F. Gordon Spear.

FOUR new appointments have been made to the staff of the U.S. National Science Foundation. Dr. E. E. Litkenhous becomes programme director for engineering sciences ; Dr. Frank K. Edmondson, programme director for astronomy ; Marguerite Risley, professional assistant for the astronomy programme ; and Dr. Robert R. Brown, professional assistant for the physics programme.

THE British Mycological Society will hold its thirtieth annual plant pathology field meeting in the Nottingham district during July 27–28. Visits will be made to the University of Nottingham Department of Agricultural Sciences, at Sutton Bonington, Loughborough, and to the Boots Lenton Experimental Station, Nottingham. Four papers will be read in the Botany Department of the University. Further information can be obtained from Dr. G. J. F. Pugh, Department of Botany, The University, Nottingham.

THE Faraday Society has arranged a general discussion on "The Physical Chemistry of Processes at High Pressures" to be held in the University of Glasgow during September 20–21. After a general introduction by Prof. A. R. Ubbelohde (Imperial College, London), there will be three sessions on the following topics : equations of state, physical properties and thermodynamic transformations ; chemical reactions and transformations at high pressures ; and detonation and other high-temperature phenomena at high pressures. Proofs of papers will be circulated in advance of the meeting. Further information can be obtained from the Secretary of the Society at 6 Gray's Inn Square, London, W.C.1.

THE Teyler's Foundation and the Teyler's Second Society, Haarlem, are offering jointly a prize for an essay on "The absolute relations, on time and space, between actual events, as brought to light by the theory of Einstein, and the interest which the new insight concerning these might have for views in other domains of knowledge". The prize will consist of a gold medal, worth 400 Dutch florins, or, if the recipient prefers it, this amount in cash. The essays may be in Dutch, French, English or German, and must be submitted by January 1, 1957. Further information can be obtained from the Directeuren van Teylers Stichting, Fundatiehuis Damstraat 21, Haarlem, Netherlands.

THE Department of Industrial Engineering of the Loughborough College of Technology is starting, as from September next, a new postgraduate course in industrial engineering. The course will last one year and will cover a wide range of advanced management topics. In addition, some special subjects will be dealt with, including nuclear energy and automation, which will be approached from the technological point of view ; there will also be sessions on men and machines, which will be concerned with the physiological effects of noise, fumes, dust, vibration, etc. The course is suitable for senior personnel from all types and branches of industry. Further information can be obtained from the Head of the Department of Industrial Engineering, Loughborough College of Technology, Loughborough, Leicestershire.

IMPLICATIONS FOR BRITAIN OF DEARER COAL

THE British public have recently been shocked again by a substantial increase in the price of coal. A figure of 8 per cent increase has only to be repeated a few more times and a serious situation in industry may be realized, for coal must remain, in spite of the marked increase in the use of oil in all branches of industry in Britain in recent years, the basis of Britain's economy. The really serious feature of these repeated unfortunate movements in price is the impetus that the rise in the price of coal gives to price- and wage-increases everywhere. Unfortunately, there are economists who believe that a rise in the price of coal is the most effective means of inducing more efficiency in the use of coal. The fallacies of these views when applied to the existing situation are being abundantly shown by the sequence of events that seem to have become a repetitive feature of our present times. They occur in spite of the trend to replace coal by oil because the outlook reveals a possible increase in the shortage of coal occasioned by still greater demands for power in industry if Britain is to maintain her competitive position in world export markets. As a further feature of the trend towards the use of oil, there is the Prime Minister's recent warning of the danger of war that might arise from the need for the maintenance of oil supplies from the Middle East—a sorry picture and prospect for a country whose greatest mineral asset lies in her coal measures.

The *Financial Times*, in a leading article of May 29, directed attention to the fact that the formidable burden that is being forced upon British industry by the impact of dearer fuel, power and transport comes at a time when other raw materials are showing a downward trend in price—copper down 30 per cent from this year's peak, tin 16 per cent, lead and zinc 11 per cent below their 1956 peak and rubber 38 per cent. Wage increases are not in the present case the only cause of the rise in price, for the nettle of the accumulated deficit in the costs of raising coal and costs of the mine reconstruction programme had to be grasped, and the sooner the better. Where lie the remedies ? Technical advances in fuel utilization have in the past contributed in a substantial measure to the advancement of Britain's economy ; but such instruments of progress can only move at the natural rate at which the means in the form of finance and technical personnel become available. Thus the call for more technologists can only meet with response in the course of years, as in the case of the development of the use of atomic energy. Meanwhile, the situation promises to become desperate, bearing the threat of the effect of foreign competition in export markets. At the moment, the only sure sign seems to be that the loss of such markets is going to be the determining factor in the situation.

There does, however, remain one saving grace : the inherent good sense of the British race, and the strange ability to 'muddle through' in times of trouble. Put in more conventional, if less expressive, form, both the industrialist and the working man, when they finally recognize a dangerous situation, have a tactical genius for mastering that situation. They do the job another way to save both heat and energy, and, if necessary, labour. Thus 'automation' to the journalist may be a magic word whereby to scare the uninitiated in a headline ; to the engineer it is mechanization and instrumentation, employing techniques which he has probably been developing for many years. In spite of many statements to the contrary, Britain is as highly skilled in these arts as any other country. In such directions lie the ultimate solutions of our problems of rising costs, aided by the inherent characteristic of refusing to panic, however black the approaching cloud.

R. J. Sarjant

THE FUTURE OF METALLURGY

AT the annual general meeting of the Institution of Metallurgists, held on May 15, Mr. G. L. Bailey, director of the British Non-Ferrous Metals Research Association, was installed as the new president. In his address, Mr. Bailey, after discussing the progress of the Institution, went on to consider the rather distant future of the metallurgical industries.

The vast majority of metals are used for traditional purposes which are neither particularly spectacular nor exciting ; but if, for example, we were compelled to carry on without steel, copper or cast iron, the question of finding suitable substitutes would in many cases be surprisingly difficult. If the demand for a specific metal exceeds the supply, the first thing to happen is a change in what is, somewhat deplorably, known as 'the pattern of use'. In the first place, more readily available metals, such as aluminium, magnesium and, maybe, titanium, would come into more extensive use, and secondly, there would be increasing employment of non-metallic materials for purposes for which metals were previously used. These are matters both of economics and of technical efficiency—if a plastic pipe has advantages over a metal one at the same price, it will be used. If it is not so good but a lot cheaper, it will still be used to some extent. This balance is an ever-changing one as new properties are discovered and new methods of production developed.

This factor, new methods of production, is one of basic importance. In connexion with estimates of known resources, it must be borne in mind that the detailed prospecting of ore body is usually carried out merely to ensure an adequate supply for a specific and limited term of years. As a result of some change of price, of the development of new methods of beneficiation or of extraction process, enabling a poorer grade of ore to be used more efficiently, what may not now be an economic ore body may well become one in the future. Aluminium, for example, is to-day produced from bauxite; but there are immense amounts of aluminium available in clays which could not, however, be used with existing knowledge except at much higher cost.

It is considerations of this kind which make it so difficult to forecast the distant future with that degree of assurance adopted by some people with less knowledge of the metallurgical industries.

Apart from traditional ones, there are emerging a series of spectacular uses of metals which will control the whole of the future development in many fields of engineering. It is yet to be seen how far alloys based on the newer metals can be produced with properties which have hitherto been unobtainable, and a vast, indeed unlimited, field of metallurgical endeavour is thus opened out.

The big competitor with the metals would appear to be the plastics, particularly when suitably reinforced, and in some quarters there is the assumption that these will go on getting better and cheaper, while the metals themselves are becoming increasingly scarce. It is by no means certain that this somewhat superficial view can be justified. Given sufficient energy, imagination and enthusiasm on the part of the metallurgist, the metals, by improving the methods of extraction and fabrication, can also, perhaps, become cheaper; and new alloys of better properties will most assuredly be developed. It is Mr. Bailey's forecast that the future of the use of metals, both for the more spectacular purposes of modern engineering, and for the older, traditional ones, is not only assured but also full of interest and, in places, definitely exciting.

THE IMPACT OF ENGINEERING ON SOCIETY

FOR the second Graham Clark Lecture, delivered to a joint meeting of the Institution of Civil Engineers, the Institution of Mechanical Engineers and the Institution of Electrical Engineers at the Institution of Mechanical Engineers on April 27, Sir Maurice Bowra, vice-chancellor of the University of Oxford, chose to speak on "The Impact of Engineering on Society", pointing out that almost every society of which we know practised engineering to some degree. A considerable degree of civilization can be secured with a minimum of engineering; but a society which does not believe in engineering, or see its possibilities, is, as the failure of the Greek and Roman systems shows, unlikely to survive. Civilization is a sensitive plant, and its first duty is to look after itself. Sir Maurice suggests that the trouble with the Ancient World was that it never had any difficulty in finding men to do tasks which we assume should be done by machines, and the educated and governing classes accordingly never turned their minds to other, and better, ways of getting work done. That the Romans, like the Chinese, rejected machines in the last resort because their ruling classes were snobs is a social fact of first importance, and Sir Maurice proceeds to demonstrate its relevance to modern times, and to show how economic forces played an important part in securing recognition of the idea that machines can do much that men cannot do by themselves and in creating opportunities for the engineer.

This great change, however, has not been revolutionary in the political sense, although it has changed the whole appearance, and even the structure, of society. Engineering is not a political activity; it aims instead at the control and exploitation of natural resources to give a greater degree of human welfare, and it becomes political only when its existence is threatened by authority or when it is taken up by authority for its own sake. Indeed, within the limits of the social frame and national States within which the engineer works, his work has a strong stabilizing influence; and so far as engineers must share the blame for man's failure to evolve means for satisfying his desire for security and prosperity, it is for sins of omission rather than of commission.

In Sir Maurice's opinion, engineers have taken too modest a view of their own task and duties. More than any other branch of human activity, engineering provides an imaginative equivalent to war and has the advantage that it creates instead of destroying. Engineering, however, contributes much towards the drive towards uniformity and the destruction of that rich variety of experience which characterizes the great humanistic tradition; and it is a serious charge that the influence of engineering interferes with the variety of the individual self and shapes it to a uniform mould by imposing on it certain patterns through modern methods of indoctrination such as the press, cinema, wireless and television. Sir Maurice questions, however, whether such means will retain their ability to impose uniformity, and he also finds grounds for hope in the undeniable tendency of men to pursue the specially difficult task of thinking for themselves.

Engineering may in the end make it easier for thought to be free, and, while admitting that engineering tends to impose a standard of culture which lacks the variety and beauty of the old craftsmanship, Sir Maurice also sees no reason why a world that relies on machines more than on handicrafts should not produce objects as satisfying as those of the old craftsmen. Because they will give delight to a far greater number of people, a new kind of grace and charm may emerge, and if men really were to know what are the ends to which he would be able to turn Nature, he should be able to do on an ever extended scale what he has already begun to do with such imagination, devotion and skill.

HEALTH HAZARDS IN THE COAL AND CHEMICAL INDUSTRIES

THE first provincial meeting of the British Occupational Hygiene Society was held in the University Hall, Liverpool, during April 19–20. In his presidential address, Dr. C. G. Warner, dust suppression scientist of the South Western Division of the National Coal Board, spoke of the satisfactory progress of the Society, an indication that by practical activities it is fulfilling its aim of promoting the science of occupational hygiene. Dr. Warner went on to talk about the remarkably changed situation regarding pneumoconiosis in coal mines which has been occasioned, on one hand, by increased awareness of the disease and, on the other, by measures taken for suppressing airborne dust.

South Wales was formerly a bad area, and after 1943, when the legal definition of pneumoconiosis was relaxed, the rate of certification rose to a peak figure of 55·6 men per thousand employed; by 1947 it had fallen to 30·3. Meanwhile, in the rest of

Britain the corresponding figure for 1947 was only 1·9 men certified per 1,000. As knowledge of pneumoconiosis spread, the number of cases reported in other parts of Britain rose from 597 in 1945 to 3,542 in 1954. The rapid improvement in dust control had its effect, however, and the number of cases in South Wales fell from 5,224 in 1945 to 927 in 1954. Many years elapse before the disease can be detected in a coal miner, even when he is working under dusty conditions, and the present victims accumulated most of the dust load in their lungs some time ago. Such conditions are by now almost eliminated, and it is expected that in twenty years time only the mildest type of pneumoconiosis will continue to be encountered.

The first paper at the meeting was read by H. Pirie, of the Technical Service Department, General Chemicals Division, Imperial Chemical Industries, Ltd., his subject being the production and uses of chlorine. Chlorine was formerly transported as bleaching powder ; but, since its use as a war gas in 1915, it has been transported as liquid, and many tens of thousands of tons a year are now handled in tanks, drums and cylinders. Many users, such as waterworks operators or baths superintendents, have no technical experience, and rules have been devised for their protection. The important points are as follows. (1) Liquid chlorine must be dry, and the packages and valves foolproof. Filling ratios must be observed, and containers serviced and tested regularly. (2) The customer should know how to use the product and to handle the packages safely. His drum and tank installations require initial inspection, and instruction and precaution cards are issued. (3) The customer should know what to do in the event of an accident. A chlorine emergency service is available to deal rapidly with trouble at the premises of any user. (4) Regular visits to the customer are made to ensure that the necessary precautions are being taken.

Trichloroethylene is one of the oldest of the commercially available organic compounds of chlorine and the one made on the largest scale. It is less dangerous than many others because it has no chronic effects. It has many uses in industry and can be used safely provided simple precautions are taken.

Mr. Pirie also referred to the system of labels for hazardous products devised by the Association of British Chemical Manufacturers. These are intended to protect the transporters of such substances—railway employees, lorry drivers, storekeepers, etc. They are distinctive and easily recognizable, name the particular hazard, describe its nature, and give simple precautions to be observed in case of spillage, fire or other accident.

The next paper, on the technique of particle measurement in industrial hygiene, was delivered by G. L. Fairs, of the Research Department, General Chemicals Division, Imperial Chemical Industries, Ltd., who described various established methods of taking samples of dust. These included isokinetic sampling downstream of a mixing baffle, sampling in ducts, and the horizontal elutriator for size separation. Cells for sampling mists containing particles liable to change in size by evaporation or condensation were also mentioned.

Dealing with microscopic analysis of samples, Mr. Fairs stated that below 1 micron it is impossible to differentiate between the images of larger particles and diffraction haloes of much smaller ones ; the electron microscope should replace the visual instrument for studying fine dusts. Sedimentation analysis, based on Stokes's law for the rate of fall of particles in liquid, suffers from the disadvantage that samples of the different size fractions remaining in suspension become very attenuated towards the end of the process and their removal creates a disturbance. An apparatus was described which is better in these respects, since it works by flushing out the settled particles for estimation.

Elutriation, by blowing air through a powder to carry away fine particles which settle more slowly than the air speed, enables size fractions to be determined by filtering the effluent and repeating at decreasing rates of flow. It has been found that 30 seconds of blowing is often sufficient to give adequate separation with the powder on a gauze support in a cylindrical elutriator tube.

The final paper was read by Dr. J. D. Paterson, of the Medical Department, General Chemicals Division, Imperial Chemical Industries, Ltd., and dealt with hydrofluoric acid. He said that considering only the acute effects, and ignoring the chronic, this compound must be regarded as even more severe in its action than mustard gas. In designing plant, the possibility of hydrofluoric acid coming into contact with the operators should be reduced to a minimum. In addition, to guard against mischance, adequate protective clothing is provided, means of decontamination are available, and effective medical supervision is at hand.

The acute hazard is associated with concentrations above 20 per cent, which damage body tissues ; acid stronger than 60 per cent causes damage which is immediately apparent. A unique effect with hydrofluoric acid is its power of penetration to a depth where it exerts a dissolving action on cellular membranes, causing liquescent necrosis and decalcification of bone. Pain is very severe and may be immediate or delayed for some hours, according to the strength of the acid. Treatment consists of washing with copious amounts of water followed by a dressing of magnesium oxide paste. This is usually sufficient for mild burns. Injection of 10 per cent calcium gluconate into and around the burned area until there is weal formation relieves more severe cases very rapidly. Dr. Paterson has not found it necessary to give an anaesthetic before injecting. Protective clothing requires careful inspection. The majority of burns are caused by pinholes in gloves which get hard wear.

The chronic hazard is the possibility of fluorosis, which is a condition of sclerosis of bone and, in extreme cases, ossification of the ligaments. Protective clothing, including a fresh-air hood to prevent inhalation of vapour, is an insurance against fluorosis ; but when the hydrofluoric acid plant of Imperial Chemical Industries came into production, a weekly urine test and estimation of fluorine content were established. The risk of fluorosis is slight when the fluorine is below 10 mgm./l. of urine, and the policy of the firm is to take 1 mgm.l. as a safe excretion-rate. It soon became apparent that the excretion-rate of fluorine was so high that daily measurements were necessary to detect peaks. After a time, these observations provided a valuable indication that all was well with the plant, and enabled small defects, which would otherwise have passed unnoticed, to be rectified. In spite of all precautions, the Medical Department still has to treat an occasional hydrofluoric acid burn, usually due to a faulty glove ; but it has never had a serious case, nor a burn of the eye. Dr. Paterson also referred to chlorine and bromine trifluorides, which are very reactive and produce thermal burns in contact with the skin, but do not penetrate in the manner of hydrofluoric acid.

The meeting concluded with a film illustrating the work of the General Chemicals Division of Imperial Chemical Industries, Ltd., and members of the Society were conducted around the Castner–Kellner and Rocksavage Works on the following day.

C. N. DAVIES

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES

ANNUAL CONGRESS IN TUNBRIDGE WELLS

THE South-Eastern Union of Scientific Societies held its sixty-first annual congress in Tunbridge Wells during May 24–27 under the presidency of Dr. W. E. Swinton. The Tunbridge Wells Natural History Society was the host society, and the choice of Tunbridge Wells for this year's meeting was particularly appropriate since the first congress of the Union, on the occasion of its foundation sixty years ago, was held there in April 1896.

At the young naturalists' evening, a panel of experts answered questions ranging from the cause of the glowworm's glow to the evolution of group flying, as with starlings in the autumn. Major Maxwell Knight showed his film of the hand-rearing of the cuckoo.

The Archæology Section was addressed by Major J. M. T. Burchell, his subject being the archæology of the Medway Estuary. He emphasized that geological evidence precluded the possibility of the manufacture of pottery, during Roman times, in the area and said that kilns have not been discovered. The creeks in the marshes were, during that period, used for trading purposes, and the abundance of material found, including the Upchurch ware, can probably be attributed to this source. Major Burchell afterwards conducted the party to Addington to view the work being carried out in the investigation upon a long barrow, where probing for outlying stones and digging to expose them is in progress. A visit was also made to Coldrum, an excavated long barrow, now in the care of the National Trust.

The president of the Zoology Section, Dr. H. R. Hewer, in his address spoke on the importance of keeping field records. He said that the natural sciences are primarily observational rather than experimental, and therefore the facilities of a laboratory and high technical training are not essential. The glory of zoology is, in the main, due to the amateur field naturalist, Darwin and Wallace being examples. The great period of accurate observational work in zoology was from 1850 to 1900, undertaken in an endeavour to determine the ancestry of species. To-day the emphasis is upon ecological studies, where natural observation with statistical correlation is of primary importance. The Zoology Section's excursion was to High Woods and Scotney Castle, by permission of Mrs. Hussey, under the leadership of Dr. L. B. Langmead.

Dr. Swinton chose as the title of his address, "Nature and the Free Mind". He began by pointing out that practical scientists at every level should be concerned with the history of science and should not leave it to the historians and philosophers. The collation and preservation of local records and the need for sharing field problems call for the national provision of finance and apparatus to help these valuable studies. Perhaps the most important role is to contribute to the understanding of the place of science in the community. While there is no need to stress some of the benefits that accrue from the advance of research, there is, at the same time, the undoubted fact that many people believe that science is something inevitable and complete, and that persistence is all that is needed to reveal the whole truth. It is salutary to remember that the rise of science was fortuitous. The ready acceptance of Darwinism may have been the result of the recognition of the power of scientific discovery as revealed in the Great Exhibition of 1851. Science tries to explain itself; but the symbols involved are frequently beyond the intelligibility of the public. The philosophers have maintained that, despite this, science is irrational, although that same public is now the patron of natural science. Yet, unlike religion, philosophy, manners and customs, science is nationally transferable, and the practice of its deleterious forms can be undertaken by backward people. A substantial increase in the numbers of servants, students and practitioners of technical science to enable Great Britain to compete in the world will be aided by an appreciation of the limitations of the various disciplines. The facts of science are neither good nor bad inherently, but are in accordance with their uses in human hands. Much scientific apparatus is limited in its application by the receptive qualities of the human eye, so there are similar limits to human intelligence, perception and morality. One of the major needs in our community is the realization that science is not a juggernaut come to crush its sponsors and creators, and, above all, it is still capable of being moulded into the instrument, not the master, of mankind. Despite discoveries and formulæ, there is still room for the freedom of the mind.

The address to the Botany Section was given by Prof. C. T. Ingold, speaking on "Gasteromycetes, or Nature tries again". He discussed the disparities of numbers in genera and species, saying that, while the numbers of genera of Hymenomycetes and Gasteromycetes differ slightly—170 in the former to 110 in the latter—there is a difference of more than ten to one in the number of species—6,900 Hymenomycetes, 630 Gasteromycetes. He suggested that, upon the evidence of spore distribution, it is probable that the Gasteromycetes have evolved from the Hymenomycetes by a process of degeneration. The members of the Section visited Saxonbury Hill and Ashdown Forest, where the rarer plants present were shown and described by Dr. Francis Rose.

The president of the Geology Section, C. C. Fagg, described the swallow holes in the Mole Gap and their effect upon the river flow and the water supply available over an area of 130 square miles with an average annual rainfall of 30 inches. The water-level is below the river bed, and the table is maintained by seepage rather than by the swallow holes, although there are twenty-nine of these still active, some being on the bare Chalk. Prof. S. W. Wooldridge, speaking on the geomorphology of the Central Weald, urged the reconsideration of the generally accepted theory of the Wealden anticline. He demonstrated that, instead of a simple anticline, there is a complex structure with at least six anticlines. Considering the effect of these upon subsequent denudation, particularly upon the direction of the flows of rivers, text-books dealing with the matter should be rewritten and a different exposition to the existing one should be given by teachers of geography and geology.

Excursions were conducted to Eridge Park and Costume Museum, and to Lewes, where the historic buildings were described by Mrs. E. Bradley, while material of interest to the botanists and zoologists on the Levels was shown by Dr. Langmead.

The sixty-second annual congress of the Union will be held next year in Hastings during April.

NATIONAL RESEARCH DEVELOPMENT CORPORATION

ANNUAL REPORT FOR 1954–55

THE report and statement of accounts of the National Research Development Corporation for the year ended June 30, 1955[*], records only 135 cases of assignment of United Kingdom patent rights to the Corporation by government departments and research councils, compared with 315 during 1953–54. Of the 597 inventions communicated to the Corporation during 1954–55 (compared with 664 during 1953–54), 203 were from government departments and research councils, 22 from official organizations of the British Commonwealth, 8 from industrial research associations, 54 from universities and 310 from private firms and individuals, 283 of which were British. Patent rights assigned to the Corporation during the year totalled 187, including 42 from universities and 9 from industrial research associations; holdings of British and foreign patents and patent applications at June 30, 1955, included 492 United Kingdom applications and 522 granted patents, and 982 overseas patent applications and 639 granted patents. The accounts show a rising trend in the return from the Corporation's activities when compared with its outgoings, the annual income of £94,749 during 1954–55 representing 61·3 per cent of the expenditure.

Of the projects initiated in previous years, the report notes that four of the six big electronic digital computers had been delivered, installed and accepted by June 30, 1955. The '401' computer, leased to the Agricultural Research Council, continues to operate satisfactorily at Rothamsted Experimental Station and has also been used in developing a numerical technique for predicting the predisposition of an aircraft to aerodynamic 'flutter', in which it has been demonstrated that the flutter speeds and frequencies may be conveniently and quickly computed by digital equipment. In addition, it has been used for computing the optimum trajectories of particles under acceleration in a cyclotron, with contributions to the understanding of cyclotron design. The response to grants for training computer engineers at the Universities of Manchester and Cambridge has been small. Uncertainties of marketing conditions and the absence of firm orders appear to be the chief barriers to obtaining licences for the Ricardo light steam engine, and prototype installations were being placed at the disposal of some Commonwealth governments for field trials and demonstrations. The production of hecogenin from sisal has been transferred to firms engaged in the industry on satisfactory commercial terms, and cortisone is being produced from the hecogenin now available. In view of the favourable report of a firm of chemical engineering consultants, the Corporation is continuing to support the acetylene synthesis project at the Imperial College of Science and Technology, London. Development of an experimental prototype stereoscopic motion-picture camera was completed during the year, and the camera is extremely promising.

Of the new projects, the Corporation is supporting an extended design study at the Manchester College of Technology of the possibility of controlling machine tools directly with a digital computer, and is sponsoring the development and initial marketing of Prof. H. S. Lipson's optical diffractometer. It is also financing the research and development work on the application of Prof. G. Pontecorvo's technique for synthesizing new strains of non-sexually reproducing micro-organisms, and is participating in a joint project with the Department of Scientific and Industrial Research and the Herring Industry Board to develop full-scale prototype equipment for commercial trials of new techniques of fish-smoking. Established projects now proving a useful source of revenue include those on the Bailey bridge, the Denny-Brown ship stabilizer, a technique for light-alloy cutting by electric arc, an air-position indicator, a course-setting dial-adjustment for aircraft, a backward-travelling-wave tube, a signalling system for teleprinter operation over radio links, a synthetic resin stoving enamel, a fire-fighting foam from degraded animal protein materials, a composition tablet for rendering brackish or sea water drinkable and an improved synthesis of an intermediate required in the production of the anti-malarial, 'Derraprim'.

UNIVERSITIES COUNCIL FOR ADULT EDUCATION

REPORT FOR 1954–55

THE report of the Universities Council for Adult Education for the session 1954–55[*] is critical of the Ashby report of adult education in Britain on two points: it has serious doubts regarding the administrative arrangements proposed for the annual assessment of grants to responsible bodies; and it regards the recommendation that a committee should be set up to advise the Minister of Education on the subjects and types of adult education courses which should receive priority in qualifying for grants as a serious threat to the academic freedom of the universities. The Council re-asserts its conviction that responsible bodies must truly exercise the responsibility of determining the form and content of their programmes, in shaping which consultation with the Ministry is always welcomed. When the Minister of Education intimated his acceptance of the recommendations of the Ashby Committee, this particular recommendation was specifically excepted, and friendly discussions with the Ministry have led to a mutually acceptable arrangement for assessing grants. The new Further Education Grant Regulations, issued in July 1955, contained the statement, according with the cardinal recommendation of the Ashby Committee for more active but flexible control of expenditure by the Ministry, that "in determining the amount of grant the Minister will have regard to the general standards of the courses, the needs of the area, the activities of other bodies providing further education in the area and the fees paid by students". The report remarks that it is to the sense of partnership built up, over the years, between the Ministry and the responsible bodies that we must look for a solution of the difficult problem of maintaining a reasonable control over expenditure while preserving the due rights and responsibilities of the responsible bodies.

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[*] National Research Development Corporation. Report and Statement of Accounts for the Year 1st July, 1954, to 30th June, 1955. Pp. ii+20. (London: H.M.S.O., 1956.) 1s. net.

[*] Universities Council for Adult Education. Report on the Year 1954–55. Pp. 24. (From the honorary secretary and treasurer, W. E. Salt, University of Bristol, 1956.)

During the session under review the Minister was able to relax somewhat the severe limitations on grant-aid during the previous two sessions and, in particular, to give some assistance towards the mounting cost of tutors' salaries. Most extra-mural departments of universities at the end of the session reported a slight increase in the number of courses provided, the total of 4,302 exceeding the peak of 4,116 in 1950–51, while the number of students increased from 78,672 in 1953–54 to 84,752. The increase was largest in short courses of three to nine meetings (19 per cent) and smallest (0·9 per cent) in tutorial classes; sessional classes increased by 6 per cent. There was an increasing tendency, particularly in tutorial classes, to provide tutorial and sessional classes outside the traditional framework of collaboration with the Workers' Educational Association, and all this expansion has been achieved mainly with the help of part-time tutors, who increased in number from 2,342 to 2,768, 1,127 being university teachers; university lecturers appear to have been responsible for 57 per cent of the tutorial classes and 48 per cent of the sessional classes.

The extension lecture course is still an important element in most extra-mural programmes; but the majority of universities now use short extension courses in the broad field of the liberal studies as a means of interesting the general public in some aspect of university study and keeping those already interested abreast of recent developments. Such courses are often given by a team of lecturers. A variety of courses has also sprung up to provide for serious study by other kinds of student groups, particularly those with a good background of previous education. Many courses of the extension tutorial or study course type are provided in collaboration with societies or professional organizations, and an increasing proportion of extension courses is now run in this way. While some of these courses have a strong vocational appeal, all are liberal in subject-matter and treatment. In the post-war years, however, the universities are also providing courses directed to providing specific vocational groups with information on recent advances in university studies, especially in science and technology, mostly at a postgraduate standard. A striking feature of post-war development is the increasing use being made by extra-mural departments of residential courses, while there is now a remarkable amount of coming and going between Great Britain and foreign countries in the field of adult education. As regards subjects of study, the largest increases in the number of courses have been in the physical sciences (26 per cent), religion (17 per cent), history (12 per cent) and international affairs (12 per cent); the decline in psychology (5 per cent) and geography (10 per cent) has continued, and there has been a sharp contraction (31 per cent) in government. The demand for history is mainly for local history or archæology, and the study of languages appears to be on the increase. Interest in the social studies is much less marked, and the substantial increase in science courses is largely vocational.

Besides the Ashby report and the new regulations, the Council discusses the report on broadcasting and adult education prepared by Mr. Maurice Bruce and is concerned about the provision of books to adult classes. Its own inquiry in England and Wales has indicated that all thirteen universities and three of the eight university colleges have their own extra-mural libraries, usually administered separately, whether or not they are part of the university or college library. Issues to book boxes ranged between 2,000 and 10,000 volumes a year, and expenditure between £200 and £800 a year, with substantially higher figures for London and Oxford. Five of the sixteen extra-mural libraries supplied 90 per cent or more of the books required by classes; three between 70 and 90 per cent; and three between 50 and 70 per cent. In four instances 20–50 per cent of the supply came from the National Central Library and few libraries did not make some use of the National Central Library.

THE NATIONAL VEGETABLE RESEARCH STATION

OPEN DAY

THE first open day of the National Vegetable Research Station was held on June 5 at Wellesbourne, Warwickshire, when visitors saw the progress made in the development and work of this Station. Field experiments were on view, and there were exhibits of various aspects of the research in progress.

The Plant Breeding Section illustrated how it is using inbreeding, followed by the crossing of inbred lines, in an attempt to produce hybrid varieties of Brussels sprouts having improvements in uniformity, yield and other characters over ordinary varieties. Male sterility is being used as a helpful tool in this work, as it is also with onions, in the production of hybrid seed. The cause of deterioration of varieties of brassicas is also being investigated. F_3 progenies from crosses between lettuce varieties and a wild species, *Lactuca altaica* Fisch and Mey, which showed little attack by mosaic virus, were exhibited. These progenies were raised from the small proportion of F_2 plants which remained mosaic-free when grown in an epidemic of the disease. Stages in the process of breeding a non-bolting, high-quality variety of red beet having single-seeded fruits were shown, also work in the production of asparagus which should give only male plants from seed instead of the usual 1 : 1 ratio of male and female. Breeding material of forcing radish, spring cabbage and early cauliflower was also exhibited.

Long-term field experiments were seen which provide the Chemistry Section with material for its soil studies and work on the nutrition of vegetables. Descriptions were given of the effects of deep and shallow ploughing and of rotavating; of the application of fertilizers and farmyard manure at different depths, rates and times; and of inorganic and organic nitrogenous fertilizers on various rotations of vegetables. A demonstration was given of the restriction in development of the root system of peas brought about by soil compaction following certain cultivation treatments. Results from the use of chromatography in the study of the biochemistry of vegetables were shown, and this technique is being used in an investigation of a virus inhibitor present in rhubarb sap. A soil map of the Station's 280 acres was on view together with soil monoliths.

The Irrigation Section demonstrated the water-loss by transpiration and evaporation from cauliflowers during bright sunshine and showed that it was equivalent to about 200 gallons an hour per acre of growing crop. Different soil moisture meters were displayed together with data on their performance, and a prototype gauge was shown which indicated the minimum amount of water required to bring soil under a crop to field capacity; this gauge takes into account rainfall and water loss by transpiration and evaporation. The accuracy and efficiency of various techniques for measurement of leaf area were demonstrated, and the effects of different soil moisture conditions on growth, yield and quality of vegetables were shown.

The Entomology Section showed the life-cycle of the cabbage root fly, the damage it causes to brassica crops, and the most effective methods of controlling it. Illustrations were given of some natural predators of the pest and of insecticidal treatments which may destroy the predators, thus leaving a clear field for severe attack by the pest. The biology of the carrot fly, a serious pest of carrots, parsnips and parsley, was shown together with methods of insecticidal control involving seed dressings followed sometimes by supplementary sprays. A tasting panel assesses the degree of taint or off-flavour of carrots which may be brought about by certain insecticidal treatments. The life-history of the pea moth and the pea aphid and their control by DDT were demonstrated. Work in progress on the biology and control of lettuce root aphid was shown; but the recent discovery of varieties resistant to attack appears to offer the best solution of the problem.

The Pathology Section illustrated the life-history of the fungus which causes crook root disease of watercress, and the promising results obtained for the control of the disease by adding to the cress beds material which liberates minute quantities of zinc. It also showed the life-history of the bacterial pathogen found to cause the silvering disease of red beet seed crops, and the degree of control obtained by seed treatment with streptomycin. Methods of eliminating sources of infection by the fungus *Didymella* on outdoor tomato crops, and the effects of fungicides in checking the spread of the disease were exhibited. Parsnip canker has been found not to be invariably associated with damage by carrot fly larvae, and a fungus which can cause the disease has been isolated. Work in progress on virus diseases of rhubarb and watercress was exhibited, also some varieties of mint found to have resistance to mint rust. Results of studies on the control of *Botrytis* in lettuce by cultural methods and by fungicides were also shown.

The Weeds Section demonstrated techniques used in its ecological studies which are providing fundamental information necessary for the development of weed control in vegetable crops by cultural and chemical means. Changes in weed populations brought about by different manurial, cultivation and rotation treatments were described, and the effects of competition between weeds and vegetable crops at different stages of growth were shown. A demonstration was given of the effects of dinoseb (ammonium), dinoseb (amine), and a substituted phenoxybutyric acid MCPB as herbicides for market garden peas, also the degree of tolerance of different varieties to the sprays. The residual pre-emergence herbicide CMU was shown also to be useful for the control of annual weeds in asparagus beds.

The Statistics Section carries out investigations with the object of improving the efficiency of field experiments with vegetables, in addition to its advisory work for other Sections and for outside bodies on the design and analysis of experiments. In studies on the origin of experimental errors in the field, the effects of different methods of sowing peas, and of using different size grades of cauliflower plants when planting in the field were demonstrated. The economics of spacing of glasshouse and frame lettuce were illustrated, and work in progress was shown on the genetics of continuous variation in French beans.

J. PHILP

NOCTURNAL TEMPERATURE PROFILE ABOVE BARE SOIL ON CLEAR NIGHTS

It has long been established that in the lowest few hundred feet of the atmosphere there is on calm clear nights on the whole an inversion (that is, temperature increases with height), presumably determined by radiation of heat from the ground. The observations of Johnson and Heywood at Leafield (Meteorological Office Geophysical Memoir 77; 1938) showed that this inversion comes into being remarkably suddenly about sunset. As part of this structure it was supposed that the lowest temperature was normally to be found on the ground surface itself, the air above being cooled by loss of heat to the ground by conduction and convection. Doubts as to whether this was always so have been expressed for a long time. J. Glaisher in 1847 reported that on all clear nights in the year 1843–44 the mean minimum temperature on short grass was 0·8 deg. F. higher than that recorded 1 in. above the top of the grass. Many other workers have found the temperature on radiation nights to be sometimes lower a few inches above the surface than on the surface; but such a structure has not been regarded by meteorologists as a regular feature.

J. V. Lake, of the University of Reading, has recently described in the *Quarterly Journal of the Royal Meteorological Society* (April 1956) the results of temperature observations with the most up-to-date instruments in the lowest few feet over bare soil on calm clear nights. Lake measured temperatures with both minute thermistor beads and with ordinary unscreened alcohol-in-glass minimum thermometers at heights of 0·1, 0·5, 1·5, 2·5, 3·5 and 54 in. The results were all the same: minimum temperature at 2–3 in. above the surface, with an inversion above and a super adiabatic lapse-rate below. For completeness the surface radiation temperature was measured with a spirit thermometer. On the early morning of March 22, 1955, the surface radiation temperature was 21° F. and the temperatures at the higher levels specified above were, in the mean of fifty-two observations at each height, respectively: 18·6, 17·3, 16·6, 16·4, 16·8 and 18·4° F. The standard deviations of the observations were 0·93 deg. F. at 0·1 in. and 0·35–0·46 deg. F. at higher levels.

The temperature profile below the minimum is of the kind which occurs over a surface strongly heated by sunshine having a lapse-rate more than a thousand times the value of the dry adiabatic lapse-rate (1 deg. F./2,187 in.) and even hundreds of times the so-called 'auto-convective' lapse-rate (1 deg. F./640 in.) at which the density of the air increases upwards. As a by-product of the investigation, it was found that the reduction of surface temperature below the value at sunset was proportional to the square root of the time, in agreement with Brunt's theory of surface-temperature changes on radiation nights, which takes no account of interchange of heat between air and ground and balances radiation loss from the ground against conduction of heat upwards in the soil. The observations were made under dead calm conditions over a level field at a point 100 yards from the nearest boundary, so that vitiation by horizontal influx of colder air seems to be ruled out, and Mr. Lake shows that instrumental errors cannot account for the profiles.

The detailed physical reason for the profile is still obscure. It appears that the air near the ground under calm conditions loses heat by radiation rather than by convection and conduction until a state of radiative equilibrium is reached depending on the water vapour content. The fact that the variation of the surface minimum temperature agreed well with Brunt's theory supports this. It is very desirable, because of the great importance of accurate forecasting of minimum temperatures for agricultural purposes and for general scientific reasons, that an adequate physical theory of the temperature distribution in the lowest foot of the air on radiation nights should be found.

THE CAPERCAILZIE

An account of the feeding habits and breeding behaviour of the capercailzie has been set out in No. 37 of the Forestry Commission's admirable leaflets. The capercailzie well merited the delightful names by which it was known in medieval times—cock of the woods, horse of the woods, avercalzie, auercalze, wild peacock, wild turkey—for the cock caper is one of the finest game-birds in Europe. In the British Isles, it is found only in the woods and forests of Scotland.

The cock bird is about a yard in length, with the hen capercailzie a foot shorter. Originally, the capercailzie was found in England, Wales and Ireland, as well as Scotland; in England the birds became extinct around 1660–70. In Scotland, the last two positive references to truly native birds seem to be those from the Abernethy and Glenmoriston districts in 1771. The capercailzies present in Scottish woods and forests to-day owe their presence to an introduction of Swedish birds, made in 1837. Then, Lord Breadalbane imported thirteen cocks and nineteen hens and turned them out on his estate at Taymouth Castle, near Aberfeldy, in Perthshire. Unlike previous introductions elsewhere, this one was so successful that after twenty-five years there were more than a thousand birds present on this estate alone.

The typical habitat of the capercailzie consists of hillsides with woods of mature Scots pine. Capercailzie appear to be invading Forestry Commission plantations of Scots pine, larch and spruce when these reach a height of about twenty-five feet.

In winter, the capercailzie's food includes the shoots, buds, leaves, seeds and young cones of the Scots pine, and occasionally those of other conifers. These, however, form only a small proportion of its total food supply, and where only relatively small numbers of capercailzies are found amid middle-aged or maturing pinewoods, little serious economic damage results. The position may be very different in young, newly established plantations, particularly where these lie close to older woods with a heavy stocking of capercailzies. These birds find the winter buds and growing shoots of the young pines very palatable, and all too often they peck out the leading bud, thus causing serious loss of annual growth, and perhaps a distorted stem. Further damage may be done because of the bird's weight; if it settles on a side branch this may break away from the main stem, causing a serious wound to the tree.

Whether or not control measures are necessary depends on local circumstances. In the older woods, the harm the capercailzie does is negligible. Under other conditions, for example, where the felling of mature woods has driven the birds to take refuge in young plantations, it may be necessary to restrict the numbers of the birds in order to avoid serious loss of timber production. Control is commonly effected by shooting, which, owing to the bird's large size and conspicuous appearance, presents no particular difficulties. Provided it does not become unduly numerous in the younger plantations, this interesting and beautiful bird may be tolerated and even encouraged.

FAT FORMATION IN A DIATOM

The photosynthesis and formation of fats in a diatom, *Navicula pelliculosa*, using carbon-14 as a tracer, has been investigated in some detail by G. E. Fogg (*Ann. Bot.*, N.S. 20, 78, 265; 1956). Fixation into the following cell fractions was determined: (*A*) material soluble in 80 per cent ethanol but insoluble in benzene; (*B*) material soluble both in 80 per cent ethanol and in benzene; (*C*) material insoluble in 80 per cent ethanol. Carbon fixed in photosynthesis was incorporated, rapidly and in amounts representing up to 70 per cent of the total fixation, into fractions *B* and *C*, as well as into fraction *A*. Considerable variation was found in the proportions of carbon entering the three fractions in the light; in actively growing cells the proportion entering fraction *C* preponderated over that in *B*, corresponding to the synthesis of protein, whereas in nitrogen-deficient cells fixation in *B* was the greater, corresponding to the synthesis of fat.

These patterns changed only slowly, over periods of days, following the transfer of cells to altered conditions of nitrate supply. However, when ammonium nitrogen was supplied to nitrogen-deficient cells a marked change in distribution of carbon fixed occurred within 5 min., fixation in fraction *B* falling to a low value and that in *A* rising correspondingly. In cells subjected to prolonged nitrogen-deficiency, fixation in fraction *B* fell to a relatively low value; but the proportion which this fraction formed of the total dry matter in the cells rose as a result of an increased rate of loss from the cells of constituents other than lipides. The distribution of carbon fixed was also dependent on light intensity. Fixation in fractions *B* and *C* rose relatively to that in *A* as light intensity was increased up to 100 foot-candles but fell again at the highest intensity used, 2,000 foot-candles.

ELECTRICAL STIMULATION OF THE HYPOTHALAMUS AND THYROID ACTIVITY

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MUCH interest has been focused on a possible relationship between the central nervous system and the activity of the thyroid gland by the numerous accounts relating psychological trauma with the onset of hyperthyroidism in the human. In recent reports[1,2] the type of individual and the kind of emotional disturbance involved have been described. However, attempts to demonstrate changes in thyroid activity following electrical stimulation of the hypothalamus have not been entirely satisfactory. No increase in oxygen consumption was observed following prolonged stimulation of the hypothalamus; but definite conclusions were not drawn from these data owing to the limitations of the method for measuring metabolic rate in rabbits[3]. Histological signs of increased thyroid activity in rats and rabbits, in which the hypothalamus had been stimulated for four 1-hr. periods on each of two days, have been reported[4].

In the present work the effect of electrical stimulation of the hypothalamus on the thyroid activity of unanæsthetized and unrestrained rabbits has been studied. Electrical stimulation was performed by a modification of the remote-control method previously described[5]. Coils, of about 3,000 turns, were implanted subcutaneously over the lumbar spine and connected by subcutaneous leads to electrodes fixed to the skull vault with dental cement. Stimulation was carried out for periods of 1–7 days, usually 2 days. Changes in thyroid activity were detected by the use of the 'thyroidal ^{131}I release curve'[6]. Following the administration of a single tracer dose of thyroidal ^{131}I this method allows either an increase or decrease in thyroid activity to be observed rapidly and continuously over periods of about 10–14 days. In seven cases the plasma protein-bound or total iodine-131 was measured at intervals throughout an experiment.

Thirty-seven experiments have been performed on twenty-three rabbits in which electrical stimulation (either bipolar or unipolar) has been applied to the pituitary gland (five animals) or some region of the hypothalamus (eighteen animals). These experiments were performed on normal rabbits (twenty-five experiments), after right adrenalectomy (three experiments) and after ovariectomy and right adrenalectomy (nine experiments). In thirty-four experiments either a decrease (twenty cases) or no change (fourteen cases) in thyroid activity was observed. In two experiments (on one normal rabbit) a definite increase in thyroid activity occurred, and in one experiment on another rabbit (after right adrenalectomy) a questionable increase in thyroid activity was seen.

In contrast to the above results are those obtained after removal of the remaining adrenal glands. Up to the present, fourteen of the rabbits described above have been studied after complete adrenalectomy, while being maintained on constant daily doses of cortisone. Electrical stimulation evoked a marked increase in thyroid activity in twenty experiments on ten animals. (Previous to adrenalectomy these ten animals had shown thyroid inhibition in ten experiments and no change in thyroid activity in five experiments.) Ten experiments on the other four animals showed no observable change in such activity on eight occasions, a questionable increase on one occasion and an inhibition on one occasion. The precise localization of the region stimulated in the various animals has not yet been determined, since many of the rabbits are still alive. However, radiographic studies of the animals' heads suggest that it is stimulation of the median eminence of the tuber cinereum which results in increased thyroid activity. During five experiments on four rabbits in which increased thyroid activity was observed from measurements of thyroidal radioiodine, estimations of the plasma radioactivity revealed a marked increase (up to × 3½) during the period of stimulation. It is of interest that hypothalamic stimulation could maintain an increased level of thyroid activity even in the presence of a high concentration of thyroid hormone in the blood. Five out of the ten rabbits that showed a clear-cut acceleration of thyroid activity during stimulation eventually died suddenly, and unexpectedly, while being stimulated.

The change of the thyroid response to electrical stimulation of the tuber cinereum after adrenalectomy may be explained in several ways. First, it has been shown that administration of adrenaline may result in inhibition of the thyroid gland in the rabbit[7–9], and it may be argued that stimulation of the hypothalamus, in the intact or unilaterally adrenalectomized animal resulted in increased secretion of adrenaline, which in turn prevented any increase in thyroid activity. This explanation seems unlikely, since stimulation of the midline tuber cinereum does not evoke secretion of adrenaline[10], and since the dose of adrenaline necessary to produce prolonged inhibition of the thyroid gland of the rabbit is high[8]. Secondly, administration of adrenocorticotrophic hormone or cortisone has been found to inhibit thyroid activity in the rabbit[11,12]. It is possible that the stimulation of the tuber cinereum caused increased secretion of adrenocorticotrophic hormone by the pituitary gland and that the raised blood-level of adrenal steroids prevented any increase in thyroid activity. Stimulation of the tuber cinereum has been shown to result in pituitary discharge of adrenocorticotrophic hormone[5,13–15], and the dose of cortisone required to reduce thyroid activity in the rabbit is within the physiological range, therefore this explanation seems to be the most likely. The site of action of cortisone in inhibiting thyroid function appears to be the pituitary gland or hypothalamus, since it has been found[12] that cortisone did not modify the thyroid response of the hypophysectomized rabbit to administered thyrotrophic hormone. It would seem then that electrical stimulation of the tuber cinereum in the normal rabbit excites the liberation of adrenocorticotrophic hormone and thereby increases the concentration of adrenal steroids in the blood, which tends to inhibit the pituitary release of thyrotrophic hormone. In the adrenalectomized animal on constant cortisone maintenance therapy similar stimulation does not result in a sudden rise in blood concentration of adrenal steroids, and consequently an increased discharge of thyrotrophic hormone follows.

These results are of interest in relation to Graves's disease for two reasons: (*a*) as regards the possible role of emotional upsets and the central nervous system in the etiology of the condition[1,2]; (*b*) as regards the high frequency of the condition in patients suffering from Addison's disease[16], and the signs of adrenocortical underactivity (lymphoid hyperplasia, large thymus, lymphocytosis and reduced urinary excretion of 17-keto-steroids)[17–19] and the small adrenal cortex that are present in such cases[20].

This work was supported by a grant from the Research Fund of the Maudsley Hospital and was carried out during the tenure of a fellowship (by J. W. W.) from the American Cancer Society.

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STUDY OF ANTICHOLINESTERASE ACTION IN INSECTS BY A LABELLED POOL TECHNIQUE

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WHEN insects are fed or injected with a suitable compound labelled with a radioactive isotope, a whole range of biochemically related metabolites becomes labelled. The insects can then be killed and extracted in entirety or as some dissected portion under conditions likely to preclude further enzymic or chemical changes. The extracted mixture can be resolved by paper chromatography and the separated labelled metabolites located and determined by scanning the paper chromatogram radiometrically.

This provides what may be described as the spectrum of labelled metabolites which obtained in the living tissues at the instant of death. By comparing the spectra so obtained from control and from poisoned insects, it has been possible to study quantitatively the biochemistry of insecticidal action *in vivo*. Only those compounds undergoing sufficiently rapid turnover will become effectively labelled, but these are the compounds most likely to be important in the minute-to-minute survival of the animal and likely, therefore, to be involved in any acute biochemical lesion. The preparation of the large numbers of radiochromatograms (radioactivities plotted against distance along the paper chromatograms) required by these studies is greatly assisted by automatic radiometric scanning and elution techniques of the kinds described elsewhere[1,2]. These techniques were first used to investigate the effects of insecticides on the phosphorus metabolism of insects[3,4]. By injecting 2-^{14}C-acetate into adult houseflies, they have been successfully extended to non-phosphorus-containing metabolites. Some of the results obtained, particularly in relation to anticholinesterase action in insects, were interesting and, to us, surprising. They may be of comparative significance in vertebrate biochemistry and a preliminary report was thought to be worth while.

2-^{14}C-Acetate was chosen as the initial substrate because of its ubiquitous and central metabolic rôle. The isotopic methyl carbon seemed less likely to be lost as carbon dioxide as the result of the operation of Krebs's cycle, etc., than the carboxyl carbon. Week-old adult houseflies (*Musca domestica* L.) were injected intrathoracically while under mild *cyclo*-propane anæsthesia with 1 µl. of water containing 18 µgm. of 2-^{14}C-sodium acetate equivalent to 2 µc. of carbon-14. Immediately afterwards, 1 µl. of acetone (control) or 1 µl. of acetone containing 10 µgm. of di*iso*propylphosphofluoridate was applied topically to the dorsal surface of the thorax of each fly. The flies were then confined to glass metabolism chambers at 30° C. There was provision for recording automatically and continuously the rate of oxygen consumption by the flies and for the collection, and later chemical and radioassay, of the expired carbon dioxide. After 0·5, 2·0, 5·0 hr., and, in the case of controls only, after 24 hr., groups of twenty flies were removed from the chambers while under mild *cyclo*propane anæsthesia, plunged into liquid nitrogen, rinsed in non-radioactive alcoholic acetate at $-10°$ C., and dissected on a cold slab of solid carbon dioxide.

Heads or thoraces (minus leg and wing appendages) were homogenized in 0·2 *N* sulphuric acid in aqueous ethanol at $-10°$ C., centrifuged at 5° C. and the

Table 1. Effects of Di*iso*propylphosphofluoridate on the Distribution of Soluble Carbon-14 in the Adult Housefly (per cent total soluble carbon-14)

	0·5 hr.		2 hr.		5 hr.		24 hr.	
	Control	DFP-treated	Control	DFP-treated	Control	DFP-treated	Control	DFP-treated
Head								
Glutamine	8·8	12·4	10·5	7·4	5·9	16·2	8·6	—
Glutamate	21·0	26·4	17·1	16·8	55·2	50·1	47·2	—
Proline + ?	47·4	32·2	48·1	36·4				—
Acetylcholine	0·44	0·80	0·38	0·51	0·48	0·43	—	—
Unknown	22·4	28·2	23·9	38·9	38·4	33·3	44·2	—
	100	100	100	100	100	100	100	
Thorax								
Glutamine	32·0	31·7	31·7	45·0	18·6	45·6	12·0	—
Glutamate	16·3	18·4	12·0	7·6	57·4	30·0	64·0	—
Proline + ?	38·4	34·5	42·7	21·5				—
Acetylcholine	0·19	0·50	0·26	0·23	0·22	0·16	—	—
Unknown	13·1	14·9	13·3	25·7	23·8	24·2	24·0	—
	100	100	100	100	100	100	100	
Acetylcholine by pharmacological assay (μgm. thorax)	0·007	0·025	0·007	0·009	—	—	—	—

clear supernatant poured off. The residue was re-extracted as before and the supernatants pooled. The acid was exactly neutralized with saturated aqueous barium hydroxide and the barium sulphate centrifuged down at a *p*H adjusted to 1·3 with hydrochloric acid. In this way 2-ml. extracts equivalent to twenty heads or thoraces were prepared and stored at −15° C. Aliquots of 20–100 μl. were fractionated paper chromatographically in an aqueous–formic acid–acetone solvent as described for labelled phosphorylated intermediates[3].

Seven distinct ^{14}C-labelled fractions (I to VII), running with mean R_F values of 0, 0·25, 0·47, 0·58, 0·66, 0·75 and 0·91 respectively, were resolved. By co-chromatographic techniques[3], fractions III, V and VI, representing some 75 per cent of the total soluble carbon-14, were identified as free glutamine, free glutamic acid and free proline, together with smaller fractions of other amino-acids. Surprisingly, less than 3 per cent of the thoracic carbon-14 was found as free alanine, and less than 1·5 per cent as free aspartic acid, although these acids are known to occur freely and in high concentrations in insect tissues[5]. They were expected to have become labelled as the result of transaminase reactions with pyruvate and oxaloacetate as occurs in vertebrate systems[6]. Hydrolysis of the thoracic protein recovered in the insoluble fraction of the original homogenate showed that almost all the protein carbon-14 was present as glutamate and proline only, which suggests that these protein amino-acids were in equilibrium with the free amino-acids. When the fastest running fraction (VII) was reconcentrated[2] and paper chromatographed in aqueous *n*-propanol–formic acid as described for separating choline esters[7], it gave a single major fraction running with an R_F value of 0·8. However, on scanning the paper chromatogram within the sensitive volume of a specially constructed 4-π Geiger–Muller tube[8], a minor fraction, running with an R_F value of 0·47, was readily located and assayed. This labelled fraction and added unlabelled acetylcholine (located with iodine[7]) could never be resolved in acid solvents. The carbon-14 activity was lost in ammoniacal solvents[7]. No detectable fraction of the soluble carbon-14 behaved as free choline, which would almost certainly have been present in the extracts[9]. The proportion of carbon-14 found in the acetylcholine fraction was independent of the weight of unlabelled acetylcholine added at any stage of the fractionation, so that no isotope exchange had occurred between carrier and some other labelled metabolite.

These observations provide independent chemical evidence for the presence of acetylcholine in the thoracic and head tissues of the adult housefly[9,10], the ester here being labelled *in vivo* in the acyl moiety only. The overall carbon-14 spectrum of the control flies did not change drastically over the 24-hr. period studied. Isotopic equilibrium between the soluble metabolites was thus effectively established within 0·5 hr., and the relative carbon-14 contents of the separated fractions were measures of their *relative* chemical concentrations at a particular time. The mean carbon-14 activities recovered in the soluble fractions are shown as a percentage of the total soluble carbon-14 in Table 1. The effects induced by di*iso*propylphosphofluoridate mentioned below were very much larger than the differences in carbon-14 distribution observed in replicate analyses and were obviously significant.

It will be seen that di*iso*propylphosphofluoridate caused an increase in glutamine at the expense of the proline–glutamate fraction, especially after 5 hr. No effects are reported for the 24-hr. exposure because at this time most of the flies treated appeared to be dead and respiration had almost ceased; irrelevant post-mortem effects could not then be excluded. The glutamine accumulation suggests that di*iso*propylphosphofluoridate may have rendered necessary an ammonia detoxication mechanism[11]. In a parallel study by the phosphorus-32 labelled pool technique[3], it was shown that topical exposure to di*iso*propylphosphofluoridate for 5 hr. had no significant effect on the thoracic levels of adenosine phosphates or other phosphorylated intermediates, and there was no evidence for the formation of inosine phosphates. The ammonia, then, was not derived by deamination of adenine nucleotides. At 5 hr. all the flies appeared to be alive, and while the rate of oxygen uptake was about normal at this time, it was steadily falling after having reached double the control value at 2 hr. Apart from convulsions within minutes of the application of di*iso*propylphosphofluoridate the flies lay motionless until death except for some slight and laboured leg movements. The failure of this substance to exert any detectable effect on the phosphorus metabolism lends no support to a suggestion that some related phosphorus compounds may exert their insecticidal action in this way[12].

Of interest was the relative rise in acetylcholine in head and thoracic tissues after 0·5 hr., followed by a fall to normal or near normal values after 2 and 5 hr. Since death ensued much later still, it appeared that the expected but temporary accumulation of acetylcholine was not the fatal lesion *per se*, despite the fact that di*iso*propylphosphofluoridate is a potent and relatively irreversible anticholinesterase[13] and has been believed to exert its toxic effect in insects by the same mechanism[14]. The fall in acetylcholine suggested that the esterase inhibition was reversible *in vivo*, or that the choline acetylase system was impaired despite evidence to the contrary[13]. The possibility of alternative pathways of acetylcholine metabolism in insects cannot, of course, be discounted.

By using large aliquots (0·5–1·0 ml.) of the unfractionated thoracic extracts, it was possible to assay the apparent acetylcholine-levels by their action on the rectus abdominis muscle of the frog. The results so obtained by Mr. S. E. Lewis of this Laboratory are given at the foot of Table 1. They confirm the rise and fall found radiochemically. These results suggested a careful investigation of the choline acetylase and acetylcholine esterase-levels in intact insects at different stages of di*iso*propylphosphofluoridate poisoning, the results of which will be reported separately (Lewis, S. E., personal communication). There is some evidence that the level of acetylcholine may fall in vertebrate tissues following an initial rise as the result of anticholinesterase action; but in these cases the inhibition of the acetylcholine esterase was much less likely to be either complete or irreversible[15]. The acute effects of anticholinesterase action in mammals may be largely ascribed to the failure of the neuromusculature of respiration and the consequent anoxia[16]. Therefore, the toxic mechanism was presumably different in these insects, the respiration of which depends largely on diffusion processes[17] and was in any event maintained at a supra-normal level well beyond the time when acetylcholine accumulation was demonstrable. The accumulation of glutamine together with the absence of certain other sustained effects indicate some disturbance in amino-acid metabolism, and this disturbance may have been the fatal lesion in these insects.

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RESOLVING POWER OF GENETIC ANALYSIS

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GENETIC analysis resolves the genome into linkage groups and the linkage groups into loci which can be graphically represented as arranged in a line. Each linkage group has its structural basis in a chromosome and each locus in a small segment of a chromosome. In the case, more unique than rare, of the giant chromosomes of the salivary glands of *Drosophila*, a locus can be identified microscopically with a precision of one band. One band, however, is still a structure of considerable size, more than 1 μ, along the axis of the chromosome.

Though the extraordinary resolving power of genetic analysis, unequalled in biology, was pointed out some years ago[1], the advances made since then render it advisable to restate the questions which it raises. We should do this for two main reasons. One is that this resolving power has increased very considerably, mainly because of the use of micro-organisms, and of selective techniques applied to micro-organisms, for genetic analysis. With some of these techniques the number of products of meiosis which it is feasible to analyse in any one experiment is of the order of 10^8. Recombination fractions of the order of 10^{-6} have already been measured in our laboratory in the mould *Aspergillus nidulans*[2].

The other reason is that we know at present a little more about the chemistry of the chromosomes. We may thus attempt to give a chemical meaning to what genetic analysis resolves, and perhaps even to what is the basis of the process on which genetic analysis is based, that is, crossing-over. In this direction a remarkable paper by Benzer[3] on bacteriophage has already given a lead. In the present paper, Benzer's attempt will be used in a comparative approach.

In the first place, let us see some extreme examples of resolution by means of crossing-over (Table 1). These are all examples of crossing-over between alleles of one gene or, as we prefer to put it, between mutational sites of one 'section' of the linkage map[4]. One section is defined as that part of a chromosome within which recessive mutants behave as allelic of one another, that is, determine a mutant phenotype when in combinations of two in *trans* but not when

Table 1. EXAMPLES OF VERY HIGH RESOLUTION BY MEANS OF CROSSING-OVER BETWEEN ALLELES IN SECTIONS WHERE MORE THAN TWO MUTATIONAL SITES HAVE BEEN IDENTIFIED

Organism and reference	Mutational sites so far identified No.	Sum of recombination fractions between the two sites found farthest apart (*a*)	Recombination fraction between the two sites found closest together (*b*)	Ratio *a*/*b*
Aspergillus				
bi	3	1×10^{-3}	4×10^{-4}	2·5
ad 8	4	$1·8 \times 10^{-3}$	$1·2 \times 10^{-5}$	150
Drosophila				
bx	5	3×10^{-4}	3×10^{-5}	10
lz	3	$1·5 \times 10^{-3}$	6×10^{-4}	2·5
w	3	5×10^{-4}	8×10^{-6}	62
Phage *T*4				
r II (*A*)	33	$4·3 \times 10^{-2}$	$1·3 \times 10^{-4}$	330
r II (*B*)	21	$3·5 \times 10^{-3}$	1×10^{-3}	35

Refs. 3, 7, 8, 9, 10 and Mackendrick (unpublished)

in *cis* ('Lewis effect'). The examples given are only for cases in which more than two mutational sites are already known, so that at least two intervals have been measured. There are, however, four more examples in *Aspergillus*, not included in the table because in each case only two mutants have been tested against one another, in all of which the recombination rates were of the order of 1×10^{-6}.

If we assume in first approximation that the recombination fraction between two non-adjacent mutational sites is the sum of the recombination fractions in all the intervening intervals, then the values in column (*a*) of Table 1 divided by the values in column (*b*) will give minimal estimates of the possible number of intervals in any section. These estimates, being minimal, have an interest only when they have high values. In the case of *ad* 8 in *Aspergillus*, of *w* in *Drosophila*, and of both *r* II (*A*) and *r* II (*B*) in phage, these values run into several tens or hundreds.

What does this tell us ? It tells us that, if the above assumption is not quite invalid, the number of mutational sites within one section of allelism (or gene) separable from one another by crossing-over may run into high numbers. That this is likely to be so can also be deduced from the independent evidence that alleles of one gene originated by different mutational events even if otherwise indistinguishable do usually cross-over with one another, that is, they represent mutation at different sites. Clearly, if the sites at which mutation can occur in one gene are numerous, the chance that two mutants of independent origin involve the same site or group of sites is small[4].

The next step is to consider what part of the total genetic map the smallest recombination fractions so far measured represent. The data are in Table 2. These smallest fractions represent 2×10^{-7}, $2·8 \times 10^{-6}$ and 6×10^{-5} of the total map in *Aspergillus*, *Drosophila* and phage, respectively. In other words, we have already resolved the total maps down to fractions of the order of less than one-millionth in some cases, and the available techniques are by no means exhausted. In fact, they could still resolve, without any improvement, linkages one or two orders of magnitude closer. The point is that we cannot at present deduce from first principles where the ultimate limit should be.

Table 2 SMALLEST RECOMBINATIONS MEASURED IN THREE ORGANISMS EXPRESSED AS A FRACTION OF THE TOTAL MAP

	Total map units (*a*)	Minimum recombination so far measured (*b*)	Ratio *b**/*a*
Aspergillus	>500	*paba* 1–*paba* 6 1×10^{-6}	2×10^{-7}
Drosophila	280	*w*^{aE}–*w* 8×10^{-6}	$2·8 \times 10^{-6}$
Phage *T*4	200	*r* II (55)–*r* II (247) $1·3 \times 10^{-4}$	6×10^{-5}

Ref. 3 and Roper (unpublished) and Mackendrick (unpublished).
* *b* here calculated as recombination percentage

The final step is to give chemical meaning to what we are resolving. In this we can follow Benzer's[3] argument, and try to see what happens when we apply it to organisms other than phage. The deoxyribonucleic acid content of a haploid nucleus (or particle) in *Aspergillus* is 0·044 gm. $\times 10^{-12}$ (from the data of Heagy and Roper[5], after correcting an obvious error). In *Drosophila*[6] this content is 0·085 gm. $\times 10^{-12}$ and in phage *T*4 0·0002 gm. $\times 10^{-12}$. These values correspond to 4×10^{7}, $7·7 \times 10^{7}$ and 2×10^{5} nucleotide pairs in *Aspergillus*, *Drosophila* and phage, respectively. Let us now assume that : (1) all deoxyribonucleic acid constitutes the linear backbone of chromosomes or of phage particles ; (2) that crossing-over involves nucleotide linkages ; and (3) that the probability of crossing-over is the same at all nucleotides, or repeat of nucleotides. From the data of Table 2 and the values for the nucleotide content just given we can calculate, as Benzer has already done for phage, to how many nucleotide pairs the smallest recombination fractions measured correspond. The number of nucleotide pairs multiplied by the values in the last column of Table 2 gives eight nucleotide pairs for *Aspergillus*, 216 for *Drosophila* and 12 for phage.

These very crude estimates would suggest a few nucleotide pairs as the size of the intervals so far resolved between mutational sites. If the backbone of the chromosome were thought of not as a simple Watson–Crick structure but as a multiple, the number of nucleotide pairs per interval would correspondingly be reduced lengthwise and increased sidewise.

Extending the present reasoning to a whole section of allelism (a gene), it turns out from Table 1 that it could include as a minimum 1,000–8,000 nucleotide pairs in *Aspergillus*, and the same order in *Drosophila* and phage ; and we could even speculate further that this is the sort of template required for making a protein.

All these are amusing exercises in numerology. They may even have some heuristic value if they are taken for nothing more than what they are ; in particular, if we keep in mind that crossing-over resolves sections held together by bonds, but tells us nothing about what these bonds are and what they hold together. However, there is one solid fact, and this is precisely why we have written this paper. With crossing-over we can analyse the genetic map down to less than one-millionth of it. Even if the total material of the nucleus went into the bonds which we are resolving, we would still have a biological tool of amazing sensitivity, a sensitivity which biochemistry still lacks.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Imprinting and the Evolution of Instincts

DR. R. E. EWER's communication[1] on this subject calls for some comment. She is concerned with only one of two evolutionary processes. A mode of behaviour may be a learned activity in ancestors, and an unlearned or instinctive one in descendants, *or conversely*. For example, Reyniers[2] reported that newborn rats do not urinate without an external tactile stimulus, but soon 'learn' to do so when their bladders fill. One cannot suppose that no ancestors of the rat urinated without external stimulation. In those bird species so far studied the pattern of song is reported to be learned and unlearned in about equal numbers. Lorenz[3] and Kramer showed that in *Lanius collurio* the practice of spearing insects on thorns was unlearned when nutrition was optimal, but had to be learned when it was deficient. Spalding[4] found that some domestic fowl chicks avoided wasps without learning, others only after being stung. It seems unlikely that the passage from learning to instinct is irreversible.

Dr. Ewer's suggestion as to the evolutionary process by which learned activities are replaced by unlearned is very similar to our own[5,6]. But we doubt[6] whether it is applicable to imprinting, which James[7] described as "the inhibition of instincts by habits". A young nidifugous bird instinctively follows a variety of moving objects. It may get the habit of following only one class of these, for example, ducks or human beings, and it may afterwards perform other activities only on seeing members of this now inappropriate class. Also the development of the usual appropriate adult reactions to members of this class may be inhibited. These reactions and inhibitions are exploited by husbandry. The good shepherd and the good goose-girl lead their flocks, rather than drive them. We think that the word 'imprinting' should be confined to the consequences in *adult* life of infantile experiences. These have not so far been investigated in the recent experiments on following reactions[8-11].

The end results of an imprinting process are remarkably unlike the typical examples of instinctive behaviour, as Lorenz[12] has repeatedly emphasized. An instinctive activity has a somewhat stereotyped motor pattern, and is evoked by a 'releaser' providing 'sign stimuli' which are usually visual or auditory patterns so simple that they can readily be replaced by dummies, that is, these patterns have a simplicity comparable to the patterns of traffic signals designed to make conditioned discrimination easy, and to the patterns which are shown by aposematic animals[13]. Imprinting, in birds at least, seems to be to a *Gestalt*, and many complex activities are directed, and complicated motor adjustments made, to the unusual partner. For example, birds imprinted to human beings often react to both human sexes, and their reactions reveal the many interpretations they put on the variation in human dress[14].

We agree with Dr. Ewer that an instinct is a danger in evolution. An 'innate releasing mechanism' or a 'fixed pattern' of motor activity makes adaptation to new environments *and* to evolutionary changes within the species concerned difficult. Wild poultry kill chicks which do not have the normal colour pattern, and thus make adaptive changes in it impossible except at a very slow rate. Many species have probably become rare or extinct because they could not adapt their behaviour to the changes produced by men. On the other hand, capacities for imprinting do not seem to have been impaired by domestication, which indeed seems to have been built on such capacities[15], even though it might *a priori* have been expected that herding with men and members of other species would have produced selection pressures against a capacity which could lead to incorrect sexual fixation.

Secondly, the capacities which we call learning have been evolved to show a much wider range of variation than morphological characters. Our memories differ among themselves much more than our bodies, and this variation contributes to, rather than detracts from, Darwinian fitness. To paraphrase James in contemporary jargon: an instinct is a behaviour pattern in which developmental homeostasis results in inconspicuous variation both in postnatal development and adult phenotype, whereas a learnt process or lesson involves demonstrable postnatal developmental flexibility[16] and usually results in adaptive variation among the adult phenotypes.

We think that any attempt to apply Waddington's[17,18] technique for what he calls genetic assimilation, so that a learnt response in ancestors is replaced by an unlearnt one in descendants, is only likely to succeed in special circumstances. If the exercise to be learnt is so 'difficult' that it can only be mastered by a small fraction of the ancestral stock, then, by breeding from this minority, in each generation, for many generations, one would hope that the fraction which can learn the task would gradually increase. The question is: Are the developmental processes which we call learning sufficiently like those concerned with wing vein and thoracic development in *Drosophila* for such a selection to result in a fraction of the population performing the task without the environmental stimulus which in the sort of experiment which we are considering would be called the exercise or the experience? Waddington has so far only obtained the genetic assimilation of phenotypes which are the result of gross disruption of the normal canalizations (morphoses). It is probable that the assimilation of 'adaptive hypertrophies' to which learning can be compared[19] would require special selection pressures; for example, adaptedness would have to be made to confer more fitness than adaptability during postnatal life. In Waddington's metaphor, the walls of an entire epigenetic canal would have to be built up higher and steeper.

We are doubtful whether selection for speed of learning which Dr. Ewer suggests would be effective, as this would merely select for animals of what Pavlov called the excitatory or choleric type[20], which can readily learn excitatory reflexes, but not inhibitory ones.

The only example which we know in the literature where selection for a learning ability may be said to have produced a change in the instinctive behaviour of the selected stocks is that recorded by Krechevsky. Tryon had selected 'bright' and 'dull' rats for seven generations. The former learned to find their way through a maze in darkness more rapidly than the latter. Krechevsky[21] found that when confronted with an insoluble problem, in which the correct path was constantly varied, the 'bright' rats chose 'spatial hypotheses', for example, tried right-hand openings before left-hand. The 'dull' rats tried 'visual hypotheses', for example, dark rather than light openings. What Krechevsky called a hypothesis might be called a type of instinctive behaviour. Krechevsky[22] found that lesions of the striata (visual) area of the cortex reduced the tendency to use visual hypotheses, while lesions of the precentral (motor and somaesthetic) area reduced the tendency to use spatial hypotheses.

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Recruitment and Maturity of the East Anglian Herring

Identification of groups of herring in the southern North Sea by the size of the central zones on their scales, expressed as a proportion of the total length of the fish, l_1, was first applied by Hodgson[1]. We have now used it to confirm that in 1952 the recruits to the East Anglian fishery comprised virtually the whole class of three-year-olds, instead of some of them being delayed to their next year of life. The East Anglian fishery is for mature fish, and this change is unusual; it has been sustained ever since 1952. Our Scottish colleagues have repeatedly told us of younger fish also becoming more important in northern groups of herring[2]. Evidence that had previously caused us to suspect this advancement of maturity is as follows.

In 1950 an increase of the order of 3–5 times in the density of *Calanus* took place on the plankton stations of the Flamborough Line, and in the same year a sharp increase in the average length of three-year-old herring was observed in a number of North Sea fisheries from the Dogger Bank southward. These increases were sustained in subsequent years, and in 1952, when the first-year class enjoying improved feeding conditions throughout all its life appeared in the fishery, the number of three-year-old fish was nearly doubled.

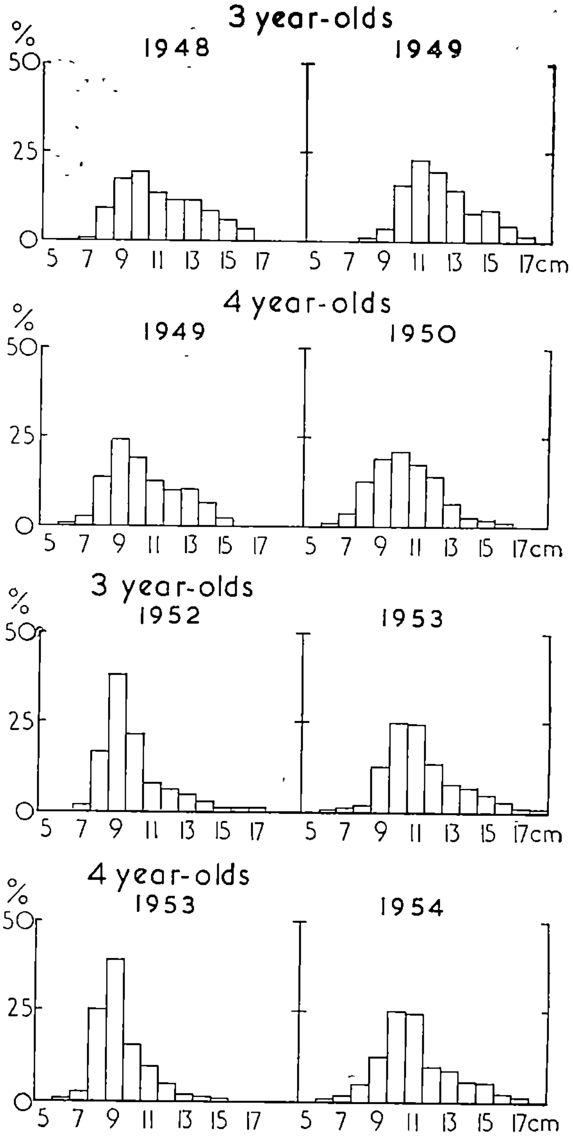

Fig. 1. Distributions of l_1 measurements in the two periods 1948–50 and 1952–54. *a*, Comparison of l_1 distributions of three-year-old fish with that of four-year-olds a year later, in the period 1948–50; *b*, comparison of l_1 distributions of three-year-old fish with that of four-year-olds a year later, in the period 1952–54

The new evidence that full recruitment does take place at three years old is given in Fig. 1. The difference between the l_1 distributions in three-year-olds and that of the subsequent four-year-olds is a well-known phenomenon. Thus, during 1948–50, few small fish with small l_1's reached the fishery as three-year-olds, but came in a year later. The difference is shown clearly in 1949–50 and is discernible, although not so clearly, in 1948–49. During 1952–53 and 1953–54, the l_1 distributions of three-year-olds and the subsequent four-year-olds are almost indistinguishable, and this is more striking in that the difference between the broods is so marked. Thus, after 1952, the first year when the herring would have had better feeding conditions all its life, the l_1 distributions of three-year-olds correspond closely with those of four-year-olds in the following year.

If it is accepted that full recruitment takes place at three years old, it means that the recent changes in the age distribution of the East Anglian herring fishery are partly attributable to natural causes.

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Protection from Whole-body X-irradiation afforded to Adult Mice by reducing the Body Temperature

It has been shown that the survival-rate after irradiation of new-born rats[1] and mice[2] may be increased by reducing the body temperature to 2–5° C. at irradiation. A slight reduction in sensitivity of adult rats to whole-body irradiation has also been shown[3] by reduction of their body temperature to 18° or 19° C. The development of a technique for inducing hypothermia in rats by Andjus and Smith[4], and recently extended to mice by Goldzweig and Smith[5], has enabled us to demonstrate considerable protection in adult mice irradiated at a body temperature of 0–1° C.

The mice used were male adults of the 'T' strain bred at the National Institute for Medical Research. The *LD*50 (counting survival at 30 days) for normal mice of this strain is approximately 620 r. of X-rays given to the whole body (Fig. 1) based on observations made on 114 mice. All irradiations were done with 190 kV. X-rays, 6 mA., filtered through 1·5 mm. of copper and 1 mm. of aluminium. The cooled mice were irradiated when all heart and respiratory movements had stopped and the colonic temperature was 0–1° C. The revival was started about five minutes after completion of the irradiation and thirty minutes after the animals' body temperature had reached 1°. Doses of 900 r. (14 mice), 1,200 r. (15 mice) and 1,500 r. (7 mice) resulted in 100 per cent survival at thirty days. The mice lost weight during the first ten days after irradiation; but had all regained their original body weight after twenty-two days. Fig. 2 shows the changes in weight of mice irradiated with 900 r. X-rays at a body temperature of 0–1° C. compared with a non-irradiated group whose body temperature was likewise lowered to 0–1° C. and with another group that were given 900 r. X-rays at normal body temperature.

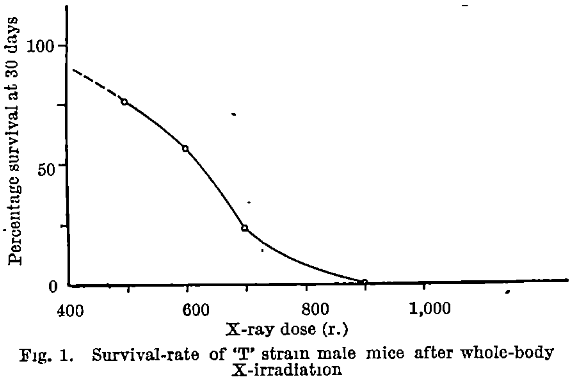

Fig. 1. Survival-rate of 'T' strain male mice after whole-body X-irradiation

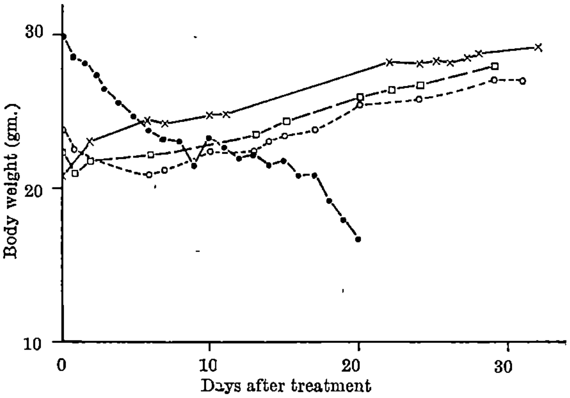

Fig. 2. Weight changes in 'T' strain male mice. ×, Normal controls; □, hypothermic (0–1° C.) controls; ○, 900 r. whole-body X-irradiation during hypothermia (0–1° C.); ●, 900 r. whole-body X-irradiation at normal body temperature

Higher doses of radiation than 1,500 r. at reduced body temperature have not yet been attempted, so the degree of protection given by this treatment has not been established. The dose required to give an *LD*50 at thirty days is, however, clearly more than 2·4 times that required at normal body temperature. The degree of protection is thus greater than that afforded to adult animals by chemical means or by partial anoxia. Nevertheless, since during the lowering of body temperature to 0–1° C. an as yet unknown degree of anoxia, which may be quite severe, is induced, the protection illustrated by these results cannot yet be proportionally assigned to the degree of anoxia on one hand and to the reduced body temperature on the other,

I am indebted to Dr. A. S. Parkes for the supply of the mice, and for facilities in his Division at the National Institute for Medical Research to learn the technique of cooling and reviving animals.

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Ultrasonic Absorption and Thermal Conductivity of Muscle

The chance of survival in severe cold of an individual already comatose and with arrested peripheral blood flow will depend, other things being equal, upon the rate at which heat escapes by conduction through skeletal tissue from the central body region. Fat acts as thermal insulation, and is indispensable to Channel swimmers[1]; but men leading a strenuous life, as in the Armed Services, usually have a thin layer only, and their ultimate tolerance of exposure must depend largely upon the thermal conductivity of their muscle tissue. This is extremely difficult to measure on the living individual; but a large number of tests of excised tissue, human and beef, disclosed a range of variation from more than

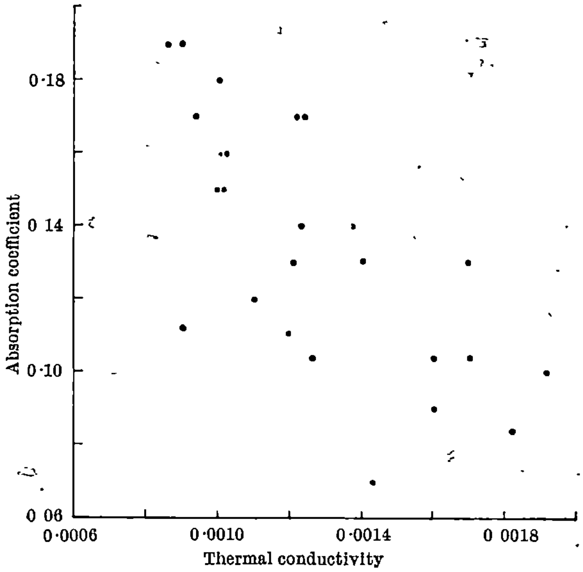

Fig. 1. Absorption of 2½-Mc./s. ultrasonic energy by beef tissue as related to thermal conductivity. Each measurement of absorption is the mean of five points on a piece of tissue 3 in. × 3 in. × 1 in.

double the conductivity of fat (which varies little) down to about the same[2]. If this range is indeed present as between normal living individuals, it would be of practical value to find a method of estimating conductivities on the living, as a help in assessing their suitability for enterprises involving exposure as a hazard.

There are grounds for supposing that the absorption of high-frequency ultrasonic waves by a material such as muscle might vary in the opposite direction to its thermal conductivity. This supposition was tested on fresh beef loin muscle, using a Kelvin and Hughes Mark IV ultrasonic 'flaw detector', which the makers kindly adapted and lent for these experiments. This apparatus causes a quartz-crystal 'probe' to emit every 1/100 sec. a short 2½-Mc. ultrasonic pulse which is received by a second identical probe and displayed on a cathode-ray screen. In the measurement of tissue absorption the probes are set facing one another in a tank of saline, which has negligible absorption. A slab of the tissue to be tested is interposed between the probes, and a fixed voltage (1,000 V.) is applied to the transmitter. The amplitude of the received pulse is adjusted conveniently, and its peak is set to a mark on the screen. The slab of material is then removed, and the voltage reduced to a value giving the same strength of reception. The method serves only for material of closely the same acoustic hardness as the liquid used, otherwise reflexion would occur at the surface of the specimen. This condition is fulfilled very closely for muscle tissue, as is easily verified.

Pieces of freshly killed beef (loin) 3 in. × 3 in. × 1 in. were first tested for absorption at five points; if none departed more than 10 per cent from the mean, the specimen was wiped dry, dipped in oil, and transferred to an apparatus similar to that originally used for conductivity determinations[2,3]. The specimen was in contact on both surfaces with stout copper plates, so that the value for the conductivity was an average of an indefinite character. The results of twenty-five such determinations are shown in Fig. 1, and it is clear that the mean absorption coefficient and the thermal conductivity do in fact vary in inverse ratio for dead excised tissue.

This apparatus will yield reasonable values for the absorption of the calf and thigh muscles of the living individual. It is, however, necessary to develop means for locating precisely the measurements, which vary from centimetre to centimetre, so that an average value can be calculated. This work is in progress.

This investigation is being carried out under consulting contract with the Admiralty (D.R.P.P.). Accommodation for it is provided by St. Bartholomew's Medical School, in Prof. K. J. Franklin's Department, to whom I owe my thanks, as also to Dr. O. G. Edholm (Medical Research Council), who supervised the work.

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Stabilization of Xanthine Oxidase Activity by Salicylate

BIOLOGICAL and chemical work with purified xanthine oxidase from cows' milk is handicapped by the loss of its enzymic activity on storage[1,2]. The rate of deterioration, which increases with the degree of purification, is not always the same with different

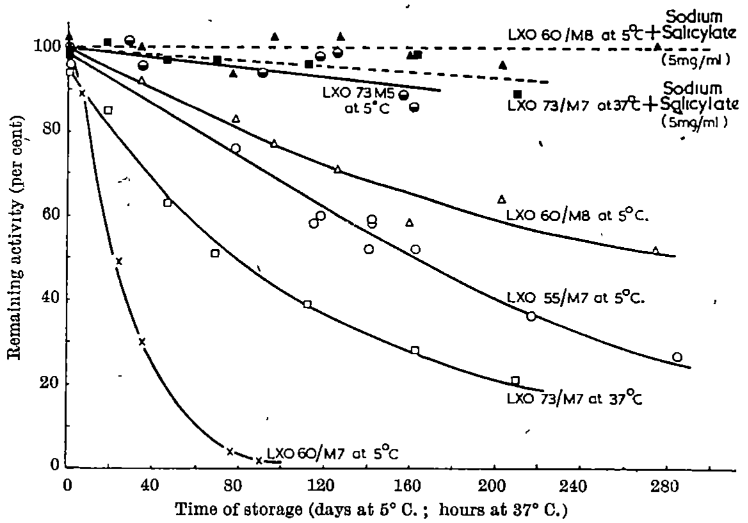

Fig. 1. Xanthine oxidase solutions (see explanation of batch numbers, ref. 10) stored in 1 *M* phosphate buffer, *p*H 6 (except for *LXO* 60/*M*7 and *LXO* 55/*M*7, which were in 0·1 *M* phosphate and 0·2 *M* sodium chloride respectively), at temperatures indicated. Enzyme concentration 0·5–2 per cent. Assays carried out spectrophotometrically (ref. 9)

samples, the cause of such variability being largely unknown so far (Fig. 1).

Stabilization of enzymes could be expected to be brought about by using (*a*) extraneous proteins or polyamides, (*b*) reducing agents, (*c*) chelating compounds and related substances, and (*d*) competitive inhibitors.

While in our case, albumin, polylysine, a di-alkyl analogue of 6.6 nylon (group *a*); glutathione, cysteine, ascorbic acid (group *b*); ethylene diamine tetraacetic acid (versene), 8-hydroxyquinoline sulphonic acid, triethylene tetramine, glyceric acid, glycerine (group *c*) afforded scarcely any significant protection at 37° C. for ten days in *M* phosphate at *p*H 6 (enzyme concentration about 0·5 per cent), sodium salicylate prevented completely any loss of oxidase and dehydrogenase activities[1] at 0–5° C. and almost completely at 37° C. (Fig. 1). Salicylic acid has been reported to act as an inhibitor, though not a very powerful one[3], and our own experiments confirmed that this inhibition was competitive in nature, with $K_i = 1{\cdot}35 \times 10^{-4}\,M$ (spectrophotometric assay at *p*H 8·2, taking $K_s = 5{\cdot}3 \times 10^{-6}\,M$[4]). It is also noteworthy that Keeser[5] reported on 'activation' by sodium salicylate of xanthine oxidase in guinea pig liver after incubation for 2 hr. at 37°; in the light of our findings, this observation may be due to stabilization rather than to activation. Of substances related to salicylic acid (all acids in form of sodium salts), salicylamide, sulphosalicylic acid, salicylaldoxime and gentisic acid showed only slight to moderate effects; but *p*-aminosalicylic acid, acetyl salicylic acid (aspirin) and benzoic acid came near or close to salicylate itself, which remained the best. Our findings may be compared with those of Veitch and McComb[6], who have very recently found a stabilizing effect with *m*-toluic acid on D-amino-acid oxidase.

Salicylate could be removed from the enzyme by dialysis, even after prolonged association. This was proved by the fact that the ratio of ultra-violet absorption at 280 mμ to that at 295 mμ (at which wave-length the salicylate ion has an absorption maximum) returned to the value found with untreated samples, and that $^{14}CO_2H$-labelled salicylic acid was removed almost quantitatively (to about 0·25 mole per mole of total xanthine oxidase) by three consecutive dialysis procedures.

Two points remain to be mentioned: one concerns the low activity established with our xanthine oxidase preparations[1] when using cytochrome-*c* as electron acceptor, which did not increase on adding salicylate, but was inhibited by high concentrations of the reagent; in contrast, 8-hydroxyquinoline augmented this activity slightly, confirming the original observation by Doisy *et al.*[7], who suggested interaction between the iron of the enzyme and the chelating agent. The second point refers to the moderate stabilizing effects of uric acid[8] and 2 : 6-diamino-8-phenyl-purine, the latter a powerful new inhibitor of xanthine oxidase.

Details of these investigations, which include the use of salicylate during the purification process[9], and some evidence for the possible mechanism of loss of activity and stabilization by salicylate will be published elsewhere.

Our thanks are due to Dr. V. C. E. Burnop for the synthesis of labelled salicylic acid, Messrs. D. A. Gilbert and P. G. Avis for the preparation of xanthine oxidase samples, the Research Department of British Nylon Spinners for the nylon analogue, Mr. G. M. Timmis for the purine derivative, and Mrs. K. Tussler for technical assistance.

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Presence of Deoxyribonuclease in Silkworm Polyhedral Virus

WORKING on the supposition[1,2] that polyhedral virus would be derived from the deoxyribonuclease-controlling gene, I have now been able to demonstrate the presence of a fairly large amount of deoxyribonuclease in polyhedral crystals.

Larvæ of a pure line, *P*44, were injected with a viral solution and polyhedra isolated in the usual way from surviving diseased individuals. Isolation was, however, carried out under cooling conditions and the last sediment washed with 2 *M* sodium chloride, in order to remove remaining cell debris. 5 mgm. of purified polyhedral virus was dissolved in 0·6 ml. of 0·025 *M* sodium carbonate and centrifuged, and the supernatant was carefully neutralized with hydrochloric acid to *p*H 7·5. The enzymic activity of the polyhedral solution was determined viscosimetrically, using spleen deoxyribonucleic acid as substrate. The velocity constant, *k*, of decomposition expressed as a monomolecular reaction at 35° C. was 0·00105. In the determination of deoxyribonuclease, 0·005 *M* magnesium sulphate was added. The polyhedra showed a very feeble nuclease action in the absence of magnesium ions, and it is assumed that they contain almost no activators. Another solution of the same polyhedral virus preparation was then mixed with 0·02 mgm. of crystalline, pancreatic trypsin and kept at 5° C. for 80 min. The *k*-value was raised to 0·00145 by this treatment. In supplementary tests, I observed, however, that the deoxyribonuclease is somewhat inactivated by trypsin at higher temperature. It seems that the nuclease exists at least partly in a special combination with other proteins in the polyhedron. Deoxyribonuclease was also demonstrated in the polyhedra prepared from strain *P*21.

In one control experiment, deoxyribonuclease of digestive organ-free tissues of host larvæ was estimated in a similar manner. It was found that the nuclease activity of a tissue preparation corresponds to only 5 per cent of that of crystalline polyhedral virus.

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Amino-acid Sequence of a Melanophore-stimulating Peptide

A HIGHLY active melanophore-stimulating polypeptide has been isolated from hog posterior pituitary extracts[1]. The amino-acid composition[2] of the active substance (MSH) is consistent with the view that it is an octadecapeptide containing the following amino-acid residues: Arg_1, Asp_2, Glu_2, Gly_2, His_1, Lys_2, Met_1, Phe_1, Pro_3, Ser_1, Try_1, Tyr_1.

In this preliminary communication we wish to report the complete amino-acid sequence of the peptide hormone as deduced from the results of 'stepwise' degradation studies on the intact molecule and from the characterization of peptide fragments isolated from enzymic digests. The methods used in this study may be summarized as follows :

Sequence studies on the intact octadecapeptide. The N-terminal sequence was investigated by a modification[3] of Edman's phenylthiohydantoin method. 2·4 mgm. of the peptide hormone was used for this study, which was carried out as previously described[3,4]. The phenylthiohydantoin derivative of the N-terminal amino-acid was obtained in 85–90 per cent yield and was identified chromatographically as that of aspartic acid. The peptide was afterwards submitted to ten successive applications of the degradation procedure, and the following N-terminal sequence was identified: Asp.Glu.Gly.Pro.Tyr.Lys.Met.Glu.His.(Phe?).

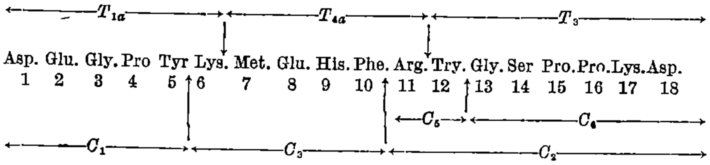
The C-terminal residue was identified as aspartic acid by the carboxypeptidase method[5].

Studies on peptide fragments from enzymic digests

Action of trypsin. The peptide hormone (4·8 mgm.) was treated with trypsin (0·05 mgm.) at *p*H 8·0 and 30° for 30 min. The reaction mixture was submitted to ionophoresis on paper in a pyridine–acetic acid buffer (*p*H 6·5) for 3 hr. at a potential gradient of approximately 40 V./cm., and was resolved into four major and two minor components. The tryptophan and histidine residues were located by means of the Ehrlich and Pauli reagents respectively, and sample portions of each peptide component were separately hydrolysed and analysed for constituent amino-acids by two-dimensional chromatography on paper. The tryptic digest was found to contain the following peptides: T_{1a}, (Asp, Glu, Gly, Lys, Pro, Tyr), T_{1b}, (Asp, Glu, Gly, Pro, Tyr), T_2, (Arg, Asp, Glu_2, Gly, His, Lys, Met, Phe, Pro, Tyr), T_3, (Asp, Gly, Lys, Pro_2, Ser, Try), T_{4a}, (Arg, Glu, His, Met, Phe), T_{4b}, (Arg, Glu, His, Lys, Met, Phe). By the further action of trypsin, T_2 gave equimolar amounts of T_{1a} and T_{4a}, showing that these two peptides are part of the same sequence. T_{1b} and T_{4b} are minor components which, as shown below, are due to chymotrypsin contamination.

Action of chymotrypsin. The hormone (4·8 mgm.) was treated with chymotrypsin (0·05 mgm.) at *p*H 8·0 and 30° for 20 min. The digest was submitted to ionophoresis on paper in a pyridine–acetic acid buffer (*p*H 3·5) for 3 hr. at a potential gradient of 35–40 V./cm.; it was resolved into four major components which were analysed for constituent amino-acids as described above. The chymotryptic digest was found to contain the following peptides: C_1, (Asp, Glu, Gly, Pro, Tyr), C_2, (Arg, Asp, Gly, Lys, Pro_2, Ser, Try), C_3, (Glu, His, Lys, Met, Phe), C_4, (Asp, Glu_2, Gly, His, Lys, Met, Phe, Pro, Tyr). By the further action of chymotrypsin C_4 gave rise to a mixture of C_1 and C_3, indicating that these two peptides belong to the same sequence, and C_2 was split into two new fragments, C_5, (Arg, Try) and C_6, (Asp, Gly, Lys, Pro_2, Ser).

Elucidation of complete amino-acid sequence. Peptides T_{1a}, T_3, T_{4a}, C_1, C_3, C_5 and C_6 were subjected to end-group analysis and sequence studies, from the amino end by means of the Léonis modification[6] of the phenylthiohydantoin method, and from the carboxyl end by means of carboxypeptidase[5]. In this manner the complete structure of each peptide was determined, and the linkages connecting the various fragments ascertained from the overlapping sequences. The complete amino-acid sequence of the melanophore-stimulating hormone is thus established as follows :



The indicated sites of enzymic cleavage are seen to have occurred in accordance with the known specificities of trypsin and chymotrypsin.

The N-terminal decapeptide sequence determined directly on the intact hormone molecule is shown to be in complete agreement with the deduced sequence. Peptides C_1, C_3 and T_3 were also examined by partial acid hydrolysis (12 *N* hydrochloric acid at 37°) and end-group analysis using Sanger's fluorodinitrobenzene reagent[7]. All the di- and tri-peptide fragments which were obtained in this way could be unequivocally located in the indicated sequence.

It may be noted that the sequence Met.Glu.His.Phe.Arg.Try.Gly (positions 7–13) has also been shown to occur in the corticotropins (ACTH, positions 4–10)[8,9]. This observation is of particular interest since it suggests a possible structural basis for the observed intrinsic melanophore-stimulating activity of the corticotropins[8,10], and recalls earlier evidence for the striking relationships between the structure and biological activities of the posterior pituitary hormones oxytocin and vasopressin[11].

Full experimental details of this work will be published elsewhere.

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Bacteria in Experiments on rearing Oyster Larvæ

THE larvæ of many species of marine invertebrates have proved difficult to rear in the laboratory; the proper control of many factors is required, including ood, *p*H, temperature and stirring. In particular, onsiderable attention has been given to the requirements of the larvæ of commercial species of lamellibranchs, especially oysters[1–4]. In such work, which has involved long series of rearing experiments, it has been a common experience of workers (in Great Britain and in the United States) that some batches of larvæ fail to develop properly although the conditions provided have been apparently suitable. Some authors have ascribed this result to either the presence or absence of organic substances in the sea water, mplying that such substances are either toxic or ssential to the proper development of the larvæ. This view has been supported by the work of Wilson[5] at Plymouth, which has suggested that different natural waters differ in their value as media for developing *Echinus* larvæ.

Observations which I have made suggest that nsufficient attention has been given to the possible development of bacteria in rearing experiments and heir effect on the larvæ. The purpose of this communication is to direct attention to the very considerable bacterial population which may quickly develop in such experiments. The effect of the presence or absence of the dissolved organic substances may therefore be indirect in that the bacterial population in a larval rearing experiment is very probably dependent on the concentration of the various dissolved organic substances. The concentration of dissolved organic matter in sea water has received omparatively little attention, but it is known to vary considerably[6].

During the summer of 1955, seventeen broods of oyster larvæ were reared under replicate conditions n the laboratory. The experiments were each made n 1 l. of sea water at a temperature of 20° C. Before use, the water was filtered twice through filter candles, he final filtration being through filter candles designed to retain particles more than 1μ in size. The water therefore contained none of the plankton with the exception of a few bacteria. A few ml. of a concentrated *Isochrysis galbana* culture and 300–700 arvæ were added to the water. The additions did not appreciably increase the bacterial population.

The density of the bacteria was observed at ntervals in each experiment by plating diluted amples in triplicate using ZoBell's agar medium No. 2216[7]. The samples were incubated for 48 hr. at 22° C. and the number of developing colonies estimated by, counting ten random microscope fields n each plate. An initial peak, varying between 30,000 and 780,000 bacteria per ml., occurred within three or four days of beginning the experiment. In eight of the seventeen experiments it was more than 200,000. After the first five days the numbers usually declined to lower levels and remained roughly tationary at 1,000 to 10,000 per ml. If there was a marked mortality of larvæ, a second peak occasionally occurred. These densities were not sufficient to make the water appreciably turbid.

Six of the seventeen experiments can be classed as successful as they yielded more than ten spat. n five of them the initial peak was less than 200,000 per ml. and in the sixth it was 300,000 per ml. Thus, five of the six successful experiments occurred in the nine experiments where the initial peak was less than 200,000. Only one successful experiment occurred in the eight experiments where the peak was more than 200,000. These experiments suggest, but do not conclusively demonstrate, that, in this case, the bacteria were influencing the successful development of the larvæ. They do, however, clearly show that the bacterial population in such experiments may be considerably in excess of that occurring in the sea, where usually not more than 1,000 per ml. are found[7]. Recent experiments by Oppenheimer[8] show that dense populations of bacteria may occur in laboratory experiments on hatching marine fish eggs. In this case the percentage hatching was improved when the bacterial population was controlled with antibiotics.

It is clear that, in experiments on rearing marine fish and invertebrate larvæ, the bacterial flora cannot be ignored. Differences which have been observed in the value of different natural waters for rearing larvæ may have their origin in the variation in the size of the bacterial flora which the water can support.

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Effect of Superinfection on Phage Sensitivity in Staphylococci

IT has been known for some time that the sensitivity of bacteria to lysis by bacteriophage is conditioned among other things by the presence of lysogenic infection with one or more bacteriophages. Various workers[1–3] have shown that when sensitive cultures were lysogenically infected with typing or even unrelated phages they undergo a change of phage type, the change being a diminution in the number of phages capable of lysing the bacterial cell.

During recent work with staphylococci[4], it was found that one strain could be lysogenically infected and formed a stable system in which every colony was lysogenic; but the culture was not completely immune to the phage in that high titres of phage gave low counts on the lysogenic culture. It is believed that this is due to the presence of a virulent mutant in the phage. The culture employed was N.C.T.C. 8354 with phage N.C.T.C. 8426, the lysogenic system formed being 8354/8426.

Further work was carried out using three other staphylococci, 60, 98 and 105, and three other phages derived from the staphylococci of similar number, that is, 8354 *P* from 8354, 60 *P* from 60 and 105 *P* from 105. These were obtained by filtering the supernatants of overnight broth cultures. The experiments are summarized in Table 1.

It will be seen that when 8354 is rendered lysogenic with 8426 *P* it becomes sensitive to 8354 *P*, 60 *P*

Table 1. PHAGE TITRES PER ML. ON THE GIVEN INDICATORS

Phage	Indicators 98	 8354	 8354/8426
8426 P	10^{10}	10^{10}	10^{6}
8354 P	10^{6}	0	10^{6}
60 P	10^{6}	0	10^{6}
105 P	10^{6}	0	10^{6}

and 105 P. The first-named being its own phage, the problem arose of the stability of the system. It was found that 8354/8426 appeared to contain no 8354 P as judged by two methods. First, indicators for 8354 P showed no plaques when spotted with the supernatant of 8354/8426. Secondly, the supernatant did not plaque on 8354/8426, which would be expected if any 8354 P was present. It appears, therefore, that when 8426 P infects 8354 it displaces the prophage of 8354 P [5] and as a result 8354 is now sensitive to its own phage and in fact to other phages. This would have the effect of changing the typing pattern of the culture in an unexpected way. This work is being extended by testing other systems made with 8426 P.

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Artificial Elimination of the *F* Factor in *Bact. coli* K-12

A FEW years ago, Lederberg and his co-workers[1,2] found that in *Bact. coli* K-12 there was a difference in sex-compatibility between the two mating cells, one having a transmissible agent, F, and the other lacking this agent. Hayes[3] demonstrated that these mating types were very stable heritable characters; but the accidental disappearance of the F factor was found by Lederberg *et al.*[1], and by Hayes[4]. The study reported here reveals that it is possible to obtain F^- cells at will from F^+ cells under certain environmental conditions. This phenomenon may be called 'F elimination'. The environmental factor responsible for F elimination is the cobalt or nickel concentration in the medium ($Co(NO_3)_2$, $CoCl_2$, etc.; $Ni(NO_3)_2$, $NiSO_4$, etc.).

The first method of artificial elimination of F factor is called the 'citrate method'. A culture of F^+ cells was inoculated into peptone medium (peptone, 10 gm., and glucose, 2 gm., in 1 litre distilled water), and incubated overnight at 37° C. After 24 hr., 0·15 ml. of 0·4 M cobalt solution was added to 3 ml. of the culture (the final concentration was 20 mM), which was incubated for 24 hr. more. This treated culture was then spread on nutrient agar containing 40 mM of sodium citrate, which was used for detoxification of cobalt, and single colonies grown on the medium were isolated at random. By this procedure, it was found that many colonies were converted into F^-. For example, in the mutant K-12 strain 58–161 and the derived strains from 58–161, 10–30 per cent of the colonies were converted into F^-. However, all the F^- were sensitive to cobalt. The frequency of conversion varies according to the strain of K-12 used.

The second method is called 'resistant isolation' in which cobalt-resistant colonies are selected b serial transfer in peptone medium containing cobal in increasing concentrations. A slow and smoot increase of resistance was observed. Starting fro a concentration of 0·5 mM, in which strains derive from the original K-12 are able to grow, resistan strains tolerating even 20 mM were obtained. Thes resistant strains were plated on nutrient agar containing 20 mM of cobalt, and ten well-grown colonie were isolated at random. In mutant strains 58–16 and Y-40, for example, all ten colonies were F^- whereas in the W-1485 strain, only four colonie were F^-. However, drug resistance and the F character of these strains could be separated; cobalt sensitive strains derived from the resistant were F as before, and cobalt-resistant strains receiving th F factor from F^+ bacteria became F^+ themselves.

The mating behaviour of the F^- strains corresponded to that of the F^- strain described by Hayes[5], and by Lederberg *et al.*[1]. By the cobalt treatment other characteristics, for example, nutritional requirements, sugar fermentation, phage-resistance, lysogenicity, indol formation, shape, Gram staining, an antibiotic resistance were not changed. The F^+ trai is very stable in successive serial passages in ordinar media such as broth, peptone and minimal medium Therefore, in the F^+ clone, the replication of the F factor may be closely concerned with bacteria reproduction.

This hereditary conversion of mating type withi a clone gives rise to the question of the basis of th change and the mechanism by which the F^- strain occurred. There are two well-recognized possibilities (*a*) F elimination may be due to the selection o spontaneous gene mutation; (*b*) it may be induce by the nickel or cobalt in the medium. From th experimental data, the following may be concluded (1) F elimination occurs even in the absence of ce division (in the first method); (2) the occurrence o F elimination is about 100,000 times more frequen than that of other bacterial mutants; (3) F^+ and F strains are equally susceptible to the killing actio of cobalt or nickel as judged by viable counts, an F^- trait is not linked with cobalt or nickel resistance These conclusions seem to exclude possibility (*a*). Th conjecture used for explaining the contradiction i the stability and instability of the F factor is tha it is a non-lytic symbiotic agent, as reported b Cavalli *et al.*[2] and Hayes[4]. It may behave as a cytoplasmic factor and/or as extruded state on to th surface of the F^+ cells at a certain stage of its life cycle. In this state, the sensitivity of the F facto to cobalt or nickel may be greater than that of othe cytoplasmic factors or of nuclear genes.

I wish to express my appreciation of the suggestion and encouragement given by Prof. H. Kikkawa. I a also indebted to Mr. T. Iijima for his advice an criticism during the course of this study.

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Carotenoids of Some Brazilian Freshwater Gastropods of the Genus *Pomacea*

VERY few reports are available on the carotenoids of freshwater molluscs[1-3]. The early researches of Kruckenberg (1882) and of MacMunn (1883) on the pigments of *Helix pomatia* revealed the presence of a not well-characterized carotenoid and of some chlorophyll in the liver of this snail. Lönnberg studied extensively the pigments of marine molluscs, and Lederer described two new carotenoids in the marine species *Pectunculus glycymeris* and *Pecten maximus*[4,5].

In a short communication on the lipochromes of *Pila glauca*, a South American freshwater species, Comfort reported that the eggs and the 'uterine gland' were bright red in colour and that the pigment could be easily extracted by crushing the material with water[6]. On partition between 90 per cent methanol and petrol ether most of the pigment appeared in the hypophasic fraction. The intact pigment in formol-fixed embryos showed a single spectral band at 550 mμ. However, the pigments were neither separated nor characterized.

More recently, Cheesman isolated the chromoprotein from the eggs of the water snail *Pomacea canaliculata* (Orb.) and was able to study some of its properties. From extensive chromatographic and spectrographic analysis he showed that the pigment resembles astacene from lobster hypodermis but its identity was not definitely established[7].

Having at our disposal several batches of eggs and of living molluscs belonging to the genus *Pomacea* (*Pomacea*, Perry, is the actual name for the genus *Ampullaria* which is very close to *Pila*[8]. We must remark that *Pila* is not found in Brazil and *Pila glauca* belongs to the genus *Pomacea*[9]), it seemed of interest to investigate the distribution and separation of their pigments. *P. haustrum* and *P. dolioides* lay bright red eggs, and the yolk gland shows the same deep colour, whereas in *P. sordida* the colour is orange-yellow and in *P. decussata* light green. These differences in colour seemed to be related to the diet of these snails, since *P. haustrum* and *P. dolioides* are carnivorous–omnivorous and *P. sordida* is mainly herbivorous. The analysis of these biochromes showed also that the carnivorous species presented almost exclusively xanthophyll esters and free xanthophylls and the herbivorous one predominantly carotene.

The separation of the carotenoids was made by the partition test with immiscible solvents. The distribution of the pigments in the epiphase and hypophase after saponification with 10 per cent alcoholic potassium hydroxide solution is given in Table 1.

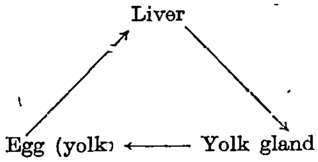
As shown in Table 1, *P. haustrum* and *P. dolioides* contained free xanthophylls and xanthophyll esters and a little carotene. *P. sordida* and *P. decussata* were found to contain only carotene. The epiphasic carotenoids were chromatographed in a magnesium oxide–'Celite' mixture (3 : 1) and the hypophasic in calcium carbonate. Besides β-carotene there has been detected a band corresponding to α-carotene. The hypophasic pigments were shown to be a mixture of three xanthophylls.

Table 1. DISTRIBUTION OF CAROTENOIDS OF SOME SPECIES OF *Pomacea*

Species	Distribution of pigments between 90 per cent methanol and petroleum ether		
	Before saponification	After saponification	Carotenoids characterized
P. haustrum	Mostly epiphasic	Mostly hypophasic	Xanthophyll esters
P. dolioides	Mostly epiphasic	Mostly hypophasic	Xanthophyll esters
P. sordida	Epiphasic	Epiphasic	Carotene
P. decussata	Epiphasic	Epiphasic	Carotene

Purified carotene extract exhibited an absorption maximum at 450 mμ and the predominant hypophasic xanthophyll one at 480–490 mμ. A tentative attempt to modify the carotenoid distribution of the eggs by feeding the herbivorous species a strictly animal diet was unsuccessful. However, the constancy of the carotene in the eggs, liver and yolk gland of these species and the predominance of xanthophyll esters in the carnivores are in accordance with the general rule for other invertebrate animals, that is, that the herbivores store carotene and the carnivores tend to store xanthophylls[3].

The carotenoids existing in the eggs are stored in the liver of the newly hatched young animals, which could be easily shown in the apex of the shell where the liver is located. In the adult female the pigments concentrated in the yolk gland originated probably from the liver. Therefore, the cycle of the carotenoids in these snails may be visualized tentatively as follows:



A study of the distribution and depletion of the liver and yolk gland carotenoids is in progress.

I wish to thank Prof. H. Souza Lopes, of the Department of Zoology, Instituto Oswaldo Cruz, Rio de Janeiro, for the snails used in this work and for help in the dissection and identification of these animals.

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Absence of Keratin in Teleost Epidermis

IT has often been stated that the outermost layers of the teleost epidermis are keratinized[1-4]. Young[5] says that, in the trout, ". . . the squamous epithelium of the epidermis provides the animal with a covering of keratin . . .".

During a study of the epidermal structure of teleosts, the following species of fish were examined: *Salmo salar*, *S. trutta*, *Esox lucius*, *Gadus callarias*, *G. virens*, *Molva molva*, *Onos mustelus*, *Tinca tinca*, *Phoxinus phoxinus*, *Anguilla anguilla*, *Conger conger*, *Nerophis lumbriciformis*, *Callionymus lyra*, *Anarrhichas minor*, *Trigla gurnardus*, *Gasterosteus aculeatus*, *Pleuronectes platessa*, *Lepadogaster gouanii* and *Lophius piscatorius*.

Material was fixed in 10 per cent formalin, Bouin and 70 per cent alcohol, embedded in ester-wax and cut at 10μ. Sections were stained with picrocarmine, Papanicolaou's[6] and Mallory's stain. These do not demonstrate any definite keratinized layer of cells, such as is found in higher vertebrates, although in many of the species examined an outer layer of flattened cells, which stains more darkly in hæmatoxylin and eosin than the rest of the epidermis, sometimes occurs.

A further examination was carried out, using the tetrazolium reaction[7], Chèvremont and Frédéric's method[8] and the DDD method[9]. These give no indication of the presence of sulphydryl groups in the epidermis.

It may be concluded from this work that keratin does not normally occur in the epidermis of the species examined; indeed, it is unlikely, from a consideration of the structure of the epidermis of fish in general, that a keratinized layer is ever found.

If it is the case that the outer layers of the epidermis of all bony fishes never contain keratin, the conclusion must be that this characteristic epidermal structural protein was only developed as a protective layer when the vertebrates began to colonize dry land.

I wish to express my sincere thanks to Prof. P. 'Espinasse, in whose Department this work was done, for his helpful advice.

This work was carried out under a Department of Scientific and Industrial Research contract placed with the University of Hull and forms part of the programme of the Food Investigation Organization of the Department of Scientific and Industrial Research.

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Digestion of Nitrogenous Compounds by Ruminants

The utilization of nitrogenous compounds by ruminants is known to be affected by a number of factors peculiar to these animals. Among these, the formation and absorption of ammonia in the rumen have become a subject of considerable interest and importance, as it could perhaps result in a significant wastage of nitrogen in the animal's economy[1–3]. The concentration of ammonia in the rumen can give little indication of the extent of its formation, and, so far as we are aware, no studies have been reported which allow the assessment of just how much of the dietary nitrogen reaches the true stomach under various feeding regimes, and how much is removed at the rumen-level.

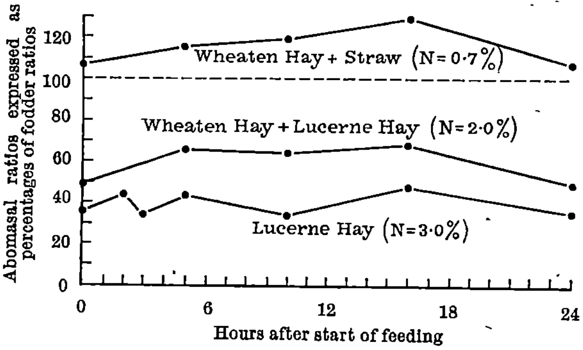

Fig. 1

By using lignin as a marker[4] in the fodder and in the abomasal contents of sheep, we have been able to make such an assessment for a number of diets of widely different protein content. The sheep were fed a regular ration of these diets before being slaughtered at various intervals after feeding. Nitrogen–lignin ratios were determined in the abomasal samples and compared with the ratios in the fodders. For ease of comparison, the ratios in the abomasum can be expressed as percentages of the ratios in the respective fodders. In Fig. 1 the results from three diets are compared in this way. (Details of these and related experiments will be published elsewhere.)

Although relatively few sampling times have as yet been used, the results suggest that they are sufficient to give an approximate measure of the amount of nitrogen reaching the abomasum on each diet. In animals fed on lucerne hay the ratio in the abomasum was maintained at about 40 per cent of the ratio in the fodder, and it must therefore be concluded that the amount of nitrogen reaching the abomasum was equivalent to only 40 per cent of the amount fed. It is to be presumed that much of the remainder was absorbed as ammonia; but it is not known to what extent other soluble nitrogenous compounds were involved. When the ration was a mixture of wheaten hay and lucerne hay, the amount of nitrogen reaching the abomasum was of the order of 60 per cent of the quantity fed.

With the diet of wheaten hay and straw, on the other hand, it appears that more nitrogen reached the abomasum than was present in the fodder. A similar result has been obtained with other low-nitrogen rations of wheaten hay. If the ratio is significantly higher in the abomasum than in the fodder throughout the day the phenomenon may prove to be due to additions of nitrogen to the stomach compartments from the saliva, the blood or the gastric juice. Such additions might be expected to be revealed on feeding low-nitrogen fodders which yield only small amounts of ammonia in the rumen.

Throughout these experiments the ratios have also been determined in the rumen and omasum. The value in the omasum of each sheep was substantially the same as that in the abomasum. So also was the value in the rumen for the greater part of the day; but on diets such as lucerne hay, higher ratios reflected the income of fresh fodder for a short time after feeding.

We consider that extension of this approach may be useful in helping to elucidate some of the many factors which may influence protein digestion in the rumen. For example, we have found that when starch is added to the lucerne ration, the nitrogen–lignin ratio in the abomasum may be raised. Precise measurements of such effects are needed.

We obtained the samples of abomasal contents from slaughtered animals in order to avoid sampling errors as far as possible. It would no doubt be more satisfactory if animals with fistulæ could be employed so that the individual samples for any one feeding cycle would be derived from the same animal.

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Evidence of a Neuromuscular Block in Tick Paralysis

Tick paralysis, as reviewed by Abbott[1], is a disease affecting man, cattle, sheep and dogs in many parts of the world. Here, in the Pacific north-west, the causative tick is *Dermacentor andersoni* Stiles. The symptoms are characterized by an ascending flaccid paralysis progressing ultimately to bulbar involvement and death due to respiratory failure. It begins after the female tick has been feeding for some days (usually 4–7) and is reversible on the removal of the tick.

The site of the block producing the paralysis was not known. We believe that the following evidence indicates that it is in the myoneural junction.

In Australia experimental work by Ross[2] involving the intrathecal injection of ground-up tick salivary glands seemed to indicate the spinal cord as the possible site of the paralytic process. However, this work has not been confirmed, and there is presumptive clinical evidence against the spinal cord as the site. First, there are no signs of meningeal irritation in the clinical disease and, secondly, in reported analyses of the cerebrospinal fluid not one showed abnormality that we feel could be attributed to tick paralysis.

In May 1954, one of us (Rose, unpublished data) obtained a response by galvanic stimulation of the thigh muscles of a child aged three who was at the time totally paralysed except for the diaphragm. This indicated that the block was situated somewhere in the nerve-muscle mechanism proximal to the muscle fibres.

In 1955 the following studies were made on laboratory animals.

(1) A 40-lb. mongrel dog was infested with thirty pairs of ticks on April 20 and 22. By April 26 paralysis was almost total except for the bulbar region. After a local skin infiltration of procaine, the fibular nerve was exposed. On electrical stimulation there was no muscle response; but the dog whined. This indicated that there was interruption of the motor but not of the sensory path. This was considered a satisfactory preparation; but general anæsthesia under intravenous sodium nembutal seemed preferable.

(2) A 35-lb. lamb was infested with fifty pairs of ticks on April 27. On the evening of May 4 it was in a state of almost total sub-bulbar paralysis; it was able to struggle slightly. Knee and ankle jerks were absent. It was anæsthetized by an intravenous (jugular) injection of 4 c.c. of sodium nembutal. The fibular nerve was again exposed, and electrically stimulated at one-second intervals. No response was obtained at voltages below 150. There was a weak response to voltages of 150 and higher (Fig. 1,*A*).

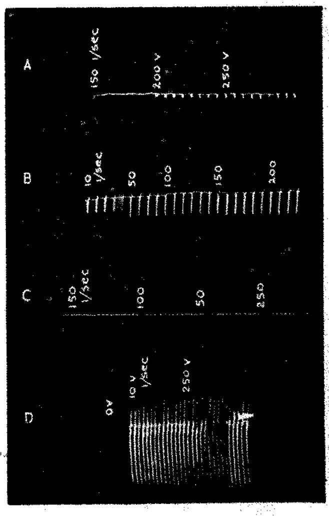

Fig. 1. Kymograph recordings of muscle response to stimulation at one-second intervals of the fibular nerve in paralysed and normal lamb and dog. *A*, Response in partially paralysed lamb at 150, 200 and 250 volts; *B* response in recovered lamb at 10, 50, 100, 150 and 200 volts; *C* response in severely paralysed dog at 150, 100, 50 and 250 volts; *D*, response in recovered dog at 0, 10 and 250 volts

All the ticks were then removed from the lamb. It was normal on May 5, when knee and ankle jerks were present and brisk. An identical anæsthetic was then given and the fibular nerve exposed. The tarsal extensor muscles responded strongly to currents as low as 10 volts (Fig. 1,*B*).

(3) A 30-lb. dog was infested with sixty pairs of ticks on May 9. Sub-bulbar paralysis developed by the evening of May 15. Knee and ankle jerks were absent. After anæsthesia with 6 c.c. of intravenous nembutal the fibular nerve was exposed. Stimulation of the nerve with voltages of up to 250 gave no response other than a minute general twitch of the leg (Fig. 1,*C*).

The control test was performed on the same dog, totally recovered, on the evening of May 17. Identical anæsthesia and preparation were used. Full muscle responses to all voltages down to ten were obtained (Fig. 1,*D*).

Although these experiments were limited in number because of the extreme difficulty of paralysing the experimental animals, we consider that they demonstrate the site of the block producing the paralysis as peripheral to the site of stimulation. This, with the previous evidence that muscle paralysed by a tick is capable of response by contraction to direct stimulation, indicates that the site of the block is at the myoneural junction.

A substance producing a neuromuscular block in a manner similar to that caused by curare is apparently involved. Such an interference with a dynamic biochemical process is consistent with the rapid recovery following removal of the tick. To-day many drugs with this action are being investigated and it may be possible by further experimentation to find more specific similarities between these and the substance produced by the tick. We have not found the paralysis produced by the tick to be lessened by curare antagonists such as prostigmine, and the mode of action, though similar, is probably not identical with that of curare.

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Effect of Environmental Temperatures on the Development of Thermoregulatory Mechanisms in Infant Rats

ON the eighteenth day after birth, rats considerably increase their oxygen consumption on exposure to cold[1,2], and their rectal temperature falls at a much slower rate than in younger rats[3]. Hahn, Křeček and Křečková[2], using the method described by Adolph[4], concluded that both chemical and physical thermoregulatory mechanisms develop rapidly between the fourteenth and eighteenth day after birth. Křeček and Martínek[5] demonstrated that in rats raised at 34° C. from birth, thermoregulation develops more slowly, so that on the eighteenth day after birth their rectal temperature falls very rapidly on exposure to cold.

In rats raised at a temperature of 0° C. thermoregulatory mechanisms develop at the same rate as in rats raised at room temperature (20° C.). Their oxygen consumption, however, is increased when measured at 29·5° C. surrounding temperature.

The present communication describes an attempt which has been made to counteract the slowing down of the development of thermoregulatory mechanisms at a high environmental temperature by short exposures to cold.

Rats raised at 34° C. environmental temperature from birth were exposed daily for one hour to 0° C. from the first day after birth up to the eighteenth day. On that day their reaction to cold exposure was studied using the method described by Adolph[4]. Rats were placed in a Bargeton–Krumm-Heller respirometer[6] and their rectal temperature was measured together with their oxygen consumption The thermocouple for measuring rectal temperatures was fixed to the tail and hind legs with adhesive tape. Oxygen consumption and rectal temperature were measured at 29·5° C. for half an hour. Then the surrounding temperature was rapidly lowered to 10° C. and both oxygen consumption and rectal temperature were further measured until the rectal temperature had dropped to 15° C. The time during which rectal temperature dropped to 15° C. after exposure of rats to 10° C. and the oxygen consumption at an environmental temperature of 29·5° C. were taken as indicators. All rats were tested on the eighteenth day after birth.

The rectal temperature of eighteen-day old rats raised at 34° C. and exposed daily for one hour to 0° C. fell at the same rate as in animals raised at room temperature and at a significantly slower rate than in animals raised at 34° C. without interruption (Table 1).

Rats raised at 34° C. and exposed to 0° C. for one hour daily from the fourteenth day up to the eighteenth day, that is, four times altogether, reacted in the same way. Their rectal temperature during the experiment carried out on the eighteenth day after birth dropped at a considerably slower rate than in rats permanently raised at 34° C. The same result was obtained with rats aged eighteen days exposed to 20° C. for one hour daily from birth and otherwise raised at 34° C. (Table 1).

Eighteen-day old rats raised at room temperature up to the fourteenth day after birth and then placed permanently in an environment of 34° C. up to the eighteenth day reacted in the same way as animals raised permanently at 34° C. from birth, that is, their rectal temperature dropped rapidly on exposure to 10° C. during the experimental procedure.

Oxygen consumption measured at a temperature of 29·5° C. during the experiment was significantly higher in rats raised at 0° C. than in all other groups (Table 1).

The large variations in the rate of decrease of rectal temperature are believed to be due to immobilization of the rats during the experimental procedure. The same variations have been observed by other authors[7]. Results indicate that the period between the fourteenth and eighteenth day after birth is decisive for the further development of thermoregulatory mechanisms. This is in agreement with other work[2,8].

It appears that thermoregulatory reactions to cold exposure in rats develop post-natally in close dependence on environmental conditions. The development of adaptation to a certain environmental temperature (0° C., 34° C.) is not identical with the development of thermoregulatory reactions. This is evident from the fact that one hour's exposure to the cold (0° C.) daily suffices to normalize thermoregulatory reactions in eighteen-day old rats raised

Table 1. THE TIME DURING WHICH THE RECTAL TEMPERATURE FALLS TO 15° C. AFTER EXPOSURE OF EIGHTEEN-DAY OLD RATS TO AN ENVIRONMENTAL TEMPERATURE OF 10° C. AND THE OXYGEN CONSUMPTION OF THE SAME RATS AT 29·5° C. ENVIRONMENTAL TEMPERATURE BEFORE EXPOSURE TO COLD

	A	*B**	*C*	*D*	*E*	*F**	*G*
(1) Time (min.)	250 ± 46·5	270 ± 47·0	248 ± 47·8	154 ± 8·3	189 ± 34·2	88 ± 3·8	85 ± 17·7
(2) Oxygen consumption/ml./100 gm./10 min.	48 ± 2·05	64 ± 3·19	44 ± 4·14	38 ± 3·58	47 ± 2·6	46 ± 4·44	38 ± 1·1
No. of animals	8	5	5	5	5	5	5

A, Rats raised at room temperature; *B*, rats raised at 0° C.; *C*, rats raised at 34° C. and exposed to 0° C. for an hour daily for eighteen days; *D*, rats raised at 34° C. and exposed to 0° C. for one hour daily from the fourteenth up to the eighteenth day; *E*, rats raised at 34° C. and exposed to 20° C. for one hour daily for eighteen days; *F*, rats raised at 34° C.; *G*, rats raised at room temperature up to the fourteenth day and at 34° C. from the fourteenth to the eighteenth day.

Differences between *F* and all other groups excepting *G* are significant to $p < 0{\cdot}01$. The same holds for the differences between *G* and groups *A*, *B*, *C*, *D*. *p* for group *G* as compared with group $E < 0{\cdot}05$. This applies to row 1. In row 2 *B* is significantly higher than in all other groups ($p < 0{\cdot}01$) and *G* is significantly lower than *F*, *C* and *E* ($p < 0{\cdot}01$ and $0{\cdot}02$).

* Figures taken from ref. 5.

at 34° C. without raising their oxygen consumption at 29·5° C.

Details of this work will be published elsewhere[9].

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Correlation of Total Body Potassium with Body-Water

THE total potassium content of the human body[1] is of considerable interest from the point of view of physiology and in connexion with the clinical study of certain muscular disorders. Recently it has acquired additional interest because the radioactivity of naturally occurring potassium-40 in the body constitutes the principal 'background' in some 4π-counters used for the measurement of the gamma contamination of human subjects[2–5]. While it has been known for some time that the total potassium varies considerably around a value of 150 gm. in the average adult male[1,6] and while it has been suspected that fat/muscle ratio is the principal determining factor, the correlation has not been clearly demonstrated.

Using the Los Alamos human counter[2], which permits the determination of total body gamma activity to a precision of 5 per cent in less than 5 min., we have measured more than a hundred subjects with body-weights ranging from 40 to 240 lb. The body-water contents of a selected group of these subjects have been determined by the isotope dilution method using tritium tracer[7,8]. The tritium assay of urine specimens was determined by liquid scintillation counting[9,10]. Fat-free weight was estimated from the body-water using the well-known approximation that body-water is 72 per cent of lean body-weight[11,12].

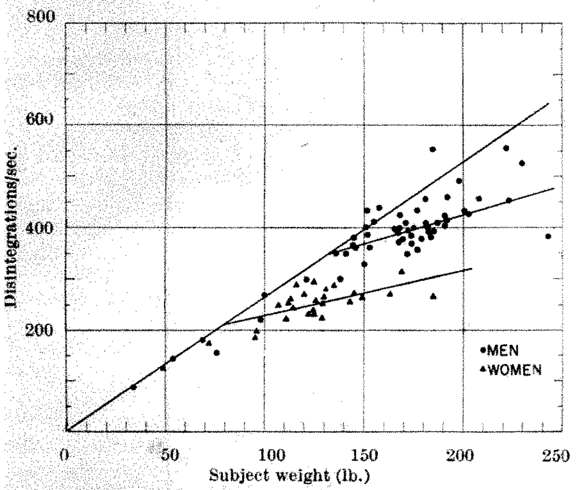

Fig. 1. Natural gamma activity of human subjects

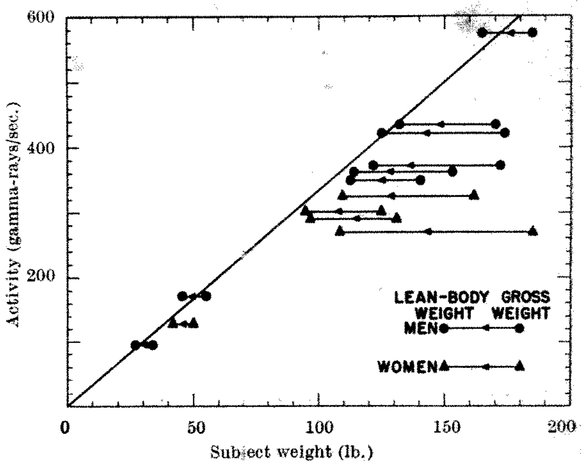

Fig. 2. Natural gamma activity of human subjects in relation to gross and 'fat-free' body-weight

Fig. 1 shows the gamma activity of eighty-one subjects plotted against gross body-weight. The pronounced scatter of the points to the right of a limiting line is clearly evident, as is also the definite separation between male and female subjects. These results indicate that the common practice of expressing total potassium as per cent of gross body-weight[1] will result in a considerable range of values depending on the sex, age, weight, body type and physical activity of the group chosen for measurement.

Fig. 2 shows the results from thirteen selected subjects for which the potassium-40 activity is plotted against estimated fat-free weight as well as against gross weight. (Body-water was not determined on the children; their fat was estimated to be not more than 15 per cent of body-weight.) While some scatter remains, it is obvious that points widely divergent on the original graph are brought close to a common line. This indicates that the amount of fat is the principal factor causing variation in apparent potassium content of the body. (The study of the residual variation is being continued.) The highest natural radioactivity observed is that of a mountain climber (George I. Bell) recently returned from the 1955 Himalayan expedition which attempted Lhotse. At the time of measurement this subject was still below his normal weight as a result of the strenuous activities of the preceding summer.

The determination of body-water should be a valuable adjunct to whole-body counters for normalizing the data to 'fat-free' weight. This will greatly facilitate the evaluation of deviations from the norm resulting from gamma-emitting contaminants or from muscular abnormalities.

The general problem of the *in vivo* determination of gross body composition is an extremely complex one, and the difficulties are clearly defined in the excellent review by Keys and Brozek[11]. The ability of the human counter to determine rapidly and accurately total body potassium, a quantity related to muscle mass, should be of considerable value in the study of this problem.

A more detailed account of these experiments will be published elsewhere. This work was done under the auspices of the Atomic Energy Commission.

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An Inactive Thyroid Gland in *Carassius auratus*

Carassius auratus has been subjected to prolonged artificial selection which has established several unusual features. Among these is the inactivity of the thyroid gland. This gland consists of follicles scattered along the anterior region of the ventral aorta; the follicles are typically inactive, with squamous epithelium and abundant colloid.

The activity of the teleostean gland increases with rising environmental temperature, particularly when nearing the upper limit of the viable range, and is indicated by structural change, which is emphasized by treatment with anti-thyroid drugs. Reaction time of the thyroids of *Phoxinus phoxinus* and *Lebistes reticulatus* varies between two and fourteen days according to the season[1,2]. *Carassius auratus* has a temperature-range of 0–41° C.[3]. Exposure to high environmental temperatures (40° C. for one week; 35° C. for three weeks; 30° C. for five weeks; 25° C. for eight weeks) has no effect on the thyroid structure, and it is not affected by exposure to a low temperature. Immersion in anti-thyroid drugs—0·1 per cent thiourea at 30° C. for five weeks; 0·005 per cent *p*-amino-benzoic acid at 25° C. for three weeks; 0·001 per cent potassium thiocyanate at 25° C. for five weeks—is also ineffective. When the thiocyanate treatment is extended to eight weeks, some glands show marked histological change with increased epithelial height and a reduced amount of colloid, although some remain inactive. Higher concentrations of the drugs prove fatal. The experiments were repeated at intervals throughout the year, so the lack of response cannot be due to a period of seasonal inactivity. Compared with the thyroid of *Phoxinus phoxinus* and *Lebistes reticulatus*, the gland of *Carassius auratus* is unusually inactive.

It has been suggested that the increased thyroid activity at high temperatures is responsible for the limiting of the temperature-range by the upper lethal temperature. It seems probable that the wide temperature-range of *Carassius* is associated with the presence of an inactive thyroid gland.

The inability of the gland to concentrate radio-iodine confirms that it is functionally inactive[4]. The thyroid is reported to be extremely sensitive to thyrotropin[5], which suggests that the latter is normally absent.

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Biting Times of Parous and Nulliparous *Simulium damnosum*

During dissections of the biting fly *Simulium damnosum* in the Sudan in July 1948[1] it was found that the proportion infected with developing *Onchocerca* worms was nearly twice as high in flies caught before 1 p.m. as in those caught later in the day. Many *S. damnosum* were dissected at Farangbaia in the Tonkolili valley, Sierra Leone, in October and November 1955, and it was noticed that, on some days at least, more flies with a plentiful fat-body (indicating that they were nulliparous) were present in afternoon than in morning catches. It thus appeared that nulliparous flies tend to bite largely in the afternoon; but no exact figures were obtained because the amount of fat-body is very variable and does not always clearly differentiate parous and nulliparous flies.

It was found, however, that the appearance of the ovaries and their ducts, when examined in normal saline, would nearly always serve to distinguish the two conditions. In nulliparous flies the oocytes are closely packed in the ovaries and the oviducts are narrow. In parous flies the oocytes, when small (as they nearly always are in caught flies because *S. damnosum* seldom bites when its eggs are developing), tend to be loosely arranged and the oviducts rather broad and wrinkled. The differences in the oviducts cannot be measured, unlike those in anopheline mosquitoes which have a definite ampulla[2]; but they can generally be quickly detected after a little practice. In the few doubtful cases the condition of the fly can be ascertained by examining other features such as the presence or absence of a meconium and the state of the fat-body.

The ovaries of flies caught biting at Farangbaia between December 14 and 29 were next examined. Out of 179 caught in the mornings 60·9 per cent were found to be parous and 12·3 per cent to contain developing *Onchocerca*. Among 202 flies caught in the afternoons 25·2 per cent were parous and 5·9 per cent contained developing *Onchocerca*.

Evidently a person bitten by the same number of flies in the morning and the afternoon would be more likely to be infected with *Onchocerca* in the former, at least in certain localities at certain seasons. When flies are required for dissection to ascertain the infection-rate it is clearly important to choose a suitable time of day for catching. It is desirable to avoid wasting time in dissecting a lot of nulliparous flies which are unlikely to be infected, and to catch at the same time in different seasons. In the dry season flies may become scarce and difficult to find except in the afternoon. Dissection of flies caught at this time can give a false impression of a seasonal drop in the infection-rate.

It will be interesting to know how general is the tendency of nulliparous flies to bite largely in the afternoon and what is its cause. Perhaps this is linked with the effect, or apparent effect, of physiological condition on the biting times of one or more species of culicine mosquitoes[3-5], biting midges[6] and *Chrysops*[4].

The observations at Farangbaia were part of an entomological survey carried out for the Sierra Leone Development Co., Ltd., and will be reported in detail elsewhere.

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Origin of the Common Wild Oat, *Avena fatua* L.

It is generally considered that differentiation of the hexaploid species of oats has resulted primarily from structural changes and gene mutations involving a small group of chromosomes more or less common to all the species. The different species hybridize readily, giving highly fertile progenies, which indicates considerable homology of the chromosomes of any one species with the others. Indeed, it would be difficult to discover a closer chromosome affinity in any group of polyploids than that indicated by Nishiyama[1] for the four hexaploid oat species *Avena byzantina, A. fatua, A. sterilis* and *A. sativa*. With complete affinity between any two species represented as 1·000 and no affinity as 0·000, values obtained by Nishiyama from crosses involving the above-mentioned species ranged from 0·983 to 0·998. More recently, however, cytological studies conducted by Joshi and Howard[2] show that meiotic irregularities are found in fairly high frequencies in hybrids with *A. byzantina* as one parent, which implies that at least some of the corresponding chromosomes of the various species are not completely homologous.

According to early literature, and popular belief, *Avena fatua* is considered to be the wild species which has given rise to our cultivated oat *Avena sativa*, and, similarly, *A. sterilis* to the cultivated red oat *A. byzantina*[3,4]. Recently, however, Coffman[5] has advanced the theory that *A. sterilis* is the more likely progenitor of all the hexaploid species, including *A. fatua*, the nature of origin of which he postulates to be on a parallel with that of the frequently appearing fatuoids in the cultivated species. It is presumed to have arisen early in the line of descent from the wild *A. sterilis* and hence possesses more of the so-called 'wild' characters than do fatuoids appearing in cultivated varieties.

Although the occurrence of fatuoids or 'false wild oats' has been noted frequently in the cultivated species and various hypotheses proposed concerning their mode of origin, we are not aware of any reports of their occurrence in *A. sterilis*. As the appearance of such aberrant types in this species would have a direct bearing on Coffman's theory of origin of *A. fatua*, it is thought that the observations reported below will be of interest.

In an experiment designed to study the effects of irradiation on mutation-rates in wild and cultivated species of oats, two lots of seed of *A. sterilis maxima* containing 10 per cent moisture were exposed to X-ray dosages of 20,000 and 30,000 r. units respectively by the senior author when on a visit to the Iowa State College, Iowa, in 1954. The X_1 generation plants produced from the treated seed were harvested separately, and in 1955 forty plants were grown from each for detailed observations of grain characteristics on a single plant basis in the X_2 generation.

Examination of these plants revealed the presence of a number of mutations in both the 20,000-r. and 30,000-r. treated groups, whereas unirradiated seed from the same original stock and grown under the same conditions gave no aberrant forms. The two predominant mutations were changes in grain colour and mode of floret disjunction, and it is with the latter that the present communication is concerned.

The panicle of normal *Avena sterilis maxima* is equilateral with long, drooping branches bearing very few but extremely large spikelets. The spikelets themselves generally comprise 3–5 fully developed florets with only the lowest and second bearing strongly twisted geniculate awns. Separation of the spikelet from the peduncle is by articulation, a well-defined sucker-mouth at the base of the first grain fitting over the top of the callus pad on the peduncle. The upper florets have no such articulation, and in consequence remain fully attached to the first even after shedding. Forcible separation results in irregular fracture of the rachilla at or near its base. A thick tuft of hairs surrounds the sucker of the basal grain of each spikelet and hairs are also present on the rachilla of the second floret.

Out of a total of 227 lines of irradiated material examined, the aberrant type of floret disjunction was observed in 12 lines, in each of which from one to seven such plants occurred. Although the mutant plants were not observed in detail in the field, it was noted in some cases that they were somewhat lacking in vigour and were erect instead of having the characteristic ascending habit of *A. sterilis maxima*. The panicles were smaller with less than ten spikelets, and the overall dimensions of the spikelet parts were 70–80 per cent of the normal.

The most important and characteristic feature of the mutants was in the morphology of the spikelets

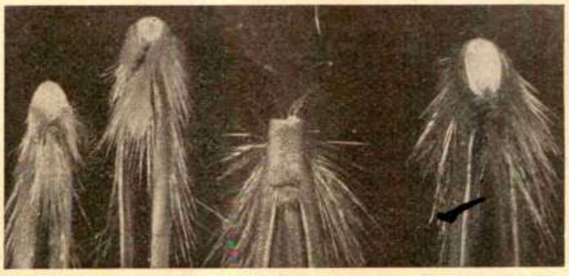

Fig. 1. Bases of first and second grains of *A. sterilis maxima* (left) and of first and second grains of mutant (right) showing difference in mode of floret disjunction

themselves. Instead of the usual number there were up to nine florets with, in some cases, as many as the first six having well-filled grain, and all bearing a geniculate awn on the outer pale except the uppermost one or two which bore only a small straight awn. Each floret was articulated with its neighbour by means of a well-developed and readily separated sucker and callus pad (Fig. 1) exactly similar to that found at the base of the first floret in the wild stock. Hairiness, also, was markedly different in these mutants, a tuft of hairs being present on the base of every floret and on each rachilla segment.

The lines producing these fatuoids could be divided into two groups, namely, those in which the mutants were completely sterile and those in which the fertility was as high as in normal *A. sterilis maxima*. No fatuoids of intermediate fertility were found, neither were sterile and fertile forms present in the same line. Differences between the two groups were slight except for a further reduction in vigour and slightly earlier panicle exsertion in the sterile fatuoids.

Apart from the rather high number of florets formed on each spikelet, these fertile fatuoids closely resemble the true *Avena fatua*, and it is suggested that this latter species could well have arisen through a mutation of this type from *Avena sterilis* as indicated by Coffman. This theory is not in conflict with the evidence from phytogeography, since most authors agree that Asia Minor is the centre of origin of oats, and both Vavilov[6] and Malzew[7] state that *A. fatua* and *A. sterilis* are found growing together in that region.

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Spores of the Large Free-living *Amoebae*

IN the course of some experiments on *Amoebae* suggested to me by Dr. P. Couillard of Brussels, I have discovered an easy method of procuring clean spores, newly hatching and developing specimens of the large free-living *Amoebae* (*proteus, lescherae, discoides, kerrii*). These stages are difficult to separate from ordinary stock cultures of the *Amoebae*. Hence, I am frequently asked for spores by teachers whose pupils are interested in the life-history of the large *Amoebae*.

The method is as follows :

Use a rather old culture of mixed ages in which fission division is going on in the full-grown adults. Having removed as much as possible of the 'debris', pipette the *Amoebae* into a vessel containing a dilute solution of inorganic salts (potassium chloride, 0·006 gm., magnesium sulphate, 0·002 gm., double super phosphate, 0·007 gm., 1,000 ml. distilled water). (I use Glasgow tap water, which is very soft, instead of distilled water.)

The change in pH very quickly kills off the ciliates flagellates and the adult *Amoebae* (often in a beautifully expanded condition).

Allow the whole to stand in a warm place for about a week, then examine the bottom of the Petri dish with a No. 7 water immersion lens. Unhatched and hatching spores, as well as young creeping *Amoebae*, will be seen, the latter feeding on the bacteria produced by the decomposition thus set up.

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Isotopic Exchange of Oxygen between Free Hydroxyl Radicals and Water

WE have investigated the exchange reaction[1-4]

$$^{16}OH + H_2{}^{18}O \rightarrow H_2{}^{16}O + {}^{18}OH$$

using potassium ozonide KO_3 [5] as a new source of free hydroxyl radicals[6]. Potassium ozonide reacts instantaneously with water enriched in $H_2{}^{18}O$, evolving oxygen according to the reactions :

$$KO_3 + H_2O^* \rightarrow KO^*H + OH + O_2 \quad (1)$$

$$OH + OH \rightarrow H_2O + \tfrac{1}{2}O_2 \quad (2)$$

$$\text{(and partly } OH + OH \rightarrow H_2O_2\text{)}$$

$$OH + H_2O^* \rightarrow OH^* + H_2O \quad (3)$$

$$OH^* + OH^* \rightarrow H_2O^* + \tfrac{1}{2}O_2{}^* \quad (4)$$

The ozonide preparation was of the following composition : KO_3, 89·3 per cent ; KOH, 8·4 per cent ; H_2O (as $KOH.H_2O$), 2·3 per cent. The experiments, in which water containing 1·38 per cent $H_2{}^{18}O$ was used, were carried out in an apparatus equipped with a magnetic stirrer and the means for introducing the potassium ozonide powder in small portions in an atmosphere of nitrogen. The process of adding the ozonide in all lasted 3–5 min. The degree of enrichment of the evolved oxygen was determined mass-spectrometrically, the error in the oxygen-18 content being less than ± 2 per cent of the measured quantity.

The degree of exchange was referred to the total amount of hydroxyl radicals less the amount utilized in the formation of the hydrogen peroxide, the latter being determined by titration with $0 \cdot 1\,N$ potassium permanganate (molecular oxygen and hydrogen peroxide are incapable of rapid exchange with water[4]). Not more than 15 per cent of the hydroxyl radicals were consumed in the formation of the hydrogen peroxide. Table 1 shows the isotopic composition of the oxygen evolved and the degree of exchange.

It can be seen from the table that at 20° and 0° C. the hydroxyl radicals exchange with water to the amount of about 10 per cent. The degree of exchange does not depend upon the pH of the solution ; this confirms that the exchange actually occurs between the hydroxyl radicals and the water, and not between the former and hydroxyl ions.

Considering the relatively low degree of exchange, it must be borne in mind that this reaction competes with the extremely rapid reactions of disproportionation and dimerization of the hydroxyl radicals.

Table 1. ISOTOPIC EXCHANGE OF FREE HYDROXYL RADICALS WITH WATER CONTAINING 1·38 PER CENT $H_2{}^{18}O$

Exp.	Weight of KO_2 sample (mgm.)	Initial solution	pH of final solution	Amount of OH formed (in millimoles)	Amount of oxygen evolved (cm.^{3}) (0·760)	Content of oxygen-18 in the evolved oxygen (atm. per cent)	Degree of isotopic exchange (per cent)
Temperature + 20° C.							
1	217·3	10 cm.^{3} H_2O*	13·4	2·23	62·4	0·226	8·9
2	191·3	10 cm.^{3} H_2O*	13·3	1·96	56·3	0·226	9·5
6	157·0	35 cm.^{3} H_2O*	12·7	1·61	44·3	0·229	11·0
3	161·8	10 cm.^{3} H_2O* + 0·17 gm. H_2SO_4 (0·35 *N* H_2SO_4)	0·8	1·66	48·0	0·227	9·8
9	163·5	35 cm.^{3} H_2O* + 0·60 gm. H_2SO_4 (0·35 *N* H_2SO_4)	0·5	1·67	46·1	0·226	10·3
							average 9·9 ± 1
12†	134·6	35 cm.^{3} H_2O	12·7	1·54	41·9	0·204	
Temperature 0° C.							
7	179·6	35 cm.^{3} H_2O*	12·8	1·84	50·0	0·229	10·5
8	155·0	35 cm.^{3} H_2O*	12·7	1·59	43·5	0·227	9·8
10	171·1	35 cm.^{3} H_2O* + 0·60 gm. H_2SO_4 (0·35 *N* H_2SO_4)	0·5	1·75	47·6	0·231	12·8
11	165·1	35 cm.^{3} H_2O* + 0·60 gm. H_2SO_4 (0·35 *N* H_2SO_4)	0·5	1·69	45·3	0·226	10·6
							average 10·9 ± 1

† Exp. 12 served as control, showing that on reaction of potassium ozonide with twice-distilled water the oxygen evolved is of normal isotopic composition.

On the basis of experiments on the decomposition of hydrogen peroxide revealing the absence of rapid exchange between hydroxyl and water, it was concluded[3] that diffusion of this radical during the radiolysis of water takes place according to the normal rather than a Grotthus-type mechanism. Our experiments, on the other hand, indicate a very rapid exchange between the hydroxyl radicals and water. Evidence is thus presented for a Grotthus-type interaction of the free hydroxyl radicals with water.

A full account of this work will be published in due course.

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Thermal and Photochemical Processes in Polystyrene in the Glassy State

RECENTLY, nylon films irradiated with ultra-violet light[1] have been reported to show a post-effect similar in behaviour to one reported earlier in polystyrene films[2]. It is also suggested that the interpretation advanced for the effect in nylon may be applicable to other polymers. In this note, evidence for different mechanisms in polystyrene is discussed. In nylon, the band that develops during both the irradiation and the post-irradiation periods is centred around 2900 A., while in polystyrene the post-irradiation band is centred around 3400 A. The irradiation spectra for the latter indicate no specific absorption in the region investigated but merely a general increase in absorption. The spectra are shown in Fig. 1, where it is seen that the absorption observed after the post-irradiation period is quite different from that observed immediately after the irradiation period.

A more detailed study of the post-irradiation effecs at 340 mμ shows that this increase of absorption it apparently the result of two independent first-order processes occurring simultaneously. Thus, if the absorption due to this thermal process results from the products of two apparent first-order reactions the relation :

$$[R] = \frac{A_\infty - A}{A_\infty - A_0} = \alpha e^{-k_s t} + \beta e^{-k_f t}$$

should hold, where α and β are the fractions of the total final absorption produced by the slow and fast reactions, respectively, A is the absorption at time t, A_0 at zero time, and A_∞ is the limiting adsorption. In Fig. 2 the data at 70° C. are shown. The curved line for the overall process is seen to be the sum of the two straight lines on the semi-log plot. Results

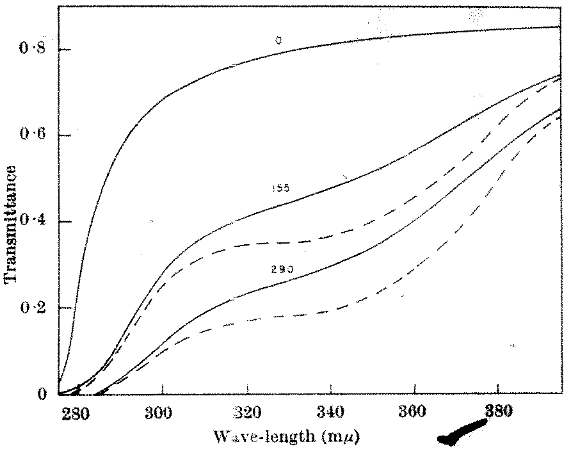

Fig. 1. Effect of radiant energy and subsequent storage on the ultra-violet transmittance of pure polystyrene film. Solid line, exposure for indicated number of hours; dashed line, storage for 290 hr. following indicated exposure time

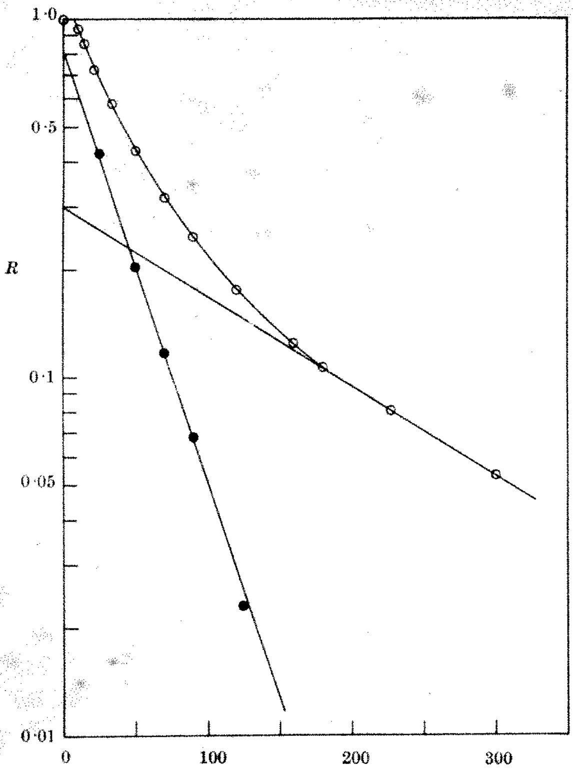

Fig. 2. Semi-log plot of the ratio [R], $(A_\infty - A)/(A_\infty - A_0)$, versus time for the post-irradiation period using polystyrene film at 70° C.

obtained at several temperatures lead to the following expressions for the rate constants : $k_s = 10^{11} e^{-23,500/RT}$ sec.$^{-1}$; and $k_f = 10^{7} e^{-16,400/RT}$ sec.$^{-1}$.

The activation energies are not unreasonable for the decomposition of hydroperoxides or for *cis-trans* isomerization processes.

The work of Lutz and Jordan[3] on the photo *trans-cis* and the thermal *cis-trans* isomerization of benzalacetophenone, a structure which may occur in oxidized polystyrene, led to an investigation of this substance in polystyrene film. Preliminary work with this system indicates similar photo and thermal effects with a shift of the maximum absorbance of benzalacetophenone to longer wave-lengths in the solid state. The rate of the thermal *cis-trans* process is considerably slower than that for the post-irradiation reactions in polystyrene. However, it is known that paramagnetic substances catalyse *cis-trans* reactions, and such substances are undoubtedly present in a partially oxidized polystyrene film.

The work of Ford[1] with irradiated nylon films, in which he postulates a "progressive equilibrium" as the general mechanism for such reciprocal photo-thermal effects in polymers, may give a partial explanation for the observed effects in polystyrene. However, this mechanism is not sufficient to explain the difference in absorption-band shape observed in polystyrene as a result of the post-irradiation effect, nor does it explain the character of the post-irradiation reactions as described above. Also, the intensity of the absorption generated in polystyrene at 3400 A. as a result of exposure to radiant energy has been found in this work to be correlated directly with the intensity of absorption bands in the infra-red region ascribed to carbonyl groups[4].

The existence of peroxy radicals in irradiated polymers as suggested by Ford[1] is not entirely compatible with the observation that the activity of γ-irradiated polymethyl methacrylate for initiating polymerization at 29° C. is reduced by exposing the material to air[5]. Exposure to air, however, increases the activity for initiating polymerization at 70° C. These facts are interpreted to mean that exposure to air destroys immobilized free radicals with the formation of hydroperoxides[5].

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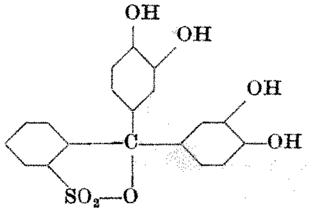
Pyrocatechol Violet as a Detection Reagent for Cations

FOR the purposes of rapid identification of unknown substances on paper chromatograms, both general reagents reacting with a great number of substances irrespective of their nature, and selective reagents allowing a closer characterization of the particular substance play an important part. The most common detection reagents used in paper chromatography and electrophoresis of inorganic cations, which include hydrogen sulphide, 8-hydroxyquinoline and alizarin, react with a large number of cations. Other commonly used reagents belong to the group of selective agents which react only with a definite and rather small number of substances. Most of these reagents react with elements of various valencies and give no indication on the charge of the cation. In the search for a suitable reagent for the detection of thorium on paper electropherograms[1] use has been made of the detection with pyrocatechol violet, which has recently proved successful as an indicator for complexometric titrations since it forms coloured complexes with some cations, especially Bi^{3+} and Th^{4+} [2]. Pyrocatechol violet is a catechol sulphophthalein with formula :



Further study has shown that the indicator can be used for a number of further cations, especially for metals of higher valencies. Best reaction was noted with tri- to hexa-valent metals, such as Al^{III}, Fe^{III}, Sb^{III}, Bi^{III}, Th^{IV}, Zr^{IV}, V^{V}, Cr^{VI}, Mo^{VI}, W^{VI}, which can be shown on the chromatogram down to 0·1 μgm. Some di- and tri-valent metals react conspicuously enough after approximately ten times greater quant-ties have been applied. Some higher-valent amphoteric elements with a prevalent non-metallic character, as, for example, arsenic, react only slightly. Monovalent metals do not react with pyrocatechol violet; of the divalent ones alkaline and rare earths and some further cations are also negative. When comparing the sensitivity of this detection reagent with other general reagents as, for example, hydrogen sulphide or alizarin, pyrocatechol violet has been shown to be more sensitive.

The best method of applying pyrocatechol violet (obtainable from Chemapol, Prague II, Czechoslovakia) on chromatograms or electropherograms is in a 0·05 per cent ethanolic solution by immersion. Reaction of individual cations is strongly dependent on *p*H. It is rather advantageous that the slightly acid reaction on paper is optimal since most solvent systems or electrolytes contain hydrochloric or nitric acid and the paper remains acid following the evaporation of the solvent. Under these conditions, blue or purple spots develop against the yellow background. In alkaline medium the colour of some spots takes a greenish hue against the blue background; at this *p*H some divalent cations (cobalt, nickel) can be detected which react only slightly in acid medium.

Thanks are due to Dr. Simon, of the Institute of Analytical Chemistry, Charles University, Prague, for a gift of some rarer compounds.

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Radio Observations of the Planet Venus at a Wave-length of 11 m.

SINCE my first communication on radio signals of 11-m. wave-length from Venus[1], further studies and observations have been made.

Fig. 1 is a record taken May 30, 1956, in which the interferometer lobe pattern due to Venus is very well defined near meridian transit and for an hour or so thereafter. Although better records have been obtained for a few hours, the May 30 record is significant because of the long duration of the Venus signals. Indications due to Venus are discernible from before 11 a.m. E.S.T., when Venus entered the main beam, until nearly 11 p.m. when the signals faded out after Venus set. The wavy line above the chart indicates the lobe pattern of the antenna with the slant lines below showing the positions of the minima. Note that the pattern is shown in rectangular co-ordinates while the actual record is on the more or less slanting co-ordinates of the recorder. The pattern was calculated and checked over much of its extent by the passage of Cygnus *A* through the lobe structure. The minima are not complete nulls since there is a slight unbalance between the two arrays of the interferometer. Ionospheric refraction and scintillation effects are pronounced at 11-m. wave-length. The former effect may be responsible for some variation in the observed positions of the minima, particularly at low angles of elevation. Refraction also presumably accounts for the lag in the time of radio fade-out after the visual setting, this effect being accentuated in the case of Venus because the planet set at an oblique angle with respect to the horizon.

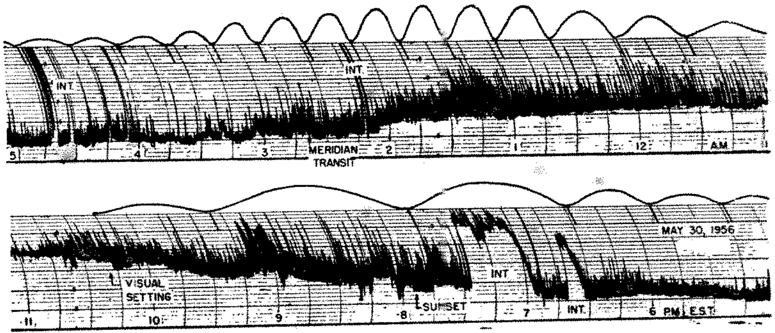

Fig. 1. Record of May 30, 1956, showing the radio noise from Venus obtained with the Ohio State University radio telescope at a wave-length of 11 m. for a period of about 12 hours

Several times on May 30 deflexions were obtained which were presumably interference of some sort (marked *INT*). Some bursts due to local atmospherics were also recorded about noon. However, the minimum in the Venus bursts is readily discernible at 12 noon in spite of this local interference by noting the trend in the shorter spikes in the region. It is to be noted that there are apparently two peaks of activity at about 1.15 and 2.40 p.m. and another pair at about 7.40 and 9.05 p.m., the second pair being 6 h. 25 m. after the first.

It is also to be noted that from 2 to 4 p.m. the base line of the record is elevated in accordance with the lobe pattern, indicating a sufficiently continuous noise to prevent the recorder with its one-quarter second time constant from returning to its normal level. The gradual downward trend in base-level from 11 a.m. to 5 p.m. and upward from 5 to 11 p.m. is due to the galactic background radiation. The small downward jumps in level are presumably due to receiver instabilities.

The Sun was relatively quiet on May 30, and this was the fourth consecutive day on which no important solar flares had been noted. On days of low solar and Venus activity, records are frequently obtained over the entire day which have a recorder pen line that is even narrower and smoother than on the May 30 record at 11 p.m.

Since May 30 further observations have been made, and based on a familiarity with the appearance of the Venus signals it has been possible to go back to the earlier records and recognize that impulsive radio signals from Venus were recorded very probably on at least one occasion in February and with considerable certainty over most of the month of March. No observations were taken during April. As reported earlier, the Venus signals seem to show a peak of intensity at about 90-min. intervals. The March records also show such a peak effect with shorter periods of approximately 20, 39 and 63 min. also in evidence. These periods of more intense activity are plotted as a function of time (E.S.T.) and day of the month in Fig. 2. These observations were made late in the day as the planet passed through the last lobes

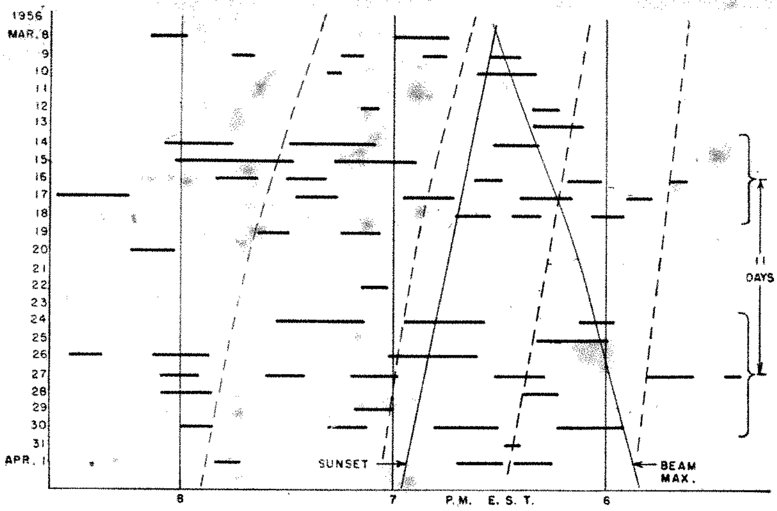

Fig. 2. Periods of peak intensity of radio signals from Venus at 11 m. during March 1956

of the interferometer pattern before setting. These lobes near the horizon are sufficiently wide and the periods of intense Venus signals sufficiently brief for the lobe pattern to have only a minor effect in separating the periods of peak intensity. The lobe minima are shown by dashed lines. The time of sunset and the time when the planet was in the maximum of the antenna primary pattern are also indicated.

The peak periods show a tendency to group around March 16 and 27. Whether this 11-day period is related to the rotation period of the planet is not definite. The peak periods in Fig. 2 also show some tendency to occur progressively earlier during the month. This apparent drift-rate amounts to 5–8 min. per day.

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[1] Kraus, J. D., *Nature*, [178, 33 (1956)].

Observations of Potential Evapo-Transpiration

The Nature Conservancy started at the end of 1955 to measure potential evapo-transpiration using the methods devised by C. W. Thornthwaite and his associates[1]. These studies are continuing; but since the first year's results for Achnagoichan in Rothiemurchus, within the Cairngorms Nature Reserve, are of special topical interest, it is worth referring to them briefly at this stage.

1955 was a particularly dry year; but it was surprising that the figures recorded for potential evapo-transpiration reached as high as 6·8 in. in July and 7·1 in. in August, while even the winter months showed in general more than 1 in. These figures are so much higher than would be given by any of the existing empirical formulæ that they are at once open to suspicion. Investigation of every conceivable source of error has so far yielded none which could account for the whole of the discrepancy, and one is driven to conclude that the formulæ fail to give sufficient weighting to one or more factors. It seems likely that wind was underweighted, and this is borne out by the readings in the present winter months, which were comparatively calm, being significantly less than for the previous winter, which was windy. The effects of wind may be augmented by a föhn effect in the intermontane basin of Mid-Strathspey.

A tentative water-budget, constructed from the evapo-transpiration figures and the rainfall, suggests that 1955 ended with a considerable water deficit, which may not be made up before the 1956 vegetative season is under way; this in spite of a very wet December. The calculations are to a large extent borne out by common observation of stream- and well-levels, wilting of plants, etc., where extremes for the century were recorded. It will be of theoretical, as well as practical, interest to see whether the prognostications of water shortage in 1956 are borne out.

On February 8 this year the Advisory Committee on Weather Control of the United States Senate, in a report to the President, put an end to the doubts about the effectiveness of rain-making by seeding clouds with silver iodide. Its demonstration that precipitation had been increased by amounts between 9 and 17 per cent in the Pacific States becomes well worth pondering in Great Britain, where we are liable to shortages such as experienced in 1955, and which we shall probably not be free from in 1956.

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Capillary Structure of Coals

A conference on the "Ultrafine Structure of Coals and Cokes"[1] was held in London in 1943; later, Bangham *et al.*[2] proposed a model for coals in which the capillary system was located between closely compacted spherical 'micelles'. More recently, in the laboratories of the British Coal Utilisation Research Association, an extensive investigation of the adsorptive properties of some British coals has been carried out, and has led to a new model of the physical structure of coal. This model may be described briefly as follows.

The ultrafine structure consists of an extensive system of cavities interconnected by a maze of narrow capillary-constrictions. These cavities appear to be flat in shape and are two or three times as wide (about 40–60 A.) as the constrictions. The interconnecting constrictions have a bi-modal distribution of widths, with modal values at 10–20 and 15–30 A. for the coals studied—which included an anthracite, a steam coal, a coking coal, and a free-burning coal. This ultrafine structure, which exhibits molecular sieve properties, accommodates about 95 per cent of the total internal surface area, but only about

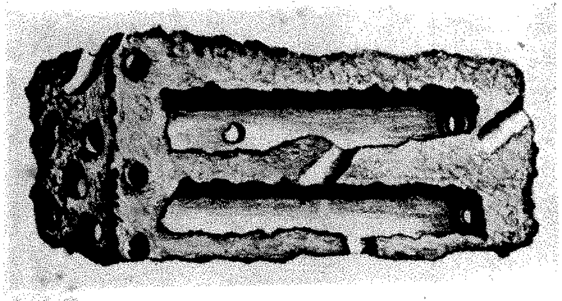

Fig. 1. Model of the constrictions and cavities in coal

50–60 per cent of the total internal free volume of a low rank coal and about 80 per cent of that of a high rank coal. The remainder of the internal free volume is associated with micro-cracks, which are orders of magnitude larger in size. Fig. 1 shows, in model form, this conception of coal structure; the section is taken to show two of the larger cavities (40–60 A. in width) that are reached by molecules permeating the maze of capillaries and constrictions.

The conclusions described above have been obtained from a study of heat of wetting, adsorption and apparent density measurements made with organic adsorbates or dilatometric fluids covering a wide range of molecular configuration, size and chemical properties. The interpretation of these results has required new theoretical treatments to be developed, details of which will be submitted for publication elsewhere.

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Heat-Flow from the Earth at Cambridge

In October 1952 work began on a deep boring at Cambridge under the joint sponsorship of the Geological Survey and the Geology Department of the University. Drilling operations ceased in March 1954 at a depth of 860 ft. 3 in., and the hole, lined with aluminium tubes to 588 ft., was left permanently open. The principal object of this undertaking was to gain further information on the underground geology of the Cambridge region, the Palæozoic succession being of particular interest[1,2]. To this end continuous coring was carried on below 176 ft. 6 in. A preliminary description of the borehole was published in 1953[3]. An outline of the lithology is given at the head of Fig. 1.

The construction of a permanent borehole near the Geophysics Laboratory at Cambridge and the availability of a column of rock from the sub-surface formations provided an opportunity of determining the rate of flow of heat from the Earth. The necessary thermal measurements were made during 1954–55 and the value $(1\cdot28\pm0\cdot12)\times10^{-6}$ cal. cm.$^{-2}$ sec.$^{-1}$ obtained.

Temperature measurements were made at levels within the borehole 25 ft. apart, the thermometric device used being a thermistor enclosed in a water-tight brass container. The high (negative) temperature coefficient of resistance of these elements makes them particularly suitable for the measurement of small temperature differences. Calibration was carried out against standardized mercury-in-glass thermometers in a series of thermostats and at the ice-point. A specially designed Wheatstone bridge was used for determining the resistance at each level. Twenty-one sets of readings were taken during the ten months following the completion of drilling, and an examination of the results with regard to the transient thermal phenomena associated with borings[4] indicates that the later readings should approximate closely to the equilibrium temperature distribution in the beds penetrated. The temperature-depth curve shown in the diagram has been constructed from values obtained at least six months after the completion of the boring. The ground temperature of 10·22° C. is the mean of daily measurements made in Cambridge between 1911 and 1940. This information was supplied by the Meteorological Office.

Thermal conductivity measurements were carried out in a divided bar apparatus of the type which has become standard in work on rock specimens[5,6]. Determinations were made at sixteen levels in the Palæozoic rocks, each measurement requiring three carefully prepared rock disks of different thicknesses. The results shown in Fig. 1 have been averaged over 25-ft. intervals to correspond with the temperature data. The large fluctuations of thermal conductivity over small vertical distances reflect the inhomogeneity of the Palæozoic rocks. The cores from this part of the borehole contain a wide variety of lithological types and no uniform section more than a few feet in length was recovered. Density and elastic wave velocity measurements were carried out on specimens from closely spaced levels and the results also exhibited a considerable scatter. Seismic refraction experiments and material obtained from other deep borings indicate that the Palæozoic basement of East Anglia is heterogeneous over a wide area[1,2].

The Mesozoic formations penetrated by the borehole consist predominantly of soft clays, and as the water content of the cores had changed considerably by the time the conductivity experiments were made it was decided to base the conductivity distribution in this section on measurements of external samples. The upper part of the Oxford Clay in East Anglia is particularly homogeneous, and a number of vertically oriented samples were collected in newly exposed quarry workings. The thermal conductivities of these specimens were determined immediately. The mean of four measurements was used for the appropriate part of the conductivity–depth curve shown in Fig. 1.

In calculating the heat-flow of $(1\cdot28\pm0\cdot12)\times10^{-6}$ cal. cm.$^{-2}$ sec.$^{-1}$ only the temperature and thermal conductivity data for the Palæozoic rocks were used. From the mean conductivity of the external samples and the illustrated temperature distribution, a heat-flow of $(1\cdot34\pm0\cdot02 \times 10^{-6}$ cal. cm.$^{-2}$ sec.$^{-1}$ is obtained for the Oxford Clay (179 ft.–338 ft. 2 in.). This is to be regarded as a check on the value quoted earlier.

In 1938 Bullard[7] made thermal measurements in a 100-ft. hole drilled in the Gault near the site of the present boring and deduced a heat-flow of only $0\cdot96\times10^{-6}$ cal. cm.$^{-2}$ sec.$^{-1}$, which is significantly smaller than the values given above for older formations. Between 138 ft. and 169 ft. 6 in. the

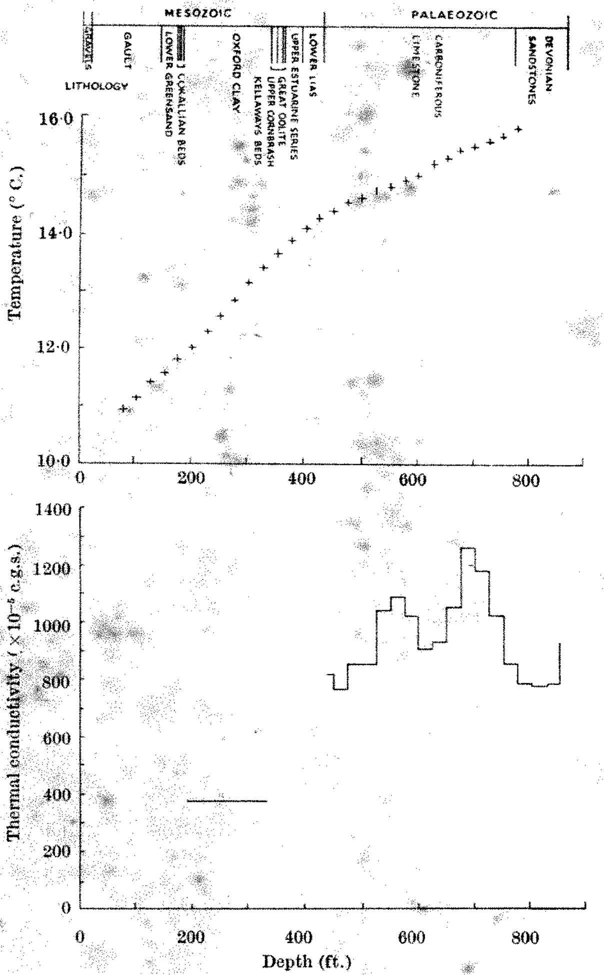

Fig. 1

Cambridge borehole passes through the Lower Greensand, which is the most important source of water supply in the area west of Cambridge. An investigation of water movements in this formation and their possible thermal effects shows that differences in heat-flow between the underlying and overlying beds of the order of magnitude found at Cambridge might be explained by this cause.

Heat-flow measurements near the Earth's surface must be corrected for such effects as climatic changes, igneous activity and rapid denudation in the recent geological past and for topographic inequalities near the point of measurement. Cambridge, however, is situated in a geologically stable area, and the only correction of any importance to be applied is for variations of ground temperature during the past million years or so. Although the Pleistocene glacial deposits of East Anglia have been intensively studied[8] the magnitude of this effect is rather uncertain; but calculations based on Birch's method[9] indicate that the measured heat-flux should be increased by about $0·20 \times 10^{-6}$ cal. cm.$^{-2}$ sec.$^{-1}$. This gives an equilibrium heat-flow of $1·48 \times 10^{-6}$ cal. cm.$^{-2}$ sec.$^{-1}$ at Cambridge.

Seventeen determinations of the geothermal flux have now been made in Britain in nine different areas, and the mean equilibrium value obtained from them is $1·57 \times 10^{-6}$ cal. cm.$^{-2}$ sec.$^{-1}$.

A detailed account of the geophysical work carried out in connexion with the Cambridge borehole is to be published in a forthcoming Bulletin of the Geological Survey.

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Electrical Resistivity of Meteorites

SOME attempts have recently been made to interpret the resistivity of the lower part of the Earth's mantle in terms of the semi-conducting properties of silicates[1]. Although it is realized that the mantle may contain a notable proportion of metal phase, as most stony meteorites do, it is generally assumed that the meta phase will occur as isolated grains which will not contribute appreciably to the conductivity.

We have recently measured the resistivity of several stony meteorites containing a variable amount of metal, using a 60-cycle a.c. bridge. Specimens were cut in the shape of square prisms with a cross-section of about 1·7 cm.^{2} and a length of not less than 2·5 cm (Measurements on shorter specimens gave extremely erratic results; for one specimen about 1·3 cm. long the conductivities in two directions at right angles varied by a factor of nearly 10^5.) Repeated measurements in the same direction on the same specimen agreed within 10 per cent; but measurements on different specimens cut from the same stone differed in some cases by nearly one order of magnitude. Results are given in Table 1.

These results show that the resistivity of these meteorites departs by several orders of magnitude from that of the silicate phase, which is about 10^9 moreover, the departure is not proportional to the metal-phase content. There is also some evidence obtained by cutting specimens in different orientations from the same stone, that the material is not isotropic with respect to its resistivity.

If one considers a simple model consisting of parallel silicate and metallic channels with resistivities

Table 1. RESISTIVITY AND AVERAGE METALLIC CROSS-SECTION (β OF STONY METEORITES

Meteorite	Metal phase (%)	Specimen length (cm.)	Resistivity (ohm cm.)	β
Kelley	0·1	2·55	5×10^8	
Arriba I* II III	4·26	2·50 2·55 8·50	$7·9 \times 10^5$ $1·2 \times 10^6$ $1·8 \times 10^5$	$1·3 \times 10^{-11}$ $8·2 \times 10^{-11}$ $5·5 \times 10^{-11}$
Richardson I II	12·15	2·54 2·53	$5·4 \times 10^6$ $1·7 \times 10^6$	$1·8 \times 10^{-11}$ $5·9 \times 10^{-11}$
Rose City I II	17·25	2·50 2·50	14·9 6·9	$6·7 \times 10^{-7}$ $1·4 \times 10^{-6}$
Estacado	31·0	2·61	$7·8 \times 10^3$	$1·3 \times 10^{-9}$

* Roman numerals refer to different specimens cut from the same stone.

ρ_s and ρ_m, respectively, the ratio β of the average metallic cross-section s_m to the total cross-sections of the sample is easily found to be

$$\beta = \frac{s_m}{s} = \frac{(\rho_s/\rho)-1}{(\rho_s/\rho_m)-1}$$

where ρ is the measured resistivity of the sample. For $\rho_s > \rho > \rho_m$ the formula reduces to $\beta = \rho_m/\rho$. The values of β listed in Table 1 were computed for $\rho_m = 10^{-5}$ ohm cm.

It is interesting to see whether the rapid rise in conductivity at depths between 600 and 900 km. inferred by Lahiri and Price[2] could be explained simply by a slight change in the distribution of the metal phase or in the size of the connecting metallic channels. Let us assume that the resistivity drops from 10^6 ohm cm. at a depth of 600 km. to 10^2 at 900 km., while ρ_s and ρ_m remain constant in this range; let us assume further that $\rho_m = 2 \times 10^{-5}$. Since $\rho_s = (1-\beta)/(1-\beta\rho\rho_m^{-1})$ must be positive, β_{600} must be smaller than 2×10^{-11}, and $\rho_s > 10^6$. Thus ρ and ρ_s are both much larger than ρ_m, and $\beta_{900} \approx \rho_m/\rho = 2 \times 10^{-7}$. Both values of β fall within the range of values listed in Table 1 and are quite possible. We conclude that the change in resistivity could be explained by textural changes and, furthermore, that the electrical properties offer no clue as to the precise metal-phase content at those depths.

In the lower part of the mantle, below 900 km., the average resistivity decreases to a value of about 1 ohm cm.[3]. If we take the resistivity of the metal phase to be about 3×10^{-4}, which is close to the generally accepted value of the resistivity in the core, and if we take $\beta = 10^{-6}$, which is probably an upper limit, we find $\rho \approx \rho_s$. It is thus legitimate to consider that the resistivity of the deep mantle is essentially that of the silicate phase. This seems surprising in view of the results reported in Table 1. The difference in behaviour arises from the fact that the ratio of the metallic conductivity to the silicate conductivity under normal conditions is about 10^{13}; a very small metallic cross-section thus produces a large change in conductivity. In the deep mantle, where the ratio is of the order of 10^3, metallic cross-sections of the order of 10^{-6} produce no appreciable effect. It remains possible, of course, that the metallic cross-section may be larger than this figure.

The presence of metallic channels which so largely affect the electrical conductivity under ordinary conditions would have but little effect on the thermal conductivity, as the ratio of the thermal conductivities of the metal and silicates phases is of the order of 10^2–10^3.

J. F. EVERNDEN
J. VERHOOGEN

University of California,
Berkeley 4,
California.

[1] Runcorn, S. K., and Tozer, D. C., *Ann. Geophys.*, **11**, 98 (1955).

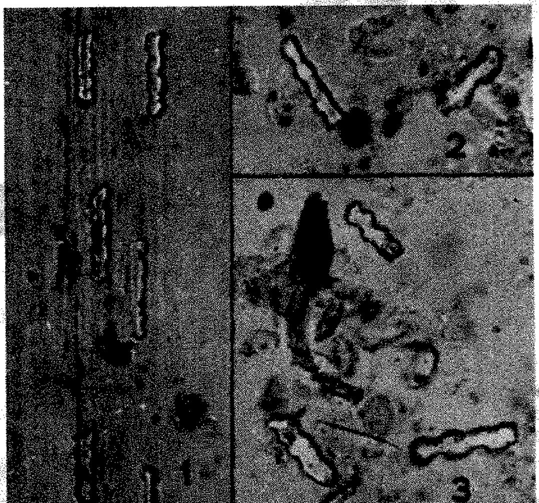
[2] Lahiri, B. N., and Price, A. T., *Phil. Trans. Roy. Soc.*, A, **237**, 509 (1939).

[3] Runcorn, S. K., *Trans. Amer. Geophys. Union*, **36**, 191 (1955).

Plant Opal in Soil

In many soils there are small siliceous bodies showing optical isotropy, low refractive index and low density, which identify them with the mineral opal, $SiO_2.nH_2O$[1]. Some are diatoms or diatom fragments. Others are simple or ornamented rods, tubes, hooks, etc., resembling the opaline bodies which are components of many plants[2-4]. Van Rummelen[5] has figured rods and tubes of isotropic silica from Indonesian soils and has suggested that such particles are always of inorganic origin, being deposited around root hairs which afterwards decay or in soil capillaries. Oosov[6] has observed biologically accumulated silica in Russian soils.

Studies now being carried out in Anglesey on the shapes and sizes of opaline bodies in the soil and in the vegetation leave little doubt that here most of the soil opal has been formed in living plants. An example of the degree of matching is given in the accompanying photomicrographs. Fig. 1 shows opaline bodies in a leaf of *Agrostis tenuis* treated with chromic acid and Figs. 2 and 3 depict objects similar in optical properties, shape and size in the silt fraction from a soil on which this grass forms the major part of the sward. It is not suggested that microscopic examination of these bodies in a soil makes it possible to name the grasses which formed them; but it should permit one to indicate what groups are or have been present. In some places the soil has yielded bodies which match those obtained by the chromic acid treatment of *Equisetum* sp. present on the site. Opaline bodies from grass are abundant in the dung of grazing animals, and many must reach the soil by this means.



Figs. 1-3. Opaline bodies in *Agrostis* leaf and in soil (× 372)

The silt of a swamp deposit normally covered by beach sand in Lligwy Bay, Anglesey (but exposed occasionally, for example, in 1912 and 1953), has yielded an abundance of opaline bodies which are now being investigated.

FRANK SMITHSON

University College of North Wales,
Memorial Buildings,
Bangor, North Wales.

March 2.

[1] Smithson, F., *J. Soil Sci.*, 7, 122 (1956).

[2] Grob, A., *Bibliothica Botanica*, **7**, (No. 36), 1 (1896–97).

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[6] Oosov, N. I., "Pedology" (Acad. Sci., U.S.S.R.), **9–10**, 30 (1943).

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, July 16

British Psychological Society (in the Psychology Department, Birkbeck College, Malet Street, London, W.C.1), at 8 p.m.—Dr. E. Colin Cherry and Mr. B. McA. Sayers: "Some Experiments on the Total Suppression of Stammering"; Mrs. Pauline M. Marland: "The Shadowing Technique for the Treatment of Stammering—a Progress Report".

Thursday, July 19

University of London (at the Institute of Psychiatry, Maudsley Hospital, Denmark Hill, London, S.E.5), at 5 p.m.—Mr. K. A. C. Elliott (U.S.A.): "Metabolism of Human Cerebral Tissues"*.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Senior Research Student in Metallurgy, Engineering (civil, mechanical or electrical) or Chemical Engineering—The Registrar, University College, Singleton Park, Swansea (July 17).

Chief Chemist in the Rivers Pollution Prevention and Fisheries Department—The Chief Inspector, Kent River Board, College Avenue, Maidstone, quoting CC/T (July 20).

Assistant Lecturer in Botany—The Secretary, The University, Exeter (July 21).

Master (preferably young bachelor) to teach Mathematics throughout the school to scholarship level—The Headmaster, West Buckland School, Barnstaple, Devon (July 21).

Research Fellow (chemist or biochemist with research experience in protein or polysaccharide chemistry), to work in collaboration with Dr. D. A. Hall of the Nuffield Gerontological Unit in the Department of Medicine—The Registrar, The University, Leeds 2 (July 27).

Senior Library Assistant (with a degree or professional library qualifications and previous library experience)—The Librarian, University College, Gower Street, London, W.C.1 (July 28).

Assistant Experimental Officer (with a pass degree in chemistry or equivalent, and preferably botanical training) to help with the biochemical study of tuberous *Solanums*—The Secretary, John Innes Horticultural Institution, Bayfordbury, Hertford, Herts (July 31).

Chief (with an honours degree in agriculture or equivalent, long practical experience in all branches of agricultural science, and considerable experience in research work and administration) of the Agricultural Research Division, Ministry of Agriculture, Sudan Government—The Chargé d'Affaires, Sudan Diplomatic Mission in London, Sudan House, Cleveland Row, St. James's, London, S.W.1, quoting "Chief Research Division 4/439" (July 31).

Lecturer (with experience in grassland husbandry) in Agriculture (Crop Husbandry)—The Secretary, The University, Edinburgh (July 31).

Principal Lecturer (with a first- or second-class honours degree in mathematics, and experience of teaching pure and applied mathematics) in Mathematics at the Royal Naval College, Greenwich—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1, quoting Ref. No. 4610/56/1 (July 31).

Principal (qualified to direct a major technical college concerned with full-time and part-time education in engineering to degree standard and other technologies, including postgraduate studies and research)—The Clerk to the Governing Body, Northampton Polytechnic, London, E.C.1 (July 31).

Scientific Officer (with a good honours degree in botany or agricultural botany, and preferably an interest in fruit culture and plant physiology) in the Pomology Department (Ref. POM/2); and a Scientific Officer or Experimental Officer (preferably graduate, with a knowledge of, and an interest in, work on insect pests of soft fruits) in the Entomology Section of the Plant Pathology Department (Ref. PP/2)—The Secretary, Scottish Horticultural Research Institute, Mylnefield, Invergowrie, by Dundee (July 31).

Lecturer in Geology—The Head of the Department of Geology, Imperial College of Science and Technology, South Kensington, London, S.W.7 (August 4).

Assistant (with a degree in science, preferably honours) in the Chemistry Department at Auchincruive, Ayr, for work relating to the spectrographic analysis of agricultural materials—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2 (August 10).

Dewar Research Fellow in Radiation Chemistry—The Secretary, The University, Edinburgh (August 11).

Professor of Agricultural Botany—The Registrar, The University, Reading (August 20).

Professor of Psychology—The Registrar, The University Reading (August 24).

Senior Lecturer (with experience in research and teaching in one of the following fields: mycology, algology or anatomy) in Botany at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, August 29).

Chair of Mathematics—The Registrar, University College of North Staffordshire, Keele, Staffs (August 31).

Lecturer in the Ramsay Memorial Laboratory of Chemical Engineering—The Secretary, University College, Gower Street, London, W.C.1 (September 1).

Assistant (preferably with a biological degree and bibliographical experience, and a knowledge of Spanish, Portuguese or Italian) for the preparation of a journal comprising an annual record of the contents of entomological publications—Commonwealth Institute of Entomology, 56 Queen's Gate, London, S.W.7.

Chemists (2) (with at least a second-class honours degree and two years postgraduate experience) with the Colonial Insecticide Research Unit, Arusha, Tanganyika, to supervise chemical aspects of research into the control of insect pests—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.195/196/06.

Lecturer (Grade II) in Physical Metallurgy—The Registrar, The University, Birmingham 15.

Lecturer in Engineering, and a Lecturer in Mathematics—The President, Mount Allison University, Sackville, New Brunswick, Canada.

Lecturer (with a good engineering degree and some experience in industry and research) in Mechanical Engineering—The Registrar, Queen Mary College (University of London), Mile End Road, London E.1.

Mycologist, to take charge of the work on plant diseases in relation to crop varieties—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

Physicist or Engineer (with an appropriate degree), for basic research on crop drying and other problems in electro-agriculture—Head of the Rural Electrification Department, Electrical Research Association Field Station, Shinfield Green, Reading.

Senior Lecturer (graduate in physics or chemical engineering and industrial experience of food processing operations)—The Registrar, National College of Food Technology, Cranwood Street, City Road, London, E.C.1.

Senior Lecturer in Physiology and Pharmacology at the Technical College, Bradford—The Director of Education, Town Hall, Bradford.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Flora of Tropical East Africa. Edited by Dr. W. B. Turrill and E. Milne-Redhead. Canellaceae. Pp. 4. 1*s.* Caryophyllaceae. Pp. 38. 3*s.* (London: Crown Agents for Oversea Governments and Administrations, 1956.) [274

Recommended Practice for Electrical Installations in Caravans. Second edition. Pp. iv+18. (London: Institution of Electrical Engineers, 1956.) 1*s.* 3*d.* [15

West of Scotland Agricultural College. Research Bulletin No. 13: Comparison of Production from Six Strains of Perennial Ryegrass. By I. V. Hunt. Pp. 55. (Glasgow: West of Scotland Agricultural College, 1956.) 2*s.* [15

General Register Office. Studies on Medical and Population Subjects. No. 9 (in continuation of Study No. 7): General Practitioner's Records—an Analysis of the Clinical Records of some General Practices during the period April 1952 to March 1954. Pp. vii+80. (London: H.M. Stationery Office, 1956.) 6*s.* 6*d.* net. [15

International Committee for Bird Preservation: British Section. Annual Report for 1955. Pp. 40+4 plates. (London: International Committee for Bird Preservation, c/o British Museum (Natural History), 1956.) 2*s.* 6*d.* [15

Association of British Pharmaceutical Industry. Annual Report and Year Book, 1955–56. Pp. 43. (London: Association of British Pharmaceutical Industry, 1956.) [15

Nuclear Power: The Journal of British Nuclear Engineering. Vol. 1, No. 1 (May 1956). Pp. 44+xx. Subscription rates: U.K., 42s.; U.S.A. and Canada, 8 dollars. Single issues, 3*s.* 6*d.* (London: Rowse Muir Publications, Ltd., 1956.) [15

Central Office of Information Reference Pamphlet No. 12: Health in the United Kingdom Dependencies. Pp. ii+38. (London: H.M. Stationery Office, 1956.) 2*s.* net. [25

Other Countries

Berichte des Deutschen Wetterdienstes. Nr. 23 (Band 4): Untersuchung zur Föhnstatistik des Oberallgäus. Von Eugen Obenland. Pp. 40. 4.10 D.marks. Nr. 24 (Band 4): Der Strömungsverlauf sowie die Erosionsvorgänge und Schneeablagerungen an künstlichen Windschirmen nach Untersuchungen im Windkanal. Ein Beitrag zur Windschutzfrage. Von Wilhelm Kreutz und Wolfgang Walter. Pp. 25. 3.20 D.marks. Nr. 25 (Band 4): Untersuchungen über die Schallausbreitung auf nahe Entfernungen. Von Georg Scheid. Pp. 16. 2.40 D.marks. Nr. 26 (Band 4): Untersuchungen zum Jahresgang des mittleren geographischen Höhengradienten der Lufttemperatur in den verschiedenen Klimagebeiten der Erde. Von Robert Bögel. Pp. 42+13 tabellen. Jahresberichte, 1955. Pp. 60. (Bad Kissingen: Deutschen Wetterdienstes, 1956.) [15

Editorial and Publishing Offices of "NATURE"
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No. 4525 SATURDAY, JULY 21, 1956 Vol. 178

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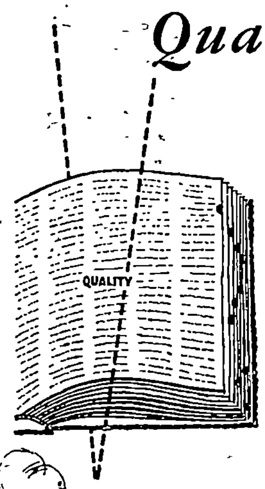

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A CENTRE FOR GEOGRAPHICAL RESEARCH

IN his presidential address at the recent annual meeting of the Royal Geographical Society, General Sir James Marshall-Cornwall made a plea that the Society should become the focal point of geographical research in Britain. It is an idea which should be sympathetically received by the numerous departments of geography which now flourish in all our universities, and not least by the geographers in the different schools of the University of London.

The Society is, of course, generally known not for its contributions to research and education, not even for its services to the public as the principal centre of geographical information in Britain, but for its sponsorship of exploration, of a scientific as well as of an adventurous kind. But its efforts to promote research and education are at least as important a part of its long and distinguished history, especially its efforts to establish geography as an academic discipline in the universities throughout Britain. By the middle of the nineteenth century, the fortunes of geography, which had steadily declined in Britain since Elizabethan days, were at a low ebb. In 1848, the Prince Consort, newly appointed chancellor of the University of Cambridge, strongly deplored the fact that there was no provision for the teaching of geography to undergraduates of the University. The position at Oxford at that time was no better. An attempt had been made there in 1857 to found a Waynflete professorship of geography. But it was soon abandoned. Then the Society, led by a redoubtable president, the late Sir Clements Markham, stepped in and achieved remarkable success. With its help, financial and moral, a readership was founded at Oxford in 1887, and the year 1899 saw the establishment there of the first Department of Geography in Britain. Two years earlier, again with the Society's help, a lectureship in geography at Cambridge, dating from 1888, was converted into a readership, and a University Board of Studies in Geography, the embryo of the future Department, was set up in 1903.

In that year, according to the late Dr. Hugh Robert Mill, the Royal Geographical Society set up its own Research Department to co-ordinate lectures on technical subjects. This also served as a centre from which attention might be directed to problems of geographical research which the supervising Research Committee felt were of particular importance*. Land utilization, coastal morphology, soil erosion and other problems of the arid and torrid zones, microclimatology, the geographical pattern of disease, were some of the fields in which the Society set out, in those early days, to promote research. The contribution of the Society's own Research Department and Committee is not easy to estimate. But its full list of subjects to be studied covers most of the main lines of advance in geographical research since that time. Meanwhile, the Society's efforts to stimulate geographical education in the universities continued unabated. Between 1887 and 1924, it has been calculated*, more than £20,000 was contributed from its funds towards the establishment of geography as an enduring part of university education in Britain.

To-day, the Society is already, in some respects, on the way to becoming a centre of geographical research of the kind its president has in mind. Its excellent geographical library is predominantly used, not, as is sometimes supposed, by the dilettante reader of travellers' tales, but by undergraduate and postgraduate students. Its technical lectures and discussions provide a forum, not only for university geographers, but also for those working in the more specialized branches of science who are concerned with geographical aspects or the application of geographical techniques. Geography, so it seems, is essentially a co-ordinating, a bridging, study involving an appreciation and an interpretation of relationships against the physical background. To geographers the water-tight department should be anathema. Close contact must therefore be maintained by them with these specialist branches, since it is the latter which provide the source of material for geographical synthesis.

In these and in other ways, as in the continuous association which is maintained with geographical research workers abroad, as in its research publications and production of special maps, and in its promotion of field-work by expeditions, the Society is already fulfilling some of the functions of a centre of geographical research.

How else then could the Society fulfil the role outlined by General Sir James Marshall-Cornwall in his presidential address. With so much achieved, with so many facilities available, might not such a centre now be formally established in the Society as an institute of geographical research, associated perhaps with the University of London, but not, of course, confined to it? An institute of this kind, administered and financed jointly by the Society and the University, was proposed many years ago by the late Sir Halford Mackinder and outline plans were printed. There are parallels, indeed, more or less, in some of the existing institutes of the University; in the Institute of Commonwealth Studies which has some association with Chatham House; in the Institute of Classical Studies which is linked to, and uses the library of, the Greek and Roman Societies; in the Institute of Historical Research. The several geographical departments of the University are widely scattered over London. The scope of geography is diffuse; its need for a central point of contact with cognate branches of learning is very marked. The emphasis given to different aspects of geography by the different schools, both inside and outside London, varies considerably. These are all considerations which suggest that geography is a field of study which would derive special benefit from the establishment of a central institute to promote and co-ordinate advanced studies and research.

---

* "The Record of the Royal Geographical Society, 1830–1930", p. 147. (London, 1930.)

* "Geography as a Humane Study", p. 6. An inaugural lecture by Prof. E. W. Gilbert. (Oxford, 1955.)

There were rumours some years ago that plans for just such a geographical institute—following up, no doubt, Mackinder's earlier plans—were to be considered by the University of London. If so, then the prospect of obtaining a suitable building and of forming afresh a library and map collection could scarcely have been encouraging. Nor would the project be easy to justify while there exists in London, in the Royal Geographical Society, the nucleus of such an institute with ample buildings of its own, with land adjacent for extensions, with an excellent specialized library, and a map collection unrivalled in Britain, and for that matter in Western Europe. It would surely seem better sense to make greater use of the facilities already available in the Society, and to adapt them as necessary for academic purposes, than to attempt to start afresh.

There should be no insuperable problem in supplying the other services which an institute of geographical studies should provide. With the co-operation of members of the geographical departments of the different schools of the University, seminars for advanced students could be held and instruction and supervision arranged. For a number of years towards the end of the nineteenth century, a studentship for geographical research was jointly offered by the Society and the University of Oxford. Once the Society had received formal academic recognition—and this would be the first important step—help might well be forthcoming from one of the great foundations towards the establishment of similar postgraduate studentships attached to the Society's research institute, including provision for field-work abroad. The administration of the institute might, it is true, pose some awkward problems. The Society is almost entirely financed from the subscriptions of its members, to whom it must have special obligations. But this again should not prove an insuperable obstacle. Some form of a joint committee with the University would probably provide an answer.

The Royal Geographical Society has, through its president, shown an evident desire to play a greater part in the promotion of geographical research by offering to include in its establishment a centre of advanced studies. It is a function for which in many ways it is ideally suited, and one for which it already has many material advantages. The Society has, implicitly at any rate, extended the invitation. It is now for the university geographers in London and elsewhere to respond, at least to the extent of showing signs of willingness to examine the invitation carefully.

CLEVELAND ABBE: A PIONEER AMERICAN METEOROLOGIST

Professor Abbe and the Isobars

The Story of Cleveland Abbe, America's First Weatherman. By Truman Abbe. Pp. xi+259+14 plates. (New York: Vantage Press, Inc., 1955.) 3.50 dollars.

CLEVELAND ABBE (1838–1916) has an honoured name in the history of meteorology as the man who, more than any other, created the United States Weather Bureau. This book, written by his son, the late Dr. Truman Abbe, gives the story of his life and recounts some of his struggles to bring into being and maintain an official weather service worthy of the name.

Abbe came of New England farming stock. As a young man, he studied astronomy at Ann Arbor and at Cambridge, Mass., after which he spent two years in Russia working under Otto Struve at Pulkova Observatory. In 1867 he returned to America, and in 1868 was appointed director of the dilapidated astronomical observatory at Cincinnati. The next year he began to publish daily weather reports under a loosely knit sponsorship of the Cincinnati Chamber of Commerce and the Western Union Telegraph Company. His first published forecast (he usually called them 'probabilities') was produced on September 1, 1869, and in his diary for the same day he wrote: "First prognostication. A Doubt and a Failure". The venture soon came to an end for lack of support, but it led to an Act of Congress providing for the use of the Signal Corps of the Army for the organization of a public weather service, in which Abbe filled the dual role of chief forecaster and what we should now call 'director of research'. The Signal Corps at that time, however, was not sympathetic to scientific work, and Abbe's enthusiasm and unfailing good nature often must have been strained to the utmost in his efforts to build up an efficient service. In 1891 Congress relieved the Signal Corps of its unwelcome task and set up the United States Weather Bureau in the Department of Agriculture, with Abbe as "professor of meteorology".

The new venture began well, but quickly ran into trouble. When, in 1893, the government changed hands, Abbe and others of the scientific staff were reduced in rank and pay, on the official but scarcely credible grounds of incompetence. From the account given in the present book this seems to have been entirely an act of political vengeance against men who had the misfortune to be appointed by the opposition party. Abbe did not regain his position and salary until several years later, when a new chief of the Bureau was appointed; but it is evident that throughout most of his long association with the Weather Bureau he was regarded as its principal scientific authority. Later, he travelled extensively, writing long letters home, and he did not resign his post with the Weather Bureau until a few months before his death, when he was nearly eighty years of age.

Abbe wrote voluminously and for many years was editor of the *Monthly Weather Review*. In addition, he published a noteworthy collection of translations of papers on dynamic meteorology entitled "The Mechanics of the Earth's Atmosphere", as well as books on instruments, forecasting, and the relation between climate and crops. It is somewhat difficult to assess the true scientific value of this large output, which is scattered over so many periodicals; but it is probably fair to say that, although not a very original worker, he did as much as any man to bring the science of his day into official meteorology. Some extracts from his writings are given in this volume, and one cannot fail to be impressed by their integrity and clarity. His article on rain-making and long-range forecasting, for example, although published in the *Monthly Weather Review* as long ago as 1903, can still be read with profit. His talents were widely recognized in his lifetime, and probably nothing pleased him as much as the award of the Symons' Memorial Medal by the Royal Meteorological Society in 1912.

The present volume is not in any sense an 'official' biography, and it attempts no objective evaluation of his work as a meteorologist—a wise decision, seeing that the author was his son and a medical practitioner. It is little more than a collection of intimate sketches and anecdotes, loosely strung together and filled out with extracts from his letters and accounts of family matters, much of which is now rather dull reading.

But the impression left on the reader is clear enough—that of a kindly, deeply religious man who, by his integrity, enthusiasm and secure knowledge of the physics of his day, helped to lay the foundations of a great scientific institution. Even if his work had not the imprint of genius, like that of Bjerknes or W. H. Dines, his contribution to meteorology was exactly what was needed for the time. When he began, meteorology was little more than folk-lore; when he died, it had become a science.

O. G. SUTTON

PROF. W. A. HEISKANEN: SIXTIETH BIRTHDAY VOLUME

Professori Weikko A. Heiskaselle hänen 60-vuotispäivänään omistettu juhlajulkaisu

Veröffentlichungen des Finnischen Geodätischen Institutes. Nr. 46. Pp. 214. (Helsinki: Suomen Geodeettisen Laitoksen Julkaisuja, 1955.) n.p.

PROF. W. A. HEISKANEN is well known among geodesists and geophysicists for his contributions to the study of isostasy and as director of the International Isostatic Institute of the International Union of Geodesy and Geophysics and research professor at the Mapping and Charting Institute of the University of Ohio; his many friends will be pleased that the Finnish Geodetic Institute has commemorated his sixtieth birthday by the publication of this volume of essays. The book is in two parts, the second of which, comprising five papers on the results of the 1945 solar eclipse expedition of the Finnish Geodetic Institute, will be read by all interested in the use of eclipse observations for geodetic position measurements.

Among the eighteen commemorative essays in the first part of the volume, four have a distinctively Finnish character. V. Erola describes the development of air survey in Finland, and K. G. Lofström discusses in detail the method of stereo-photographic triangulation, peculiar to Finland, in which the horizon is photographed by two horizontal cameras to determine the tilts of the vertical camera by which the ground is photographed; Errki Kääriäinen compares two different methods for calculating the uplift of the land from the results of the two precise geodetic levellings of Finland, and Heikki Tuori reviews the technical delimitation of territorial waters with reference to the particular problems of the Finnish coastline. The paper by Tauno Honkasalo, in which he describes some tests of height measurements with aneroid barometers with a mean error of 1·6 m., will be useful to others who have to make gravity meter observations in places where heights found by spirit-levelling are few or absent.

There are two essays on geophysical subjects. Prof. Gutenberg's calculations of pressure as a function of depth beneath high mountains, beneath continental lowlands and beneath the deep oceans, in which he uses the most recent evidence about the properties of materials down to 50 km., emphasize again that, even assuming that the granitic layer is really composed of granite of density 2·67 gm./cm.^{3}, the mean density of 2·67 gm./cm.^{3} for the upper layers usually postulated in isostatic calculations is too low and that existing isostatic anomalies calculated on the assumption of 2·67 gm./cm.^{3} do not represent the true disequilibrium in the crust of the Earth. E. Niskanen reviews the application of Bijlaard's theory of plasticity to the buckling of the Earth's crust, but his calculations do little more than confirm what Sir Harold Jeffreys has so often emphasized—that buckling, in its usual engineering sense of elastic instability, never occurs in the Earth's crust.

In view of Prof. Heiskanen's own studies, the papers that will probably be read with most interest are those dealing with the determination of the form of the geoid—the gravitational equipotential surface at sea-level. Dr. de Graaff Hunter puts forward a new proposal for finding the difference between the deflexions of the vertical at two intervisible sites from comparisons of the apparent optical elevation of each above the other when the height of each above the geoid is known, the essence of his proposal being a new way of eliminating the effect of atmospheric refraction by symmetrical observations. In his present position, Prof. Heiskanen is responsible for a large programme, having the object of calculating the detailed form of the geoid from gravity measurements by using an integral formula due to Stokes. One of the difficulties of such a project is that there are no gravity observations in large areas of the Earth, and the question of the effect of these areas on the calculated form of the geoid is discussed in two papers: one, by Prof. Hirvonen, on a spurious first-order harmonic term that may be introduced; and the other, by Prof. Vening Meinesz, on the estimation of the magnitude of the effect from plausible assumptions about the isostatic anomalies in the unsurveyed regions. An aspect of the theory of the application of Stokes's formula to the actual Earth is considered by Dr. Ledersteger, who calculates the effect of topography on the gradient of gravity between the surface of the topography and the geoid.

Most of the papers in this volume deal with topics of current interest, and none is within its limits inadequate; yet the collection as a whole leaves one disappointed. When such a collection is prepared, the reader may hope that, taken together, the subjects of the essay will give him a good idea of the important work in progress in the particular field; but the present collection does not do this, not even for current work in Europe, to say nothing of that in Britain or America. There is, for example, no paper on the problem of establishing a consistent world-wide gravity network on which a great deal of work is being done, nor is there one from Prof. Heiskanen's own group in the United States dealing with any of the interesting work being done there.

Furthermore, anniversary volumes afford an opportunity for critical reviews or expositions of important new ideas, and again it must be said that, in this volume, the opportunity has been missed. This work does indeed do honour to a distinguished colleague, but the honour would have been greater had the anonymous editors conceived it on broader lines and encouraged their contributors to write with greater depth.

A. H. COOK

DETAILED REPORTS ON NUCLEAR ENERGY

Progress in Nuclear Energy

Series 1: Physics and Mathematics. Vol. 1. Edited by R. A. Charpie, J. Horowitz, D. J. Hughes and D. J. Littler. Pp. x+398. (London: Pergamon Press, Ltd., 1956.) 84*s*.

THE Geneva International Conference on the Peaceful Uses of Atomic Energy released a welcome flood of information, and the long process of assimilation is now under way. This first volume of a series on the physics and mathematics of nuclear energy is largely devoted to helping the process by a number of critical reviews of the data presented at the conference, although some additional material is also included. Subsequent volumes, we are told, will be published as progress demands. The same plan for the first and later volumes is to be followed in the seven related series on reactors, process chemistry, technology and engineering, metallurgy and fuels, biological sciences, medical sciences and economics.

The striking feature of the first volume is its detail; these are articles for the expert to relish, not for the student to face. In some respects, however, the detail is fascinating for anyone: the elegant graphs in the article by J. A. Harvey and J. E. Sanders show scores of points from laboratories in many countries all lying snugly on smooth curves and explain why V. F. Weisskopf was stimulated by the Geneva Conference to write his foreword to this volume on the theme that science is international.

The Harvey–Sanders article on a summary of data on the cross-sections and neutron yields of uranium-233 and -235 and plutonium-235 and the associated one by P. A. Egelstaff and D. J. Hughes on their resonance structure form a valuable source of information on these important nuclei. H. A. Bethe's theoretical analysis completes a trio of reports on the fissile materials and gives the main conclusions to be drawn from the experimental data.

The volume becomes more general with an excellent survey of experimental techniques for measuring neutron cross-sections, but returns to the particular when dealing with the cross-section of xenon-135, the fission product which is so important as a reactor poison. G. R. Keepin's article on delayed neutrons emphasizes the important part they play in the control of chain reactions and gives extensive information on their energies, periods and abundances. In this and a later article and also in other recent publications the 'dollar' is used as a unit of reactivity; this seems to be inviting confusion with economics.

The articles mentioned so far are connected with the background information for reactor design. The last four articles deal with various aspects of complete reactors: S. M. Feinberg gives a detailed discussion of the methods used in the U.S.S.R. for the calculation of heterogeneous reactors; Dixon Callihan writes on homogeneous assemblies; the experimental and theoretical work with highly enriched reactors is described by H. Hurwitz and R. Ehrlich for intermediate and thermal energies; and that for fast reactors by J. Codd, L. R. Shepherd and J. H. Tait. The section on fast reactors includes a very interesting description of the Harwell experimental reactor, ZEPHYR, and some of the results obtained with it. These articles cover very recent work and show the beneficial effect which the Geneva Conference had on the release of information. Perhaps it is a little too much to expect that the next volume in this series will have a detailed article on fusion.

J. WALKER

GENES, SPECIES AND MEN

Evolution, Genetics and Man

By Prof. Theodosius Dobzhansky. Pp. ix + 398. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1955.) 44*s*. net.

EACH phase of the development of evolutionary theory has been characterized by books and monographs dealing with various aspects of the field. Prof. T. Dobzhansky's main contribution has been a comprehensive study, first published in 1937 and now in its third edition, on "Genetics and the Origin of Species". His present book is intended to form a simple introduction to evolutionary studies, and to point out the "bearing of the topics discussed on human problems".

The introductory chapter deals with the continuity of life, and the author then enters into a discussion of the basic principles of genetics. This section occupies by far the greater part of the volume. It is developed along what have now become conventional lines to include accounts of the origins of genetic variability, the genetics of populations, the mechanics of natural selection, adaptation, and the formation of races and species. The principles elaborated in these first eight chapters are illustrated by instances of the rapid evolutionary changes that have taken place in domestic animals and plants.

Then follows a discussion of the 'principles' that have been developed empirically in the field of comparative anatomy. It is somewhat surprising that the author apparently makes little attempt to survey the theoretical background of this subject critically in the light of genetical findings. He does nevertheless point out that genes control biochemical processes during embryonic development rather than individual characters of the adult; but again, little mention is made of the new and relevant concepts that have been developed in the field of 'epigenetics'.

A chapter on the evolution of sex follows. This might have been more suitably placed in the earlier part of the book for, in its present position, it breaks the continuity between the discussion of the principles of comparative studies and the survey of the fossil record that follows.

The author deals rapidly with the main features of the evolution of the vertebrates, and as the text proceeds, less and less prominence is given to the genetic background. Finally, the reader is confronted with a not unduly critical account of the fossil remains of man's presumed ancestors. Prof. Dobzhansky stresses that living men form one species, and concludes with a discussion of the evolutionary possibilities that are open to man as being the only animal capable of conceptual thought and therefore able to transmit culture.

There can be little doubt that, for many students, Prof. Dobzhansky's book will provide a stimulating introduction to the genetic basis of the biological variation on which selection acts. The unevenness of his work may well reflect the fact that the very size of the subject precludes any one scholar from being equally competent in all its branches. A companion volume providing an introduction to the elements of developmental genetics, and to the application of genetical principles to the study of palæontology and comparative anatomy, would prove a welcome addition to present-day evolutionary literature.

E. H. Ashton

THE LOWER PRIMATES AND EVOLUTION

The Non-Human Primates and Human Evolution

In Memory of Earnest Albert Hooton, 1887–1954. Arranged by James A. Gavan. Pp. v+134 (8 plates). (Detroit: Wayne University Press, 1955.) 3.50 dollars.

In a symposium at the annual meeting of the American Association for the Advancement of Science in 1953, a series of papers was presented on the relation of studies of the lower Primates to problems of human evolution. These papers were published in the issue of *Human Biology* for September 1954, and have now been republished in the form of a book dedicated to the memory of the distinguished American anthropologist, Dr. Earnest A. Hooton, who died in 1954.

While the title was no doubt suitable as an indication to the contributors of the main theme of their symposium, it is not altogether appropriate for this volume, since it implies to the prospective reader that the subject is treated with some degree of comprehensiveness and in logical sequence. In fact, the book consists of a number of short articles dealing with rather disconnected subjects, not all of which have a very obvious relation to immediate problems of human evolution.

Three essays on the study of behaviour in lower Primates will be found of more particular interest, for the reason that they present some original ideas which, it is suggested, may have a bearing on the mental and cultural evolution of the early Hominidæ. Dr. C. R. Carpenter advances tentative generalizations on the grouping behaviour in non-human Primates—generalizations which (he makes clear) are no more than hypotheses to provide a basis for future studies. Dr. H. W. Nissen discusses problems of mental evolution in Primates, and insists that there are no fundamental or qualitative differences between the emotions and motivations of man and the other Primates: "What especially characterizes human motivation is not its initiating goals, but rather the indirection and complexity of its approach to those goals". Finally, in an article by Dr. and Mrs. K. J. Hayes, an attempt is made to relate personal observations on a young chimpanzee (who spent the first six years of her life in their home) to speculations on the sequence of events which led to the development of cultural behaviour in human evolution.

It is a pity that two of the most interesting papers presented at the actual symposium—interesting because they deal with subjects about which there is so little published information—are only recorded in this book in the form of short abstracts: Dr. G. L. Jepsen, on the fossil Primates of the New World, and Dr. G. E. Erikson, on the comparative anatomy of the New World Primates.

W. E. Le Gros Clark

PARASITES OF LIVESTOCK

Veterinary Parasitology

By Dr. Geoffrey Lapage. Pp. xvi+964+34 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1956.) 63*s*. net.

While the medical man is adequately supplied with text-books on human parasitology in the English language, the veterinarian is less fortunately situated; for there are scarcely any modern books covering the field of animal parasitology, in spite of the economic and public health importance of parasitic diseases in livestock. There is therefore an urgent need for an up-to-date handbook dealing with the parasites and the diseases produced by them in domestic animals. No one could be better qualified to undertake this formidable task than Dr. G. Lapage, who has now provided teachers of animal parasitology and veterinary students with a comprehensive account of the protozoa, helminths and arthropods of veterinary importance.

Two introductory chapters are devoted to the general principles and concepts of parasitism, such as the types of animal associations, the characteristics of parasites, their life-cycles and methods of transmission, their effects upon the hosts and the reactions of the latter to infection. The remaining twenty-eight chapters are divided into four parts dealing (in the order that follows) with nematodes, flat worms, arthropods and protozoa. The description of the species considered in each of these phyla includes their systematics, morphology, life-history, host–parasite relations, control and drug treatment, illustrated by numerous text figures and plates. Among the arthropods are included—in addition to true ecto- and endo-parasites—also vectors of parasitic infections, as well as species which affect the health and well-being of livestock in other ways. Although the parasites are considered mainly from the zoological point of view, the course and epidemiology of the infections are described in some detail; but data on their therapy are only briefly mentioned, while diagnostic procedures are left out altogether. However, since this book does not claim to be a practical guide to clinical parasitology, and its size had to be kept within the bounds of a single volume, omissions could scarcely be avoided. Readers desiring to extend their knowledge of parasitology will find the necessary references in the bibliography, which occupies twenty pages. There is also a useful alphabetical index.

This authoritative and comprehensive text-book, which successfully fills the gap in the literature on parasitology, will be welcomed not only by veterinarians—for whom it is primarily intended—but also by medical workers and zoologists.

C. A. Hoare

A Supplement to the Catalogue of the Grace K. Babson Collection of the Works of Sir Isaac Newton and Related Material in the Babson Institute Library, Babson Park, Massachusetts

Compiled by Henry P. Macomber. Pp. viii+91. (Babson Park, Mass.: Babson Institute, 1955.) 4.90 dollars.

IN 1950 appeared the "Catalogue of the Babson Collection of the Works of Sir Isaac Newton", an ordered description of an important Newton library, housed in Babson Park, Massachusetts (see *Nature*, 166, 284; 1950). The present "Supplement", compiled by Mr. Henry Macomber, the curator of the Collection and associate compiler of the original catalogue, lists a number of items of all kinds—books, reprints, manuscripts, photostats, photographs, portraits and so on—which have accrued to the Collection since the first catalogue was issued.

There are a few early books of high importance, such as copies of Huygens's "Horologium Oscillatorium", Kepler's "Astronomia Nova", l'Hospital's "Analyse des Infiniment Petits" and Hooke's "Micrographia"; but many of the acquisitions are in the way of recent writings about Newton, including reprints and extracts from journals. There are also a number of items of minor interest, in the case of some of which the Newtonian interest tends to be remote, as, for example, Hollar's etching of the Royal Exchange, made in 1644, which is a charming work, and an odd Vol. 1 of a two-volume edition of Boswell's "Life of Samuel Johnson", published in Philadelphia in 1841.

The work is produced uniformly with the original catalogue, all owners of which will certainly wish to acquire this supplement, which, incidentally, contains an errata list for the original volume.

E. N. da C. Andrade

Progress in Organic Chemistry

Edited by Prof. J. W. Cook. Vol. 3. (Progress Series.) Pp. viii+273. (London: Butterworths Scientific Publications; New York: Academic Press, Inc., 1955.) 45*s*.

THE third volume of this useful series certainly continues to enhance its reputation for providing up-to-date reviews of live topics. The first survey, on the total synthesis of steroids, by Dr. J. W. Cornforth, is that rarity—a comprehensive account of a complex subject written with clarity, modesty and humour. Every synthetic route is discussed and the story of this triumph of organic chemistry makes stimulating and enjoyable reading.

Since Prof. W. Baker's 1945 Tilden Lecture on non-benzenoid aromatic compounds, important new advances have been made in this field, and it is fitting that Prof. Baker (with Dr. J. F. W. McOmie) contributes to the volume a chapter on these compounds, which fully incorporates the recent work. This account is complemented by the succeeding chapter on the fulvenes, by Prof. E. D. Bergmann, which is a very full description of these interesting compounds.

The advantages of organo-lithium compounds over the more conventional Grignard reagents have been gaining recognition for some time. The chapter on organic compounds of lithium, by Prof. E. A. Braude, is therefore particularly timely and useful, and achieves a nice blend of practical and theoretical considerations. The pharmacological properties of reserpine have focused much recent attention on the yohimbine group of alkaloids. In the final chapter, on the indole alkaloids, Profs. V. Boekelheide and V. Prelog describe the modern investigations on this group and on other indole alkaloids, the unusual fine structures of which have been recently unravelled (the corynantheine, cinchonamine and erythrina alkaloids).

R. A. Raphael

An Index of Mineral Species and Varieties Arranged Chemically

With an Alphabetical Index of accepted Mineral Names and Synonyms. By Dr. Max H. Hey. Second, revised edition. Pp. xxiv+728. (London: British Museum (Natural History), 1955.) 60*s*.

IT is five years since the British Museum (Natural History) issued the "Index of Mineral Species and Varieties", compiled by Dr. M. H. Hey (see *Nature*, 167, 873; 1951). In the interval, much progress has been made in mineral chemistry, and the new edition of this valuable work of reference has been revised throughout by Dr. Hey. New information, up to March 1955, has been incorporated in the text, and last-minute addenda and corrections, up to April 1955, have been printed on four pages at the end of the book. The only other change is the addition of a "Pronouncing Index of Accepted Mineral Names", which has been included in an attempt to establish uniformity of pronunciation of mineral names in English-speaking countries—not an easy task; this index occupies sixty-six pages. Scientific libraries not already owning a copy of this work will no doubt welcome the opportunity to purchase it in its revised form.

Genetics in the Atomic Age

By Dr. Charlotte Auerbach. Pp. vii+106. (Edinburgh and London: Oliver and Boyd, Ltd., 1956.) 8*s*. 6*d*. net.

A GROWING number of persons are becoming concerned about the genetic consequences of the exposure of human populations to radiation, but few are well informed about the scientific principles underlying the question. This little book has the timely purpose of helping to fill this gap for the non-biologist, and is admirably designed to do so. It is a model of lucidity and conciseness. Dr. Charlotte Auerbach, herself a first-rank teacher and investigator in genetics, presents the facts necessary for a grasp of the radiation question without recourse to ratios, equations or technical terms. Mutations, their effects, their hereditary transmission, and their evolutionary role are discussed in four chapters; the final two deal with the production of mutations by radiation and with facts relevant particularly to the human problem, and examine the nature of the consequences that future generations of mankind may suffer through exposure of the present ones to radiation.

The drawings by Miss I. G. Auerbach are most helpful, and have an original charm of their own. An appendix of scientific terms, not themselves used in the text but describing facts and ideas explained there, will assist readers who go on to more technical writings in genetics.

This book will do much to give its readers the knowledge necessary to judge wisely the genetic hazard due to radiation. Its obvious power to stimulate interest would make it a valuable addition to any biology class-room shelf or school library.

Alma Howard

HIGH-ENERGY NUCLEAR PHYSICS

MOSCOW CONFERENCE

A CONFERENCE on high-energy nuclear physics was organized by the Academy of Sciences of the U.S.S.R., and the main sessions were held in the Lebedev Institute in Moscow during May 14–22. Although it was not officially described as an international conference, and physicists from the Soviet Union made up the majority of the six or seven hundred who attended, visitors from many other countries were also present as the guests of the Academy of Sciences. They included thirteen from the United States, seven from the United Kingdom, and others from the European Organization for Nuclear Research, Canada, Australia, France, the Federal German Republic, Italy, Norway, Sweden, Yugoslavia, Egypt, India, the Eastern European countries and China. It was an exciting occasion. Many laboratories were open to visitors, and it was possible to discuss physics freely with Soviet scientists at their work, as well as in the conference hall.

The programme was a very full one, with many relatively short papers in three sections usually running in parallel. The numerous formal contributions, and the large audience, often prevented adequate informal discussion of the papers except in the theoretical section. However, in the later stages, the anterooms and corridors began to fill satisfactorily with physicists engaged in discussion; there were always plenty of interpreters to assist, and many of the Soviet physicists spoke excellent English. The language difficulty was partially overcome in the formal sessions by the use of simultaneous translation from Russian into English; English-speaking contributors had to wait at short intervals for the Russian translation to be interposed. One speaker made his address in Chinese, which was translated by one of his colleagues into Russian and thence, by the official interpreter, into English.

Accelerators

In the first session, opened by M. G. Mescheryakov, the most important Soviet high-energy accelerator projects were outlined by A. L. Minz, V. I. Veksler and V. V. Vladimirsky. The accelerators described were the 6-metre synchrocyclotron, which has been operating since 1949 at 480 MeV. and since 1953 at 680 MeV., the 10 GeV. proton synchrotron now nearing completion, a 6–7 GeV. alternating-gradient proton synchrotron, and a projected 50-GeV. alternating-gradient proton synchrotron. More detailed reports on these machines were given in the accelerator sessions proper; but in addition, papers were presented on practically every known method of acceleration of particles to high energy and on experimental techniques. Of the sixty papers read, all but seven were Russian. There has been a great upsurge of activity in high-energy accelerator development during the past few years, but the Soviet effort in this field, revealed in full for the first time, is on a very massive scale by any standard.

We visited the Institute for Nuclear Problems, situated about 120 km. north of Moscow near the junction of the Volga with the Moscow–Volga canal, to see the two large accelerators. The Institute also contains a high-flux reactor and a heavy-ion accelerator, and is being built into a major centre for all aspects of nuclear physics under the direction of Blokhintsev. It is understood that ultimately it is to be an international centre, with eleven Communist States invited to share the facilities free of charge; we were told that physicists from Western countries would also be able to work there.

Both accelerators impressed by the excellence of their engineering. Of particular interest was the radio-frequency system of the 6-m. synchrocyclotron; this appeared, to those of us with experience in the field, the most elegant we had seen. Moreover, the reported operating data put the system ahead of all others known to us in respect of reliability and performance. The experimental enclosures attached to the synchrocyclotron are well shielded and very large in area, and contained more apparatus, such as analysing magnets and equipment for particle detection, than we had seen in any other single installation. Here again the quality was excellent, but in some respects did not match the standard set by the machine itself; for example, the external proton beams had to travel considerable distances in air after emerging from a metal window in the vacuum chamber.

The larger machine, the 10-GeV. proton synchrotron, was nearly complete. Final assembly and adjustments were expected to be completed by the end of 1956. The magnet contains 35,000 tons of steel; but, contrary to some reports, is not at all extravagant in this respect for an energy of 10 GeV. in a constant-gradient machine.

The new alternating-gradient machine now being designed, for 50-GeV. protons, may not be built on the Volga site. It was described in a number of papers by V. V. Vladimirsky and his colleagues. Similar machines of 30 GeV. and 25 GeV. are in a rather more advanced stage at Brookhaven and the European Organization for Nuclear Research respectively, but the Russian group has made an original contribution whereby the transition energy phenomenon, requiring a change of the stable phase of the particles, may be avoided at the expense of a 20 per cent increase in orbit-path and weight of steel. This proposal may have limited practical value, however, because recent work at Brookhaven has shown that the transition point may be passed safely with the help of careful design and accurate control.

A symposium on high-energy proton linear accelerators was held at the Moscow Physical Institute (of which I. V. Kurchatov is director). A group in Prof. Artsimovitch's department there had become interested in the design study carried out at the Atomic Energy Research Establishment, Harwell, in which one of us (T. G. P.) was closely concerned, and had begun studies of their own. They stated their intention to construct a 1,000-MeV. machine of this type. An exciting programme in the same Institute is being conducted by a team under G. I. Budker. This involved the production, in an apparatus of betatron type, of an intense circulating beam of relativistic electrons, 'pinched' by neutralization of the space charge by the introduction of positive ions. Inside this electron beam there may exist intense magnetic fields with a spatial configuration such that stable orbits of high-energy protons may be set up. The protons may be accelerated by the application of radio-frequency fields. If successful, this project could lead to the construction of an accelerator for 100 GeV. with an orbit radius of 3 m.; but it is of fundamental interest in any event.

Experimental Results

The first section of the main session was devoted primarily to the presentation of experimental results, with some papers discussing their theoretical interpretation. Very many of the papers presented by the Soviet physicists described work that has been done with the 680-MeV. synchrocyclotron; with the nucleon and π-meson beams from this machine, they have been able to extend to higher energies knowledge of the cross-sections for the elementary scattering processes.

While for energies up to 300 MeV. most of the possible elementary experiments on scattering of nucleons have now been made, so that a phenomenological interpretation in terms of phase-shift is becoming clear, the more complex situation at energies up to 600 MeV., with the competition of the inelastic meson-producing events, is still far from being completely understood. Soviet physicists described preliminary work on the polarization of scattered nucleons at these energies, which will give some of the extra clues needed. Neutron–neutron scattering has been investigated with the help of deuterium targets, and the evidence supports the belief that the scattering should be the same as for protons on protons, as is already well known at lower energies. The scattering of π-mesons has now been explored up to 300 MeV., but the new data are insufficient to yield any fresh information about the interaction of mesons and nucleons.

Other sessions were devoted to photonuclear reactions, and to new particles. In the latter, A. I. Alikhanyan produced evidence for the existence of a new meson; in an analysis of the masses of cosmic-ray particles he found, in addition to groups corresponding to μ-, π- and K-mesons, a clearly separated group (twelve events) of particles with a mass of 560 ± 120 electron masses.

In addition to the papers by Soviet physicists, there were a number of papers presented by the visitors, especially those from the United States, surveying recent and current work on the same topics in other institutes.

Field Theory and Related Matters

There were four sessions devoted to field theory and other technical theoretical matters. These naturally did not command so large an audience as those in the main section, but the sustained interest of a large number of young Soviet physicists was remarkable. Several of the papers presented related to the question of the utility of field theory; a subject which also overflowed into the main section. One extreme point of view, strongly advocated by L. D. Landau, I. Ya. Pomeranchuk and others, contends that the theory is nonsense because a logically consistent discussion of the solution of the equations appears to lead to the absurd conclusion that there is no interaction at all between different fields. Against this it is contended, not only that this conclusion has not been proved rigorously, but also that, in meson physics, the field theoretical ideas have proved to be qualitatively correct in many respects, and should be retained as a guide until a better theory can be formulated.

Among the applications of field theory there was discussion about the formulation and use of 'dispersion relations' for the scattering of nucleons; at present there is no simple way of using these, analogous to their successful employment in the discussion of meson scattering.

The discussions at this conference, and the close personal contacts made at many levels, were very encouraging for future international collaboration in scientific work. There appears to be reason to hope that they will be followed, not only by further conferences in which East and West will co-operate, but also by individual visits and by correspondence on matters of common interest.

T. G. Pickavance
T. H. R. Skyrme

GENEVA CONFERENCE

The symposium on High Energy Accelerators and Pion Physics, organized by the European Organization for Nuclear Research (C.E.R.N.), was held in the Institute of Physics of the University of Geneva during June 11–23. Although some of the participants had attended the Moscow Conference, and a few of the papers were repeated, the great majority of the papers were heard for the first time. There were representatives of all the twelve member States of the Organization, about fifty each from the United States and the U.S.S.R., and others from Australia, Canada, Czechoslovakia, India, Spain and the United Nations Educational, Scientific and Cultural Organization.

High-Energy Accelerators

The first week was devoted to high-energy accelerator problems, with the emphasis on new ideas rather than recitations of lists of parameters. Authors of main papers, of 30 min. duration, had been invited to submit texts well in advance for reproduction and distribution by the Organization, and nearly all of them had co-operated. This procedure lends itself well to accelerators, development of which takes years of effort by large teams, though less well to experiments in physics. Many authors had taken the opportunity to write up their work in considerable detail and at greater length than could be accommodated in a half-hour talk. The conference 'preprints' were therefore very useful documents, and greatly aided discussion after the formal presentation of papers. Ample time was left for informal discussion, and there were no parallel sessions.

Main papers were presented by the Middle West (MURA) Group from the United States (D. W. Kerst, K. R. Symon, L. W. Jones) on the new fixed-field alternating gradient machines (FFAG). The object of the MURA project is to accelerate protons to energies of 15 GeV. or more, in a ring-shaped magnet energized by direct current and accommodating a large range of particle momenta in a small range of orbit radii. A disadvantage of normal synchrotrons, whether of constant gradient or alternating gradient type, is that the rate of repetition is limited to a low value by the problem of cycling the magnetic field; this difficulty is absent from machines of fixed-field type, and much higher intensities are hoped for. However, it is necessary to introduce azimuthal variations of magnetic field, and there are severe fundamental difficulties in establishing a stable system of particle dynamics. High-intensity operation also poses serious radio-frequency and phase-stability problems. All these matters were discussed, together with a proposal by the MURA group to combine the beams of two such accelerators so that protons travel in opposite directions before collision. The energy liberated in the centre of mass system of co-ordinates would then be 30 GeV., for two 15-GeV. accelerators, and this would correspond, in the usual system where the target proton is at rest, to a bombarding energy of about 600 GeV. However, very high beam intensities would be needed for a useful yield of collisions.

Colliding-beam systems have been discussed for many years, but efforts are now beginning to be made to discover means of making them more plausible. There was much discussion of 'storage rings', for example, by W. M. Brobeck (Berkeley) and G. K. O'Neill (Princeton). A pair of these could produce colliding beams in a common sector, the rings being fed alternately by a single high-energy accelerator. Some of the informal discussion entered the realms of fantasy, but it was very stimulating.

Fixed-field alternating gradient systems may also be applied to cyclotrons, and a main paper by the Harwell group (T. G. Pickavance) discussed studies of machines of that type for high-intensity operation at about 3 GeV.

Three important Russian papers were presented on 'new ideas'. A. Naumov reported the work of Budker on relativistic stabilized electron beams (previously reported in Moscow). V. I. Veksler, in a most interesting contribution, speculated upon the possibility of accelerating particles in dense bunches using the field between a bunch and another group of charges, a plasma, or an electromagnetic wave. Such methods Veksler called 'coherent', because the force on a single particle would be proportional to the number of particles in the bunch. One possibility would be to exploit an 'inverse Cerenkov effect', according to which a medium, travelling rapidly past a charged particle, imparts energy to the particle. Ya. B. Fainberg discussed a system in which a plasma could be made to act as a wave-guide, particles being accelerated by an applied radio-frequency field. Phase and radial stability could be achieved and power losses would be less than those experienced with ordinary metal waveguides.

The remaining accelerator sessions dealt mainly with problems of existing machines or machines under construction. Papers on phase transition, radio-frequency acceleration injection, and extraction were presented by members of the Brookhaven, CERN and Russian groups concerned with the large alternating-gradient proton synchrotrons, and on magnet problems by the same groups and by M. Bruck (Saclay), J. M. Blamey (Canberra) and D. W. Kerst (MURA). There was a session on the important topic of non-linear betatron oscillations, in which main papers were read by R. Hagedorn (CERN), E. D. Courant (Brookhaven), A. A. Kolomenski (U.S.S.R.) and K. R. Symon (MURA), and another on linear accelerators with contributions from Brookhaven, Harwell, Kharkhov, Berkeley and Stanford. L. W. Smith (Brookhaven) and E. J. Lofgren (Berkeley) reviewed the operational problems of the 3-GeV. cosmotron and the 6-GeV. bevatron, respectively. These two great machines have now become organized facilities for research; the scale of organization required impressed everyone at the conference. For example, the bevatron requires the full-time services of nearly eighty people, from graduate physicists and engineers to craftsmen and technical assistants, not counting the research workers engaged in experiments. A degree of organization, at one time considered foreign to fundamental research, has therefore to be applied to the research programme; this is a difficult problem.

The accelerator sessions were most lively and successful, and it was noteworthy that the informal discussion was maintained at an exceedingly high standard to the end. Accelerator studies have developed into a branch of learning in their own right, and the conference showed that many laboratories in many countries are making vital contributions to this rapidly advancing field.

Developments in Technique

The first one and a half days of the second week were devoted to discussions of developments in technique. An introductory talk by D. A. Glaser, of the University of Michigan, on bubble chambers was followed by seven other papers on the subject from laboratories in France, Italy, the United States and the U.S.S.R. Attempts to improve the cycling time of cloud chambers were discussed by British and American groups.

In a review of recent advances in millimicrosecond-counting techniques, O. Chamberlain (University o California) mentioned the production of an experimental transmission type of photomultiplier by Sternglass and Wacktel, of the Westinghouse Research Laboratories. In one design the multiplying electrodes consist of gold foil 20 A. thick followed by a layer of potassium chloride 450 A. thick. The tubes require a few kilovolts per stage, and with seven stages of multiplication yield pulse-rise times of less than 1 millimicrosecond, but at the present stage of development they suffer from severe fatiguing troubles. A new R.C.A. tube (type number 6810) is, however, commercially available and this has the advantage of an output of 0·3 amp., so that for many applications it is possible to dispense with further amplification. By limiting the area of the photocathode it is possible to get rise-times as short as 1·5 mμsec.

One afternoon of the conference was devoted to the presentation and discussion of experimental results. It is perhaps a significant pointer to the future that pride of place was given to a session entitled "Antiproton Physics". E. Segrè gave a review of the antiproton work at Berkeley. For the time being, antiprotons have been produced only by proton bombardment of copper targets in the bevatron. From a study of stars produced by the interaction of antinucleons with matter, it has been determined that some stars show a visible energy release greater than Mc^2, which is proof that the antiproton is annihilated with a nucleon. It is not yet known whether the mechanism of production is a nucleon–nucleon collision producing an antinucleon–nucleon pair, or whether an intermediate step involving the production of a π-meson is required.

Interaction cross-sections in beryllium and in copper have been measured and found to be about twice the cross-section for protons. A possible explanation of this unexpected result has been given by Duerr and Teller (*Phys. Rev.*, 101, 494; 1956).

Another striking event of the conference was an announcement by Prof. W. Pauli of news from the United States that the well-known inverse beta decay experiment of Cowan and Reynes had yielded a positive result, compatible with a cross-section of about 6 × 10^{-44} cm.^{2} Evidence for the existence of the neutrino has thus been established.

Meson Physics

Most of the remaining sessions were devoted to meson physics. This was a deliberate policy on the part of the organizers of the conference, who had in mind the experiments that will be carried out on the C.E.R.N. synchrocyclotron (due for completion in 1957). The continued great interest in this important field was illustrated by the large number of interesting papers presented from many laboratories. It must suffice to summarize the proceedings by saying that many experiments gave supporting evidence for the existence of an isobaric state of the pion–nucleon system and of such a state in the charged-pion production process.

An elegant experiment outside the field of meson physics was reported by R. Hofstadter, on the structure and size of the proton. This experiment was carried out by measuring the angular distribution and differential cross-section for the scattering of high-energy electrons by protons. At large angles and high energies, the cross-section for scattering deviates from that expected for a point proton by about a factor of nine. The results fix the root mean square radius of the proton at $0{\cdot}77 \pm 0{\cdot}10 \times 10^{-13}$ cm. for each of the charge and momentum distributions.

There were visits to the CERN site at Meyrin, near the French frontier. It was most encouraging to see the great progress made on the construction of the elaborate foundations and ring building of the 25-GeV. machine. Construction of the 600-MeV. synchrocyclotron appeared to be well advanced. The whole conference was well organized and was a good augury for the continued vitality of this absorbing field of study.

T. G. PICKAVANCE
G. H. STAFFORD

SYNTHETIC DETERGENTS AND THE TREATMENT OF WATER AND SEWAGE

SINCE 1949 there has been something like a threefold increase in the sales of synthetic detergent mixtures in Britain, the majority of which contain as their most important constituent anionic surface-active agents of the alkyl aryl sulphonate type. Although these substances are used to some extent in industry, the big expansion in their sale during the past ten years has been for domestic purposes. Thus most of the synthetic detergents now used in Britain are discharged by the housewife to the sewers of local authorities and, except in some coastal towns, eventually pass to a sewage-disposal works.

Domestic sewage is normally treated by sedimentation and biological purification, and although the methods used may appear to the uninitiated as somewhat crude and primitive, they are in fact extremely efficient and capable of effecting a high degree of purification at a remarkably small cost. They are, however, rather easily upset by the presence in the sewage of certain types of substances, particularly those which interfere with microbiological processes, this being the main reason why it is often difficult to treat sewage in an industrial district where large quantities of trade effluent are discharged to the sewers. During the past few years there has been a growing feeling that household synthetic detergents are among the substances which cause difficulties at sewage works. Moreover, it is known that part of the surface-active agent they contain often passes through a treatment plant and so is discharged with the effluent to a river. It is common knowledge that during the past few years there has been a marked increase in the extent to which foam is formed on polluted rivers, particularly at places where they pass over weirs, and this again is commonly attributed to the presence of the surface-active materials in the water. In some parts of Britain rivers to which sewage effluents have been discharged have to be used as a source of raw water for domestic supply, and there has therefore been some anxiety as to whether surface-active agents may persist throughout a water-treatment plant and so be present in the supply distributed to a town, particularly since this is known to have occurred during exceptionally dry weather in at least one place in the United States[1]. For these reasons the Minister of Housing and Local Government some time ago set up a committee under the chairmanship of Sir Harry Jephcott to study the subject; its report has just been published[2]. A few weeks ago also the Association of American Soap and Glycerine Producers (who make synthetic detergents), through a report prepared by F. J. Coughlin, chairman of the Association's Technical Advisory Sub-Committee on Research, has made available the results of its own observations on the position in the United States[3].

The report of the American Association gives the impression either that the effects of detergents are not so marked in the United States as they are in Great Britain, or that if they are the Association has not fully appreciated the difficulties that have been caused. It is certain that at many sewage works in Britain, and especially at those using the activated-sludge process, frothing has increased during the past few years to a point at which operation of the plant is made very difficult, and in some cases dangerous, and that this frothing is due to the presence of surface-active constituents of synthetic detergents in the sewage; indeed, the British report includes two photographs of frothing at sewage works, at one of which the layer of foam appears to be several feet thick. The American Association, while agreeing that frothing has increased in the United States, does not appear to accept that detergents are the cause of it. It says also that frothing on the surface of aeration tanks and activated-sludge plants can be stopped by increasing the concentration of activated sludge in the mixture aerated. This was not found to be so in Britain, where experiments were made, at the suggestion of Sir Harry Jephcott's Committee, at several sewage works without any marked success. An important point of principle is, in any event, involved here; the processes used at sewage works have been evolved from experience and experiments over many years and the conditions at any particular plant are chosen to bring about the most effective purification of the sewage. It is very rarely that they can be drastically changed merely to prevent some difficulty caused by the discharge to the sewers of some strongly interfering substances whether of domestic or industrial origin.

Where an effluent which would seriously interfere with sewage treatment is discharged to the sewers from a factory, it is very often required (legislation being available to enforce this) that it should be pre-treated by the manufacturer to remove the most noxious constituents. For example, effluents from electro-plating works are often treated in this way to remove cyanides and toxic metals. It is clear that washing waters containing synthetic detergents cannot be pre-treated by the housewife; but an obvious suggestion is that manufacturers of these substances should endeavour to produce materials which, though satisfactory for washing purposes, would be readily decomposed by the processes, including microbiological processes, commonly used at a sewage works. Difficulties in sewage treatment would thereby be greatly reduced, and the material would not be discharged with sewage effluent to rivers. Thus, any risk there may now be of constituents of detergents persisting in potable water supplies would be removed. Another important reason—not mentioned in the American report—is that it is known that surface-active agents in a river may seriously reduce the rate at which atmospheric oxygen dissolves in it[4]; it would be expected, therefore, that they would accentuate the de-oxygenation of a river containing a given amount of polluting matter.

One of the recommendations of the British report is that manufacturers of household synthetic detergents should investigate the possibility of producing efficient washing products based on materials which can be readily oxidized or eliminated when treated at a sewage works. The American industry also accepts that research of this kind is necessary and is sponsoring work at the Massachusetts Institute of Technology. Preliminary work in Britain[5] has shown that the resistance of alkyl benzene sulphonates to bacterial attack is correlated with the nature of the alkyl group, straight-chain compounds being much more readily decomposed than those with branched chains. The development of readily decomposable substances with the necessary detergent properties, and which could be economically manufactured from available raw materials, might obviously require lengthy research, but should surely yield to the combined attack of the organic chemist and microbiologist.

The question arises whether the public interest is sufficiently safeguarded while research of this kind is being carried out. It is reported that in 1955 a Bill was introduced in the Kansas Legislature which would have made it unlawful to put detergents into a public sewer. The British Committee has not recommended anything like such drastic action. The majority, however (four members dissenting), considered that there is at least a possibility that a serious situation might arise before a practicable remedy has been found. It points out that there are at present no statutory powers for controlling the composition of detergents sold to the public and recommends that the Government should consider whether to seek these powers now or to defer obtaining them until a clear need for them has arisen. It recommends also that in the meantime an advisory body, including representatives of the sewage authorities and manufacturers concerned and of appropriate Government departments, should be set up to give counsel and facilitate research, and to keep watch on the position at sewage works, on rivers, and at water works, in relation to the continued use of synthetic detergents of the type at present being manufactured.

B. A. Southgate

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[1] Gallaher, W. U., *J. Amer. Water Works Assoc.*, **42**, 22 (1950).

[2] Ministry of Housing and Local Government. Report of the Committee on Synthetic Detergents. Pp. 60. (H.M. Stationery Office, London, 1956.) 3*s.* net.

[3] F. J. Coughlin, "Detergent Research Related to Water and Sewage Treatment". Pp. 17. (From the Association of American Soap and Glycerine Producers, Inc., 295 Madison Avenue, New York 17.)

[4] Gameson, A. L. H., Truesdale, G. A., and Downing, A. L., *J. Inst. Water Eng.*, **9**, 571 (1955).

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THE STUDY OF MAN-MADE FIBRES

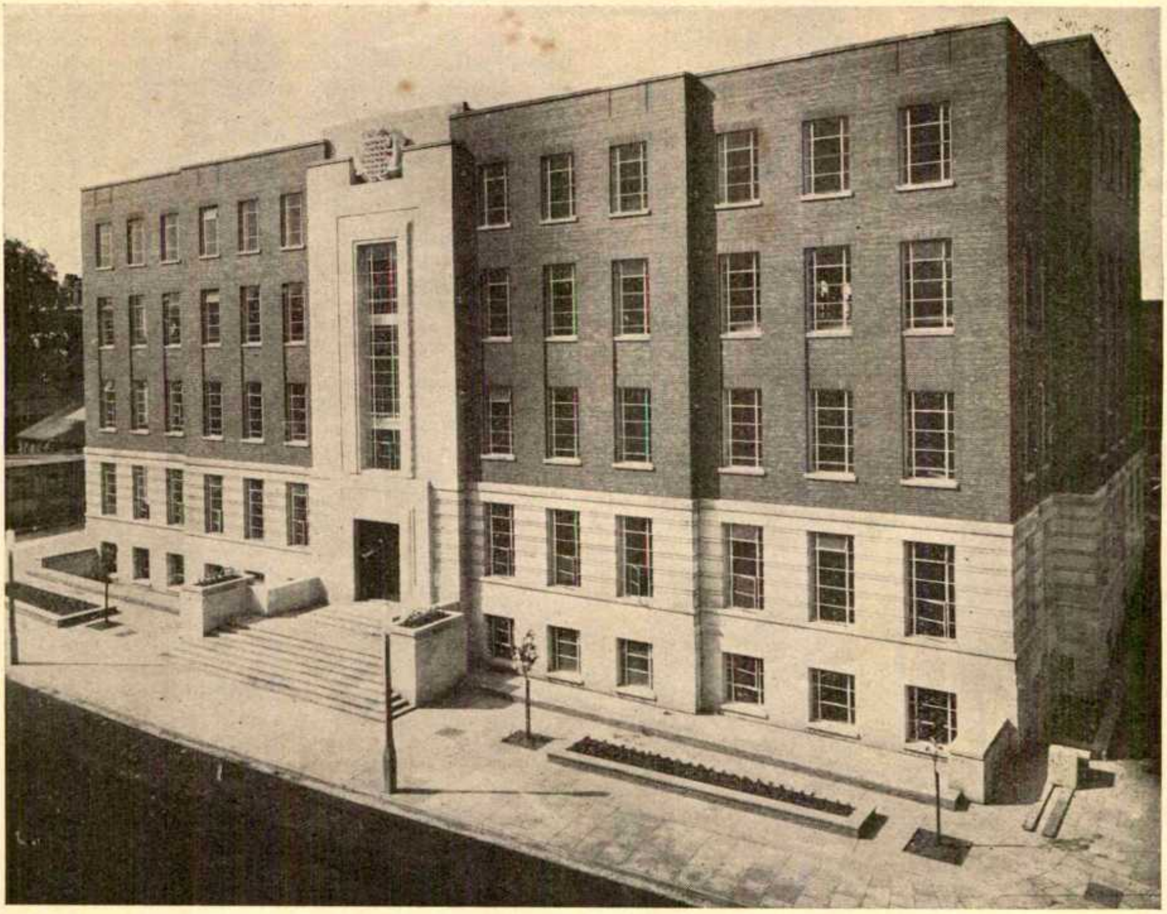
By Prof. J. B. SPEAKMAN

Department of Textile Industries, University of Leeds

A NEW building for the Man-made Fibres Division of the Department of Textile Industries of the University of Leeds was opened by the Duke of Edinburgh, in the presence of the Chancellor of the University, the Princess Royal, on June 29. Besides being the crowning point of some fourteen years endeavour in the Department of Textile Industries, the opening ceremony marks the beginning of a striking new period of expansion of the Faculty of Technology in a University which was already remarkable for its strength in the field of applied science.

The new Man-made Fibres Division is the direct outcome of the scientific revolution which the textile industry has undergone during the past forty years. Not only has this period seen the emergence of a science of fibres, based on the discovery of the main features of the constitution and structure of the chief natural fibres, with simultaneous rapid advances in the production of regenerated fibres from cellulose, cellulose acetate and proteins, but also the study of polymerization reactions has led to the synthesis of fibre-forming polymers and the manufacture of truly synthetic fibres.

Changes as profound as these could not, of course, take place without affecting the nature and scope of the training of the textile technologist; but progress seems to have been handicapped by the traditional structure of the textile industry in the United Kingdom. Regional segregation of industries based on the different natural fibres led to corresponding specialization in the main educational centres. Just as the University of Leeds focused attention on wool, so other institutions gave chief place to cotton, silk, flax or jute. Although the growing importance of man-made fibres has everywhere been recognized, pride of place is normally given to the natural fibres with which the institutions are traditionally associated,



Photograph by W. Blackledge, University Photographer

Fig. 1. Man-made Fibres Division, Department of Textile Industries, University of Leeds

and the man-made fibres are relegated to a second place bearing little relation to their importance in the national economy.

The magnitude of the man-made fibre industries may be gauged from the fact that, in 1954, the world production of regenerated fibres was about one-quarter of the world production of cotton and nearly double that of wool, while the production of fibres from synthetic polymers, which was negligible in 1935, was six times that of silk. Considerations such as these make it obvious that there must be at least one institution in the United Kingdom where the study of man-made fibres is not subordinated to that of natural fibres—one where textile technologists can receive specialized training for the industries which are engaged in making and using man-made fibres.

A project of this kind was conceived in 1942, and conversations were then begun with the directors of Courtaulds, Ltd., about the possibility of establishing a Man-made Fibres Division of the Department of Textile Industries in a new building near the Clothworkers' Departments of the University of Leeds, now the Wool Division. Immediate action was impossible because of the War, but with characteristic generosity Messrs. Courtaulds made a donation of £60,000 towards the cost of the building in 1947. This donation was followed by one of £40,000 from the Man-made Fibres Producers' Committee in 1949. By then, plans for the new building (Fig. 1) had been prepared by Dr. T. A. Lodge, the University architect; but the estimated cost was far higher than the sum available, building permits were difficult to obtain, and the shortage of labour was acute. In 1952, however, a grant of £201,000 was made by the University Grants Committee to cover the balance of the estimated cost, and work was begun in July 1953.

The Department of Textile Industries at Leeds has been fortunate also in receiving further generous donations towards the cost of equipping the new Division. These include £25,000 from the Man-made Fibres Producers' Committee, £20,000 from Imperial Chemical Industries, Ltd., £7,000 from the Federation of Calico Printers, and £5,000 from the Tootal Broadhurst Lee Co., Ltd., as well as £70,000 from the University Grants Committee. In addition, machines and other equipment have in many cases been supplied free or at reduced cost by the makers.

As may be seen from the photograph, the new building has four floors and a semi-basement. As regards machinery, the key floor is the first. Here, along the north wall, is housed pilot plant for demonstrating methods of producing viscose and cellulose acetate rayons, nylon, 'Terylene' and orlon. Cotton carding and spinning machinery for converting staple fibre into yarn is housed in an adjoining room in the centre of the building, and continuous filament and staple fibre yarns are converted into woven and knitted fabrics in rooms on the west and east walls, respectively. The carding and spinning, weaving, and knitting rooms are all provided with equipment for maintaining atmospheres of constant relative humidity. From the first floor the fabrics pass to the ground floor for dyeing (east end), printing (west end) and finishing (north wall). The ground floor includes also a dark room for the preparation of screens for screen printing, and two humidity rooms in which textile testing equipment is housed, one room being for use by undergraduates and the other for research students. On the second floor are two large laboratories for practical work in textile chemistry and textile physics by second- and third-year undergraduates, and the third floor includes a well-lighted design studio, for use mainly by students specializing in textile design, and two lecture theatres. Research laboratories are provided on the south side of each floor: in the semi-basement, for textile physics (electron microscopy, infra-red spectroscopy and X-ray analysis of fibre structure); on the ground floor, for applied chemistry (dyeing and finishing); on the first floor, for textile engineering; on the second floor, for textile chemistry; and on the third floor, for applied physics and textile chemistry (chemistry of high polymers).

In accordance with the 1942 plan, therefore, the Man-made Fibres Division is self-contained. It possesses equipment covering all stages of processing from fibre to fabric and confirms the rising stature of the man-made fibre industries. The advantages attached to the creation of the new Division have not, however, obscured its dangers. There is a unity in the science of fibres which transcends divisions, and there is so much common ground and interplay between the various branches of textile technology that division is dangerous. For these reasons, the Wool Division and the Man-made Fibres Division are to be regarded as complementary. Together they provide unrivalled opportunities for teaching and research, and all members of the staff will have responsibilities in both Divisions. Similarly, undergraduates will make use of both Divisions in the early years of their courses, leaving specialization in either wool or man-made fibres to the final year. In this way the unity of the science of fibres will be preserved and the growing unity of textile technology promoted.

In his address at the opening ceremony, the Duke of Edinburgh stated that "This new building can only be justified if the Man-made Fibres Division has constantly in mind that its work can be of direct service to the country. . . . The Division cannot possibly flourish without the active and continued interest of the industry, and I would go further and say that the Division will only be kept up to the mark if the industry makes sudden and impossible demands upon it". The close and cordial relationships between the Department of Textile Industries and the industries it serves ensure that such demands will be made and the high hopes entertained of the new Division realized.

GRASSLAND RESEARCH INSTITUTE: NEW RESEARCH BUILDINGS

By Dr. WILLIAM DAVIES

Director

THE new research laboratories of the Grassland Research Institute at Hurley, Berkshire, were opened by the Right Hon. D. Heathcoat-Amory, Minister of Agriculture, Fisheries and Food, on June 29.

The Institute was founded in 1949 for the investigation of grassland and of the many problems associated with the production and use of pastures by the grazing animal. The governing body is under the chairmanship of Sir James Scott Watson and consists of scientists and practising farmers, who are appointed by the Ministry of Agriculture, Fisheries and Food, the Secretary of State for Scotland and the Agricultural Research Council, the latter being responsible for the scientific supervision of the Institute, which takes its place among the other grant-aided research stations operating under the scientific guidance of the Agricultural Research Council. The Grassland Research Institute was preceded by the Grassland Improvement Station, established in 1940 at Drayton (near Stratford-on-Avon) under the inspiring leadership of Sir George Stapledon. In 1949 the new Institute took over the functions, facilities and staff of its forerunner, but since that time has considerably extended in terms of both staff and facilities. The new research buildings at Hurley have been in full occupation since the autumn of 1955 when, for the first time, the scientific staff had the very real advantage of working together at a single centre with adequate laboratory and field facilities.

The opening of the new laboratories marks, therefore, the end of the first important phase in the development of the Institute. The scientific staff can now settle down to develop the research programme, the basis of which is already laid. As this programme unfolds and is developed along lines of fundamental research both in field and laboratory, it will provide new information leading to improved techniques upon which progress in grassland farming can be made.

The main work of the Institute is concerned with the study of herbage as a crop for feeding to farm animals, and also as a medium for maintaining and improving the crop potential of the soil. Untended grassland is characteristically seasonal in growth, showing a large peak of production in late spring and early summer, followed by a shortage after midsummer and little or no production after September. This marked seasonality in growth is accompanied by equally sharp differences in the quality of the herbage offering to the grazing animal, and this confronts the pastoral farmer with a difficult series of problems in stock husbandry. This is a matter of importance, because grassland in one form or another provides the main basis for the livestock industry as concerns cattle and sheep.

One important field of endeavour, therefore, is to investigate means for providing a more even supply of pasturage not only throughout the normal growing period from April to September but also into the autumn, winter and early spring. Because different

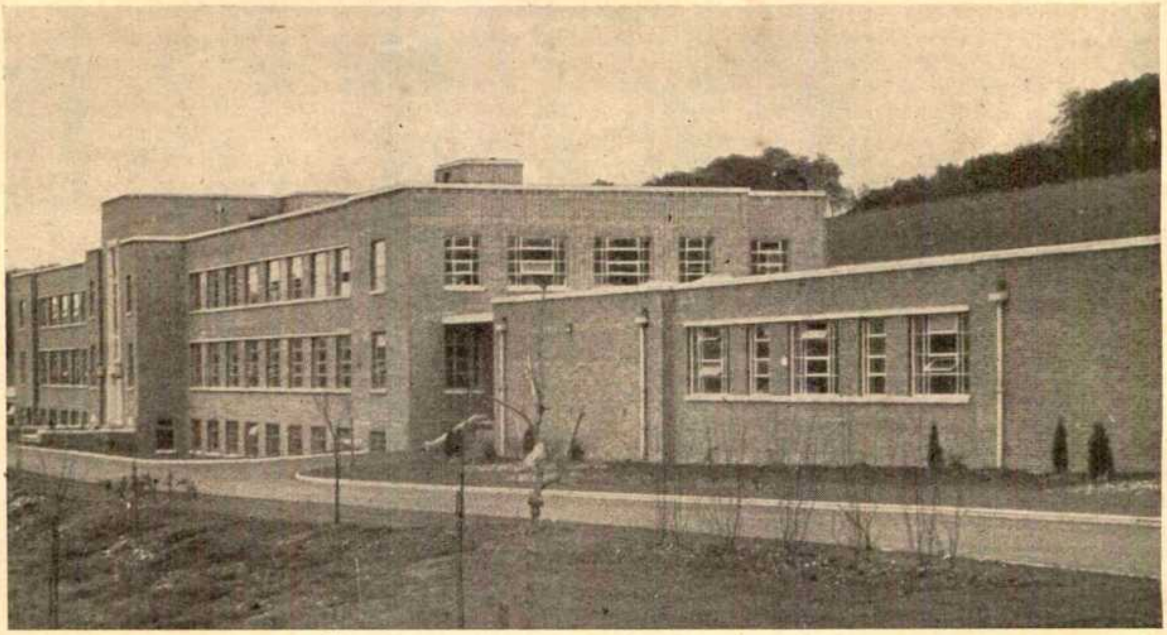


Fig. 1. New buildings of the Grassland Research Institute

species and strains of herbage plants show different growth rhythms, some emphasis is placed on using different seeds mixtures in order to provide for the periods of normally low production. Similarly, the influence of differential fertilizer treatments and of manner of usage of the pasture is being studied with the practical aim of extending the grazing season and of providing a more uniform diet for the grazing animal while at pasture.

The studies of the production and use of the grass crop, however, extend beyond the question of seasonality. The facilities offered by the new laboratories will enable the research staff to follow up the work already commenced in the sphere of animal nutrition and in the evaluation of herbages as livestock feed. Interesting studies on the appetite of animals at pasture are being made and some progress is apparent in the use of methods which will provide a more accurate picture of herbage digestibility as well as of herbage intake. No wholly satisfactory method is yet available which gives a true picture of what the animal eats when at pasture. Indoor feeding and digestibility trials provide only a partial answer and it will, therefore, be an important advance when a reasonably simple series of chemical values can be correlated directly with digestibility and other biological characters of the feed intake. Work along these and associated lines is in progress, and some of this is concerned with the biochemical study of herbage fractions, including both the proteins and the carbohydrates in herbage of different sorts and in various stages of growth.

Detailed studies are being made on growth and development in a number of the grasses, and this work is extended to studies into the physiology of seed production. The ontogeny of the grass shoot (that is, tiller) has been given attention and has led to the interesting suggestion that most tillers are annual or nearly annual. There is a large and very profitable field of work awaiting the attention of the physiologist in the study of both tops and roots of herbage plants subjected to different agricultural treatments. The facilities made available by the new research buildings enable the Institute to investigate a number of problems in this important sphere.

Capital grants for the construction of the laboratories and glasshouses at Hurley have been provided by the Ministry of Agriculture, Fisheries and Food. The main building is in brick with a flat roof. It is pleasing in appearance, due regard having been given to its site in the beautiful countryside of the Thames Valley and Chiltern Hills. The building is of two stories with semi-basement. The latter contains the instrument mechanics' workshop, various stores and several laboratories. It also includes a staff canteen of modern design, and a small staff common room.

The boiler house is at the eastern extremity of the basement. Heating is by oil-burning boilers which, in necessity, could be modified to use solid fuels. The whole building is panel-heated, the panel installation being in floor and ceiling. There are no radiators and therefore no obstructions to laboratory benching on this score. All laboratory equipment is electrical, and since there is no gas supply, all chemical work is also by electric heating, including nitrogen and other determinations. Butane gas cylinders are available for glass-blowing and for other occasional requirements. Demineralized water is serviced to certain of the laboratories, and this has already proved to be most useful. Plastic piping has been used extensively throughout the laboratories, including plastic waste and drainage pipes.

The ground floor houses plant physiology, part of the agronomy units, microbiology, entomology and biometrics. On this floor there are five large laboratories; two of these are for plant physiology, one is for herbage work, another for soil studies and the fifth for microbiology. In addition, there are a number of smaller laboratories and laboratory offices. The main conference room occupies a central position, and above it on the top floor is the Sir George Stapledon Library, which houses the joint Grassland Research Institute/Commonwealth Bureau of Pastures and Field Crops collection of books and periodicals.

The west wing (top floor) is occupied by animal agronomy, animal nutrition and biochemistry. The east wing contains the offices and administrative units of both the Institute and the Commonwealth Bureau of Pastures and Field Crops (Director, A. G. Glendon Hill).

Annexed to the main research block there is a one-story building which is essentially functional in design. This outbuilding contains the cold store (capable of holding 25–30 tons of deep-frozen herbage) with the refrigeration machinery. There is a large herbage weighing room, adjacent to which are grinder and oven rooms; the latter is equipped to house six 'Unitherm' drying ovens used for dry-matter determination on herbage samples. Near the cold store is a spacious metabolism house sufficient to hold twenty-four sheep crates at one time. Alternatively, it will house a dozen or so cattle in individual pens. Already a series of critical digestibility trials has been conducted in the metabolism house, feeding both fresh and frozen plant material to sheep. The outbuilding also contains space for storage, including a store for volatile chemicals, various workshops and arrangements to house technical equipment currently used in the field experiments. There is also shedding for tractors and other vehicles employed in technical work.

To the south of the main building space is reserved for the glasshouse block, and the first glasshouse (subdivided into six units) is already erected. This is heated and is thermostatically controlled. It has been designed primarily for physiological and related agronomic investigation.

The new laboratories at Hurley are well equipped and offer excellent facilities for conducting basic studies on biological materials. There is good laboratory accommodation of functional but simple design and excellent facilities for postgraduate workers, whether of Britain or overseas, to pursue investigations and to train in the important fields of grassland agronomy, animal nutrition, biochemistry of herbage materials, physiology of grassland plants, microbiology, soil problems relating to grassland, and biometrics as applied to grass and animal experiments.

At the opening ceremony, Mr. Heathcoat-Amory spoke of the vital part that the Institute would play in the future of British farming. "Making the most of grass" is the most important single way in which farmers can help themselves and their country. Nearly two-thirds of Britain's 31 million acres of farmland are under grass—but this great asset is under-exploited. Less than one-fifth of our grassland receives regular dressings. Mr. Heathcoat-Amory pointed out that this neglect of grass contrasts sharply with the care devoted to arable crops. The full exploitation of the grass crop would save millions of pounds in the national import bill; for the thousands of small farms, most of which will remain under grass, it offers the greatest hope for the future. The Minister summed up the present position by saying that grass is still taken for granted rather than treated as a crop. Advisory officers are, Mr. Heathcoat-Amory said, devoting more and more attention to the improvement, production and use of grass, and for guidance and news of progress they look to scientific research of the kind the Institute is doing so well. By all reports, the Institute is fulfilling its crucial role. The Minister was particularly impressed by the work being done to extend the grazing season—work of the greatest practical importance. The new laboratories mark, he said, another stage in the Ministry's programme of agricultural research, and proof of the value of this research can be seen in the increasing use made of new techniques and materials in agriculture. British agriculture can only hold its own in a competitive world by the extension and intensification of research —but the funds available for the purpose cannot be increased. Research is useless unless the results are passed on to other research workers and farmers. In this connexion he welcomed the fact that the Commonwealth Bureau of Pastures and Field Crops is housed in the same building as the laboratories.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, LONDON

REVISED EXPANSION SCHEME

THE architectural plans for new Imperial College buildings on the rectangular site bounded by Queen's Gate, Imperial Institute Road, Exhibition Road and Prince Consort Road were described and illustrated in *Nature* of April 21. The plans, prepared by Messrs. Norman and Dawbarn, provided for the very large new buildings needed for the major expansion being undertaken by the College at the Government's request. Much public attention was focused on one feature of the architectural scheme, namely, the proposed demolition of the Imperial Institute building, designed by Collcutt, the high central tower of which is a well-known feature of the London skyline. The Royal Fine Art Commission expressed the wish that the whole of the Collcutt building should be preserved. The London County Council, as town planning authority, considered the scheme would somewhat overbuild the site, and that a reduction in density might also make it possible to retain at least the tower of the Collcutt building. In consultation with the Royal Fine Art Commission and the London County Council, the College and its architects have now reconsidered the scheme, and have prepared the revised plans announced by the Lord Privy Seal in the House of Commons on June 21.

In the new scheme the Collcutt tower is retained as a free-standing campanile rising from a central court. The whole of the central area of the site has been replanned, and the height of the buildings reduced to avoid conflict between modern rectangular building masses and the tower. Asymmetrically arranged, the central area includes a building for Civil Engineering and one for Electrical Engineering. Behind them will be a Great Hall for about eight hundred, and a low central block containing refectories and common rooms. A high central block placed behind the Electrical Engineering building will contain libraries, administrative offices, common rooms and committee rooms (Fig. 1). The remainder

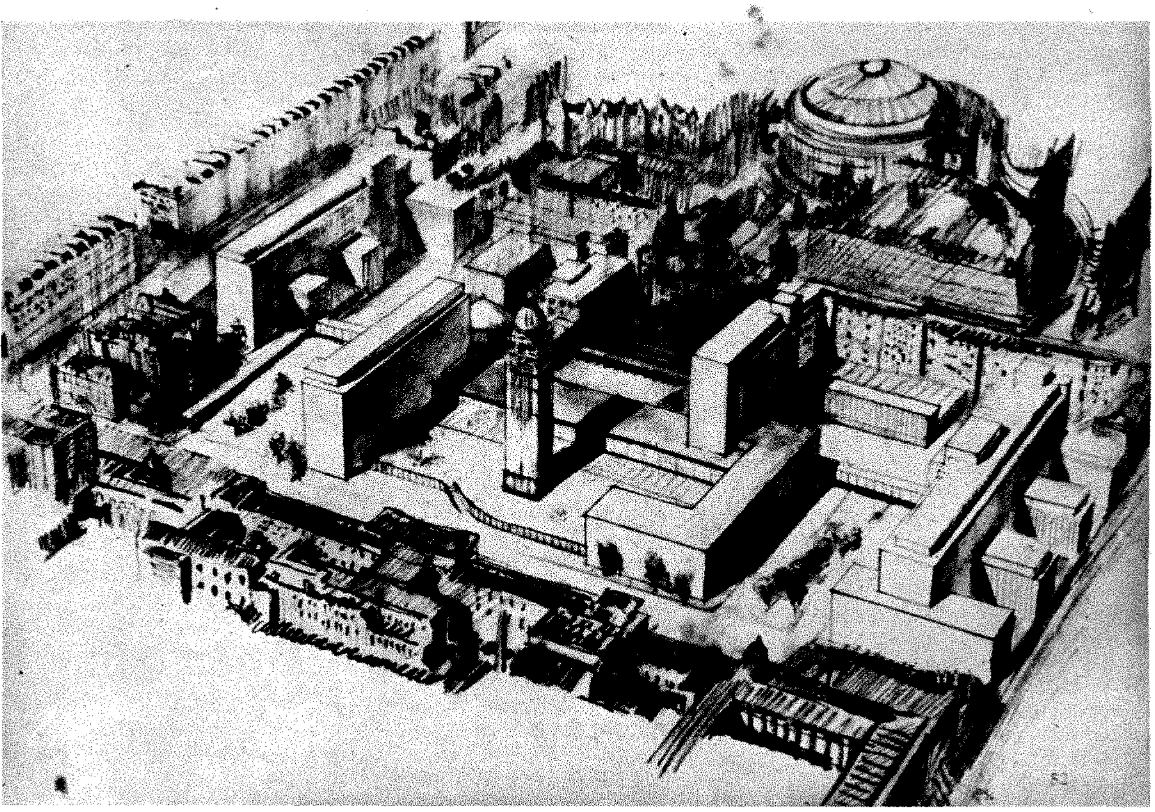


Fig. . Revised scheme, retaining the Collcutt Tower, for the Imperial College of Science and Technology

of the scheme for the main College expansion will be in accordance with the original plans. It has not been found possible to reconcile an expansion on the scale required with the retention of the whole of the Imperial Institute building.

The reduced density of building now proposed for the main site has been made possible by the recent acquisition by the College of the north, east and south sides of Princes Gardens. The Gardens lie just off Exhibition Road, and are about a hundred yards from the College buildings. These sites are reserved for residential purposes, and have been acquired by the College primarily to provide much-needed Halls of Residence for its students. The existing Halls cannot accommodate more than a very small fraction of the growing number of students, and the College hopes to provide 480 new study-bedrooms by the immediate development of the east and south sides of Princes Gardens.

While the Princes Gardens sites are not in any sense a substitute for the central site, the original plans for the central site provided for certain common rooms and refectory facilities which the Planning Authority is prepared to accept in Princes Gardens. Thus a portion of these facilities will now be transferred to the Princes Gardens scheme, where they will occupy half the new building proposed on the south side. The other half of the south side, and the new building proposed for the east side of the Gardens, will be for residence.

NEWS and VIEWS

Oceanography at Gothenburg :

Prof. Hans Pettersson, For.Mem.R.S.

PROF. HANS PETTERSSON, whose election to the foreign membership of the Royal Society of London was announced recently (*Nature*, 177, 918; 1956), retired on July 1 from the directorship of the Gothenburg Institute of Oceanography. Pettersson's activities have ranged over a wide field, with particular success in studies of the penetration of light into the sea and of the radium content of abyssal oceanic sediments. A burning desire to probe much deeper into the latter in the interests of geochronology than had earlier been possible led Pettersson during what he called "the enforced inactivity of the Second World War" to promote the construction of, and to test, the implements required. A novel vacuum corer developed in 1942 in association with Kullenberg gave place to the latter's very efficient piston corer, and thereafter the call was for opportunity to use it widely over the great ocean depths. It is Pettersson's crowning achievement that his boundless enthusiasm and persuasiveness produced the large funds which made possible the justly famed Swedish circumnavigation cruise of the *Albatross* during 1947–48, when, as leader, he so effectively fulfilled his "longing to grapple with the mysteries of the ocean floor".

Prof. E. B. Kullenberg

PROF. EINAR BÖRJE KULLENBERG, who succeeds Prof. Pettersson, was born in Scania, south Sweden, in May 1906, the son of a farmer. Educated at the

University of Lund, where he studied mathematics, physics and chemistry, Kullenberg graduated in 1928. Ten years later he gained his doctorate with a thesis, "Stark Effect of Hydrogenic Fine-Structure". Demonstrator in physics at the University of Lund during 1933–37; on the staff of the Swedish Hydrographic-Biological Commission for a number of years; a staff member of Gothenburg Oceanographical Institute since 1939; a lecturer in oceanography at the University of Gothenburg since 1942; associate professor there since 1948, and a member of the Swedish Board of Fisheries since 1949, Kullenberg has been his country's delegate to the International Council for the Exploration of the Sea since that year. Since 1947 he has been a member of the Academy of Arts and Sciences of Gothenburg, and was, in 1954, elected to the Royal Swedish Academy of Sciences. In 1947 he won the 10,000 Kr. Sixten Heyman Prize, and three years later the Walberg Gold Medal. Kullenberg is the author of publications on the Stark effect, on inertia currents in the sea, on internal waves, the water exchange in estuaries and channels, marine sediments, and the techniques of core sampling in the ocean depths. Widely and rightly famed for his important invention of the piston-corer which has made it possible to take long undistorted sediment cores from great depths, it was upon Kullenberg's calculations of the shapes of long trawl cables that the crowning success of the Danish *Galathea* Expedition in bringing up life from 10,190 m. depended.

Earthquake in the Aegean Sea

A STRONG earthquake with its epicentre near lat. 36° 24′ N., long. 25° 26′ E. occurred on July 9. The epicentre is in the Aegean Sea near the Island of Thira, or Santorin, which has some 15,600 inhabitants. It is reported that more than forty people were killed and several injured as a result of the earthquake, which caused considerable damage, particularly on the western side of the Island. A *tsunami* accompanying the earthquake, and initiated by ground movement on the sea-bed, is reported to have attained a vertical height of 12 ft. and to have travelled as far as Kalymnos, Astipalaia, Andiparus and Iraklion (Crete). The shock was felt in Athens, and was recorded at the Royal Observatory, Edinburgh, at 03h. 17m. 31s. G.M.T. Aftershocks continued for some days after the first earthquake.

The Solar Event of February 23

THE solar outburst that occurred on February 23, 1956, beginning at about 3.32 U.T., was certainly a very remarkable event. A large flare was observed in India (Kodaikanal) and Japan (Mitaka), and the Japanese observers report that the flare was seen in white light as a bright spot near the limb—a very rare observation. World-wide cosmic-ray effects set in within fifteen minutes, and the increase of the intensity of low-energy cosmic rays was greater than any previously reported. The nucleonic flux at sea-level in Britain appears to have increased by a factor of more than 40. Synchronous with the arrival of the cosmic-ray flux, there occurred a disturbance of the lower ionosphere on the night-side of the Earth of a type that does not seem to have been observed before. The reflexion ceiling for very low-frequency waves was lowered and the attenuation increased in a few minutes to beyond the normal day-time values. This effect must be attributed to particles penetrating down at least to the *D*-level, and it is thus to be thought of as connected with the cosmic-ray increase. The data concerning this event that have been obtained in the United Kingdom are published in the May issue of the *Journal of Atmospheric and Terrestrial Physics*.

Reduction of Expenditure in the Department of Scientific and Industrial Research

IN a written answer on July 5 to a question in the House of Commons the Parliamentary Secretary to the Ministry of Works, as representing the Lord President of the Council, said that the reduction of £150,000 in the published estimate for the Department of Scientific and Industrial Research was made up of £33,000 through slowing up the rate of recruitment of staff; £20,000 through reduced grants for industrial research; a reduction of £49,000 in capital and general expenses of departmental establishments, chiefly through economies in purchases of equipment and consumable stores; and a reduction of £20,000 by delaying the commencement of a new bore-hole for the Geological Survey. Increases in test fees and other similar charges would yield a further £70,000; but against these economies, expenditure on scientific grants was increased by £42,000, of which £37,000 was for nuclear physics.

Mathematics in Industry

IN the *American Mathematical Monthly* of February, Thornton C. Fry, of the Bell Telephone Company, writes on "Mathematics as a Profession Today in Industry". To-day we educate to-morrow's mathematicians, and our curriculum should be adapted to to-morrow's needs; we cannot forecast these needs in detail, but by extrapolation from what has happened during the past fifty years, we may be able to foresee general lines of development. We shall make new things, standards of precision will be more stringent, and over-all planning for a total situation will be at least as important as concentration on accuracy in functional components. Such tasks demand collective knowledge and the exploitation of collective knowledge demands collective action. The requisite breadth and depth of technical competence can be supplied only by a team of experts, fully equipped and co-ordinated. What is the proper place of the mathematician in such a team? He should not be there as a problem solver; that is not his job, but the job of a machine. He should be there to formulate problems, to analyse relations, to strip off the superficial flesh and lay bare the essential structure. Fry illustrates this by reference to the central position occupied by mathematicians in the 'Nike' project, and draws the inference that industry requires mathematicians of the highest class to serve as superior consultants in planning operations; they are not to be called in merely to solve petty problems. To train such mathematicians, teachers must first understand the requirements; secondly, they must economize in time, so that training does not consume the fruitful years of the young mathematician. Fry suggests that algebra might be taught along with or even before arithmetic, that calculus and complex variable could be introduced in the ninth school-year, and that this could be done without any increase in the time allotted to mathematics in the schools. He admits that this is not an easy programme; many teachers in Britain favour the early introduction of calculus, but few would advocate any serious study of algebra before a firm grasp of arithmetic had been ensured.

The Need for Capital Investment in British Industry

In an article on "The Capital Question", in the May issue of the *Westminster Bank Review*, Mr. Graham Hutton stresses the need for more industrial capital in Great Britain; he argues that a substantial expansion of savings is needed, a severe reduction in 'investment' in public apparatus to provide consumers' services or durable goods, and a large increase in real investment in productive equipment and services, whether State or privately owned. Governments, he continues, have not looked carefully enough at the amounts and kinds of capital needed by Britain in its post-war situation, in which the population over the age of sixty is increasing faster than in any other industrialized nation, the birth-rate steadily falling, the money-income level rising annually faster than output and productivity, and in which the highest personal taxation on higher earnings in the Western world and the fastest inflation have redistributed incomes in favour of mass consumption rather than mass saving, so that there has been too little net personal saving in the decade. During the seven years 1948–56, capital formation for transport and communications represented nearly 12 per cent of the total, but contributed only 8 per cent to national output, and capital has not yet begun to be spent for more than maintenance (if that) of roads and railways. Manufacturing industry, providing 94 per cent of exports and nearly 40 per cent of output, only received 25 per cent of gross capital and had its capital programmes cut in each of the four post-war economic crises. On an average over the seven years, public enterprises received broadly two-thirds of all capital formation, and private enterprise, which provides all the exports and 75–80 per cent of output, only one-third, if that. Moreover, since 1948 the crude index of output against employment in manufacturing has risen 9 per cent more in France than in Britain, and 100 per cent more in West Germany and Japan, and Mr. Graham Hutton asserts that more hours a week or year are actually worked in Britain than in any of these countries. On an average, for British male adults a full working day in industry is longer than that for industrial workers in the United States, and the material return roughly one-half the American worker's real earnings.

Muelleria: a New Herbarium Journal

As Mr. A. W. Jessep, the director and government botanist at the Melbourne Botanic Gardens and National Herbarium, has pointed out, the National Herbarium of Victoria is the oldest and most extensive repository of Australasian herbarium material. It contains approximately one and a half million numbers of botanical specimens—evidence of the floristic richness of this great region. The adjacent Melbourne Botanic Gardens also support very rich and important collections. A new journal, *Muelleria* (1, No. 1 (August 1955); published by the Botanic Gardens and National Herbarium, Melbourne), which is named after the first government botanist of Victoria, F. J. H. Mueller—a man of great distinction whose work began a century ago—is intended primarily as a medium for the publication of botanical monographs, descriptions of new species and taxonomic studies generally, horticultural papers, and other botanical matters of general interest to professional and amateur botanists. In short, as the sub-title indicates, it will be an *Australian Journal of Botany*. As Prof. J. S. Turner rightly points out in a foreword, systematic botany is important, and, indeed, occupies a fundamental place, in contemporary research in agriculture, horticulture and forestry. The journal is edited by Mr. J. H. Williams, and the first issue contains notes and descriptions of a variety of new species of flowering plants and of cryptogams, and historical and bibliographical matter.

Journal of the Textile Machinery Society of Japan

The Textile Machinery Society of Japan is an organization formed for the purpose of advancing knowledge and technique in textile processing. It is a professional organization apparently similar in general structure to the Textile Institute in Britain. The Society publishes a monthly *Journal* in Japanese and, in 1955, decided to publish an English edition containing translations of articles which are considered to be of international interest. Judging from the first two issues (1, Nos. 1 and 2 (March and November 1955); from the Society at 28, 2-Bancho, Namba Shinchi, Minami-ku, Osaka; 10*s*. per copy), the scope of the new *Journal* appears to be wide, covering all the textile fibres, and all stages of textile processing. The papers cover general topics, articles on textile machines and scientific research. The technological and scientific papers are of a standard similar to those published by the Textile Institute. The Society also arranges public lectures, seminars and visits, and it is proposed to publish reports on some of these activities in future issues of the English edition. Each number contains about seventy pages, of quarto size, with good printing and diagrams and very readable English translations of the original papers. They also contain some seventy pages of Japanese textile advertisements, but these are kept at the back of the publication and do not impair the reading of the papers.

Nutritive Aspects of Preserved Food

International conferences can be very stimulating affairs for those who attend, and the discussions, in particular, often open up entirely new lines of thought. Publication of the proceedings can extend the stimulus to a much wider circle of workers, but only if publication follows close on the heels of the conference itself. All too often there is a delay of a year or more, by which time the material in the papers themselves has staled, and suggestions for further lines of inquiry have already been followed up. The proceedings of the symposium on nutritive aspects of preserved food, held in the Swedish Institute for Food Preservation Research, Gothenburg, during October 1954 (pp. 173; Publication No. 115 of S.I.K., Göteborg, 1956; 30 kr.), have been published approximately eighteen months after the conference took place; despite this delay, many of the papers are still badly in need of editing, the English sometimes being so poor that a sentence must be read several times over before the meaning can be grasped. The papers dealt with various aspects of nutrition and food technology and were presented by delegates from half-a-dozen different countries; they range from well-documented scientific studies to uncritical generalities put forward with insufficient and unsubstantiated evidence. The main use of the publication now lies in the review articles by Prof. G. Borgström (nutrition and food technology), Prof. R. A. Gortner (recent progress in the field of nutrition) and Prof. A. C. Frazer (the control of the use of chemical aids in food processing), and the evidence provided by the other papers about different lines of work being followed by different countries in 1954.

Bird Collection at Birmingham Museum and Art Gallery

The collection of British nesting birds in the Natural History Department of Birmingham Museum and Art Gallery commemorates in part the eminent public services of the late Alderman C. G. Beale, first vice-chancellor of the University and four times Lord Mayor of Birmingham. Funds provided by public subscription enabled work to be started in April 1913, and in May 1920 the memorial, encompassing forty-two nesting groups of common British species, was complete. Wherever possible, each nesting site was removed bodily from its surroundings, carefully preserved and reassembled for display. Every effort was made to secure the original parent birds, their eggs and their young. In the few instances where modelling became necessary, the original surroundings were photographed, measured, described and accurately reproduced. The greatest possible care was constantly taken by the taxidermists to give a faithful presentation of the various nesting groups, so that the collection is now rightly regarded as one of the best of its kind. A booklet describing the collection has been issued by the Museum (price 2*s*.), and photographic postcards of most of the groups in the collection are also available (price 4*d*. each).

Tracer Techniques in the Study of Host–Parasite Relationships

The accumulation of radioactive substances at loci of infection of some facultative and obligate fungal parasites and of tobacco mosaic virus has been investigated by M. Shaw and D. J. Samborski (*Canad. J. Bot.*, 34, 3, 389; 1956). Excised, parasitized leaves were placed with their bases in radioactive solutions or exposed to radioactive carbon dioxide, and the uptake and distribution of the tracers followed by autoradiography. Carbon dioxide and twenty other carbon compounds, including sugars, amino- and organic acids, phenols, and indoleacetic acid, and/or their metabolic products, as well as phosphate and calcium, accumulated strongly at uredial and conidial loci of the obligate parasites *Puccinia* and *Erysiphe* respectively. An accumulation of glucose, which occurred in the host tissue at the sites of mildew colonies on leaves from which the ectoparasitic fungal mycelium had been removed, ran parallel with the respiration-rate and increased progressively with the development of the parasites. It was inhibited by sulphur dust (with mildew), sodium azide, 2,4-dinitrophenol and, reversibly, by anaerobiosis, and was therefore dependent on aerobic respiration. On the other hand, the tracers did not accumulate within senescent rust and mildew colonies or within the necrotic lesions produced by bacterial and fungal parasites which kill the tissues of their hosts. Radioactive glucose did not, but calcium and phosphate did, accumulate within young local lesions of tobacco mosaic virus on *Nicotiana*. The tracers did not enter dead areas on mechanically wounded leaves, and only accumulated at fresh wounds under conditions conducive to a high rate of water-loss from the damaged surface.

The Soul in a Primitive Society

In his Fraser Lecture for 1955, given under the title "The Fate of the Soul" (Cambridge: At the University Press, 1955; 2*s*. 6*d*.), Prof. Raymond Firth returns to a subject examined by Sir James Fraser in his "Belief in Immortality and the Worship of the Dead". Firth's approach is, however, functional and not ethnological, as was Fraser's. His interest lies in these beliefs in terms of their social functions and, in support of his argument, he examines the eschatological beliefs of a particular society, Tikopia, relating them to its social structure and organization, with particular reference to the changing religious system. His conclusion is that the framework of ideas about the fate of the soul is in many respects a framework of ideas about the state of society, and that they are concerned primarily with emphasizing the continuity of society rather than the continuity of the individual personality.

Standard X-ray Diffraction Powder Patterns

The fifth in the series of "Standard X-ray Diffraction Powder Patterns", prepared by the National Bureau of Standards, Washington, D.C., has recently been published as Circular No. 539 of the Bureau (pp. 75. Washington, D.C.: Government Printing Office, 1955. 45 cents). In it, forty-five standard X-ray diffraction patterns are presented relating to two elements and forty-three inorganic compounds. The patterns are recommended to replace seventy-four cards in the card file of the American Society for Testing Materials, and, in addition, five compounds (cæsium chloroplatinate, cæsium chlorostannate, germanium iodide, rubidium chloroplatinate and thallium chloroplatinate), which are not represented in the file, are included. The experimental procedure used for obtaining the patterns and the general plan of the reports are the same as those in the volumes previous to Circular 539. The patterns are of use in many applications, but primarily for the identification of unknown crystalline materials. The samples used were of exceptionally high purity, and the patterns were made with a Geiger-counter X-ray diffractometer. The new publication concludes with a cumulative index to Vols. 1–5; but it is emphasized that further work on the programme is in progress, and it is anticipated that additional volumes in the series will be issued.

Professional Engineers Appointments Bureau: Report for 1955

The report for 1955 of the Professional Engineers Appointments Bureau (9 Victoria Street, London, S.W.1) shows that there was no significant change in the numbers of civil, mechanical and electrical engineers registering with the Bureau, but the number of vacancies notified increased by 20 per cent. The total placings rose by 15 per cent above the figure for last year, but the more rigid specification of requirements laid down both by those registered and by prospective employers tended to reduce the field of selection. More of the placings were for senior appointments and fewer for junior posts. More employers and engineers approach the Bureau informally to discuss their problems and to review the general employment market. In general, firms which are rapidly expanding are having great difficulty in securing staff who have the particular specialized experience that is now required in many posts in industry.

Directory of British Insecticides, Fungicides and Weedkillers

THE Association of British Insecticide Manufacturers has recently published the third edition (1956) of its "Directory" of British insecticides, fungicides and weedkillers (pp. 128; from the Association, London, 1956). In addition to a directory of member firms of the Association, the publication provides information on the chemicals available for the control of insects, fungi and weeds, and where they may be obtained. Proprietary and trade names are also given, with an indication of the use of each proprietary product. Information is also given on where to obtain accessory materials such as wetters, spreaders and stickers and the machines for applying the chemicals. The Directory should prove most useful to all those interested in the supply and use of chemicals for pest control. It is fully indexed.

Library of the University of Leeds: Report for 1954–55

THE annual report of the librarian of the University of Leeds for the session 1954–55 (pp. 12; from the Brotherton Library, Leeds) records holdings on June 30, 1955, of 389,118 volumes and 163,866 pamphlets. Of these, 279,625 volumes and 110,988 pamphlets are in the Brotherton Library, the corresponding figures for the Medical Library being 28,209 and 3,645, respectively; for the Agricultural Library, 9,457 and 25,980; and for the Textile Library, 5,225 and 900. Accessions for the year totalled 9,859 volumes, 2,355 pamphlets and 25,762 periodical parts, a decrease of 7 per cent. Loans to readers totalled 94,531, an increase of 4 per cent, and inter-library loans totalled 4,218, the books borrowed increasing by 22 per cent to 1,510 and those lent by 2 per cent to 2,708. Detailed consideration was given during the year to regulations for the consultation and loan of theses, and there was no difficulty in accepting the general desirability of making available the work contained in theses of the University. Subject to the desire to protect the author and obviate premature publication prejudicial both to the author himself and the department concerned, every effort will be made to facilitate the proper use of thesis material by qualified readers both in the University and outside it. The Council of the University has also generally approved the proposal that graduate members of the library staff should, in suitable circumstances, be given periods of up to three months of leave for research. Staff changes have been largely responsible for a 34 per cent fall in the cataloguing output, but the insistent demands of the reading room and the need of assistance in the sectional libraries have also contributed to this.

Oversea Service Division, Colonial Office

THE following appointments have recently been made in the Oversea Service Division, Colonial Office: W. H. Edwards (agricultural officer, Uganda), assistant director of agriculture (field), Uganda; A. M. M. Rees (agricultural economist, Northern Rhodesia), agricultural economist, Jamaica; T. A. A. Talbot (assistant agricultural officer, Kenya), agricultural officer, Kenya; J. D. Yelf (agricultural officer, Northern Rhodesia), senior agricultural officer, Fiji; P. F. Burgess (assistant conservator of forests, Federation of Malaya), senior assistant conservator of forests, North Borneo; F. G. Harper (conservator of forests, Gold Coast), deputy chief conservator of forests, Gold Coast; Dr. J. R. Audy (medical officer, Institute for Medical Research, Kuala Lumpur, Federation of Malaya), specialist (grade B), senior virus research officer (superscale H), Federation of Malaya; E. F. Duck (government pathologist, Hong Kong), pathologist, General Hospital, Bahamas; M. P. Hutchinson (research epidemiologist, West African Institute for Trypanosomiasis Research), deputy director, West African Institute for Trypanosomiasis Research); Miss V. Suter (scientific officer, Colonial Microbiological Research Unit, Trinidad), senior scientific officer, Colonial Microbiological Research Unit, Trinidad; P. T. Walker (scientific officer, Colonial Insecticides Research Unit, Tanganyika), senior scientific officer, Colonial Insecticides Research Unit, Tanganyika; A. E. Dorman (provincial veterinary officer, Kenya), assistant director of veterinary services, Kenya; K. J. R. Maclennan (senior veterinary officer, Northern Region, Nigeria), principal veterinary officer, Northern Region, Nigeria; W. Plowright (veterinary research officer, Federation of Nigeria), veterinary research officer (pathologist), East African Veterinary Research Organization, East Africa High Commission; A. J. Bearman (principal, School of Pharmacy, Federation of Nigeria), chief pharmacist, Federation of Nigeria; E. Cundiff, agricultural officer, British Guiana; C. L. M. van Eynatten, scientific officer, plant breeder, Maize Rust Research Unit, Federation of Nigeria; K. Paijmans, assistant conservator of forests, Gold Coast; M. J. Fleuty, geologist, Uganda; J. D. Arneaud, pathologist (grade A), Trinidad; A. T. Brough, statistician, East Africa High Commission; G. D. Phillips, veterinary research officer, East Africa High Commission.

Announcements

DR. T. K. WALKER, reader in fermentation processes in the Faculty of Technology, University of Manchester, has been given the status of professor, with the title of professor of industrial biochemistry, in the University.

IN the article entitled "Tube Investments Research Laboratories" in *Nature* of July 14, p. 60, it should have been stated that the cobalt irradiation equipment was designed and built by Nuclear Engineering, Ltd., of Greenwich Metal Works, London, S.E.7.

Tubercle, the journal of the British Tuberculosis Association, has, since the beginning of this year, appeared two-monthly in an enlarged size, with an improved format. In addition to tuberculosis, the journal deals with respiratory disease in general and related infections, for example, leprosy; laboratory as well as clinical and epidemiological aspects are included. Dr. J. R. Bignall has recently been made editor and a new Editorial Committee appointed.

IN 1955, the Muséum d'Histoire Naturelle, Paris, set up an exhibition to direct attention to the importance of safeguarding natural resources and to illustrate the damage done to animal and plant life and to the soil itself. The nucleus of this exhibition is now being sent to a number of different countries. In Britain, under arrangements made by the Society of the Men of the Trees, it is being shown in the Senate House of the University of Cambridge during July 18–31; and it is hoped that it will be shown afterwards in London.

ERRATUM. In the communication entitled "Origin of the Common Wild Oat, *Avena fatua* L.", by D. J. Griffiths and T. D. Johnston (*Nature*, July 14, p. 99), Fig. 1 has been inadvertently printed upside-down.

A NUMERICAL CALCULATION OF THE GENERAL CIRCULATION OF THE ATMOSPHERE

MUCH work has been done in recent years in the calculation of changes in the wind and temperature of the atmosphere from hydrodynamic and thermodynamic theory. The equations are non-linear partial differential ones and, moreover, the atmosphere is a turbulent fluid of variable viscosity, subject to heating and cooling by radiation and changes of state of water and retarded at the ground by surface friction. It is now well realized that only by applying dynamical theory to the atmosphere can serious progress be made, and the method is the classical scientific one of studying simplified model atmospheres and comparing the results with observations.

Hitherto, the models used have not allowed for friction or for heating and cooling by radiation. In such models, temperature changes adiabatically only in association with pressure. Now, however, in a paper in the April number of the *Quarterly Journal of the Royal Meteorological Society*, which has since been awarded the first Napier Shaw Memorial Prize, N. A. Phillips, of the Institute of Advanced Study, Princeton, describes an experiment in the numerical calculation of atmospheric changes allowing for friction and non-adiabatic heating. Phillips starts with an atmosphere at rest relative to the Earth and at a uniform temperature, and calculates developments. The calculation is based on approximate equations of motion and thermodynamic energy-change. The upper atmosphere is represented by the 250-mb. level and the lower by the 750-mb. one. The surface of the Earth and its associated friction and zero vertical velocity is everywhere at 1,000 mb. The divergence at the 750-mb. level is necessarily equal and opposite in sign to that at 250 mb. Important assumptions are: hydrostatic equilibrium in the vertical; geostrophic wind except in one term of the equations; constancy of the Coriolis parameter and its derivative with respect to latitude; and constancy with height of the stability parameter $(\theta_1-\theta_3)/\theta_2$, where θ_1, θ_2, θ_3 are potential temperatures at 250, 500 and 750 mb.

The atmosphere is supposed to be heated by radiation from the equator to latitude 45° and cooled from there to the pole at a rate independent of height but proportional to distance from latitude 45°. Friction at the ground and lateral and vertical diffusion are allowed for with reasonable assumptions. Empirical mean values are used for the various constants. The equations of motion and energy are reduced to finite difference form and solved on an electronic computer for values at a grid of points at intervals of 625 km. latitudinally and 375 km. longitudinally.

Calculations were made over a rectangular area of width 6,000 km. from west to east and depth 10,000 km. from south to north. The boundary conditions were: (*a*) identity of values of all elements at a given latitude on the east and west boundaries; (*b*) zero normal geostrophic wind and zero disturbed geostrophic vorticity on the south and north boundaries.

Starting from the state of rest and uniform temperature and with the restraint that the flow was independent of longitude, the flow and temperature patterns were first computed step by step for a period of 130 days, by the end of which time there were a nearly uniform fall of temperature from equator to pole, broad westerly winds with the reasonable maximum of 36·3 m./sec. in middle latitudes at 250 mb., a weak easterly wind (order 1 m./sec.) at the surface and a minute southerly wind at 250 mb. On this circulation there was then superimposed a small random flow initially independent of height but varying horizontally in a random manner, and the development again computed. This culminated in the formation of a large central depression moving eastward at about 1,800 km./day and having features, such as isobars like those at fronts, corresponding to real depressions and with a marked westerly jet-stream and a mean poleward flux of energy.

Considering the assumptions made, the result must be regarded as a remarkably close approximation to reality, and the paper is one to be read by all meteorologists and mathematicians interested in that most difficult problem of hydrodynamics, the circulation of the atmosphere.

INDUSTRIAL APPLICATIONS OF THE ELECTRON MICROSCOPE

A CONFERENCE on "Industrial Applications of the Electron Microscope", organized by l'Association des Ingénieurs sortis de l'École de Liège, was held in Liège during May 2–5. Representatives of fourteen countries were present. The main part of the conference was devoted to the study of metals and one session to chemical problems. Throughout the conference it was noteworthy that, although applications of the electron microscope were described in all papers, in few was the microscope given undue prominence. It appears that the electron microscope is now being used as just one more piece of apparatus in the laboratory. The results obtained are valuable and, in many cases, not obtainable in any other way; but the time has passed when problems are being sought specifically to find a use for the electron microscope.

Dr. L. Habraken (Centre National de Recherches Métallurgiques, Liège) welcomed the visitors on behalf of the Association and of the C.N.R.M. and introduced the first speaker, Dr. J. B. Le Poole (Technisch Hoogeschool, Delft) who traced the history and probable future of electron microscopes. Early electron microscopes were merely optical analogues of light microscopes; the resolution obtainable to-day had only been achieved when methods of lens correction specifically applicable to electrons and not to light had been applied. New methods in the optics of charged particles, in particular, devices using velocity selection, made it possible to go further and use the electron microscope as a direct means of chemical analysis of the specimen. Prof. C. Fert (University of Toulouse) described the present state of his researches on the direct examination of metallic surfaces by the reflexion electron microscope. Resolution of 300 A. is now obtained and the distortion of the image resulting from the small angle of viewing has been eliminated, partly by viewing at larger angles, partly by the use of cylindrical lenses to equalize the magnification in directions parallel to and perpendicular to the beam. A paper from Prof. G. Mollenstedt (University of Tübingen) and read by Dr. H. Mahl described a new form of microscope which depends on focusing electrons released from metallic specimens by ionic bombardment. Using it, bulk metallic specimens can be examined with a resolution of 500 A. The theoretical limit of resolution is 100 A., and specimens can be examined at any temperature, for example, during the course of phase transformations.

One session was devoted to new techniques in metallography. There were no papers describing yet more replica techniques. Instead, all contributors dealt with methods of making use of the full resolving power of the electron microscope instead of the many times inferior resolving power of replicas. The highest resolving power (10 A.) was claimed by Prof. R. Castaing (University of Toulouse) for his thin-specimen techniques. Metal foils are first etched, then bombarded cathodically until they are thin enough to transmit electrons. Using specimens prepared thus, it has been possible to study the early stages of precipitation in aluminium – 4 per cent copper alloys, including observations of the formation of Guinier–Preston zones. Thin films had also been studied by Dr. K. Ito (Electron Optical Laboratory, Tokyo), who had prepared his metal films by evaporation. The Japanese workers had constructed small furnaces and cryostats in which these films could be heated and cooled while actually under observation in the electron microscope. The stages in the precipitation of the various intermetallic phases from a 50–50 aluminium–copper alloy had been followed at high temperatures, and the crystallization of mercury had been observed at −180° C. Mme. Stoyanova (Electron Microscopy Laboratory of the Electronics Industry, Moscow) described how electron microscopy under dark-field conditions made possible the chemical identification of sub-microscopic and even sub-electron microscopic particles. In conjunction with the thin-film methods of Castaing and Ito, these dark-field techniques give most powerful methods of investigating the earliest stages of segregation of foreign atoms in metallic solid solution. Two papers from the Technical High School, Aachen, were devoted to the location and identification of fine precipitates in steels. In a new process described by Dr. H. Goosens, the specimen is etched until the precipitates stand out from the surface. A plastic film is then cast on the surface in order to hold the precipitates in position and finally the rest of the metal is etched away. By this means the actual precipitates can be examined free from the matrix but in their correct relative positions and at the highest resolution available in the electron microscope. Their chemical nature can likewise be determined by X-ray or electron diffraction. An application of this method to the study of grain-boundary inclusions was reported by Dr. H. K. Gorlich of the same laboratory, while a third paper describing the use of a similar technique was delivered by Dr. A. Schrader (Max Planck Institute, Dusseldorf), who had examined extremely fine precipitates in chromium–nickel–molybdenum steels, and followed the changes produced in them during creep.

Several invited papers reviewed the current position in the study of the relationship of microstructure to mechanical properties: Dr. J. Nutting (Metallurgical Laboratory, University of Cambridge), dealing with ferrous materials, showed that it was now possible to predict the creep properties of steels quickly by means of the electron microscope and without the necessity for lengthy creep tests at high temperatures. Creep resistance has been found to require the presence of highly refractory, very small (about 20 A.) particles highly dispersed in the matrix. Dr. A. Saulnier (Société Pechiney, Chambéry) explained how the strength of non-ferrous alloys were derived from the clustering of solute atoms into metastable aggregates with dimensions often less than 1/10 μ. In the aluminium alloys containing copper or magnesium, and also in various titanium alloys, these aggregates had been detected and identified by the electron microscope. Similar work in relation to the complex gas-turbine alloys containing nickel, copper, aluminium and titanium was reported by Dr. Y. Baillie (Office National d'Études et de Recherches Aéronautiques, Paris). Plastic deformation of pure metals was reviewed by Dr. A. F. Brown (University of Edinburgh). Present evidence obtained from electron microscope observations of the surface of pure metals conflicted with the results of other experiments, such as electrical resistance measurements, which aimed at studying the properties of the bulk of the material. Thus, experiments required to be devised by which the effects of plastic deformation could be detected under the surface of the metal. One such method based on the use of radioactive tracers was further developed in a paper by Prof. N. Feather, Dr. D. J. Shapland and Dr. A. F. Brown (University of Edinburgh), which described an electron optical method of improving the resolution of autoradiography.

A study of fracture surfaces had been systematically carried out by J. Plateau, G. Henry and Prof. C. Crussard (Institut de Recherches de la Sidérurgie, St. Germain-en-Laye), who presented micrographs showing the fine structure of brittle, ductile, intergranular and fatigue fracture surfaces. In ductile fracture it has sometimes been possible to trace the origin of the fracture to submicroscopic inclusions. Etching techniques of great delicacy had been employed by Dr. Wan Wijk (Metaalinstitut, Delft) to reveal the distribution of dislocations in pure iron and mild steel. It appears that the Cottrell atmospheres which surround the dislocation lines are either more or less susceptible to chemical attack than the surrounding matrix, depending on the nature of the impurities and the etchants. The surface of the metal is thus seen to be covered with a system of about 10^{10} tiny pits or mounds per cm.^{2}, giving the well-known 'orange peel' appearance usually observed after electrolytic polishing.

A complete session was devoted to the uses of the electron microscope in the chemical industry. The chief speaker was Dr. H. Mahl (Zeiss, Oberkochen), who reviewed the methods available and the results achieved in industrial quality control. Dr. J. J. Fripiat (University of Louvain) described how the electron microscope was assisting conventional techniques of soil analysis. Other notable contributions to the conference included a brief description by Prof. G. M. Kushnir (Electron Microscopy Laboratory of the Electronics Industry, Moscow) of the various electron microscopes and electron diffractographs manufactured in the U.S.S.R. All types are available, including electrostatic instruments and reflexion instruments, the best resolution commercially available being about 20 A. There are about 350 electron microscopes in use. From the United States, Dr. W. L. Grube (General Motors Corporation, Detroit) summarized the work of the committee of the American Society for Testing Materials, which is investigating the electron microstructure of steel. It is intended to collect complete metallographic evidence of the structure of steels as seen in the electron microscope at highest resolving power, and thus to encourage the use of the results in steel works laboratories for ordinary quality control.

The final session included a visit to the laboratories of the Centre National de Recherches Metallurgiques. These richly equipped laboratories have been built since 1945 on the site and using the external architecture of an old abbey. They have already made notable contributions to metallurgy, particularly to the knowledge of steels. A. F. Brown

HYPOTENSIVE DRUGS AND THE CONTROL OF VASCULAR TONE IN HYPERTENSION

UNDER the auspices of the Co-ordinating Committee for Symposia on Drug Action, a symposium on hypotensive drugs and the control of vascular tone in hypertension was held at the Wellcome Building, London, N.W.1, during April 5 and 6. The meeting was organized by a committee representing the British Pharmacological Society, the Physiological Society, the Section of Experimental Medicine and Therapeutics of the Royal Society of Medicine, the Fine Chemicals Group of the Society of Chemical Industry, the Biochemical Society, the Pharmaceutical Society, the Association of Anæsthetists and the Society for Endocrinology.

The conference was opened by Sir Charles Harington, chairman of the Co-ordinating Committee for Symposia on Drug Action, who briefly reviewed the function of the Committee in organizing symposia on subjects which are of interest to several different societies. He expressed appreciation of the generous hospitality of the Wellcome Foundation, Ltd., the contributions of which to knowledge of the subject extend over many years. He felt particular pleasure in opening the symposium because of the work of the late Dr. Harold King at the National Institute for Medical Research on the development of the methonium compounds and on the elucidation of the chemical structure of D-tubocurarine. After referring to the work of Dr. H. R. Ing, Dr. Zaimis and others, he invited Prof. F. Bergel to take the chair at the session on "Chemical and Biochemical Aspects".

The first speaker was Dr. H. R. Ing (Oxford), who discussed "Structure-action Relationships of Hypotensive Drugs". Of the veratrum alkaloids, the most potent are the ester-alkaloids, which retard the heart-rate and respiration by interference with the afferent nerve endings in the lungs. The vasodilator amidines behave similarly and, of these, phenyldiguanide, its *o*-chloro derivative, and 2-α-naphthylethyl*iso*thiourea are especially potent. Compounds of similar type which have found clinical application are tolazoline, hydralazine (1-hydrazinophthalazine), and phentolamine, all of which produce rapid but transient competitive inhibition of the actions of adrenaline and noradrenaline.

Dibenamine (N-[2-chloroethyl]diphenylamine) exhibits a non-competitive inhibition. The onset of activity is slow and, though the blockade can be overcome in the early stages, its action becomes permanent. It is suggested that initial adsorption at an active centre, possibly involving intramolecular alkylation, is followed by reaction of the ethyleneimmonium ion with groups such as —SH, —OH, or —NH_2.

The *Rauwolfia* alkaloids, for example, reserpine, deserpidine and reserpinine, also show a slow onset of action. Little is known of their structure–action relationships.

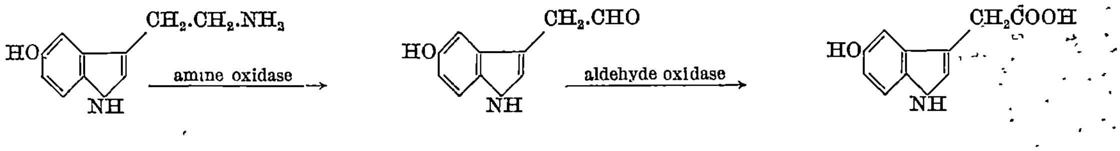
Ganglionic stimulating and blocking activity is shown by a considerable number of secondary, tertiary and quaternary bases. Several quaternary trimethylammonium bases exhibit stimulatory activity, while their triethyl analogues are inhibitors. The *bis*-quaternary ammonium bases, such as hexamethonium and pentolinium, have a purely blocking action. The end-groups vary in potency with differences in chain-length. $Me_2Et\overset{+}{N}.CH_2.CH_2.OCH_2.CH_2\overset{+}{N}Et_3$ is more effective as a blocking agent than corresponding symmetrical compounds. The blocking agents are frequently of value in hypertension when administered parenterally. It is probable that the quaternary bases will eventually be supplanted by tertiary or *bis*-tertiary compounds, which are usually better absorbed from the alimentary canal. These are frequently stimulatory in small doses, but inhibitory in larger amounts.

Dr. H Blaschko (Oxford) then presented a paper entitled "Biochemical Principles in relation to Hypotensive Drug Action". After explaining that the effectiveness of a given compound is governed by its concentration in the neighbourhood of the receptor centre, the biosynthetic route to adrenaline was traced. The metabolic pathway appears to be as follows:

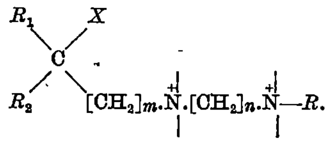
Tyrosine → 3 : 4-dihydroxyphenylalanine (DOPA) → 'Dopamine' → noradrenaline → adrenaline.

It has been established that chromaffin tissue is rich in DOPA decarboxylase, which controls the second stage of this route, and also that in various systems about 6 per cent of 'Dopamine' can be converted into noradrenaline. Inhibitors of DOPA decarboxylase have been investigated, but it seems that studies of 'Dopamine' dehydrogenase might offer a more hopeful approach.

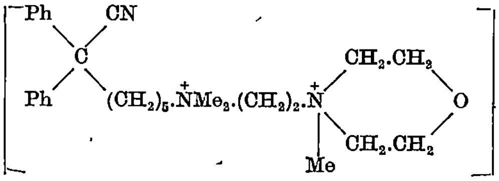
Reserpine has been shown to stimulate the release of 5-hydroxytryptamine (serotonin) from mitochondria. This substance then undergoes degradation to 5-hydroxyindoleacetic acid, which is excreted in the urine:



The discussion was opened by Mr. J. W. Billinghurst (Beckenham), who summarized the results of a search for new ganglionic blocking agents in the series:



As the value of m is increased to a maximum of 6, the duration of the effect (mydriasis in mice) is prolonged. One of the most interesting compounds from the clinical point of view is:



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Prof. H. McIlwain (London) pointed out that the diversities of action of the compounds mentioned during the session are a hopeful sign, and illustrated his point by reference to the many effects of protoveratrine. In reply to Dr. H. J. Barber, who asked if the nature of the anion has any effect on the activity of the ganglionic blocking agent, Dr. M. Harington said that the anion appears to influence only the rate of absorption of the drug.

The second session was devoted to "The Pharmacology of Hypotensive Drugs", under the chairmanship of Prof. J. H. Burn. The first paper was by Dr. J. Tripod (Basle) on "Some Pharmacological Differences between Hypotensive Drugs, with special reference to Hydralazine and Reserpine". He discussed the differentiation of hypotensive drugs according to their specific antagonisms of a variety of vasoconstrictor agents. The fall in blood pressure produced by hydralazine is abolished by previous incubation with rabbit serum. Veratrine and reserpine, on the other hand, are not affected by such treatment.

During discussion it was stated that the inactivation of hydralazine is not due to hydrazone formation. While protein hydrolysates cause inhibition, no amino-acids are found to produce this effect.

Dr. Marthe Vogt (Edinburgh) then discussed "Theories concerning the Site and Mode of Action of Reserpine". The central effects of reserpine, for example, sedation, are mediated through the hypothalamus, but this is not the only site of action. After 1·5–2 mgm./kgm. in rabbits, the encephalogram shows the disappearance of the high-voltage slow waves which are normally seen in sleep or after barbiturates. The effect is different from that of barbiturates, for the animals can be roused. The chief peripheral effect is flushing, that is, dilatation of the capillaries, which is independent of the central nervous system.

The long latent period of action ($\frac{1}{2}$–1 hr.) implies that some metabolite is responsible for the effects of reserpine, but no products of hydrolysis have been shown to have any pharmacological action. It has been suggested that it causes release of 5-hydroxytryptamine (5-HT) from body stores; thus the urinary output of 5-hydroxyindoleacetic acid is increased, and the 5-HT stores in the argentaffin cells, the brain and the platelets are diminished after the administration of reserpine. Furthermore, 5-HT prolongs barbiturate-induced sleep in mice, and all known *Rauwolfia* alkaloids showing a central effect affect the release of 5-HT. Thus, it would appear that depletion of the 5-HT stores is responsible for the effects of reserpine; but this cannot be the case since amphetamine also causes a fall in 5-HT storage without inducing sedation. Moreover, patients with carcinoidosis who have very high circulating levels of 5-HT do not exhibit disturbances of the central nervous system.

Prof. F. Smirk described experiments which provided evidence that reserpine might also have a peripheral effect, and Prof. J. H. Burn asked if 5-HT is known to be present in sympathetic ganglia. In reply, Dr. Vogt said she has been unable to detect it, but its presence cannot be excluded.

Dr. W. S. Peart (London) then presented a paper on "Substances Antagonistic to Adrenaline and Noradrenaline", which dealt with the action of the β-haloalkylamines, dibenamine and dibenylene. The latter is active orally. Dealing with the theory that these substances owe their activity to the ethyleneimmonium ion, he pointed out that sodium thiosulphate blocks their action by combining with the ion, but as it also combines with the haloalkylamine, this evidence is inconclusive.

In man the main effects are postural hypotension, meiosis and vasodilatation in the skin. Side effects observed include nasal congestion, nausea and vomiting. His main conclusion was that these substances, which are very potent blocking agents for sympathomimetic effects, have an action which is entirely peripheral, that is, in the arterial wall.

In discussion, Dr. A. C. Dornhorst said that a marked adrenolytic effect can be obtained in man with a dose of 25·mgm. dibenylene, but he is not sure that no effect is produced on the central nervous system. Dr. Ginsburg said she has found that chlorpromazine is more effective against noradrenaline than against adrenaline, but dibenylene is more effective than chlorpromazine against both. Dr. Chapman and Dr. Graham described the results with haloalkylamines. Using purified stable salts of the immonium ions, they showed these to be the active species—a conclusion accepted by Dr. Peart.

Dr. J. G. Widdicombe (London), speaking on "Veratrum Alkaloids", said that they act by eliciting the Bezold reflex, the sensory receptors for which lie in the ventricular muscle of the heart: there was also some evidence for a direct central action. Intravenous injection produces bradycardia and a fall in blood pressure due to peripheral vasodilatation. The cardiovascular effect appears to be mediated by the vagus, since that can be abolished by cutting this nerve. The ventriculo-pressor and pulmonary-depressor reflexes also appear to be involved, but different mechanisms seem to operate in different species.

Dr. Eleanor Zaimis (London) then reviewed "Ganglionic Blocking Substances". A study of the quaternary bases, 'Ecolid' and 139C55, and the secondary amine, mecamylamine, showed all three to exert a prolonged action, especially 'Ecolid', but mecamylamine showed better absorption. Dealing with tolerance to the methonium drugs, she pointed out that patients vary in the rates at which tolerance is developed. It appears to bear no relation to the severity of the disease or to its duration. Repetition of administration of the drugs increases the paralytic effect on the nictitating membrane of the cat; but blood pressure effects tend to be reduced. Hexamethonium appears to potentiate the action of adrenaline. These observations suggest that tolerance may be due to increasing sensitivity of the end organ to adrenaline and not to lack of effect of the methonium compound on the block.

Dr. A. F. Green, opening the general discussion, referred to the new compounds, 139C55 and 356C54, which are more effective than the -onium compounds in increasing pupil diameter, and have a much longer period of action. The degree of ganglionic blockade depends upon the number of stimuli passing; thus different functions, for example, blood pressure, inhibition of gastric secretion, delay in gastric emptying, may be affected to different extents. Dr. M. Harington described observations on patients under controlled conditions showing that the action of hexamethonium might be potentiated after reserpine.

In opening the third session, "Clinical Applications of Hypotensive Drugs", the chairman, Prof. J. McMichael, apologized for the absence of Prof. Pickering and welcomed Prof. F. Smirk.

The first paper, "Results of Methonium Treatment in Malignant Hypertension: Five Years' Follow-up", was by Prof. J. McMichael (London). Hypertensive patients have been classified into four groups according to the changes occurring in the fundus oculi, their survival being directly related to the extent of such changes. The value of the methonium drugs has been assessed in patients in the worst of these categories, group IV. It was originally planned to use half the patients as controls; but this proved impossible because the improvements in the treated series were so good that treatment could not be withheld from the others.

Hexamethonium has now been replaced by pentolinium given by subcutaneous injection three times daily, but it seems that equally satisfactory results can be obtained by giving a double dose at night and an afternoon injection. If 0·1 mgm. reserpine is given thrice daily, smaller doses of the methonium drugs can be used, with a consequent reduction in the side effects.

Survival depends upon the extent of renal damage, but if the blood urea is not greater than 60 mgm. per 100 ml. there is an even chance of the patient being alive after five years. Of the symptoms associated with hypertension, methonium treatment rapidly clears the retinitis and the headache disappears; the size of the heart diminishes and signs of heart failure are less obvious; attacks of encephalopathy are usually diminished, but the drugs have no influence on hemiplegia or arteriosclerosis.

Prof. F. Smirk (Dunedin) followed with a paper on "Principles and Details in Hypotensive Therapy", in which he said that the aim must be to reduce the blood pressure to normal, but the presence of other lesions may not permit this to be achieved. Impressive reductions in the mortality of hypertensive patients have been obtained using a combination of reserpine and pentolinium by mouth.

The main considerations to be taken into account in initiating hypotensive therapy include: (1) posture: the drugs are more effective when the patient is standing than when lying down; (2) meticulous adjustment of the dose to bring the blood pressure down to 120/80 mm. when maximum effect is exerted; (3) combination of drugs, for example, reserpine (0·5 mgm.) and ganglionic blocking agent; and (4) frequent checks of the response of blood pressure to the doses given throughout the period of treatment using all-day tests.

In reply to Prof. C. Wilson, Prof. Smirk said that side effects are more troublesome in the malignant phase of the disease. If treatment is pressed too hard the patient may abandon it. Some relief may be obtained by trying variations in the drugs used. Dr. Gilchrist asked whether, after obtaining an initial response with intravenous pentolinium in acute cardiac asthma, digitalis provided adequate continuation, whether pentolinium could successfully be combined with hydralazine, and whether pentolinium exacerbated symptoms in a uræmic patient? Prof. Smirk replied that their practice was not to use digitalis, mersalyl, etc., in conjunction with hypotensive drugs, since after intravenous hexamethonium a dramatic response is obtained in 1–1½ minutes. Renal disease is not affected, except indirectly through improvement of the circulation. Dr. B. Hood said that the side effects of hydralazine are unpleasant, but when combined with the ganglionic blocking agents, an enhanced response is obtained.

The last paper of the third session was "Hypotensive Drugs: Clinical Evaluation under Controlled Conditions", by Dr. G. A. Perera (New York). No veratrum alkaloid proves effective unless the dosage is so high that unpleasant side effects are produced. In benign hypertension, pentolinium and hexamethonium have little therapeutic value, while the *Rauwolfia* alkaloids exert benefit by their sedative effects. In the accelerated phase, the *Rauwolfia* alkaloids are of little value, and pentolinium, while it lowers blood pressure, has no effect on renal failure. Hydralazine rarely produces improvement and may cause further renal damage.

Insufficient time has elapsed to assess life prolongation, but it seems that survival is prolonged when there is little kidney damage.

Of three thousand patients who underwent sympathectomy, 40 per cent survived five years. Drugs will probably not improve upon that figure.

Prof. C. Bartorelli (Milan) described his experiences with hexamethonium and reserpine, and Dr. B. Hood (Gothenburg) reported that 90 per cent of his hypertensive patients treated with a combination of reserpine, pentolinium and hydralazine were able to resume work. Prof. McMichael disagreed with Dr. Perera concerning surgical sympathectomy, which in his experience was never complete and seldom reduced blood pressure. A general discussion of the value of oral administration of methonium drugs then followed. Dr. Dornhurst supported Dr. Perera's plea that it is not possible at present to make a final evaluation of these drugs, and Dr. R. W. D. Turner deplored the promiscuous use of drugs in cases in which there was no evidence of hypertensive disease other than raised blood pressure.

The closing session was devoted to "The Control of Vascular Tone in Hypertension", with Prof. Clifford Wilson in the chair.

The first paper, on "Clinical and Experimental Indications", was presented by Prof. Clifford Wilson (London). Except in the case of phæochromocytoma, the primary cause of hypertension is not known. In this case an adrenal medullary tumour secretes an increased quantity of adrenaline and noradrenaline, the actions of which can be inhibited by sympathetic blockade. The blood pressure may remain high (established hypertension) even after surgical removal of the tumour. The symptoms of essential hypertension are all due to the high blood pressure and spontaneous reversals are rare. Sedation has no effect on the blood pressure. There is no evidence in support of the view that over-production of adrenaline or noradrenaline is responsible, and renal lesions have been excluded as the cause. Obesity increases the tendency, and women tolerate hypertension better than men.

When the renal arteries of rats are clipped, encephalopathy develops, but disappears on removal of the clips.

Whatever the primary cause of the raised blood pressure, when it persists new mechanisms arise leading to the malignant phase of the disease. It seems that some extra-renal factor which leads to the breakdown of renal control is involved.

The next paper was by Dr. B. Folkow (Gothenburg) on "Structural, Myogenic, Humoral and Nervous Factors controlling Peripheral Resistance". The resistance to blood flow of the vessels in the forearm was measured when these were fully dilated under conditions of ischæmia. This resistance is unchanged when the normal person is made acutely hypertensive with noradrenaline, but is increased in patients with essential hypertension. It appears that this may be due to a thickening of the vessel wall.

Dr. M. A. Floyer and Dr. J. M. Ledingham (London) then read papers on "Renal and Extra-renal Factors in Experimental Hypertension". Dr. Floyer described experiments on rats with one kidney clamped and the other removed, from which he concluded that some extra-renal factor under the control of the kidney is responsible. Dr. Ledingham produced evidence in support of the view that the adrenal cortex is involved.

In discussion, Dr. J. Conway (London) concluded that something other than spasm is the cause of increased peripheral resistance, and suggested that methonium drugs might enhance the effect of long-acting nitrites. Dr. R. S. Duff described the results of measurements of the blood flow in the hand under standard conditions, and found that hypertensives are more sensitive to adrenaline. Dr. W. S. Peart used the method of maximum heat elimination to assess the peripheral vasomotor tone. In phæochromocytoma this is much reduced but returns to normal after removal of the tumour, even if hypertension is not relieved.

THE MOTIONS OF THE OUTER PLANETS

FOR his George Darwin Lecture which he delivered last year to the Royal Astronomical Society, Prof. Dirk Brouwer chose for his subject "The Motions of the Outer Planets" (published in *Mon. Not. Roy. Astro. Soc.*, **115**, 3 (1955), and also, slightly condensed, in *The Observatory*, **75**, No. 886 (1955)). Prof. Brouwer discussed four topics : the masses of the outer planets ; accuracy of the numerical integration orbits ; classical planetary theory in rectangular co-ordinates ; and generalized planetary theory.

Masses of the outer planets. For numerical integration the mass of Pluto has been taken as 1/360,000 (the mass of the Sun is the unit throughout), and for the masses of Jupiter, Saturn, Uranus and Neptune those used by Newcomb and Hill have been adopted. A recent investigation by Hertz indicates that the mass of Saturn should be increased by 1 per cent, and from the perturbations of this planet on Jupiter he has obtained for the reciprocal of the mass of Saturn 3497·64 ± 0·27 p.e., which is in excellent agreement with the results derived from satellite orbits. The most comprehensive determination of the mass of Neptune is that made by Eichelberger and Newton from the observations of Triton, but the large difference between the results from visual and photographic observations suggests that there are systematic errors in both. During 1939–42 Alden made a series of photographic observations of Triton with the Yale telescope—at that time in Johannesburg—and the material is now being used at the Yale Observatory with the special object of a new determination of the mass of Neptune. Reference was made by Prof. Brouwer to other new work going on in the study of the satellites of Uranus and Saturn with the main object of finding more-accurate values of the masses of the planets, and preliminary steps for determining Jupiter's mass have been undertaken at the United States Naval Observatory, where observations of thirteen minor planets near the 2/resonance region are in progress. In deriving the mass of Pluto from observations of Uranus, the residuals for the pre-discovery observations are very large ; the result largely depends on Flamsteed's observations in 1712 and 1715, which are not accordant, and rejection of the latter, as favoured by Kourganoff, yields a mass of Pluto comparable with, or greater than, that of the Earth. Brouwer's view is that it is safer to give equal weight to all the pre-discovery observations and to refrain from rejecting any of them. This unexplained deviation in the motion of Uranus largely destroys the confidence in the solution of Pluto's mass from Neptune in which the latitudes of the planet contribute much of the weight, and for this reason it seems advisable to use only the longitudes of Uranus and Neptune.

Accuracy of the Numerical Integration Orbits. As a test of general interest the three area integrals and the energy integral have been evaluated for five dates and the differences from constancy do not reach the last printed decimal place. The available evidence indicates that, for intervals of four centuries for which the numerical integrations were carried out, these orbits are of a quality that would be extremely difficult to attain with general theories. A disadvantage of the numerical integration procedure is that the orbit is determined only for the period for which the integration has been carried out; but Stiefel has recently discussed a method by which a numerical integration could be related to the general planetary theory. Nevertheless, Brouwer is of the view that the numerical methods "should be looked upon as an aid for testing the results of analytical theories and for stimulating further theoretical developments".

Classical planetary theory in rectangular co-ordinates. A large portion of this section of Prof. Brouwer's lecture was devoted to an explanation of a method described by Dziobek in 1888 : an elliptic reference orbit is selected which nearly coincides with the orbital plane of the perturbed body so that the z co-ordinate is of the order of the perturbations. There is not space in this review to consider the method in detail, and it suffices to say that Davis and Clemence have found it superior to all other methods for perturbations of higher order than the second, and that van Woerkom and Brouwer are now using it in new theories for Uranus, Neptune and Pluto. Their introduction of certain additional methods has rendered it particularly suitable for automatic calculating machines, and the work has now the highest priority on the computing programme at Yale Observatory.

Generalized Planetary Theory. Although many attempts have been made to solve the planetary theory, there is still no satisfactory representation of planetary motions over long periods of time, and the only completed investigations of this type are solutions of the equations of secular variations. Though limited in scope, they may be suitable as a starting-point towards developing a general analytical theory. For reasons given in Prof. Brouwer's lecture, the choice at present is restricted to the Sun, Jupiter and Saturn, and to simplify the problem, inclinations are ignored. In the actual work the principal task is the development of the disturbing forces as the expansion of negative powers of the mutual distance, and this has been carried out by the staff of the Watson Scientific Laboratory. At the time of the delivery of the lecture, it was not known whether unforeseen difficulties would arise in the solution of the equations for the eccentricities and perihelia, but the indications at the time were favourable.

At the end of his lecture Prof. Brouwer said that much time has been devoted "to an unfinished project" in which team work is important. The work is a joint project of the United States Naval Observatory, the Watson Scientific Computing Laboratory and the Yale University Observatory, supported by the Office of Naval Research. The results obtained so far have been only made possible "by the magnificent support we have received and the unselfish co-operation of everyone concerned".

POPULATION OF BRITISH UNIVERSITIES IN THE 1960's

By Dr. WALLIS TAYLOR
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A REPORT appeared in *Nature* of January 21, p. 115, of the final session of the 1955 Conference of the Universities of Great Britain and Northern Ireland, when the topic discussed was "The Age-group Bulge and its Possible Effect on University Policy". At this Conference, two different estimates of the 'age-group bulge' in the United Kingdom were put forward. It would appear that both these estimates are too small. If this is so, and it is not quickly remedied, it may well result in a failure to make adequate provision for the universities in the next twenty years. I am not including here the increased demand for university education which is likely to come about because of the trend towards larger sixth forms in schools. This is a relevant issue; but at this stage I merely wish to urge a reconsideration of the estimates of the actual number of adolescents which we may expect to be alive in the years 1965 and later.

In the report cited, Dr. G. E. F. Chilver is quoted as saying that during the years 1964–67 we may expect "at least 7,500 more applicants for the universities each year; afterwards there will be a plateau, when the number of applicants will be at least 2,500 more than at present". Prof. R. G. D. Allen found these figures too small, forecasting that at the peak we may expect "more than 105,000, as compared with . . . 80,000 now", and in the plateau after the peak "at least 10–15 per cent higher than now, rising slowly and steadily during the late 1960's and 1970's as the trend towards more seventeen-year-olds at school operates".

While these estimates are in fair agreement about the peak, they diverge sharply in their consideration of the problem of the plateau. In terms of total university population in the United Kingdom (for this is the crucial issue) and if we regard the normal university course as one of three years, Dr. Chilver's estimates represent an increase of 28 per cent at the peak and 9 per cent afterwards in the plateau, whereas Prof. Allen's estimates represent 31 per cent increase at the peak and 10–15 per cent in the plateau. It is not clear from the report how much this discrepancy is due to the omission or addition of those students expected to arise from the trend to later school-leaving; but in any event I believe both estimates to be too small before we add on this extra load.

Since those children who will be the students aged 18, 19 and 20 in the years up to 1975 have already been born, our problem is merely to forecast their survival. The results of this exercise appear in Table 1.

If these figures are of the correct order, then we may expect a potential university population of, at the peak, 40 per cent greater than now, and over a period of eleven years (which includes the peak) a university population which varies between 18 and 40 per cent greater.

The calculations make allowance for the decreasing mortality which this population has experienced. We can check that this allowance is clearly not excessive so far as our present experience is concerned by reference to the Census of Population, 1951. The Census estimated the age-group 15–19

Table 1. Estimated Population of University Age, England and Wales, 1955–72

Year of birth	No. of births	Expected survivors at age 18	Total aged 18, 19, 20 in year stated		Proportion of 1955
1930	648,811	573,000			
1931	632,081	561,000			
1932	613,972	547,000	1,681,000	1950	102
1933	580,413	519,000	1,627,000	1951	99
1934	597,642	537,000	1,603,000	1952	98
1935	598,756	540,000	1,596,000	1953	97
1936	605,292	548,000	1,625,000	1954	99
1937	610,557	555,000	1,643,000	1955	100
1938	621,204	567,000	1,670,000	1956	102
1939	614,479	563,000	1,685,000	1957	103
1940	590,120	543,000	1,673,000	1958	102
1941	579,091	534,000	1,640,000	1959	100
1942	651,503	604,000	1,681,000	1960	102
1943	684,334	636,000	1,774,000	1961	108
1944	751,478	702,000	1,942,000	1962	118
1945	679,937	637,000	1,975,000	1963	120
1946	820,719	772,000	2,111,000	1964	128
1947	881,026	832,000	2,241,000	1965	136
1948	775,306	735,000	2,339,000	1966	142
1949	730,518	695,000	2,262,000	1967	138
1950	697,097	666,000	2,096,000	1968	128
1951	677,529	649,000	2,010,000	1969	122
1952	673,735	647,000	1,962,000	1970	119
1953	684,372	657,000	1,953,000	1971	119
1954	673,657	647,000	1,951,000	1972	119

inclusive to number 2,696,700 at the Census date. This is a very close approximation to the sum of the survivors to age 18 of those born in the years 1932–36 (Table 1). These latter number 2,691,000—a difference of 0·2 per cent. This rather circuitous argument is necessary because no detailed figures of the 15–19 age-group by single years of age are available for England and Wales. It does show, however, that the method is accurate so far as the present population is concerned.

The survival-rates for the later births have been calculated at progressively lower mortality-rates; but the lowest mortality-rates used are taken from the 1950–52 life-table[1]. This gives a conservative estimate of the survivors expected in the future and assumes that the mortality of those under the age of twenty will not fall from the present level. If mortality continues to decrease (as it has done during the past fifty years), we may expect a larger university population than these figures show. It is highly unlikely that anything will cause mortality-rates to be higher in the future than they were in the years 1950–52. The 1950–52 life-tables show that if the mortality-rates of these years continue for the next twenty years, we may expect 96 per cent females and 95 per cent males born in these years to survive to exact age twenty. Clearly mortality-rates cannot fall very much lower; but there is still a certain amount of room for improvement.

Estimates of future births can be, and have been, made to continue the series shown in the table. Briefly, they suggest that the numbers are unlikely to fall very much for some years. In so far as the number of births does fall, this is likely to be compensated in some degree by lower mortality of these later births.

For various reasons we may expect a higher proportion of 18-year olds to reach the required academic standard for entrance to the universities. These estimates, therefore, are likely to be minimal, since no allowance has been made for this factor.

If adequate provision is to be made for university expansion in the United Kingdom to allow the same proportion of each age-group to enter the universities, it is high time that we reached agreement about the expansion needed. I shall welcome, therefore, criticism of these estimates.

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SUCCESSFUL SKIN HOMOGRAFTS IN INBRED CHICKENS

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THE skin-homograft reaction, especially in mice[1], has proved to be a very sensitive indicator of slight genetic differences. There is a need for chickens of established antigenic uniformity, for example, in studies of 'immunological tolerance'[2], to which chickens are otherwise well suited. Previous attempts to obtain (without the aid of tolerance) persistent homografts of normal chicken tissues have made use of lines with quite low coefficients of inbreeding (F), and have met with complete failure[3], or only very slight success[4].

We have carried out skin-grafting tests on the I line of White Leghorn from the National Poultry Institute Northern Breeding Station, Reaseheath, Cheshire. Following an early history of irregular inbreeding in the United States, this line has been maintained since 1939 exclusively by full-sib matings[5]. The chicks used by us have an F of 98·75 per cent (slightly more than the equivalent of twenty generations of full-sibbing). Some use has also been made of two other inbred lines from Reaseheath: the C line (White Leghorn, F = 98·91 per cent) and the M line (Rhode Island Red, F = 78·5 per cent). The technique used in grafting was essentially that of Cannon and Longmire[6], with minor changes in the siting and orientation of the grafts. Homografts (approximately 1 cm. square) were exchanged between pairs of chicks, and each chick received in addition an autograft of its own skin. All grafts were made 13–14 days after hatching, this being safely beyond the age at which a foreign graft may sometimes survive by conferring tolerance on the host[2,6].

We have not succeeded, even with autografts, in obtaining a uniformly satisfactory 'take'. There has been conspicuous variation in the amount of tissue successfully healed-in (judged by the number of feathers) and some variation in the promptness with which feather-growth was initiated. A series of arbitrary grades has been used to express this variation in the 'vigour' of grafts: grade 3 for grafts which have been in every way unexceptionable; grade 2 for minor, and grade 1 for major deficiencies. Grade 0 covers grafts which disappeared at an early stage without having shown clear signs of an immunological reaction. Grade R is reserved for cases in which a typical and unmistakable homograft reaction was observed.

Three types of homograft have been used in testing the I line: (a) donor and host full sibs; (b) donor and host both pure I, but having the great-grandfather as latest common ancestor; (c) I donor on F_1 (C♂ × I♀ or $M \times I$) host, with the grandmother as latest common ancestor. A miscellaneous group, in which one or both parents of the donor are foreign to the host line(s), serves as control material. Table 1 shows the results according to grades.

The controls confirm earlier findings[2,6] that a rapid and violent homograft reaction normally occurs in

Table 1

	Grades (see text)					Total
	3	2	1	0	R	
(a) I on I (full sibs)	28	21	7	3	—	59
(b) I on I (non-sibs)	6	5	1	2	—	14
(c) I on $C \times I$ or $M \times I$	7	3	2	1	—	13
Total homografts testing I line	41	29	10	6	—	86
Autografts on same hosts	58	17	4	7	—	86
Miscellaneous controls (I on C, $C \times I$ on I, $C \times I$ on $M \times I$, etc.)	—	—	—	6	26	32
Autografts on same hosts	23	4	2	3	—	32

chicks of this age. In all but one of the twenty-six grade *R* cases destruction of the graft was complete by 9–12 days after grafting. (It is perhaps significant that in the remaining case, where the graft survived for about 20 days, the host was a very stunted individual.)

In contrast, only six of a total of eighty-six *I* line homografts have failed to survive, an incidence no higher than among the autografts on the same hosts. The remaining eighty have shown every sign of being permanent. All were inspected regularly for at least fifty days after grafting; all but nine were kept under observation for periods in excess of five months, and some, on hosts retained for breeding, are now of more than a year's standing. The only aspect of the results which suggests that the tissue antigens of the *I* line are not completely uniform is the lower proportion of homografts in grade 3, in comparison with the autografts. While the purely statistical significance of this difference is undoubted ($\chi^2_1 = 6\cdot65$, $P \simeq 0\cdot01$), it must be remembered that the 3–2–1 grading is necessarily somewhat subjective. If slight differences in tissue antigens exist within the *I* line, they merely make homografts more susceptible to unfavourable conditions of healing, without prejudicing the survival or well-being of tissue that has passed the healing-in stage. There is, moreover, no indication that homografts are less successful when donor and host are less closely related within the *I* line: the results of types (*a*), (*b*) and (*c*) are substantially identical. In this, and in the lack of any qualitative deficiencies peculiar to the homografts, the situation differs from that described by Billingham *et al.*[1] in certain inbred lines of mice yielding low-grade homograft reactions.

While it is thus open to question whether or not the *I* line is completely uniform in respect of tissue antigens, it at least approaches sufficiently close to uniformity for most experimental purposes. However, our colleague, Dr. D. G. Gilmour, informs us that recent agglutination tests show the *I* line to be segregating for at least one pair of alleles determining different red-blood-cell antigens, which suggests that the two types of antigen are genetically, as well as immunologically[2], quite distinct.

Owing partly to poor fertility and selective mating among the breeding stocks, results bearing on the uniformity of tissue antigens within the *C* and *M* lines are few in number and mostly indirect, being based on grafts exchanged between F_1 hybrids. They suggest, however, the tentative conclusion that the *C* line is considerably less uniform than the *I* line, whereas the *M* line (in spite of its much lower *F*) seems to be comparable in uniformity with the *I* line.

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MICROSCOPICAL MEASUREMENTS OF OPTICAL PATH-DIFFERENCE BY MEANS OF COLOURED BIREFRINGENT INTERFERENCES AND A NEW COMPENSATION METHOD

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THE optical path-difference given by the light when it passes through small objects in a microscope may be measured by means of a wave-shearing interferometer as originally proposed by Jamin[1] and using a Savart plate according to Françon[2].

The measuring device which we use is a Françon eyepiece in which the thickness of the Savart plate is chosen in order to give a sideways displacement between the two interfering wave-fronts somewhat larger than the enlarged image of the object detail to be measured. The eyepiece is combined with a measuring device designed by one of us (L. P. J.) with a reference area incorporated into the field of view.

Fig. 1 shows the optical components in the microscope. The white light from a thin slit goes as a parallel beam through the object. Any good normal objective may be used. After the lens L_3 the light goes as a parallel beam through the Savart plate, placed between two crossed 'Polaroids' P_1 and P_2. The device for measuring the optical path-difference is placed at image 1. This device consists of a rotatable glass wedge and is thus isotropic, which is a great advantage over birefringent compensators. Lens L_4 gives at image 2 a new image of the object and an image of the wedge. Fig. 3 shows the field of view, where a double image of the object is seen. In Fig. 2 the same object is photographed in an ordinary microscope.

Different optical path-differences in the two images give rise to different interference colours on the Newtonian scale equally distant on both sides of the coherent background colour. By turning the wedge the light passes through the Savart plate at different angles, and the colour will be changed. A hole in the middle of the wedge through which the undistorted background appears serves as a reference. To measure the optical path-difference of part *a* in Fig. 3 the colour of a_1 is made equal to the reference colour by turning the wedge a certain angle β from the zero point. If also the second image is free, or by rotation of the microscope table can be made free, from other parts of the object, as in a_2, etc., its colour is compensated by turning the wedge in the

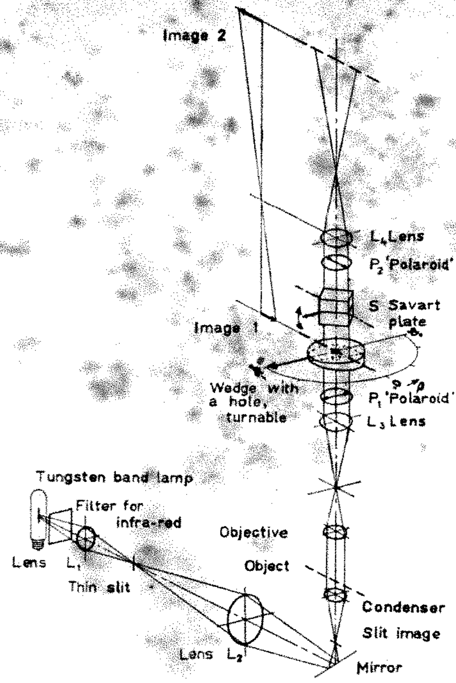

Fig. 1.

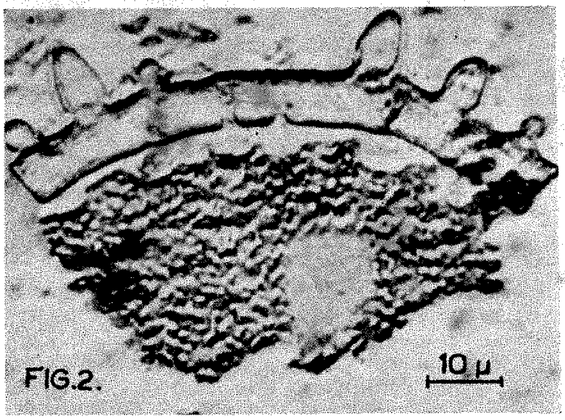

Fig. 2. Section through part of osmium-fixed pollen grain of *Althaea rosea*. Geometrical thickness of the section, 4800 A.

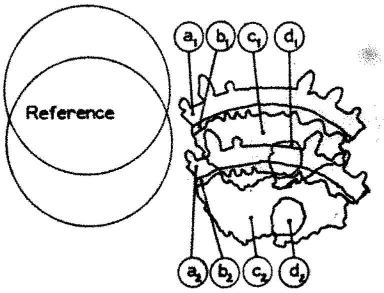

Fig. 3

opposite direction. The angle between the two settings is then 2β. We then obtain: optical path-difference = constant × sin β.

The constant depends on the glass wedge and the Savart plate used. The range of measurement can be altered by choosing different wedges. In order to obtain the highest possible accuracy, the colours of the field of view should be even. That means that the light is parallel through the Savart plate. The Savart plate also has to be adjusted to give the background, 'the sensitive colour' (purple-violet) of the first order[3]. Under ideal conditions, an accuracy (maximum error) of about ± 10 A. in optical path-difference can be obtained. Ideal conditions mean a relatively large detail of the object for comparison; the detail ought also to be uniform. If the object is not regular, the accuracy will, of course, not be so high. The method has been tried for measuring the optical path-difference of various objects; for example, thin films of evaporated zinc sulphide, small grooves etched in glass (these may be used as a standard object), silver bromide crystals in photographic emulsions and blood corpuscles. It is also possible to use the same compensation method for measuring the optical path-difference by reflexion microscopy; for example, for studying metallographic surfaces.

Table 1. OPTICAL PATH-DIFFERENCES (IN A.)

Mean value of ten settings and the standard deviation of the settings. The Roman numerals indicate different glass wedges used

	Extine (*a*)	Intine (*b*)	Cytoplasm (*c*)	Part of nucleus (*d*)
Section of osmium-fixed pollen grain of *Althaea rosea*	in air (III) 2260 ± 62 in water (II) 925 ± 48 (III) 880 ± 75	in air (II) 765 ± 20 (III) 640 ± 80 in water (II) 260 ± 30 (III) 275 ± 82		in water (II) 1060 ± 20 (III) 1025 ± 85
A second section of *Althaea rosea*	in air (III) 2125 ± 160 in water (III) 1260 ± 43 (III) 1200 ± 48	in water (III) 435 ± 63 (III) 400 ± 60		
A third section of *Althaea rosea*	in air (IV) 2450 ± 65 in water (III) 910 ± 34 (III) 880 ± 85 (IV) 850 ± 105		in air (IV) 1775 ± 120	
Section of pollen grain of *Cobea penduliflora* preserved in acetic acid	in air (IV) 1140 ± 75		in air (IV) 875 ± 150	
Section of acetolysed microspore of *Regnellidium diphyllum*	in air (III) 825 ± 56 (IV) 775 ± 65 in water (III) 290 ± 65			

More complete descriptions of apparatus and measurements will be published elsewhere. The apparatus is being manufactured and will be put on the market by Jungnerbolaget, Stockholm 14.

As an example of the uses of this instrument, we give some measurements of the optical path-differences of different cell components in thin sections of pollen grains and spores measured in air and water, respectively. The sections were made on a Spencer microtome modified for thin sectioning at the Palynological Laboratory in Bromma, Sweden. No measurable anisotropy was found in these objects.

The pollen wall consists principally of two layers, exine (*a*) and intine (*b*). The difference in optical path-difference between the exine and the intine is clearly shown in Table 1 and is tolerably constant. In a well-fixed grain the cytoplasm (*c*) comes out in various colours. The optical path-differences of the cytoplasm given in the table are mean values obtained by integration over the whole area. On account of the heterogeneity of the cytoplasm, it is, of course, of less value to give a mean value of its optical path-difference, and it might be possible to measure different cytoplasm components.

Some measurements from part of a nucleus (*d*) are given. This part of the nucleus gives a greater optical path-difference than the exine. It must be borne in mind, however, that the exine does not stain with osmium tetroxide[4], whereas the nucleus does.

[Feb. 27

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GROWTH OF SUCROSE CRYSTALS

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THE manner of growth of cane or beet sugar crystals resembles in many ways that observed on crystals of many salts by Bunn and Emmett[1], and first reported at the Faraday Society Discussion on Crystal Growth at Bristol in 1949. These authors observed, in the light microscope, layers 1000 A. or more in thickness spreading over the faces of growing crystals of many salts and a few organic substances containing strongly polar groups, but did not see them on sucrose crystals. I have found, however, that on sucrose crystals growing on a microscope slide at room temperature in syrup of 1·05–1·3 supersaturation, layers can be seen spreading over the various faces (Figs. 3,4). Perhaps those on 100, 101 and 001 are the most perfect, while the 'end' faces 110, etc., sometimes suggest rather an 'end grain' effect, which with any encouragement develops into a castellated type of multi-crystal development. In some cases the layers may be seen to spread outwards from some origin in the mid-section of the face, and other phenomena seen by Bunn and Emmett which are also exhibited by sucrose crystals are the 'wrapping over' of a layer on to a neighbouring face, and the formations of pits by layer encirclement. No definite signs of growth by the screw dislocation mechanism have yet been seen.

To facilitate the recognition of the faces to which references have been made, two diagrams (Figs. 1 and 2) have been reproduced, the one the simplest or most perfect sucrose crystal, the other a more complex form which illustrates faces which may develop under different conditions of growth.

Electron micrographs of a cleavage face parallel to 100, at a magnification of 20,000, show a stepped structure, perhaps related to layer growth (Fig. 6). Some micrographs show a kind of mosaic structure; the first such micrograph was shown to me by Dr. van Hook, who used an alcohol etched surface, and a similar mosaic structure was also shown by some more of the micrographs kindly prepared for me by the Associated Electrical Industries Research Laboratories, using the above internal cleavage face (Fig. 5). Further work is necessary and is in progress; but it seems to me that these results do indeed indicate probable internal structure, particularly since X-ray photographs by the above Laboratories also showed diffuse reflexions which could indicate crystallite formation or extensive imperfections.

A phenomenon of considerable technological importance which depends upon the mechanism of crystal growth is the presence of water inside the crystals. Vapour pressure measurements before and after crushing prove the presence of relatively pure sucrose solution inside the crystals as distinct from the thin layer of relatively exhausted low-purity syrup remaining on the surface of 'dry' sucrose crystals. The proportion of water present increases rapidly with the size of crystal, normal granulated sugar crystals of about 0·5 mm. length having only 0·01 per cent, while crystals of 25 mm. length may have as much as 0·4 per cent. Some of this water is present in cavities large enough to be seen in the light microscope (Fig. 7), which would be seen more frequently in large than in small crystals, but the possibility that some of it is trapped between layers or in mosaic cracks cannot be overlooked. There is an intriguing problem awaiting solution as to the

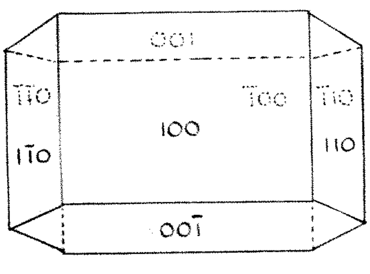


Fig. 1. The simplest eight-faced sucrose crystal

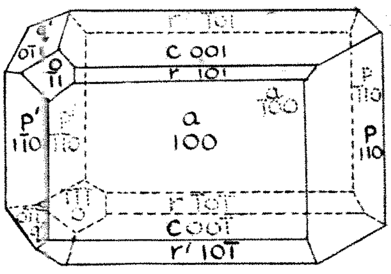
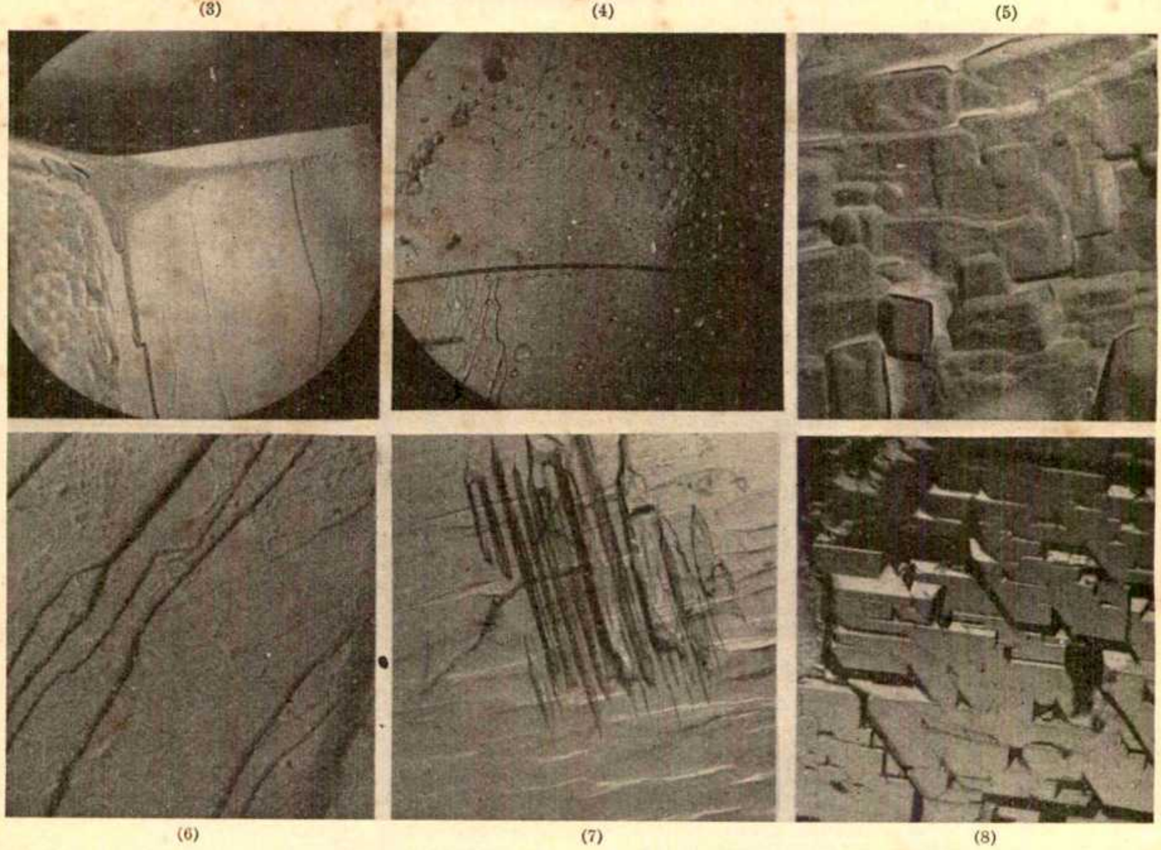


Fig. 2. The more complex form, which may have up to eighteen faces


(3) (4) (5)

(6) (7) (8)

Fig. 3. Layer growth repairing a broken corner. Fig. 4. More complex layer growth—a particularly fortunate photograph which illustrates how the liquor intrusion may originate. Fig. 5. Electron micrograph of cleavage face parallel to 100 face. Fig. 6. Electron micrograph of cleavage face parallel to 100 face. Fig. 7. Internal liquor in fjord-like formation also showing layers. Fig. 8. Tesselated surface of 100 produced by growing in agar

The photomicrographs are × c. 40, the electron micrographs × c. 20,000. Acknowledgment is due to the Associated Electrical Industries Research Laboratories for permission to publish the electron micrographs

mechanism of the layer growths enclosing these liquor intrusions.

When sucrose crystals are grown in static agar gel (to damp down free syrup movement), growth does not occur by the spreading of the layers right across the faces; there is a striking surface development I have termed 'tesselated' (Fig. 8). There is a large number of independent growth centres on each face, each bounded by what appears to be 101, $10\bar{1}$, etc., facets. Prof. Tolansky is examining the interfacial angles of these tesselations to see if they do indeed correspond to the normal side faces. Other gelling agents produce similar effects, which, therefore, are probably not due to a surface adsorption effect, but to an interference with that movement of solution which may play so vital a part in normal layer growth.

A study of nucleation of sucrose has also provided certain features which may be of interest. A single large crystal was attached to an axis which was then rotated at varying speeds in a nuclei-free solution of known supersaturation. The resulting solutions were cooled to assist nuclei to grow. Counts were then made of nuclei produced under different conditions. At sufficiently high speed, nucleation appears to be produced virtually in a saturated solution. At the suggestion of Dr. C. W. Bunn, a 'Perspex' model was then used in place of the sucrose crystal. Nucleation was effected under these conditions at a speed of several hundred revolutions per minute and 1·2 supersaturation. It appears to me that a plausible theory to account for this latter phenomenon is that the violent movement produces a periodic node and antinode distribution in the normally uniform distribution of sucrose and water molecules in solution, thus increasing the statistical chances of true nuclei being formed by the excessive local supersaturation. I find that a similar theory was put forward by the Earl of Berkeley, but this does not appear to be widely known.

It also appears a tenable hypothesis that the nuclei produced by shedding from a pre-existing crystal are larger initially than those produced in absence of any pre-existing crystal and that this accounts for the difference in the borderline supersaturation. Further, there is some slight evidence that in concentrated sugar solutions there may exist formless aggregates of molecules which have not yet attained regular crystal lattice formation.

I wish to attract the attention and collaboration of others carrying out similar researches upon substances other than sucrose, since it is becoming increasingly evident that allied phenomena are being discovered in the crystallization of substances so dissimilar as inorganic salts, metals (from melts) and non-polar organic substances such as sucrose. Prof. J. Bernal, at a recent conference in Oxford, directed attention to the desirability of more intensive study of non-polar molecular crystals.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Immunity of Lysogenic Bacteria

BACTERIAL virus (phage), in its symbiotic phase (prophage), renders the host bacterium lysogenic, and confers on it immunity against lysis by free phage particles of the homologous type, whether temperate or virulent in character. Hyper-virulent mutants, which are rare, may be exceptions to this rule.

Earlier work suggested that this immunity might cover not only homologous phage but also phages of related types. An extensive survey of the *A* phages of *Salmonella typhi-murium* (which form a closely related group) shows that this conception needs revision. Some cross-immunity does exist, but it is far from being universal or complete. Four different reactions have been found.

(1) Reciprocal cross-immunity may be absolute, so that lysogenic bacteria carrying prophage *L* and lysogenic bacteria carrying prophage *M* (the letters used are symbols only, and do not refer to named phages) are equally resistant to temperate particles of phages *L* and *M*. Neither lysis, nor any change in lysogenesis, occurs, although the free particles may be well adsorbed.

(2) There may be reciprocal sensitivity. Thus, when lysogenic bacteria carrying prophage *L* are exposed to temperate particles of phage *N* or, vice versa, when lysogenic bacteria carrying prophage *N* are exposed to temperate particles of phage *L*, some bacteria may be lysed while others may become doubly lysogenic, and carry both prophages *L* and *M*.

(3) One phage may be partly dominant over the other. In this case, when lysogenic bacteria carrying prophage *L* are exposed to temperate particles of phage *O*, they show complete resistance; but when bacteria carrying prophage *O* are exposed to temperate phage particles of phage *L*, some bacteria are lysed and others survive, showing double infection with prophages *L* and *O*.

(4) One phage may be completely dominant over the other. Thus when lysogenic bacteria carrying prophage *L* are exposed to temperate particles of phage *P*, they show complete resistance: but when lysogenic bacteria carrying prophage *P* are exposed to temperate particles of phage *L*, some are lysed, while in others phage *L* evicts and replaces prophage *P*, so that the surviving bacteria carry only prophage *L*. Sometimes, however, a few of the surviving bacteria are phage-free; the strong phage has apparently turned out the weak, but has failed to take its place, so that the bacterium has been 'cured'.

Certain of the 'cured' bacteria recovered in this way are very efficient indicators. The first to be encountered, strain *Q*1, supports the growth of all the identified phages of *S. typhi-murium.* Hitherto it has been necessary to use two different indicator strains (for some time suspected to contain weak symbiotic phage) to isolate the complete series; this has made exact comparisons of the phages difficult. It is an easy matter to prepare pure suspensions of these temperate phages, and with them to produce lysogenic strains of *Q*1 which are alike except for their prophage content. These lysogenic strains have a specific immunity which provides a delicate means of identifying phages. A test, based on this principle, has revealed differences which were hitherto unsuspected, and has greatly enhanced the accuracy of the method of 'typing' bacteria by determining the prophages they carry.

In the course of these experiments no 'hybrid' phages have been found; but a much larger number of colonies would need to be examined before the possibility of their occurrence could be definitely excluded. Certain of the free phage preparations contain a non-particulate lytic principle which acts on some strains of lysogenic bacteria and not on others. This also has still to be investigated.

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Role of Non-Protein Nitrogen in the Synthesis of Hæmoglobin in the Reticulocyte *in vitro*

A CONSIDERABLE increase of non-protein nitrogen takes place when washed suspensions of red cells of anæmic rabbits, which are rich in reticulocytes, are incubated in physiological saline. This does not occur in suspensions from animals which are low in reticulocytes (see Table 1). The relation between increase of non-protein nitrogen and respiration, which is indicated by the data, is further borne out by the observations that: (*a*) increase of non-protein nitrogen is lower under anaerobic conditions (Table 2); (*b*) that it is inhibited by 2,4 dinitrophenol (Table 3).

Table 1

Reticulocytes per cent	Medium	O_2-consumption mm.$^3O_2$/h./ml. cells	NPN mgm /ml. cells/6 h.
1·5	NaCl	16·5	+0·08
18·1	NaCl	164·5	+0·51

Red cells of rabbits, made anæmic by repeated bleeding, were used. They were washed three times with isotonic sodium chloride solution. One part of washed cells was suspended in 3 parts of medium and incubated in Warburg vessels at 37·5°

Table 2

Medium	Conditions	NPN mgm./ml. cells/6 h.
NaCl	Aerob.	+0·27
	Anaerob.	+0·08

Conditions as in Table 1

Table 3

Medium	Conditions	Δ NPN mgm./ml. cells/6 h.
NaCl	Aerob.	+0·33
+2,4 DNP (final concentration 10^{-4} *M*)	,,	−0·04

Conditions as in Table 1

Table 4

Medium	Conditions	Δ NPN mgm./ml. cells	Δ Hb. mgm./ml. cells
NaCl	Aerob.	+0·27	0
Phosphate + glucose +11 amino-acids	,,	+0·05	+9·8

Conditions as in Table 1

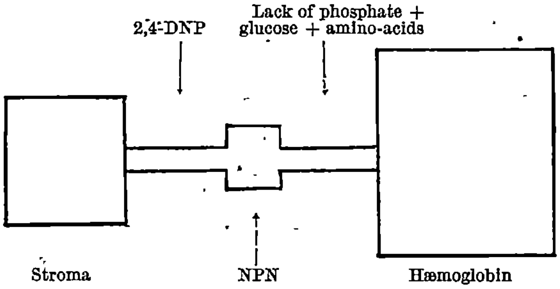

Fig. 1. Scheme of hæmoglobin formation with inhibitory effects

In the presence of phosphate, glucose and eleven essential amino-acids, non-protein nitrogen increases only minimally (Table 4); on the other hand, new formation of hæmoglobin is observed. No increase of hæmoglobin takes place in saline alone.

The stroma is the source of both non-protein nitrogen and newly formed hæmoglobin[1]. Thus the formation of hæmoglobin may be considered as a process of transformation of one protein (stroma) to another with an intermediate non-protein nitrogen phase. Fig. 1 shows a scheme which summarizes the observed effects. It indicates that lack of phosphate, glucose and amino-acids blocks the synthesis of hæmoglobin from non-protein nitrogen, while addition of 2,4-dinitrophenol inhibits breakdown of stroma.

Two points may be made: (1) The same conditions are necessary for hæmoglobin synthesis that have proved optimal for the breakdown of the substantia reticulo filamentosa, which is a specific ribonucleic acid[2]. A relation between *breakdown* of ribonucleic acid and synthesis of protein is suggested. (2) The effect of 2,4-dinitrophenol suggests a connexion between breakdown of protein, that is, non-protein nitrogen accumulation, and oxidative phosphorylation. A similar relation is assumed for the breakdown of ribonucleic acid[3].

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Recovery from Irradiation following the Administration of Cultured Tissues

CBA mice which have been given a lethal dose of X-rays recover if treated with intravenous injections of spleen cells from infant mice. Barnes and Loutit[1] have shown that this therapeutic activity can be preserved by storing fragments of such spleen with glycerol at − 79° C.

Storage of whole spleens *in vivo* in the peritoneal cavity of mice does not preserve the activity.

Tissue culture of fragments of infant spleen and of embryo liver preserves activity for some days. These tissues were cultured in a basic medium of rabbit serum and glucose, using Trowell's culture-cup technique[2] and, more recently, a modification of Chen's lens-paper technique[3]. The latter gave better mechanical recovery of explants.

Table 1. Post-irradiation Protection by IV Injection of Tissue Cultures

Injected material	30-day survival	Per cent survival
1. Cultures (*CBA* mice)		
Infant spleen, rabbit serum/glucose, 48-hr. culture	11/15	73·3
As above, 'wandering cells'	0/5	0
Embryonic liver, rabbit serum/glucose		
48-hr. culture	56/93	60 2
72-hr. culture	3/5	60
96-hr. culture	3/5	60
As above, 'wandering cells'		
48-hr. culture	0/5	0
72-hr. culture	5/15	33·3
5-day culture	0/5	0
Embryonic liver, synthetic medium, 48-hr. culture	1/10	10
Embryonic liver, heat-inactivated rabbit serum/glucose, 48-hr. culture	0/10	0
2. Controls		
Fresh rabbit serum	1/105	0·95
Rabbit serum/saline	0/5	0
Saline	0/30	0
Culture medium	0/35	0

Results are given in Table 1. The cultured embryonic liver is active for as long as four days of culture, although two days has been taken as a standard culture time. Cells which drop out or wander from the explant into the culture medium are variably active, depending upon the duration of culture.

Cultures in synthetic medium[4] or fresh rabbit serum-glucose which has been inactivated at 56° C. for half an hour are not active. Their gross and histological appearance is excellent, however.

Controls usually die by the fourteenth day following irradiation and injection. In treated mice, the survivors live for many months.

Active cells are known to be hæmatopoietic in nature[5,6] and preliminary experiments indicate that the failure of heat-inactivated and synthetic media to produce active cells may be due to a deficiency of a principle for stimulation of hæmatopoiesis.

I wish to thank Dr. D. W. H. Barnes and Dr. J. F. Loutit for advice and assistance in this work.

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Metabolism of Glycerol, Sorbitol and Related Compounds by Spermatozoa

The finding that the addition of glycerol to semen increases considerably the proportion of spermatozoa which survive freezing and storing at − 79° C.[1,2] opened up the question as to whether or not glycerol can be metabolized by the intact sperm cells. Early experiments indicated that, unlike certain glycolysable sugars and organic acids, glycerol, in common with other alcohols, has no marked initial-rate preserving effect on the sperm respiration[3], and exerts its action mainly through a protective influence on sperm colloids, probably owing to its high electrolyte- and water-binding capacity[4,5]. More recent investigations, however, have shown that although glycerol does not affect sperm motility and respiration in a diluent containing fructose, it increases markedly the oxygen consumption of washed sperm suspensions, giving rise at the same time to significant quantities of lactic acid[6]. It has also been demonstrated that glycerol labelled with radioactive ^{14}carbon enters spermatozoa in measurable amounts; sperm cells separated from the seminal plasma showed a higher uptake and utilization of glycerol than did spermatozoa in the presence of seminal plasma[7]. The present study was undertaken to investigate: (1) the relationship between glycerol disappearance and lactic acid formation; (2) the behaviour of compounds related to glycerol such as dihydroxyacetone and phosphoglycerol. Glycerol was determined colorimetrically[8], and the other methods used were those described earlier[9].

The results, which are based on experiments with ram spermatozoa, are briefly as follows.

(1) Glycerol (0·01 *M*) is utilized aerobically by suspensions of washed spermatozoa (3×10^8 cells/ml.) at a rate of about 1 mgm./10^9 sperm/hr. at 37° C. The disappearance of glycerol is accompanied by an increase in the oxygen uptake, of the order of 0·1–0·3 ml. O_2/10^9 sperm/hr., and by the accumulation of lactic acid, which appears to be an intermediary product in the oxidative breakdown of glycerol.

(2) The extent to which lactic acid accumulates depends on the concentration of phosphate used for the preparation of the sperm suspensions. It is about 0·4 mgm. lactic acid/10^9 sperm/hr. in the presence of phosphate buffer *p*H 7 (0·08 *M*) as compared with 0–0·1 mgm./10^9 sperm/hr. in the absence of phosphate. A higher rate of lactic acid accumulation in the presence of phosphate coincides with a lower oxygen uptake; this is due to a depressing effect of phosphate on the oxidation of lactic acid by spermatozoa.

(3) The breakdown of glycerol is a function of live spermatozoa and can be abolished either by heating or by the addition of spermicidal agents, for example, cetyltrimethylammonium bromide. It is not affected by the addition of penicillin. There is little or no disappearance of glycerol under anaerobic conditions. Glycerol has no appreciable effect on the rate of anaerobic fructolysis in sperm suspensions to which fructose has been added; but it exerts a 'sparing effect' on the aerobic fructolysis.

(4) In the normal course of glycerol oxidation, both in the presence as well as in the absence of phosphate, there is little or no accumulation of bisulphite-binding substances. However, such substances, mostly alkali-stable, can be shown to accumulate in the presence of sodium fluoride (0·02 *M*), particularly when glycerol is used in a high concentration (0·1 *M*). Moreover, when glycerol is replaced by dihydroxyacetone (0·01 *M*), the oxygen uptake of spermatozoa is increased and lactic acid is formed in about the same amounts as from glycerol. Phosphoglycerol (both α- and β-) is dephosphorylated by washed ram spermatozoa anaerobically as well as aerobically. Whereas, however, anaerobically glycerol accumulates as the final product of the enzymic dephosphorylation of phosphoglycerol, aerobically it is oxidized further, thus increasing the oxygen consumption of spermatozoa. Unlike phosphoglycerol, glycerylphosphorylcholine has no effect on sperm respiration.

(5) Apart from glycerol, a number of other alcohols have been tested as well as inositol, mannitol, dulcitol, erythritol and sorbitol. Sorbitol was the only one which produced a marked increase in the oxygen uptake of washed spermatozoa. The oxidation of sorbitol (0·01–0·1 *M*) was accompanied by the formation of lactic acid and a yeast-fermentable ketosugar which was identified as fructose. The ketose appears in considerable amounts when a high concentration of sorbitol (0·1 *M*) is used or else when the sperm suspension contains a low concentration of sorbitol (0·01 *M*) together with an equally low concentration of glycerol.

This investigation was carried out on behalf of the Agricultural Research Council; one of us (I. G. W.) is indebted to the Australian Council for Scientific and Industrial Research for a fellowship.

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Metabolism of Lysergic Acid Diethylamide

Although the hallucinogenic agent, lysergic acid diethylamide, has been the subject of numerous investigations, little is known about its biological fate. The development of a specific and sensitive method for the estimation of lysergic acid diethylamide in biological materials has enabled us to study its physiological disposition and metabolism.

Lysergic acid diethylamide was extracted from a salt-saturated alkaline solution of biological material into heptane containing 2 per cent *iso*amyl alcohol. The compound was returned to dilute hydrochloric acid and the fluorescence measured in a Farrand or Bowman spectrophotometer[1] at 445 mμ after activation at 325 mμ. As little as 0·001 μgm. of lysergic acid diethylamide could be determined by this method. Concentrations of the drug greater than 5 μgm. per ml. may be measured spectrophotometrically at 310 mμ.

After the administration of lysergic acid diethylamide to a cat, the drug was found in all tissues in the following order of decreasing concentrations: bile, plasma, lung, liver, kidney, brain, cerebrospinal fluid, spleen, intestine, muscle and fat. From tissue distribution studies, it was calculated that lysergic acid diethylamide exerted its psychological effects in man at a concentration of 0·0003 μgm. per gram of brain tissue.

Lysergic acid diethylamide was almost completely transformed when administered to the intact animal,

Table 1. THE ENZYMIC TRANSFORMATION OF LYSERGIC ACID DIETHYLAMIDE

Additions	LSD metabolized (μmole)
Microsomes + soluble fraction	0·53
Soluble fraction	0·00
Microsomes	0·04
Microsomes + 35 μmoles of glucose-6-PO_4	0·04
Microsomes + 35 μmoles of glucose-6-PO_4 + 1 mgm. of glucose-6-PO_4 dehydrogenase*	0·48

The microsomes and soluble fraction were prepared by fractional centrifugation of a homogenate of 200 mgm. of guinea pig liver in five volumes of isotonic potassium chloride. The reaction mixtures contained 500 μmoles of potassium phosphate buffer (*p*H 7·9), 25 μmoles of magnesium chloride, 1 μmole of triphosphopyridine nucleotide, 25 μmoles of nicotinamide, 0·66 μmole of lysergic acid diethylamide, and water to make a final volume of 5·0 ml. Incubation time 120 minutes at 36° in an atmosphere of 95 per cent oxygen and 5 per cent carbon dioxide.

* 2·4 Kornberg units per mgm. of protein (ref. 2).

only traces being excreted in the urine or faeces. Considerable species differences in the rate of metabolism of lysergic acid diethylamide were found. When tissue slice preparations were used, it was observed that only the liver was capable of metabolizing the compound. Further studies at a subcellular level indicated that the transformation of lysergic acid diethylamide was catalysed by enzyme systems present in mammalian liver microsomes when supplemented with oxygen and a reduced triphosphopyridine nucleotide generating system (Table 1). Microsomal enzyme systems requiring triphosphopyridine nucleotide and oxygen have previously been found to catalyse many metabolic reactions[3].

Lysergic acid and *nor*lysergic acid diethylamide, possible metabolic products of lysergic acid diethylamide, were not found after incubation of lysergic acid diethylamide with guinea pig liver microsomal preparations. After extracting the residual lysergic acid diethylamide from the reaction mixture, a butanol-soluble metabolite was found which gave a positive Folin–Ciocalteu reaction[4]. Unlike lysergic acid diethylamide, the metabolite gave no reaction with Hopkins-Cole or Van Urk's dimethylaminobenzaldehyde reagents[5]. These observations suggested that substitution had occurred on position 2 of the indole ring. Since alkaline hydrolysis is known to cleave oxindoles at the amide linkage with the formation of the salt of an amino-acid containing a diazotizable aromatic amino group[6], the lysergic acid diethylamide metabolite was heated at 100° in 2 *N* sodium hydroxide for five minutes and afterwards treated with nitrous acid in acid solution. An intense wine colour appeared when the diazotization mixture was added to an alkaline solution of β-naphthol. These observations indicated that lysergic acid diethylamide was converted to 2-oxy-lysergic acid diethylamide by the microsomal enzyme system dependent on triphosphopyridine nucleotide. Preliminary studies have shown that ergotamine may undergo a similar transformation.

Previous studies have shown that lysergic acid diethylamide blocks synaptic transmission in the lateral geniculate nucleus[7]. An intracarotid administration of 0·4 mgm./kgm. of 2-oxy-lysergic acid diethylamide in nembutalized cats did not alter the postsynaptic response to optic nerve shock, whereas 0·03 mgm./kgm. lysergic acid diethylamide resulted in an 80 per cent decrease in the amplitude of the postsynaptic response. 2-Oxy-lysergic acid diethylamide was also found to be without effect on the spontaneous cortical activity recorded during barbiturate anæsthesia. The oral administration of 300 µgm. of 2-oxy-lysergic acid diethylamide did not produce any psychological effects in human subjects who responded to 30 µgm of lysergic acid diethylamide. It may be concluded on the basis of this evidence that 2-oxy-lysergic acid diethylamide does not show activity like lysergic acid diethylamide in the central nervous system.

Since other investigators have shown biological interactions between lysergic acid diethylamide, serotonin and tranquillizing agents[8], the effect of serotonin, chlorpromazine and reserpine on the metabolism of lysergic acid diethylamide by the microsomal preparation was examined. It was found that chlorpromazine (1×10^{-4} *M*), serotonin (1×10^{-3} *M*) and reserpine (1×10^{-3} *M*) inhibited the enzymatic oxidation of lysergic acid diethylamide 70 per cent, 40 per cent, and 20 per cent, respectively.

A detailed report of these investigations will be published elsewhere.

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Soil as a Habitat of Vitamin-requiring Bacteria

MOST of the B vitamins have been shown to occur in arable soil, their presence being attributable to release from vitamin-containing plant and animal residues, liberation from the roots of growing plants and synthesis by micro-organisms. It is therefore not surprising that bacteria are present for which certain vitamins are essential for growth. It has been previously shown[1,2] that among the indigenous soil bacteria are forms requiring one or more preformed vitamins, while other reports[3,4] have pointed to the need of other types for certain specific factors, namely vitamin B_{12} and the terregens factor. However, apart from a recent report[5] on the incidence of bacteria requiring vitamin B_{12} and the terregens factor in soil and in the rhizosphere of certain plants, no information is available concerning the abundance in soil of bacteria requiring specific vitamins for growth.

A study has been made of the indigenous bacteria of a field soil for which vitamins of the B group were needed for growth, the experiments having been arranged to permit an estimation of the numbers of those requiring specific vitamins. This involved the use of non-selective plating and isolation procedures and determinations of the individual needs of the isolated cultures for the following vitamins by employing suitable vitamin-free basal media: thiamine, biotin, riboflavin, pantothenic acid, nicotinic acid, *p*-aminobenzoic acid, folic acid, vitamin B_{12}, pyridoxin (with pyridoxal and pyridoxamine), choline and inositol.

Table 1

Vitamin required (either alone or with others)	Vitamin-requiring bacteria		
	No of isolates	Percentage of total isolates	Approximate number per gm. soil
Thiamine (B_1)	96	19·2	10,100,000
Biotin	81	16·2	8,500,000
Vitamin B_{12}	35	7·0	3,700,000
Pantothenic acid	23	4·6	2,400,000
Folic acid	15	3·0	1,600,000
Nicotinic acid	10	2·0	1,000,000
Riboflavin	3	0·6	300,000

Of a total of 499 isolates, 135 or 27·1 per cent (corresponding to 14·1 millions per gm. of soil) required one or more vitamins for growth. The vitamins found to be needed, either alone or with others, are shown in Table 1 in order of frequency. With the great majority of the strains more than one vitamin was required; only in the case of thiamine, biotin and riboflavin were organisms found that needed but a single vitamin. In all, seventeen different 'patterns' were noted for vitamin requirements. For none of the isolates was pyridoxin, *p*-aminobenzoic acid, choline or inositol found to be essential, though in some cases these factors provided stimulation of growth.

Microbial growth-promoting substances and organisms requiring or synthesizing them have received less attention than the subject of microbial antagonisms in soil; yet growth-factor effects could well be as important as antibiotic activity in affecting the microbial equilibrium. The findings reported underline the importance of including growth-promoting substances in any consideration of the microbial economy of soils, whether related to problems of fertility or to those of the interrelationships of the normal soil microflora, plant disease organisms and the plant itself. The results also emphasize the wide diversity of the soil microflora in its nutritional aspects and point to the soil as an important habitat of vitamin-requiring bacteria.

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Action of Pepsin on Synthetic Substrates

It has recently been suggested[1] that the apparent first-order kinetics observed in the hydrolysis of certain synthetic substrates (for example, acetyl-L-phenylalanyl-L-tyrosine) by pepsin could be explained if one of the hydrolysis products (acetyl-L-phenylalanine) were only slowly released from the enzyme, as indicated in the following scheme:

$$\begin{array}{ccccccc} E & + & AB & \underset{k_2}{\overset{k_1}{\rightleftharpoons}} & E.AB & \xrightarrow{k_3} & EA + B \\ e & & s & & p & & q \\ \text{(total)} & & & & & & \end{array}$$

$$EA \xrightarrow{k_4} E + A$$

where $k_4 < k_3$. (A, acetyl-L-phenylalanine; B, L-tyrosine. The small letters will be used as symbols for the concentrations of the various species, in the equations which follow.) The reaction-rate was measured by the rate of production of B (L-tyrosine amino nitrogen). This scheme would not, however, explain the observed results.

Making the usual steady-state assumptions and putting $K_m = \dfrac{k_2 + k_3}{k_1}$ we have:

$$\frac{ds}{dt} = k_3 p = \frac{k_3(e - q)s}{K_m + s}$$

This equation cannot be integrated directly (contrast ref. 1, equation 22) since q is a function of t. However, in the steady state $k_3 p = k_4 q$. That is, dq/dt, like dp/dt, is so much smaller than ds/dt that it can be neglected except in the initial stages of the reaction.

$$\text{Therefore,}\quad q = \frac{k_3 es}{K_m k_4 + (k_3 + k_4)s}$$

$$\text{and}\quad p = \frac{k_4 es}{K_m k_4 + (k_3 + k_4)s} = \frac{es}{K_m + \left(1 + \dfrac{k_3}{k_4}\right)s}$$

When $k_3 > k_4$, first-order kinetics will only be observed when $s \ll K_m$. This mechanism cannot explain the observed results, since s was of the same order of magnitude as K_m. It is clear, from the equation for p, that the proposed mechanism will lead to Michaelis–Menten kinetics with apparent k_3 and K_m values that are $k_4/(k_3 + k_4)$ times their true values.

The succeeding communication describes further experiments which provide the correct explanation of the first-order kinetics.

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IN a previous communication[1] regarding the action of pepsin on two of its synthetic substrates, acetyl-L-phenylalanyl-L-tyrosine and N-acetyl-L-tyrosyl-L-tyrosine, results were obtained which seemed to indicate that the products of the hydrolysis were released from the enzyme-substrate complex at different rates, and that it was this phenomenon which accounted for the logarithmic course of the reaction. A communication afterwards received from Dr. N. M. Green showed that the release of the second product at a very slow rate, according to the hypothesis presented, would not lead to a logarithmic course (see accompanying communication by Dr. N. M. Green). A further study of the hydrolysis of acetyl-L-phenylalanyl-L-tyrosine by pepsin was therefore made, and has shown the conclusions that were previously drawn to be incorrect.

Since Haldane[2] has shown that a hydrolysis will follow a logarithmic course when the affinity of one of the products for the enzyme is the same as that of the substrate, experiments on the inhibiting effects of the products were again made. In these experiments it was found that concentrations of acetyl-L-phenylalanine and of the combined products of the hydrolysis which had previously inhibited the hydrolysis of acetyl-L-phenylalanyl-L-tyrosine only 6 per cent now caused 22 per cent inhibition. A search for any differences in technique that might account for these divergent results revealed that in the experiments previously reported the pepsin that had been used for forming the products had remained with those products until the experiment on their inhibiting effect was made (about 24 hr. later); while in the present experiments the pepsin that had been used for forming the products was heat-killed as soon as they were formed. Also, in the experiments previously made, the acetyl-L-phenylalanine had been mixed with the pepsin on the day before the experiment, just for convenience, and stood in the ice box at pH 2·0 until the experiment was made. Tests designed to ascertain if this standing with the pepsin was the cause of the low inhibition that was observed revealed that the combined products of a hydrolysis which caused 21 per cent inhibition if they were used immediately after being formed would produce only 9 per cent inhibition after they had stood overnight at room temperature with pepsin; and acetyl-L-phenylalanine, that caused 22 per cent inhibition before standing with pepsin, caused only 10·3 per cent inhibition after standing overnight at pH 2·0 in the ice box.

It is evident from the above that the inhibiting effect of acetyl-L-phenylalanine is much greater than previous results had indicated. To ascertain if its affinity for pepsin was the same as that of the substrate, the velocity constants that would be obtained, if this were so, were calculated from the Haldane equation[2] for a number of different concentrations of this product and the substrate. These were found to agree closely with those obtained experimentally for the same conditions. The logarithmic course of these reactions may therefore be attributed to the fact that the affinity of one of the products for the pepsin is the same as that of the substrate; and not, as was previously supposed, to a difference in the rate at which the two products are released from the enzyme-substrate complex.

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Growth of Mouse Tumour in the Chick Embryo with Retention of Capacity by the Chick to form Antibody to the Tumour Cells in Later Life

THE development of tolerance to foreign antigens following introduction of these antigens during embryonic life does not necessarily mean that exposure of the embryo *per se* is a sufficient condition for the production of the tolerant state. It appears that the most impressive tolerance has followed the introduction of living homologous cells[1–4], while other types of antigens produce no tolerance or only partial tolerance[5,6]. The possibility exists that the greater effectiveness of the living cells is derived not from their interaction with the embryo alone, but from their persistence in the growing animal over a more prolonged period. If an experimental method existed by which transferred homologous cells could, after a time, be destroyed and the antigens eliminated, this hypothesis could be tested. The following experiment dealing with an analogous situation for heterologous cells is consistent with such a hypothesis.

The Krebs-2 ascites tumour, a highly malignant, uniformly fatal tumour of mice, can be grown in the chick embryo. When we injected a suspension of these cells intravenously into 11-day chick embryos, the tumour cells invaded the chick organs and could regularly be found growing in the embryonic liver, brain or heart in the form of separate islands, each presumably arising from a single injected cell. On about the seventeenth day of incubation, the tumour cells began to degenerate and the tumour areas became infiltrated with eosinophilic cells. By the time of hatching (twenty-first day) the tumour was generally eliminated and the birds could be raised to maturity in a tumour-free state. (The reason for the general failure of the tumour cells to survive in embryos is not clear and is the subject of continuing investigation. In some cases the tumour is not eliminated, but instead kills the chick, either in embryonic life, or shortly after hatching. The destruction around the eighteenth day of incubation of foreign tissue cultivated on the chorio-allantoic membrane of the chick embryo has been attributed to an immune reaction[7]. However, in the absence of any direct demonstration of antibody in chick embryos this interpretation remains in doubt.) Such birds were shown to possess the capacity to form antibody to the tumour.

Forty-three chick embryos on their eleventh day of incubation were injected with 0·04 ml. of a 1 : 100 dilution of mouse ascitic fluid which contained about 10^8 tumour cells per ml. Incubation of the embryos was continued together with sixteen non-injected controls. Of those injected, nineteen died within 48 hr., presumably from tumour cell emboli; of the remainder, nine selected at random were killed during the sixteenth to eighteenth days of incubation, and their livers, brains and hearts were examined in microscopic section. A portion of the liver of each of the embryos killed on the seventeenth and eighteenth days was crudely minced and injected intraperitoneally into two mice. Of the embryos examined, all but one contained living tumour in their organs. In some embryos, roughly 2 per cent of all cells in the liver were found to be tumour cells. In all cases in which tumour cells were seen microscopically in liver sections, transfer of liver mince to mice was followed by the development of typical ascites tumour.

Eight of the embryos injected with tumour and eight controls hatched and lived through to adulthood. At first the injected chicks were somewhat smaller and less vigorous than the controls; but by the age of one month these differences had disappeared. The sera of the birds were tested periodically for their ability to agglutinate a standard suspension of washed ascites tumour cells (0·25 ml. diluted serum plus 0·05 ml. of 1·5 per cent cell suspension read after 20 min. in Kahn shaker at room temperature). No antibodies were detectable until the age of five weeks, when low-titre agglutinins begin to appear in normal chickens. At this time the birds were divided into two groups, *A* and *B*, each consisting of four injected and four control animals. The members of group *A* were injected periodically with the washed cells from 0·2 ml. of ascites fluid while those of group *B* were not.

In Fig. 1 are shown the resulting serum dilution titres for agglutinins against a standard suspension of ascites cells. In group *A*, each pair of points was preceded one week earlier by the immunizing injections of ascites cells. These animals showed strong specific antibody responses whether or not they had contained growing tumour cells during their embryonic life. The small difference shown between chicks of

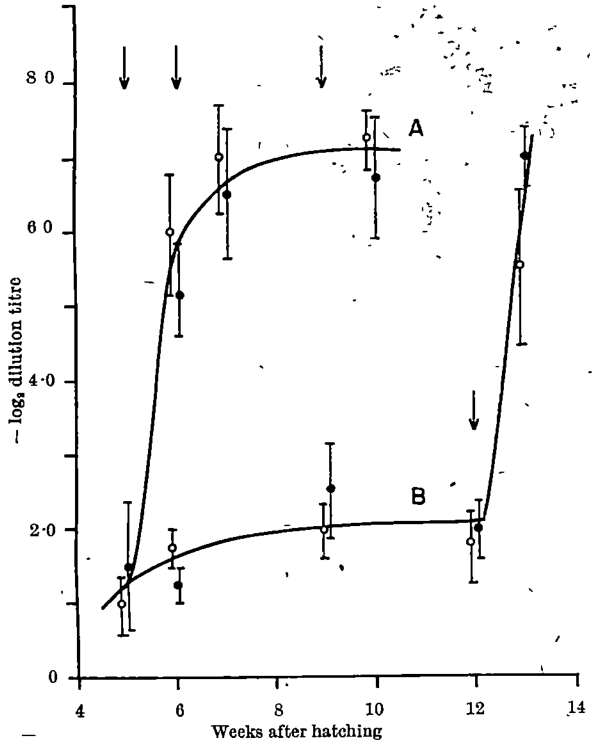

Fig. 1. ●, Chicks from tumour-injected embryos; o, chicks from uninjected embryos. Each point is the mean of four birds (range indicates standard error). ↓, Intraperitoneal injection of washed cells from 0 2 ml. of ascitic fluid

the two classes is not statistically significant. Group *B* animals of both classes developed only low-titre agglutinins until the age of twelve weeks, when a single injection of tumour cells resulted in a sharp rise in titre in all animals.

It is clear from these experiments that the presence of foreign cells growing in an animal during its embryonic life is not in itself a sufficient condition for the production of a state of permanent tolerance to the cellular antigens. In the case of tolerance following the introduction of homologous cells, permanent survival of the cells could result not only in persistence of the antigens involved but also in great increase in their amount. Such cells might liberate antigen over the period of maturation of the animal, producing a type of tolerance not fundamentally different from the condition produced postnatally in rabbits[8-10] by the administration of simple antigens.

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Resting Tension in Snail Muscle

WHEN weighted with even a very small load, the smooth retractor of the snail's pharynx extends to great lengths[1]. This phenomenon has been taken to indicate an almost complete absence of elastic material in parallel with the fibres of that muscle[2]. In connexion with work to be published elsewhere, we have been able to show that the snail muscle actually has a parallel elastic component which produces resting tension at appropriate lengths.

It is well known that above a length which coincides with that at which maximum isometric tension is developed, frog sartorius muscle exerts a resting tension[3]. We find that precisely the same is true of the snail muscle. Maximum isometric tension is produced at about 40 mm. and decreases on either side of that length (upper curve, Fig. 1). Resting tension appears at any lengths greater than the optimum length for isometric tension (lower curve, Fig. 1). But in comparison with its own maximum isometric tension or with the resting tension exerted by frog sartorius, the highest value for the resting tension of the snail muscle is small. This is explained by the dimensions of the snail muscle: it weighs only 30–40 mgm. and at a length of about 50 mm. its cross-section is very small. Although at such a length the active muscle develops tension of the order of 20 gm., the resting muscle may tear at approximately 8 gm.—a breaking stress of 1·5 kgm./cm.^{2}, which points to the presence of a reasonable amount of parallel elastic material.

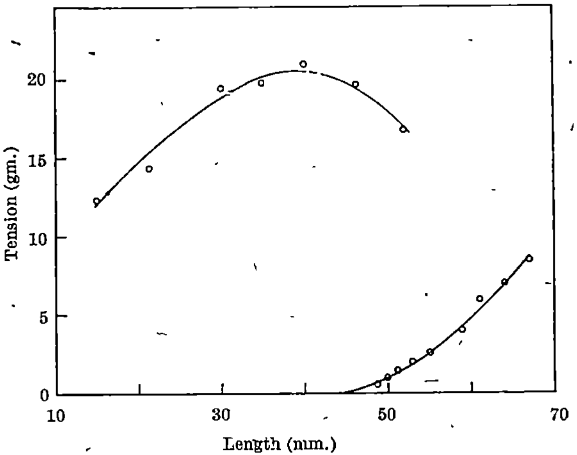

Fig. 1. Tension–length diagram of the pharynx retractor muscle of *Helix* at 14° C., during isometric contraction (upper curve) and at rest (lower curve)

The length–tension curve during isometric contraction in Fig. 1 also shows that the snail muscle can still produce appreciable tension down to lengths less than 12 mm. (30 per cent of its optimum length). It thus has a remarkably wide working range: frog sartorius at the equivalent short length develops no active tension at all[3]. The wide working range of the snail muscle probably explains why the existence of its resting tension has not been hitherto clearly demonstrated.

We conclude that snail muscle (and most likely other types of smooth muscle) can exert resting tension at appropriate lengths. This, together with evidence we have obtained from studies of tension changes resulting from quick stretch of resting muscle, force–velocity relations of active muscle, and shortening heat production, strengthens the view that the mechanical properties of smooth and striated muscle do not differ fundamentally.

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Experimental Maturation or Ageing of Collagen in Rabbits' Ears

In the course of a study of direct connective tissue changes, observations were made which have a bearing on the problem of ageing of collagen.

Rabbits' ears were subjected to rhythmical stretching and relaxing movements (20,000–80,000) by mechanical means. Histological examination revealed a thickening of the collagen fibres which were more wavy, crinkled and often fragmented. Although the spaces between the loosened fibres in the stretched ears were larger and more numerous than in the controls, the general appearance was that of a greater homogeneity of the whole corium. A cellular infiltration and in particular an increase in the number of fusiform, that is, mature, fibroblasts were noticeable.

The most interesting finding, however, was that of 'clearing' or 'dispersal' of the amorphous ground-substance coating of the fibrils seen on the electron microscope photographs. A count of individual fibrils in five classes, into which they were divided according to the lesser or greater amount of coating material which allowed the unaltered periodicity of cross-striation of individual fibrils to be distinguished, or obscured it in varying degrees, showed a shift towards a distribution found in aged tissues.

A decrease, with increasing age, in the amount of the amorphous substance coating the fibrils in other tissues has been reported[1-3].

Our findings indirectly confirm those of Angevine[4], who found in his histological preparations that when a stress or tension is exerted on the rabbit's ear by pulling, there is a mechanical stimulation of fibroblasts; they form in greater abundance, and the direction of stress determines the direction in which they are distributed. Banfield[5] found that the extractability with acetic acid of collagen from human skin, tendon and dura varied with age. Similarly the swelling of human Achilles tendon in acetic acid decreased as age increased.

Other alterations in the properties of collagen variable with age were found by Verzár[6]. The tendons of the tails of white rats show after the fifth month a thermo-elastic contraction which increases progressively with ageing. Similarly the skin shows an increasing thermo-elastic contraction after the third month.

Disregarding the mechanical effects, it is reasonable to assume that thermal and *p*H changes—though probably on a small scale—have taken place in the stretched ears. The underlying morphological changes brought out in the histological and electron microscope studies in our series may belong to the same category of events as those occurring with thermal and chemical contraction[7,8]. The degree of these may depend on the degree of the stimulus applied.

Although the nature of the coating material, its dissolving or removal or translocation are all matters of conjecture, it is thought that a correlation of changes occurring after thermal, chemical or other stimuli, with the connective tissue changes in our series due to experimental wear and tear, may throw some light on processes underlying ageing.

A detailed account of the method and results will be published elsewhere.

This work was supported by a grant from the British Empire Cancer Campaign.

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Effect of Molybdenum Deficiency on Catalase and Peroxidase in *Neurospora*

Molybdenum has been identified as a constituent of nitrate reductase in some bacteria[1], fungi[2-4] and higher plants[5], and the micro-nutrient was shown to undergo a valence change involving Mo^{6+} and Mo^{5+} during the enzymatic reduction of nitrate[6]. Apart from its role in nitrate reductase, it is known that molybdenum is also important for other metabolic processes in plants. When ammonium is the sole source of nitrogen, nitrate reductase does not usually form in plants, and the molybdenum requirement, although considerably reduced, is not completely eliminated.

In this communication it is shown that a deficiency of molybdenum in *Neurospora crassa* reduced the catalase and peroxidase enzymes in cell-free extracts of the felts by 1/10 and 1/4 respectively of that in normal tissues.

Neurospora crassa wild type 146 (microconidial type) was grown in a modified Fries medium containing ammonium nitrate as the source of nitrogen[2]. The removal of molybdenum from the basal culture solution was achieved by the copper coprecipitation methods[7]; molybdenum (20 μgm. per litre) was then added back to some of the purified culture media which served as controls. The media were dispensed in 200-ml. amounts in 1-litre Erlenmeyer flasks, inoculated with a spore suspension of the fungus contained in triple-distilled water, and incubated for four days in the dark at 28° C. The mycelial mats from the normal and molybdenum-deficient cultures were collected separately in a Büchner funnel, washed well with triple-distilled water, and frozen for 1–3 hr. at − 15° C. They were ground with a cold pestle

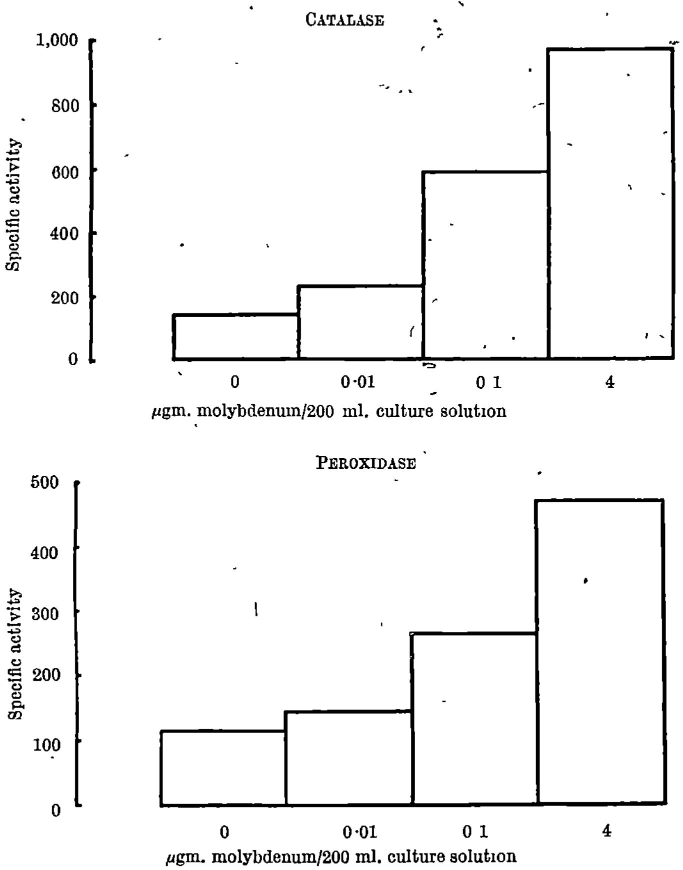

Fig. 1

and mortar with three times their weight of cold 0·1 *M* phosphate buffer (*p*H 7·5) and then in a TenBroeck glass macerater. The solutions were centrifuged at 2,000 *g* for 10 min. at 4°.

The protein contents of the extracts were determined by Lowry's method[8]. Catalase was determined in aliquots of the extracts by the perborate method[9] and the enzyme activity is expressed as μmoles perborate degraded in 5 min. per mgm. protein. The peroxidase was determined by the method of Smith *et al.*, as the change in log I_0/I_l of 0·001 per minute calculated from 15 to 75 sec. per mgm. protein[10].

Molybdenum deficiency in *Neurospora* resulted in a 40–55 per cent reduction in growth. The effects of the deficiency on the two iron enzymes are shown in Table 1.

A deficiency of molybdenum in *Neurospora* significantly reduced the two iron enzymes; the effect on catalase is more severe than for peroxidase.

Table 1. EFFECT OF MOLYBDENUM DEFICIENCY ON CATALASE AND PEROXIDASE IN *N crassa*

Enzyme	Expt.	+Mo	−Mo	Reduction: as per cent of controls
Catalase	1	640	193	30
	2	732	158	22
	3	756	83	11
Peroxidase	1	330	134	40
	2	138	63	45

+Mo cultures contained 20 μgm molybdenum per litre. Enzyme units given in text.

In Fig. 1 are shown the effects of adding graded amounts of molybdenum to the basal culture solution on the two enzymes present in cell-free extracts of the felts. Increasing the molybdenum content of the medium is paralleled by increases in the two enzymes; the maximum activity is reached when 4 μgm. molybdenum is given per 200 ml. culture solution.

When molybdenum was added aseptically *in vivo* to the omit-molybdenum cultures after three or four days' growth, the two enzymes were adapted to the added micronutrient and were reconstituted within 24 hr. to about 70 per cent of those in the control cultures. It was not possible to reconstitute the two enzymes by adding 0·1 μgm. or 1 μgm. of molybdenum to homogenates of the molybdenum-deficient felts. Mixing extracts of normal with those of molybdenum-deficient felts proved that there was neither an inhibitor in the deficient felts nor an activator in the normal ones.

Whether molybdenum is a constituent of the iron enzymes or whether the effect is an indirect one is as yet unknown. It is established that molybdenum deficiency results in a reduction in certain flavoprotein enzymes which produce hydrogen peroxide[11]. A deficiency of the micronutrient could therefore result in a low production of hydrogen peroxide in the fungus so that catalase and peroxidase, which are known to be adaptive enzymes, would thus be depleted. Experiments now in progress may elucidate the role of molybdenum in relation to the two iron enzymes.

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Cumulative Effect of Sub-Lethal Doses of Insecticides on Houseflies

THE effectiveness of repeated small doses of insecticides is of considerable practical importance. For example, mosquitoes and houseflies entering houses treated with residual insecticides make intermittent contacts with deposits, and tsetse flies may receive a succession of doses when applications of insecticides are made from aircraft on a number of parallel runs in each day's sortie, and the area treated at the end of one sortie is re-treated at the beginning of the next. Hoffmann *et al.*[1] exposed houseflies intermittently to small amounts of DDT residues and found that the longer the intervals between exposures the greater the number of flies that survived. There is, however, little quantitative information, and the experiments summarized below were designed to determine the cumulative effect of sublethal doses of insecticides on houseflies.

Flies for the experiments were taken from a normal laboratory colony with no previous experience of insecticides. Females only were used; they are less susceptible than males, and although their susceptibility decreases during the first four days after emergence it remains fairly constant for the next week or more. Small measured volumes of each insecticide solution were applied to the dorsal surface of the thorax of individual flies from a microburette similar to that described by Kerr[2]. The concentration of each insecticide in kerosene (0·25 per cent gamma-BHC, 1 per cent DDT, 0·07 per cent dieldrin, and 0·25 per cent 'Diazinon') was selected so that a range of kills for the calculation of the *LD*50 was obtained with volumes of 0·029–0·058 µl. Breeding, treatment and storage after treatment were all at 25° C.

In the first series of experiments, the volumes of insecticide solutions were applied in two equal doses with an interval of 0, 24 and 48 hr. between them. Other batches of flies from the same culture and of the same age were given the two doses on the second and third day of each experiment to check variation in susceptibility with age. Results of one series of experiments are summarized in Table 1; repeat experiments provided essentially the same results. The two doses of DDT, dieldrin and 'Diazinon' were fully cumulative even with an interval of 48 hr. between the application of the first and second dose, whereas when 24 or 48 hr. elapsed between the application of the first and second dose of gamma-BHC, mortalities were significantly lower than when the two doses were applied one immediately after the other. It would appear that approximately 50 per cent of the first dose had been rendered ineffective by the time the second dose was applied 24 or 48 hr. later.

In the second series of experiments smaller volumes of 0·009 µl. of each insecticide solution were applied daily to individual flies, and variation in susceptibility with age was checked by treatment of other batches of flies from the same culture on various days. Results of one set of experiments are summarized in Table 2, and are similar to those obtained on other occasions.

When mortality counts had been made 24 hr. after the application of the sixth daily dose of gamma-BHC, survivors from the various replicates were pooled and then divided at random into batches. Different doses of gamma-BHC were applied to each batch and the *LD*50 determined. The survivors had an *LD*50 of 0·075 µgm. gamma-BHC per fly (ignoring the six daily doses) compared with 0·094 µgm. for untreated flies of the same age from the same culture. In the same way it was found that the survivors from the six daily doses of DDT had an *LD*50 of 0·15 µgm. DDT per fly (again ignoring the daily doses) compared with 0·39 µgm. for untreated flies of the same age from the same culture.

Table 1

Age of flies at first dose	Time interval between the two doses	*LD*50, µgm. insecticide per fly			
		Gamma-BHC	DDT	Dieldrin	'Diazinon'
4–5 days	48 hr.	0·148	0·492	0·028	0·100
4–5 ,,	24 ,,	0·146	0·465	—	—
4–5 ,,	0 ,,	0·104	0·450	0·027	0·103
5–6 ,,	0 ,,	0·112	0·486	—	—
6–7 ,,	0 ,,	0·101	0·475	0·028	0·098

Table 2

Dosages are in µgm. insecticide per fly; *LD*50's are for flies from the same culture

	Age of flies (days)	3–4	4–5	5–6	6–7	7–8	8–9
Gamma-BHC	Cumulative dosage	0·023	0·045	0·068	0·090	0·113	0·135
	Cumulative per cent kill	0	0	0	0	1	1
	*LD*50	0·092	0·105	—	—	—	0·092
DDT	Cumulative dosage	0·09	0·18	0·27	0·36	0·45	0·54
	Cumulative per cent kill	0	0	1	1	11	20
	*LD*50	0·32	0·40	—	—	—	0·39
Dieldrin	Cumulative dosage	0·006	0·013	0·019	0·025	0·032	
	Cumulative per cent kill	0	0	2	16	42	
	*LD*50	0·022	0·027	—	—	0·024	
'Diazinon'	Cumulative dosage	0·023	0·045	0·068	0·090	0·113	
	Cumulative per cent kill	0	0	4	20	60	
	*LD*50	0·087	0·100	—	—	0·094	

In no case were the daily doses of one-fifth to one-quarter of the *LD*50 fully cumulative; but the degree of tolerance for the four insecticides varied considerably, being lowest for 'Diazinon' and increasing through dieldrin and DDT to a high value for gamma-BHC. In fact, the doses of gamma-BHC had little cumulative effect; kills after six doses were negligible, and the dosage required to kill 50 per cent of the survivors was nearly as much as that required to kill the same proportion of untreated flies.

It is evident that houseflies from a normal strain have the ability to eliminate, metabolize or store in a harmless condition, to a greater or lesser extent depending on the insecticide, a proportion of the absorbed insecticide provided that the dosage is sufficiently low. The results of these experiments appear to substantiate biologically the biochemical findings of Perry and Hoskins[3] that susceptible, as well as DDT-resistant, flies are able to detoxify DDT, and those of Oppenoorth[4] and Bradbury and Standen[5] that susceptible flies can rapidly metabolize gamma-BHC. The significance of this ability of normal flies to metabolize insecticides in relation to the development of resistance, however, must be determined by further research.

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March 8.

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Interspecific Competition in Higher Plants

THE results of experiments on interspecific competition between vegetable crops and annual weeds suggest that a relationship exists between the crop weight and weed weight per unit area when the relative density of the two species is varied. The relationship appears to be of the type:

$$(X-Xo)(Y-Yo) = C \qquad (1)$$

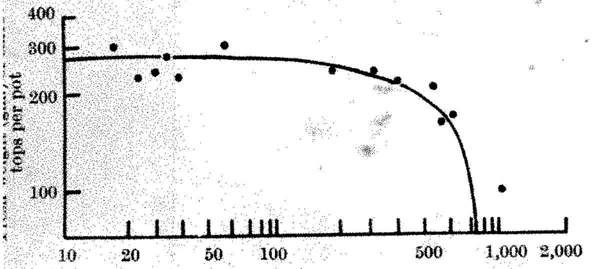

Fig. 1. Fitted curve: $(x - 3{\cdot}10)(y - 2{\cdot}45) = 0{\cdot}054$

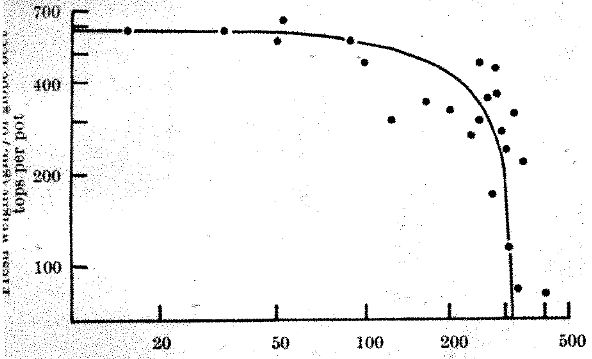

Fig. 2. Fitted curve: $(x - 2{\cdot}53)(y - 2{\cdot}82) = 0{\cdot}27$

where *Xo* and *Yo* are the logarithms of the yields of given numbers of plants of species *A* and *B* respectively, grown separately in a given area, and *X* and *Y* are the logarithms of the corresponding yields when the two species are grown together in the same area. The value of *C* will depend upon the two species concerned and the environment.

Fig. 1 illustrates the relationship obtained in a pot experiment on competition between carrot and chickweed (*Stellaria media* (L.) Vill.). The carrot stand was the same in each pot and the seed was sown on one date. The various weed weights were obtained by varying the weed density or the sowing date. The manner in which the various weed weights were obtained has not obviously affected the relationship. In another experiment three densities of globe beet were used, all sown at one date, and one density of annual nettle (*Urtica urens* L.) sown on two dates (at crop sowing and crop germination). Fig. 2 illustrates the results obtained.

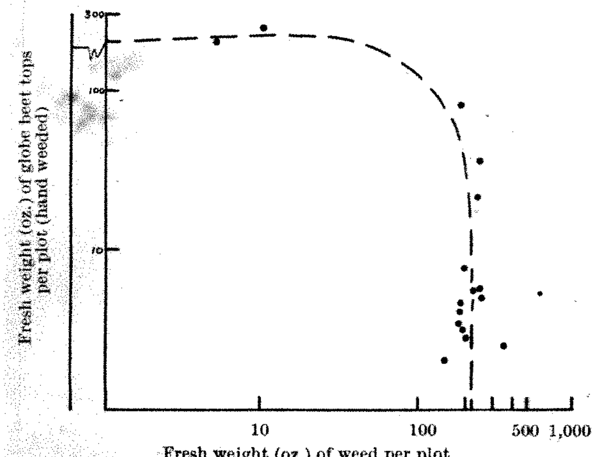

Fig. 3. Possible curve of hyperbolic type, drawn in by eye

A field experiment with a naturally dispersed and mixed weed population and a crop of globe beet grown in rows yielded results which tend to confirm the results of the pot experiments. However, the absence of values in the region of maximum curvature of the graph plotted in Fig. 3 does not allow a detailed study of the trend. The various weed weights were obtained by reducing the natural weed population by applications of a contact pre-emergence herbicide at different rates.

The results presented by Mann and Barnes[1] in a series of papers on the competition between barley and certain weeds and between rye-grass and clover may be plotted to show that the relationship between the logarithms of the weights per unit area of species *A* and *B* can be adequately described by a curve of type (1).

The practical point of interest is the amount of weed a crop can tolerate before competition starts. Preliminary results suggest that the weight of weed in a crop is linearly related to the percentage cover of the weed (at least over a considerable range of cover). It is hoped that cover assessments, which are non-destructive and easily obtained, may prove useful in determining the time of onset of competition. Such information could then be used for assessing the best time to apply weed control measures and to evaluate present weed control practice.

I am indebted to Mr. H. A. Roberts for his co-operation in the field experiment described, and to Mr. J. A. Nelder for his help with the mathematical aspects of this communication.

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Toxicity and Breakdown of 'Hormone' Herbicides

DURING the course of an investigation of the effect of certain 'hormone' herbicides, when applied to the rooting medium, on the growth and nodulation of white clover (*Trifolium repens*), some interesting features emerged on the relative toxicities of these compounds. The substances utilized were the sodium salts of 24*D* (2 : 4-dichlorophenoxyacetic acid), *MCPA* (2-methyl-4-chlorophenoxyacetic acid), 245*T* (2 : 4 : 5-trichlorophenoxyacetic acid), 24*DB* (γ-(2 : 4-dichlorophenoxy)butyric acid) and *MCPB* (γ-(2-methyl-4-chlorophenoxy)butyric acid). Their action on the white clover was determined by growing the plants in (*a*) aseptic agar culture in test-tubes and (*b*) soil culture in pots. The agar rooting medium was the nitrogen-free formula described by Thornton[1] and the soil was John Innes compost which had been allowed to weather for a year in the open air. The plants were inoculated with a known effective strain of *Rhizobium trifolii*. The hormone substances were incorporated in the agar in the appropriate concentrations. In the case of the pot experiment, the soil was air-dried, and 100 c.c. of the chemical at the appropriate

Table 1. EFFECT OF HORMONE HERBICIDES ON THE NODULATION AND GROWTH OF *T. repens*

Each reading is the average of seven tubes

TUBE EXPERIMENT

Substance	Length of root (mm.) (*a*)	(*b*)	No. of nodules (*a*)	(*b*)	Total dry wt. of plants (mgm.) (*a*)	(*b*)
24*D*	65	38	3	0	4	1
MCPA	238	33	9	0	11	1
245*T*	529	55	15	1	35	2
MCPB	1,009	282	19	12	35	18
24*DB*	1,009	1,056	33	17	45	34
Control (inoc.)	1,283	1,283	35	35	47	47
Control (uninoc.)	601	601	0	0	3	3

(*a*) Concentration 0·1 p.p.m. (acid equivalent).
(*b*) Concentration 1·0 p.p.m. (acid equivalent).

Each reading is the average of seven pots

SOIL EXPERIMENT

Substance	No. of plants harvested (*a*)	(*b*)	No. of nodules (*a*)	(*b*)	Wt. of nodules (mgm.) (*a*)	(*b*)	Dry wt. of plants (mgm.) (*a*)	(*b*)
245*T*	8	0	52	0	4	0	235	0
MCPA	13	7	188	43	7	2	481	111
MCPB	14	9	132	76	5	4	499	295
24*D*	23	22	285	222	16	11	1,238	1,123
24*DB*	21	22	348	384	16	20	1,518	1,802
Control	22	22	305	305	18	18	1,359	1,359

(*a*) Concentration 5·0 p.p.m. (acid equivalent).
(*b*) Concentration 12·0 p.p.m. (acid equivalent).

concentration was added to each pot containing 175 gm. of soil. Each pot was stood in a Petri dish of water to eliminate the effects of leaching. There were seven tubes and seven pots per treatment.

The plants were grown for ten weeks in a cool greenhouse and then harvested. The results are shown in Table 1.

From Table 1 it is clear that in the tube experiment the order of toxicity is (1) 24*D* most toxic, (2) *MCPA*, (3) 245*T*, (4) *MCPB*, and (5) 24*DB* least toxic. This may be looked upon as a measure of their true toxicity. In the soil, however, the order of toxicity is (1) 245*T*, most toxic, (2) *MCPA*, (3) *MCPB*, (4) 24*D*, and (5) 24*DB* least toxic.

From the tube experiment it can be seen that 245*T* in itself is not more toxic than 24*D* or *MCPA*. It is postulated that 245*T* owes its greater effectiveness in soil to its greater persistence there. Similarly, *MCPA* lasts[2] much longer in the soil than 24*D* and it therefore is much more effective.

The toxicity of the *MCPB* in the soil may be attributed to its breakdown in the soil to *MCPA* by micro-organisms possessing the β-oxidizing system. The possibility of such a breakdown has already been mentioned by Wain[3]. The relative ineffectiveness of 24*DB* may be attributed to its breakdown by similar organisms to 24*D*, which is afterwards rapidly rendered innocuous by other soil micro-organisms.

Our thanks are due to Messrs. May and Baker who supplied the 24*DB* and *MCPB* for experimental purposes. It is hoped that these experiments will be published in more detail elsewhere.

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Impression Methods for the Study of the Distribution of Deposits and Organisms on Plant Surfaces

THE use of transmitted illumination in microscopic studies of chemical or biological material on plant surfaces is limited by the opaqueness of the plant tissues. The methods described by Crisp and Thorpe[1] and Bryson[2] for obtaining transparent impressions of various surfaces in gelatin and cellulose acetate respectively have been successfully applied to the study of deposits on leaf surfaces. Such impressions can be readily enlarged and examined visually or photographically; simple 35-mm. projection provides ample magnification for general distribution studies of materials on plants, but for more detailed studies much higher magnification can be used.

Leaf impressions are obtained by pressing the leaf to be examined on to a cellulose acetate film (0·005 in. thick) previously moistened with a 5·0 per cent solution of cellulose acetate in acetone. When the impression has hardened (approx. 60 sec.) the leaf is carefully peeled off. In a similar manner gelatin impressions may be obtained on a glass slide coated with a warm solution of gelatin in water in approximately equal proportions. These impressions may take up to 30 min. to set hard.

By one or other of these methods it is possible to examine almost all solid spray deposits on plant material. Since many of the organic insecticides and fungicides are soluble in acetone the cellulose acetate method cannot be used to detect such materials, while for similar reasons gelatin is not suitable for water-soluble deposits. A gelatin impression (Fig. 1) illustrates a deposit of BHC crystals on the upper surface of a broad-bean leaf; these crystals are relatively large, but the distribution of crystals of the order of 1·0μ has been studied by this method.

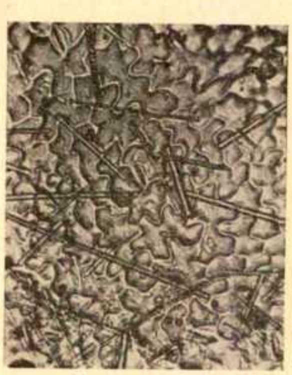
Fig. 1. (× 82·5)

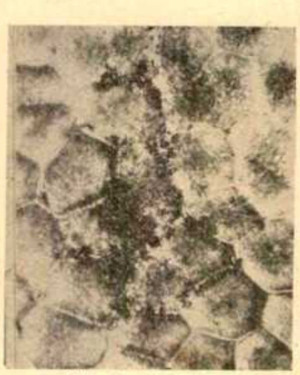
Fig. 2. (× 115)

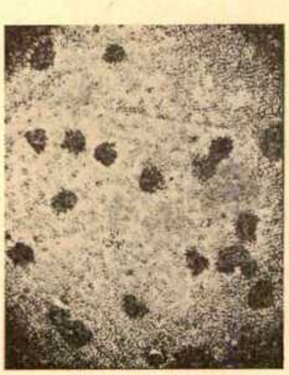
Fig. 3. (×17·5)

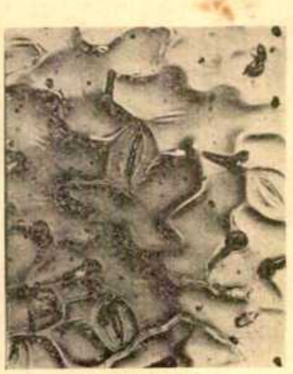
Fig. 4. (× 185)

Spray deposits of copper and lime sulphur are neither crystalline nor strongly coloured, and for these reasons are not clearly distinguishable in an impression. They are, however, completely removed on to the surface of a cellulose acetate impression and may be developed by treating the impression with a suitable solution which converts the deposit into a more highly coloured compound. Thus a solution of sodium diethyldithiocarbamate converts copper to a dark brown complex and lead acetate solution produces a black deposit of lead sulphide from lime sulphur. Fig. 2 is a high-power photomicrograph showing the distribution of copper from a single spray droplet (approximately 100μ diameter) of Bordeaux mixture on the upper surface of a cyclamen leaf. The particles of copper fungicide have collected in the cuticular depressions at the edges of the epidermal cells. Fig. 3 is a low-power photomicrograph of the deposit produced by discrete drops of 32 per cent lime sulphur on the upper surface of a broad-bean leaf, and it demonstrates the value of the method in rapidly assessing the macroscopic distribution of spray deposits. The use of the methods is not restricted to leaves, but on other surfaces, such as fruit or bark, difficulty may be experienced in applying even pressure to a sufficiently large area. In such cases a satisfactory method is to remove strips of the surface before impressing them.

The method may also be used for studying the distribution and development of fungus spores, which are removed in a cellulose acetate impression of a leaf surface and can be stained with a suitable dye as illustrated in Fig. 4, which shows the distribution of germinating spores of *Botrytis fabae* stained with saffranin on a broad-bean leaf. The method is very useful in studying the range of action of fungicides, since a single impression can show both spore development and the distribution of the fungicide. Population studies of small animals such as mites on plants can be made ; all stages of the mites are removed from the leaf surface in cellulose acetate and are easily distinguishable under simple projection.

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Lack of Christmas Factor in Horse Plasma

Bell, Archer and Tomlin[1], using the thromboplastin generation test, recently found the prolonged clotting time of horse blood to be due to a deficiency of antihæmophilic factor. However, Soulier and Larrieu[2] have used horse plasma as a source of this factor. The thrombin generation test[3,4] is useful in differentiating between classical hæmophilia and Christmas disease[5]. Applied to citrated horse plasma (containing 130,000 platelets per c.mm.) the following results were obtained (Fig. 1).

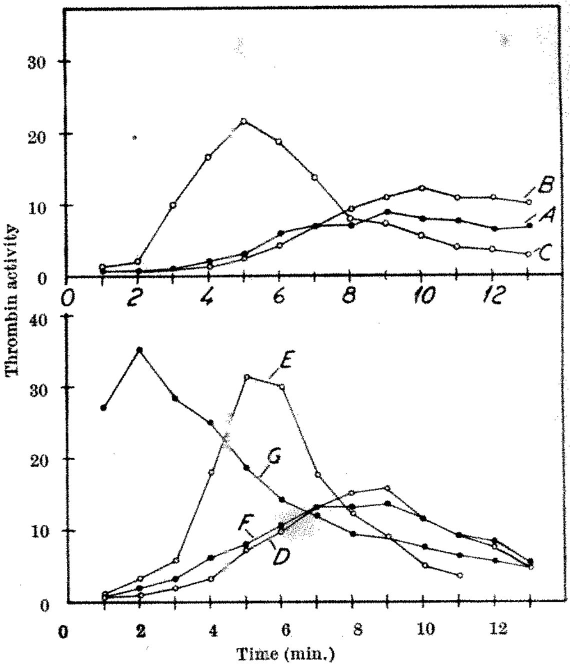

Fig. 1. Thrombin generation in horse plasma. *Abscissa*, reaction time in minutes ; *ordinate*, reciprocal clotting time of fibrinogen solutions expressed as $600/t$ (t in sec.)

Curve *A* shows the thrombin generation in 1 ml. normal horse plasma. The addition of 0·2 ml. plasma from a patient with Christmas disease did not improve the results (curve *B*). Addition of normal human serum (curve *C*) made the thrombin generation normal, whereas barium sulphate absorbed normal human plasma without effect (curve *D*). After the addition of 0·2 ml. plasma from a patient with classical hæmophilia (AHF deficiency) the thrombin generation became normal (curve *E*), whereas the addition of plasma from a patient with Christmas disease and classical hæmophilia was without effect on the thrombin formation (curve *F*). Addition of a preparation of Christmas factor made according to Aggeler *et al.*[6] produced a very rapid generation and a high concentration of thrombin (curve *G*).

Apparently the defect in the thromboplastin system of horse plasma is caused by lack of Christmas factor.

This research was aided by grants from Kong Christian den Tiendes Fond and from the Josiah Macy Jr. Foundation, New York (to Dr. Tage Astrup).

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A New Blood Parasite in British Pigs

Parasites of the genus *Eperythrozoon* do not appear to have been reported previously as occurring in the pig in Great Britain. In the United States Splitter[1] has recorded two species, *E. suis* and *E. parvum* ; the former causes a disease known as ictero-anæmia in swine. We wish to report the occurrence of ring-like and coccoid structures, closely resembling those described by Splitter, in the blood of British pigs. The organisms are pleomorphic, rods, triangular and dumbbell forms occur ; but ovoid rings or cocci are the most characteristic. The parasites are found in close association with the red cells and may also be extra-cellular. They stain well with Giemsa and may also be detected when numerous with Leishman's stain. Other workers who have kindly examined infected blood smears concur with our opinion that the organisms are *Eperythrozoa*. (We wish to acknowledge the assistance of Dr. June Thurston, Molteno Institute, University of Cambridge, in this respect.) While we are as yet uncertain of the species concerned, it seems likely that the parasite is *Eperythrozoon parvum*.

The organisms have been found in seven splenectomized pigs less than three months old. They have been seen in the blood within nine days of splenectomy and have remained evident for at least seven days. Initially few in number, they increase until a peak infection is reached, then gradually regress. Recrudescences occur, and in one case this was associated with a mild anæmia (haemoglobin-level reduced by 3 gm./100 ml. and red blood cell counts reduced by 2 million per c.mm.) and a mild fever. A number of attempts at culture on bacteriological media and in developing chick embryos, together with transmission to small laboratory animals, have been unsuccessful. Three pig-to-pig transmissions have been accomplished. A detailed account of these experiments will be published elsewhere.

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Unexpected Anomalies in the Behaviour of Neutral Red and Related Dyes

The colour base of neutral red, 2-amino-8-N,N-dimethylamino-3-methylphenazine, together with 2-amino-8-N,N-dimethylaminophenazine (the colour base of 'neutral violet' in German usage), the amphoteric 8-amino-2-phenazinol, and 2-amino-7-N,N-dimethylaminophenazine have been made for the first time by unambiguous means: bomb-tube reactions of aqueous ammonia with the corresponding chloro- or bromo-N,N-dimethylaminophenazines, or with the halogenated 2-phenazinol[1]. The phenazines were made by ring closure through the nitro group of the corresponding 2-nitrodiphenylamines, according to the method of Waterman and Vivian[2].

None of the four compounds stained two species of *Amoeba* (*A. proteus* and *A. dubia*), or cells of sarcoma 37 ascites tumour when they were dissolved in dilute hydrochloric acid and the solutions brought to approximate neutrality. The staining power, on the other hand, was retained by the purified colour base of commercial neutral red (obtained by passing the crude dye twice through basic alumina), when this purified sample was likewise dissolved in dilute hydrochloric acid and the solution neutralized.

Analytical figures for carbon and hydrogen of this latter sample corresponded closely to the theoretical for aminodimethylaminomethylphenazine; the infra-red spectrum of the purified commercial base was ambiguous with regard to that of the synthetic 2-amino-8-N,N-dimethylamino-3-methylphenazine. This line of investigation is being continued. The melting points were different, however, for the base from the commercial dye melted with decomposition at 241–245°, while the synthetic base melted without decomposition at 166–167°. Also, the latter gave a brown colour with concentrated sulphuric acid, while the base from the commercial dye gave a green. In addition, the yellow solution of the synthetic base in ether showed a marked green fluorescence on exposure to ultra-violet light which was absent from the ether solution of the less-soluble purified commercial base.

Significantly, it was found possible to obtain forms of all three of the synthetic 2,8-substituted colour bases which gave vital stains when dissolved in dilute hydrochloric acid. These forms were made by dissolving the colour bases in concentrated sulphuric acid, diluting, and precipitating with ammonium hydroxide. The finely divided products were isolated by centrifuging. It is significant that the 2-amino-7-N,N-dimethylaminophenazine did not give a stain when subjected to this process.

The colour bases so obtained contained varying amounts of water, depending on the humidity of the atmosphere in which they were spontaneously dried; but in the instance of the colour base of neutral red, and presumably for the others, this water was not essential to the staining properties, which were retained undiminished when the compound was dried at 110°.

There apparently exists a third form, also, of the colour base of neutral red at least; for dissolving the synthetic compound in concentrated sulphuric acid and neutralizing directly by concentrated ammonium hydroxide, without prior dilution, produces a non-staining form which cannot be converted to the stain by subsequent treatment with sulphuric acid, dilution, and neutralization by ammonium hydroxide.

Both of the first two forms have been shown to be monomers in methanol solution by the Signer method[3].

Further investigation is being undertaken to determine the nature of the structural differences between the three forms.

We wish to acknowledge the technical assistance of Walter G. Hardy, and of Dr. W. C. Alford for molecular weight determinations.

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Separation of Carbohydrates by Electrophoresis on Glass Filter Paper

In recent studies on the paper electrophoresis of carbohydrate compounds, we have found that replacing the cellulose filter paper by paper made from glass fibres[1] greatly facilitates the identification of sugars and their derivatives, especially those which are difficult or impossible to detect on cellulose paper.

Sugars, methylated sugars, sugar alcohols, lactones, sugar phosphates, neutral and acidic polysaccharides may be detected by spraying with a solution (0·5 per cent) of potassium permanganate in *N* sodium hydroxide. The more stable methylated methyl glycosides, methylated polysaccharides and acetal derivatives of sugars are readily detected by spraying with a solution (5 per cent) of 1-naphthol in 10 *N* sulphuric acid.

The paper electrophoresis experiments were carried out in a 'sandwich' type of apparatus[2,3]. The glass paper (made with 3 A. fibre and no organic binder)[1], held between two thin insulating sheets of polythene, is placed on a sheet of foam rubber (0·5 in. thick) and clamped between two sheets of plate glass (0·25 in. thick) by means of two simple wooden clamps[2]. The foam rubber enables an even pressure to be applied to the paper[3]. Since evaporation is prevented, cooling need not be applied except when dealing with proteins, in which case the upper glass plate is replaced by one to which has been cemented a 'Pyrex' dish and through which cold water can be circulated[2].

For electrophoretic analysis of carbohydrates, 0·1 *M* sodium tetraborate was used as the buffer, a voltage of 600 was applied and separations were carried out for 0·5–3 hr., depending on the nature of the substances being examined. Ethylene glycol, D-glucose, tetra-O-methyl D-glucose or its methyl glycoside were used as reference compounds. After the separation, the paper, still containing borate buffer, was placed on a glass plate and dried in the oven at 100° and, while still hot, the reagent was applied as a spray in the usual way. With the 1-naphthol reagent mono-, oligosaccharides, methyl sugars, glycosides, sugar acetals, polysaccharides and methyl polysaccharides were located by the appearance of dark blue spots on a white background, while with alkaline permanganate all oxidizable compounds were detected by the appearance of well-defined white or pale yellowish brown spots on a pink or greenish-pink background. The same glass fibre paper chromatogram may be subjected to the alkaline permanganate treatment (this detects all the oxidizable components), and then with the acidified 1-naphthol reagent (this detects sugar derivatives that escape permanganate oxidation).

Many other substances, including the amino-acids, proteins, sterol glycosides, organic acids and phenols, can be separated in the same manner and readily identified by taking advantage of the fact that a wide variety of reagents and conditions may be used for locating the substances on the glass papers.

Using glass instead of cellulose paper, the possibility of combination between polyhydroxy compounds and the paper through a common borate ion is impossible, whereas this is not necessarily the case when cellulose paper is employed. Hence, structural deductions from borate complex formation, as revealed by electrophoresis, are likely to be more reliable when glass paper is used instead of cellulose paper. The method has proved useful in the separation and comparison of *cis* and *trans* C_5, C_6, and C_7 saturated cyclic diols and other cyclic and straight-chain polyols. The steric effect of neighbouring groups and of the nature and size of rings on vicinal hydroxyl groups has also been investigated.

It will be apparent that this method will also simplify certain quantitative determinations which, hitherto, have had to take into consideration material extracted from the cellulose filter papers, and it is also likely that electrophoresis on thick sheets of glass paper will prove to be useful for preparative work.

The glass filter paper can be re-used after a suitable washing treatment, and a further saving can be effected by using glass paper only for the central portion of the chromatogram, with overlapping extensions of cellulose filter paper to make contact with the buffer solution.

Further details of this work will appear elsewhere.

We wish to thank the National Bureau of Standards, Washington 25, D.C., through the courtesy of Dr. R. B. Hobbs and Dr. M. J. O'Leary, for the glass fibre papers.

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Spectrum of the Cyclopentadienyl Radical

The great stability of benzene has aroused much interest in the properties of other planar symmetrical cyclic species of formula $(CH)_n$. For even values of *n*, only cyclo-octatetraene is stable, and is of limited interest owing to puckering of the ring[1]. The odd series can exist only as radicals or ions and, while several calculations have been made of their resonance energies[2-4], only $C_7H_7{}^+$ has been observed spectroscopically[5], although the acidity of cyclopentadiene[6] provides evidence for the stability of the ion $C_5H_5{}^-$. Like benzene, both these species have six π-electrons and are expected to have higher resonance energies than the 38 k.cal. predicted for the cyclopentadienyl radical (C_5H_5)[3,4].

Experiments have been carried out on the flash photolysis of both cyclopentadiene and 'ferrocene' (biscyclopentadienyl iron) in the gas phase using the apparatus previously described[7]. Pressures of 1–10 mm. of cyclopentadiene or 1 mm. of ferrocene diluted with 250–750 mm. of inert gas (nitrogen or carbon dioxide) to limit the rise in temperature were used. In all these mixtures, the spectrum shown in Fig. 1 was observed during the photolysis but disappeared rapidly, its half-life being less than 10^{-4} sec. This spectrum consists of two heads at 29,581 and 29,911 cm.$^{-1}$, which are relatively sharp, having widths of about 10 cm.$^{-1}$; this spectrum must presumably be due to the C_5H_5 radical, since it is difficult to visualize any other transient species except atoms which would be formed directly in the photolysis of both these compounds. Furthermore, recent calculations by McEwen and Longuet-Higgins[8] using a semi-empirical molecular orbital treatment predict an E_1'' ground-state for this radical, with an A_2'' first excited state to which a transition would be allowed (transition moment symmetry—E_1'). Neglecting second-order interactions, they find an excitation energy of [illegible]·02 eV. for this state, which is in strikingly good agreement with the observed values of 3·67 and 3·70 eV. Also, they predict that there will be no other states lying below 6 eV., which is in accordance with the absence of further absorption bands above the limit of observation at 2400 A.

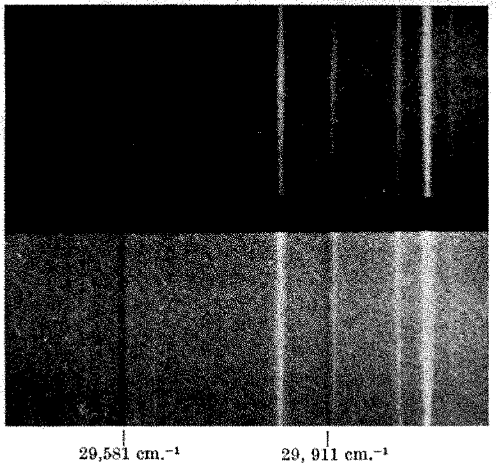

Fig. 1. Absorption spectrum attributed to the cyclopentadienyl radical

The decay of the C_5H_5 radical is accompanied by the appearance of featureless continuous absorption below 3500 A., due to a stable product which has not yet been investigated. In the absence of an inert gas, the rise in temperature due to the light energy absorbed by either cyclopentadiene or ferrocene is insufficient to produce appreciable thermal decomposition; under these conditions, the continuous absorption by the products appears without the intensity of the C_5H_5 spectrum reaching the limit of detection. This increase in the rate of the reactions removing the radical indicates that they have an appreciable activation energy, which is not surprising in view of the high resonance energy expected for C_5H_5. During this photolysis in the absence of inert gas, ferrocene shows strong absorption from iron atoms in the sub-levels of the (x^5D) and (a^5F) states, the latter being intense enough to suggest that the iron atoms might be liberated in this state.

I wish to express my gratitude to Miss K. L. McEwen and Prof. H. C. Longuet-Higgins for permission to quote results from an unpublished paper.

B. A. Thrush

Department of Physical Chemistry,
University of Cambridge. March 21.

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A Test of the 'Redox' Hypothesis of Active Ion Transport

The concept that the electron transfer in the oxidation–reduction reactions of respiration constitutes the driving force for active ion transport has provided the basis for several hypotheses of ion transport[1-7]. All these have in common the quantitative limitation that no more than four univalent ions can be actively transported per molecule of oxygen consumed, because oxygen can accept just four electrons per molecule in its complete reduction.

To test this 'redox' hypothesis of ion transport, simultaneous measurements were made of active ion transport and oxygen consumption by isolated frog skin. Ussing and Zerahn[8] have shown that, with the same solution bathing both sides of an isolated frog skin, the short-circuit current measured, when a counter potential is applied across the skin so as to reduce the spontaneous membrane potential to zero, is equal to the net sodium transport through the skin. Hence the short-circuit current was taken as the measure of active sodium transport. Oxygen consumption was measured polarographically with a vibrating platinum micro-electrode[9].

A total of eighty-seven individual, simultaneous measurements of oxygen consumption and active ion transport was made on the ventral skins of nineteen frogs (*Rana temporaria*). The ratio of ions transported to molecules of oxygen consumed was found to range from 2 to 13 with a mean of 6·93 and standard error of the mean of ± 0·21. In all but five periods this ratio was above 4·0. The experimental error propagated into the determination of a single value of this ratio is estimated to be ± 9 per cent.

These results are incompatible with the 'redox' hypothesis of ion transport in which molecular oxygen is the electron acceptor. Similar results in this same tissue have recently been obtained by Zerahn[10].

Active sodium transport through the frog skin is augmented by neurohypophyseal preparations of mammalian origin[8]. We find in all but one of sixteen experiments that this effect is associated with a simultaneous increase of oxygen consumption by the stimulated membrane. Thus the mean rates of sodium transport for the sixteen periods just before and the sixteen periods just after addition of neurohypophyseal preparations were 1·69 and 2·76 μequiv./cm.^{2}/hr. respectively, the mean difference was 1·07 and its *S.E.* ± 0·089 and $P < 0·001$. The mean figures for oxygen consumption for the same periods were 0·278 and 0·341 μmole/cm.^{2}/hr., the mean difference was 0·063 and its *S.E.* ± 0·0129 and $P < 0·001$. If the one experiment in which no stimulation of oxygen consumption was observed is excluded, the mean ratio of increment of sodium transport to increase in oxygen consumption following stimulation of the skin with neurohypophyseal preparations was 21·1 ± 3·0 sodium ions transported per molecule of the increment of oxygen consumed. Though such a calculation is open to some criticism[11], this mean figure of the ratio of increase in sodium transport to increase in oxygen consumption represents the best estimate possible at present of the actual stoichiometric relationship of ion transport to oxygen consumption by the fraction of cells in this tissue engaged in the ion transport process.

The minimum energy required for the active ion transport process constitutes 8 and 10 per cent of the total energy available to the tissue from aerobic metabolism before and after stimulation with neurohypophyseal preparations, respectively, and 22 per cent for the increment of ion transport and oxygen consumption following hormonal stimulation. Thus no inconsistency is encountered when the energetics of the observed rates of ion transport are considered.

Previous attempts to evaluate the relationship of ion transport to oxygen consumption in this tissue have been made. Stapp and Lund[12] obtained values close to 4 but realized that, as they were not using a totally short-circuited skin preparation, their results gave only a minimal value. Linderholm[13] has estimated this relationship and his results give a value of 3·28. However, his oxygen and ion transport measure nents were not made simultaneously on the same skin but were mean figures. More important, the skins used in his study gave very low rates of ion transport averaging 0·7 μequiv./cm.^{2}/hr. as compared with our higher values recorded above. Thus, even though our values for oxygen consumption are higher than his, the ion transport rates were sufficient to give the higher ratios produced here.

The results indicate that the 'redox' hypothesis of ion transport in which oxygen is the final electron acceptor is quantitatively insufficient to account for observed rates of ion transport and oxygen consumption by the isolated, short-circuited frog skin.

The full paper will be published in due course.

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Formation of Hydroperoxides from Nucleic Acids by Irradiation with X-Rays in Aqueous Systems

IN the course of our studies of the chemical effects of X-rays on nucleic acids in aqueous solutions[1], we have had occasion to measure the amounts of peroxide produced. Two methods were employed: (*a*) the reaction with titanium sulphate reagent[2] and spectrophotometric measurement of the resulting complex at 405 mμ; (*b*) the oxidation of potassium iodide[3] and determination of the liberated iodine (I_3^-) by the absorption at 353 mμ. It was found that, in solutions of thymus deoxyribonucleic acid and also of yeast ribonucleic acid irradiated in the presence of oxygen, the yields of total peroxide, as determined by the iodide method, were always greater than those of hydrogen peroxide, estimated by titanium sulphate. This observation can be explained by the presence of organic hydroperoxides in the irradiated nucleate solutions, since it is known that hydroperoxides will oxidize iodide ions, but do not give, in general, the coloured complex with the titanium sulphate reagent.

For example, in the irradiation of deoxyribonucleic acid solutions (0·1 per cent w/v, Signer acid, $p\mathrm{H} \sim 7$) with X-rays (200 kV.), in the presence of oxygen (1 atm.), with a total dose of $\simeq 3 \times 10^4$ rep, the yield of total hydroperoxides was $G = 2{\cdot}5$ (molecules/100 eV.), whereas for hydrogen peroxide $G = 1{\cdot}5$; this gives a difference of $G = 1{\cdot}0$ to be accounted for by organic hydroperoxides.

These hydroperoxides showed a marked post-irradiation decay. In the case of the above-mentioned deoxyribonucleic acid solutions, the disappearance of the organic hydroperoxides could be accounted for on the basis of the occurrence of two simultaneous first-order processes, with half-lives of about 1 hr. and 30 hr. respectively (at 25° C.).

In order to throw some light on the nature of the hydroperoxides in irradiated nucleate solutions, experiments have been carried out with several ribonucleotides and ribonucleosides and also with the corresponding purine and pyrimidine bases. Evidence for the presence of hydroperoxides was obtained in irradiated solutions of uridine-3′-phosphate, uridine, cytidine-3′-phosphate, cytidine and with uracil and thymine; but negative results were found with guanosine-3′-phosphate, the adenosine-3′- and 5′-phosphates, as well as with adenosine and with adenine. Hence, we may conclude that these hydroperoxides are associated with the pyrimidine bases. These experiments suggest that the two different hydroperoxides which are found in the irradiated deoxyribonucleic acid solutions are derived from the two pyrimidine components.

The presence of molecular oxygen during irradiation is essential for the production of hydroperoxides from these compounds. This is in agreement with the general idea that the formation of organic hydroperoxides proceeds through the addition of molecular oxygen to the free radical, $R\cdot$ (formed by the action of a radiation-produced OH radical on the solute, RH), leading to the formation of an organic peroxy-radical $RO_2\cdot$, which, on reduction, can form a more or less stable organic hydroperoxide (RO_2H) [4].

The production of such hydroperoxides from deoxyribonucleic acid and ribonucleic acid may be of considerable importance from a radiobiological point of view; in particular, this may have a bearing on some delayed effects of ionizing radiations *in vivo*.

Work on related and various other compounds of biological importance is in progress.

Full details will be published elsewhere.

Note added in proof. It has now been found that the formation of hydroperoxides from these compounds can also be induced by irradiation of their aqueous solutions with ultra-violet light in the presence of oxygen.

We wish to thank the North of England Council of the British Empire Cancer Campaign and the Rockefeller Foundation for financial support.

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Influence of Surface Oxygen in the Activation of Carbonized Coals by Partial Combustion

IT has long been appreciated that surface compounds as well as gaseous oxides are formed when carbons and oxygen interact. Rhead and Wheeler's original suggestion[1] that the so-called surface oxides are intermediates in the overall reaction mechanism is not borne out by more recent work[2,3], which shows that at least a proportion of the oxides should be regarded as by-products of the main reaction.

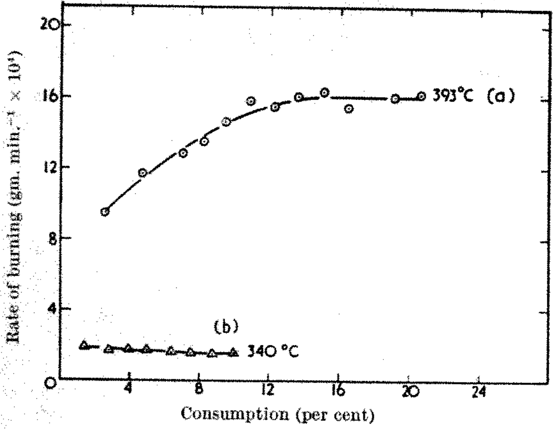

Fig. 1. Relation between rate of burning and per cent consumption for 812° C. char burned at two temperatures at an oxygen partial pressure of 20 per cent of 1 atmosphere: *a*, 393° C.; *b*, 340° C.

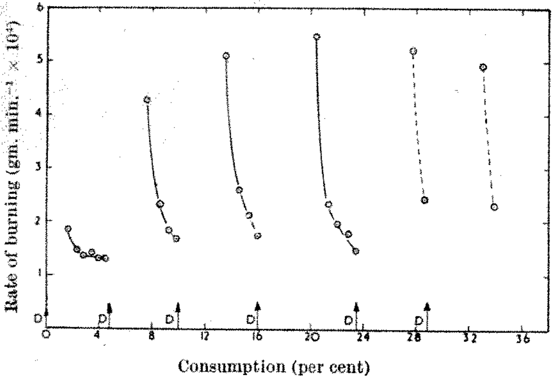

Fig. 2. Relation between rate of burning and per cent consumption for 812° C. char burned at 340° and 7·7 per cent oxygen partial pressure with periodic degassing (*D*) of the fuel in nitrogen at 750° C. Initial charge 3·1 gm. Size-range 7–10 B.S.S.

A study of the slow reaction in oxygen of several carbons covering a wide range of reactivity has shown clearly that surface oxygen can retard the normal development of reactivity of porous carbons accompanying their partial consumption. The reaction was followed by gravimetric estimation of the oxides of carbon in the outflow gases, in which large quantities of oxygen were still present. Under suitable conditions (reactive fuel and low reaction temperature), consumption of the fuel did not lead to the increase in reaction-rate that would be expected as a result of marked activation. For example, the curves in Fig. 1 show the variation in rate of gasification with extent of consumption for one fuel at two working temperatures, namely, 340° and 393° C. In the latter case (curve *a*) the increase in rate with consumption indicates marked activation, whereas in the former (curve *b*) the rate shows little change. The influence of surface oxygen in determining the form of curve *b* was demonstrated by interrupting a run and heating the carbon, in an atmosphere of nitrogen, to a temperature slightly below that of its preparation. This process led to the release of oxides of carbon from the sample. On cooling to reaction temperature and re-admitting oxygen a very high initial reaction-rate was observed which decayed rapidly towards its previous low value. This cycle may be repeated (Fig. 2). With more reactive fuels, exposure to oxygen after degasification often led to uncontrollable temperatures.

The precise mechanism of retardation by surface oxygen is unknown; activation of porous fuels is thought to proceed mainly by an 'opening up' of the internal structure. This presumably goes on while the surface oxides are present on the fuel; but the new surface is not available for rapid combustion until the oxides are removed. This effect would provide a reason, apart from temperature control, for preferring to activate fuels in steam rather than in air or oxygen; for, so far as we are aware, no oxide by-products from the steam/carbon reaction have been reported.

This role of surface oxygen in the practical ignition of a fuel on a grate is probably small if auxiliary sources of ignition are used, since the temperature-range in which the surface oxides would be most influential is rapidly traversed.

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E. J. Newitt
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Randalls Road, Leatherhead. March 13.

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Solid-State Reaction in the System $ZrO_2-Al_2O_3-SiO_2$

A number of compositions at 10 per cent intervals along three possible compatibility joins within the system have been heated at 1,650° C. All were formulated from mixtures of the pure oxides and, where applicable, a high-grade natural zircon.

X-ray analysis of calcined specimens of the series of simple oxide mixtures equivalent to compositions along the possible compatibility join ZrO_2—$3Al_2O_3.2SiO_2$ showed each to consist of a binary mixture of zirconia and mullite. The exclusive presence of these two solid phases suggested the validity of the join. Confirmation of the non-existence of the intersecting join Al_2O_3—$ZrO_2.SiO_2$ was provided by the fired nature of the series of compositions along it. The first five members (90–50 per cent Al_2O_3) of the series were found after calcination to comprise ternary mixtures of zirconia, mullite and alumina, while the last four (40–10 per cent Al_2O_3) consisted of ternary mixtures of zirconia, zircon and mullite. If the join were valid, solid-state reaction would have resulted in the production of binary mixtures of alumina and zircon in all cases. The X-ray diffraction charts of compositions made up with natural zircon clearly indicated the disappearance of this phase immediately the valid join ZrO_2—$3Al_2O_3.2SiO_2$ was crossed from the side of zircon to the side of alumina. The absence of zircon in fired specimens of a control composition equivalent to the mixture 60 per cent Al_2O_3, 40 per cent $ZrO_2.SiO_2$, which had been prepared from the simple oxides, and its successful synthesis in similar specimens corresponding to the mixture 30 per cent Al_2O_3, 70 per cent $ZrO_2.SiO_2$, was considered strongly to confirm the indicated location of these compositions within dissimilar compatibility triangles.

A series of mixtures of zircon, alumina and silica corresponding to points along the possible compatibility join $ZrO_2.SiO_2$—$3Al_2O_3.2SiO_2$ were found after calcination to be predominantly binary mixtures of zircon and mullite. Further confirmation of the validity of the join was provided by fired specimens of a composition equivalent to the mixture 40 per cent $ZrO_2.SiO_2$, 60 per cent $3Al_2O_3.2SiO_2$, which was made up from the simple oxides. The X-ray diffraction chart of these specimens showed them to be essentially a mixture of zircon and mullite, an indication that the simultaneous synthesis of the two end members had occurred.

Experimental evidence of the validity of the compatibility joins $ZrO_2—3Al_2O_3.2SiO_2$ and $ZrO_2.SiO_2—3Al_2O_3.2SiO_2$ points to the existence of the three compatibility triangles or sub-systems $ZrO_2—3Al_2O_3.2SiO_2—Al_2O_3$, $ZrO_2—ZrO_2.SiO_2—3Al_2O_3.2SiO_2$ and $ZrO_2.SiO_2—SiO_2—3Al_2O_3.2SiO_2$ within the ternary system $ZrO_2—Al_2O_3—SiO_2$. The fired nature of the specimens of the three series studied gave no indication of ternary compound formation on either of the two valid joins or within the compatibility triangles $ZrO_2—3Al_2O_3.2SiO_2—Al_2O_3$ and $ZrO_2—ZrO_2.SiO_2—3Al_2O_3.2SiO_2$. A final composition within the compatibility triangle $ZrO_2.SiO_2—SiO_2—3Al_2O_3.2SiO_2$ indicated that it also was free from additional compound formation. Evidence of partial fusion was apparent in compositions at the high $—ZrO_2.SiO_2$ end of the series $Al_2O_3—ZrO_2.SiO_2$ and $ZrO_2.SiO_2—3Al_2O_3.2SiO_2$. These compositions are in the vicinity of the binary eutectic between alumina and zircon at about 20 per cent Al_2O_3 and 1,680° C., previously reported by Rea[1]. Glass formation was associated with considerable decomposition of the zircon present. The results obtained are only partially in agreement with those of a recently published investigation of solid-state reaction in the quaternary system $MgO—Al_2O_3—SiO_2—ZrO_2$ [2]. The earlier investigation was carried out at considerably lower temperatures.

A more detailed account of this work will be published elsewhere.

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March 12.

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Class II Radio Signals from Venus at a Wave-length of 11 Metres

IN two earlier communications[1], the reception of impulsive radio signals from the planet Venus at a wave-length of 11 metres was reported. These signals have burst-like characteristics somewhat resembling atmospherics from terrestrial thunderstorms and may presumably originate in similar storms on Venus. The bursts are of very short duration, being a small fraction of a second.

The purpose of this third communication is to report the reception at the Ohio State University of radio signals of a distinctly different kind which also appear to come from Venus. For convenience, these signals will be referred to as Class II signals, while the previously reported atmospherics-like signals will be designated Class I signals. The same equipment as described earlier has been used for receiving both types of signals.

The Class II signals are usually of a more sustained type, lasting about 1 sec. or considerably more, and appear to be modulated at an audiofrequency-rate. Modulation frequencies in the neighbourhood of 15, 60, 125 and 150 c./s. have been noted. The emissions are slightly reminiscent of signals from a terrestrial radio telegraph station, and they were at first presumed to be interference from this type of station. However, over many weeks they were observed to appear only when Venus was in the antenna beam of the radio telescope and usually seemed to be strongest when Class I signals were also being received with greatest strength. Sustained signals of several seconds duration have also been observed from Jupiter[2]. These have a very low-frequency modulation of 30 c./s. or lower.

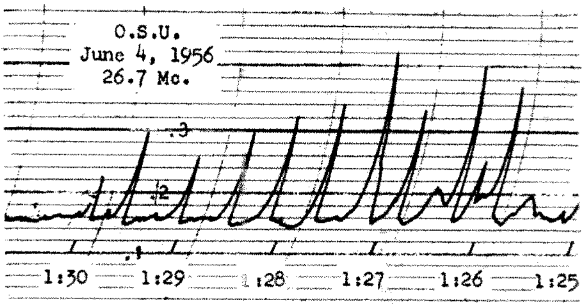

Fig. 1. A series of Class II pulses received on June 4, 1956, at 11 m. wave-length

One of the most prominent Class II signals has a modulation of approximately 125 c./s. and occurs in pulses of about 1 sec. duration. Fig. 1 shows recorder indications of a series of such pulses received on June 4, 1956. The pulses may occur at intervals of a few seconds to a minute or more. In the group shown in Fig. 1 the intervals are mostly between 20 and 30 sec. On some occasions when pulses were being detected, it was observed, by tuning the receiver, that they could be received over a frequency-range of at least 2 Mc./s. Since each pulse has a sloping front and an abrupt termination, the detection over a 2 Mc./s. frequency-range cannot be due to a narrow band pulse swept rapidly in frequency since this would produce a symmetrical pulse having the same shape as the receiver band-pass characteristic. Hence, it appears that the pulses possess a band-width of at least 2 Mc./s.

The pulses are not usually observed for a long enough period of time (rarely more than 5 or 10 min.) to obtain a conclusive interferometer lobe pattern, and although it appeared likely that these signals might be of Venusian origin some independent type of observation was needed to make the identification more definite. This came about from a study of the magnetic sound tapes, on which the audio output of the receiver had been recorded; when it was noted

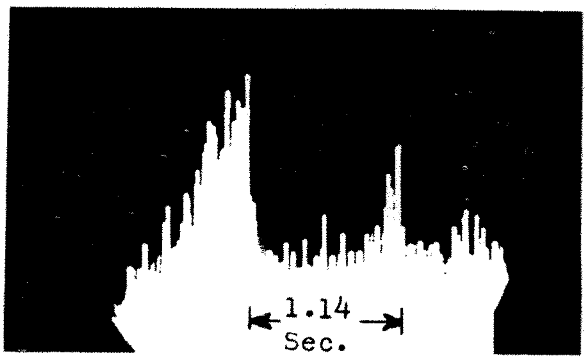

Fig. 2. Class II pulse with echo observed about 1.15 p.m. E.S.T. on June 4, 1956. Time increases to the right, the echo being the smaller peak to the right of the main one

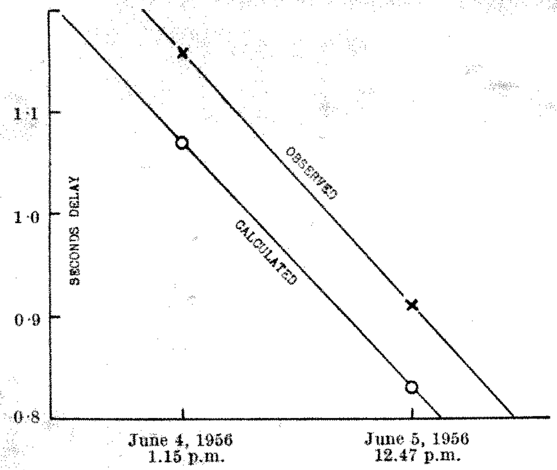

Fig. 3. Comparison of observed and calculated moon echo delay times

that on rare occasions a pulse was followed by a weaker one which sounded like an echo. Two such pulses with echoes were noted on the sound tape for June 4, 1956, occurring within a few minutes of each other about 1.15 p.m. E.S.T. One of the pulses with echo is shown in Fig. 2 as photographed on a cathode-ray oscillograph. This pulse echo has a measured delay time of 1·14 sec. The other pulse echo delay was 1·18 sec., giving an average of 1·16 sec. The Moon was above the horizon at the time and the calculated delay time for a signal reaching the Earth from Venus through a Moon reflexion with respect to a signal reaching the Earth directly from Venus was about 8 per cent less. A search for more pulses with echoes revealed a single one on the sound tape of June 5, 1956, at 12.47 p.m. E.S.T. This one had a measured delay of 0·91 sec. The calculated delay was 0·83 sec., the movement of the Moon causing a reduction in the echo delay time of 0·24 sec. (1·07–0·83) between the times of observation on June 4 and 5. It is highly significant that the observed delay time changed by 0·25 sec. (1·16–0·91) or by nearly the same amount. The results are compared in Fig. 3.

There appears to be a consistent difference between the observed and calculated delay times on the two days due to a relatively constant experimental effect, but the change in both observed and calculated times is very nearly equal. The probability of this being a coincidence or due to some other cause is very small, so that it appears that the pulses are of Venusian origin. A lower signal velocity than for waves in empty space could account for the difference between the observed and calculated values, but any such reduction in velocity would probably be sufficiently small to account for only a portion of the difference.

To receive a Moon echo of the strength observed requires about fifty decibels more echo-power than the Moon would provide as a uniform spherical scatterer of radio waves. Nevertheless, such enhancement could occur if a relatively large flat area of the Moon were properly oriented so as to give a direct reflexion to the Earth. In fact, if the surface in question were slightly concave (as a shallow valley) and of approximately parabolic contour, with the Earth at the focus, very large increases in power of echo could be expected. However, the proper orientation of the Moon to obtain such a reflexion would be a rather rare occurrence, which would account for the fact that echoes are seldom observed.

I am indebted to Dr. H. C. Ko for making independent calculations of the echo delay times.

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June 25.

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Diffraction of Light by Ultrasonic Waves at 300 Mc./s.

THE highest frequency so far adopted for the study of diffraction of light by ultrasonic waves is 180 Mc./s. reported by Bhagavantam and Rao[1]. Diffraction patterns at these frequencies were found to show some unusual and interesting features which were studied in detail by these authors.

Using an *RCA* 826 valve in a parallel line oscillator circuit and a *z*-cut precious red tourmaline crystal 0·6 mm. thick, we have recently been able to push up this frequency to nearly 300 Mc./s. and study the diffraction effects due to progressive waves set up in water. Diffraction patterns could be observed at all frequencies up to 300 Mc./s. by exciting the crystal at one of its odd harmonics. In order to measure dispersion, if any, of ultrasonic velocity in water, the crystal has been excited at the highest frequency and another lower frequency and the diffraction patterns photographed on the same plate at about the same time using a camera of 21-cm. focal-length. Fig. 1 shows the patterns at the two frequencies of 50·34 and 297·03 Mc./s. photographed at the Bragg angle of incidence for the higher frequency, using the mercury green line as the source of light.

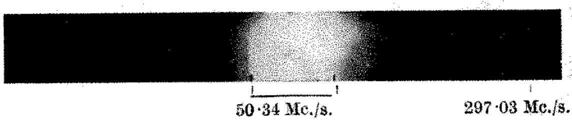

Fig. 1

Results for the velocity of sound waves measured at the two different frequencies are given in the accompanying table along with the fringe-width and the order of the harmonic of the crystal which was excited. The lower frequency was measured accurately by a Marconi precision heterodyne wave-meter while the highest frequency was measured by using a Lecher-wire set up.

In view of the appreciable angle of diffraction (6° 10′) at the higher frequency, it is not possible to approximate sin θ to tan θ and take the fringe-width as proportional to the frequency as is usually done in the lower frequency-range. The velocity at 300 Mc./s. is calculated by evaluating sin θ from the value of d/D. The sound beam at 300 Mc./s. is confined close to the surface of the crystal due to heavy absorption, and as the liquid in contact with the crystal is sub-

Table 1. FOCAL LENGTH OF THE CAMERA $D = 21$ CM.

Order of harmonic	Frequency ν^* (megacycles per sec.)	Fringe-width d (cm.)	$\frac{\nu^*}{d}$	Velocity (m. per sec.)	Temp. (° C.)
9	50·34	0·3844	130·6	1,502	24·8
53	297·03	2·2744	130·9	1,508	27·0

ject to heavy radio-frequency heating the average temperature of the liquid could not be determined quite accurately. Considering the uncertainty in the measurement of this temperature, the results may be taken to indicate that there is no dispersion of ultrasonic velocity in water up to 300 Mc./s. The values for the velocity are in fairly good agreement with those reported by other investigators. The wave-length of sound in water corresponding to 297·03 Mc./s. employed in this investigation is 0·000503 cm., which is only about twelve times the wave-length of mercury green light in water.

The general features of the diffraction pattern at 300 Mc./s. are similar to those at 180 Mc./s. reported earlier. The sharpness of the appearance of the diffraction line around the Bragg angle of incidence is, however, more prominent at the higher frequency. Quantitative study of the variation of intensity of the diffraction pattern with angle of incidence and width of the sound field is in progress and the results will be reported in due course.

B. RAMACHANDRA RAO
J. SATYANARAYANA MURTY

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Waltair.
Feb. 24.

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[1] *Nature*, **161**, 927 (1948); *Proc. Ind. Acad. Sci*, **28**, 54 (1948).

Calibration of Vibration Pick-ups at High Frequencies using a Michelson Interferometer

MOST existing methods of calibrating vibration pick-ups employ some form of extrapolation, that is, the pick-up is calibrated at low frequencies, where the amplitude can be made large, and the result is then extended to higher frequencies. Since it is considered that this method is unsatisfactory, a Michelson interferometer capable of measuring vibratory amplitudes down to 4 × 10^{-6} in. has been constructed. The upper limit of the calibration frequency is largely determined by the type of vibration pick-up and by the driving vibrator, but the present arrangement can be used up to 10 kc./s.

The Michelson interferometer takes its usual form except that it is mounted in a vertical plane for convenience. One of the two mutually perpendicular mirrors is attached to a block on the vibrator armature and the vibration pick-up is fixed to the same block. Using monochromatic light (in this case the green line of mercury at 5461 A.), circular fringes are set up in the usual manner. As the vibration amplitude is slowly increased, the fringes alternately disappear and reappear. The disappearance, that is, when the field of view is apparently uniformly illuminated, is quite sharp and each disappearance corresponds to a definite amplitude of vibration of the moving mirror, and Ostberg (1932) has calculated these amplitudes. Provided the vibration wave-form is a pure sinusoid, these amplitudes are determined by a Bessel function of order zero and the first three values are approximately 4·1, 9·4 and 14·8 millionths of an inch for a light wave-length of 5461 A.

Preliminary experiments have shown that this apparatus can be used for calibrating a barium titanate accelerometer over a frequency-range of 500 c./s. to 10 kc./s. It can also be used for proving that the output of the accelerometer at a given frequency is proportional to the amplitude of vibration, that is, to the acceleration.

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March 29.

Inadequacy of Recombination as the Source of Light from Enduring Meteor Trains

IT has been suggested[1,2] that the enduring column of light left by a meteor in its passage across the sky is produced by radiative recombination of the meteoric ions and free electrons. We wish to criticize this hypothesis on a quantitative basis.

Consider a line of q ion pairs per cm. which diffuse with an ambipolar diffusion coefficient D cm.^{2}/sec. to form a column with a Gaussian cross-section.

Let α_e be the recombination coefficient of the ions and electrons and p be the luminous energy emitted per recombination event between wave-lengths 4680 A. and 5560 A. The luminous energy, I, emitted per cm. of train per second is then given by the equation

$$I = \frac{p\,\alpha_e\,q^2}{8\pi D t} \qquad (1)$$

where t is the time that has elapsed since the passage of the meteor.

Let us consider a Perseid and a Geminid meteor with absolute visual magnitudes − 2·0 and − 3·0 respectively. The work of various authors enables us to compute the brightness of the train from equation (1).

(i) Öpik[2] has computed the visual intensities from the cascade spectra for recombination of the ions that are to be expected in meteor columns; he finds that the most efficient reaction is Fe II (a^4p) + e → Fe I, where $p = 1{\cdot}51 \times 10^{-12}$ ergs. Öpik computed the recombination coefficient for this reaction and for recombination events involving other atoms. After correction to a temperature of 212° K., we may adopt $\alpha_e = 2{\cdot}6 \times 10^{-12}$ cm.^{3} sec.$^{-1}$.

(ii) From the duration of radio echoes observed by Millman[1], we may deduce[3] that for a Perseid meteor of visual absolute magnitude − 2·0, $q = 1{\cdot}25 \times 10^{15}$ ion pairs per cm., and for a Geminid of absolute magnitude − 3·0, $q = 1{\cdot}43 \times 10^{14}$ cm.$^{-1}$.

(iii) Millman[1] has given the mean height of Perseids and Geminids of absolute visual magnitude + 0·5 as 102·6 km. and 97·0 km. We may assume that these heights apply to the brighter meteors as well, and compute values of the diffusion coefficient, D, from the results of Greenhow and Neufeld[4].

Substitution of the values of sections (i), (ii) and (iii) and $t = 1{\cdot}0$s. in equation (1) yields the luminosity, I, of a cm. length of meteor train. These values are given in Table 1.

Table 1. LUMINOSITY OF PERSEID AND GEMINID METEOR TRAINS ONE SECOND AFTER FORMATION

	Absolute visual magnitude	I ergs/cm./sec. estimated from recombination	I_0 ergs/cm /sec observed visually
Perseids	−2·0	1·22	400
Geminids	−3·0	3·82	400

Naked-eye observers[1] have recorded the visible duration of trains produced by Perseid and Geminid meteors. We may assume that a line source is on the limit of visibility when it is equivalent to a succession of stars of apparent magnitude + 6·0, all spaced at the limit of angular resolution of the human eye, which is 3·5′ or 0·00102 radians. Thus a train on the limit of visibility, making an angle θ with the line of sight, emits I_0 ergs of visible energy per cm. of length according to the relation

$$I_0 = \frac{4\pi R \cdot F_S \sin\theta}{0{\cdot}00102} \qquad (2)$$

where R cm. is the range of the element of the train and F_S is the flux produced by a star of 6th magnitude between wave-lengths of 4680 A. and 5560 A. For an unreddened star of apparent photo-visual magnitude[4] + 6·0 and spectral type *AO V*, the formula of Cook and Millman[5] and the tables of Milford give:

$$F_S = 1{\cdot}52 \times 10^{-8} \text{ ergs cm.}^{-2} \text{ sec.}^{-1} \qquad (3)$$

If the observer's field of attention, of approximate diameter 0·4 radian, is centred on the radiant, then the mean value of sin θ for a large number of trains is 0·138.

In the radio-visual correlations described by Millman the mean range R of the trails was 155 km., which we adopt for the trains. From the train observations we may deduce that for − 1·0 magnitude Perseids and − 2·0 magnitude Geminids the trains were at the limit of visibility 1 sec. after the passage of the meteor. The observed luminosity from equation (2) is included in Table 1.

A comparison shows that the meteor train is about two hundred times brighter than we would expect from ionic recombination. We are led, therefore, to postulate an alternative method for storing energy and producing visible radiation. A possible method is the formation of active nitrogen which afterwards excites neutral meteor atoms in the trail[6]. This mechanism is being studied further at the time of writing, and the results will be published elsewhere.

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Feb. 20.

[1] Millman, P. M., *J. Roy. Astro. Soc. Can.*, **44**, 209 (1950).

[2] Öpik, E. J., *Proc. Roy. Soc.*, A, **230**, 463 (1955).

[3] Greenhow, J. S., and Hawkins, G. S., *Nature*, **170**, 355 (1952).

[4] Greenhow, J. S., and Neufeld, E. L., *J. Atmos. Terr. Phys.*, **6**, 100 (1955).

[5] Cook, A. F., and Millman, P. M., *Astrophys. J.*, **121**, 250 (1955).

[6] Whipple, F. L., I.A.U. Publication (in the press).

Effect of Drawing on the Infra-red Dichroism of Nylon-66 Filaments

We wish to report on studies made of the polarized infra-red spectra of variously drawn nylon-66 filaments, where it has been found that the method used for specimen preparation may have an important influence on the experimental results. The optics of the 0·78 N.A. reflecting microscope used, in connexion with a Perkin–Elmer Model 12-*C* infra-red spectrometer, were identical with those mentioned by Quynn and Steele[1]. A set of silver chloride sheets was used for obtaining polarized radiation.

A series of nylon-66 filaments, prepared by melt spinning and ranging in draw ratio from one (undrawn) to four, was kindly supplied by E. I. du Pont de Nemours and Co. The undrawn filaments had a diameter of about 120 microns, which decreased with drawing to about 65 microns at draw ratio four, or at each draw ratio the filaments were approximately twice the diameter of those used by Quynn and Steele[1]. Specimens of approximately 4–6 microns in thickness were found suitable for infra-red examination, and these were prepared by microtoming.

It is possible to obtain desirably thin specimens by mechanical flattening of single filaments as well as by longitudinal sectioning with a microtome. But we have found that the flattening process can induce orientation in a filament and that this effect is accentuated when the filament is of initially low orientation. Such induced orientation may be greatly reduced when longitudinal sections are prepared by microtoming filaments embedded in a plastic. The embedding medium used in our work was plasticized polymethylmethacrylate. Three different methods of specimen preparation were used: (*a*) microtoming of previously flattened samples with the direction of blade motion parallel to the filament axis, (*b*) microtoming undeformed samples in a direction perpendicular to the filament axis, and (*c*) microtoming undeformed samples in a direction parallel to the filament axis.

Another problem associated with microspectroscopic examination of fibres in the infra-red region is that of delusive energy or 'stray light'. When only the nylon filament is located at the specimen stage of the reflecting microscope, it is found that a significant portion of the energy transmitted to the thermocouple of the spectrometer is energy which has gone around the edges of the filament and has become part of the filament image at the entrance slit of the monochrometer. In our experiments the 'stray light' was masked out at the specimen stage by placing pieces of thin aluminium foil, with slits 30–70 microns wide, over the longitudinal sections of filaments.

In calculations of the dichroic ratios shown in Table 1, allowance has been made for the reduction of energy caused by scattering at the sample, but no correction has been made for the effect of beam convergence in the reflecting microscope. It may be shown, using an analysis of the type described by Fraser[2], that the latter effect is a small one. Generally, the mean values shown in Table 1 are for measurements made on 5–14 filaments. In the cases

Table 1. Dichroic Ratio $(\epsilon\pi/\epsilon\sigma)$ Values for Nylon-66 Filaments

cm.$^{-1}$	Draw ratio			
	1·0	2·0	3·0	4·0
(*a*) Microtoming previously flattened samples in direction parallel to filament axis				
3,310	2·39	0·88	0·79	—
3,080	2·35	0·90	0·78	—
2,925	1·37	0·94	0·90	—
2,360	1·58	0·92	0·89	—
(*b*) Microtoming in direction perpendicular to filament axis				
3,310	1·18	0·81	0·56	0·50
3,080	1·14	0·77	0·61	0·54
2,925	1·03	0·68	0·63	0·56
2,860	1·06	0·81	0·68	0·66
(*c*) Microtoming in direction parallel to filament axis				
3,310	0·78	0·72	0·54	0·55
3,080	0·78	0·67	0·52	0·45
2,925	0·93	0·73	0·70	0·68
2,860	0·85	0·78	0·70	0·65

of part (a) of Table 1 at draw ratio three and of parts (b) and (c) at draw ratio four, however, only two filaments were studied.

When appropriate statistical consideration is given the results, it is observed that the effect of specimen preparation is greatest at draw ratio one and becomes ess important at the higher draw ratios. Flattening nduces considerable parallel dichroism of all the four absorption bands at draw ratio one, and this effect is much greater than that caused by microtoming plastic-embedded filaments in a direction perpendicular to the filament axis. Some perpendicular dichroism appears to be induced at draw ratio one when the microtoming is done in a direction parallel to the ilament axis.

The dichroic behaviour of the 3,310 cm.$^{-1}$ band N—H stretching) is identical with that of the 3,080 cm.$^{-1}$ band (presumably N—H stretching). The two methylene-group stretching motions at 2,925 and 2,860 cm.$^{-1}$ exhibit nearly the same dichroic behaviour, and the extent of their dichroism is generally less han that of the two N—H stretching motions. With hese filaments, there is no reversal of dichroic character in going from draw ratio two to higher draw ratios, as was observed by Quynn and Steele[1]. The results suggest a random arrangement of nylon polymer chains at draw ratio one, with increasing drawing causing increasing alignment of these chains with respect to the filament axis.

The results of X-ray diffraction studies carried out on these filaments are consistent with those of the infra-red measurements. It is suggested that the parallel dichroism found for the four nylon absorption bands at the lower draw ratios by Quynn and Steele[1] was caused by the mechanical flattening procedure they used to obtain suitably thin specimens.

The experiments discussed here will be reported in greater detail elsewhere.

GINO CAROTI
JOSEPH H. DUSENBURY

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Princeton, New Jersey.
Dec. 16.

Quynn, R. C., and Steele, R., *Nature*, 173, 1240 (1954).
Fraser, R. D. B., *J. Chem. Phys.*, 21, 1511 (1953).

Biological Research in East Africa

In the account, entitled "Zoonoses in East Africa", of the conference held earlier this year in Kampala by the East African Medical Research Scientific Advisory Committee (see *Nature*, March 3, p. 406), it is stated (p. 407, col. 1) that "it is regrettable that in East Africa so little collecting is being done". Contrary to this statement, the Coryndon Museum, Nairobi, has hundreds of thousands of specimens and eceives two thousand specimens monthly. A few ines further on, the article says, "it is difficult to get birds, mammals or insect identifications done in East Africa". Again, contrary to this statement, the Coryndon Museum, Nairobi, under Dr. L. S. B. Leakey, the curator, can do all this and, more to the point, has type specimens.

For birds, the Coryndon Museum has a first-class rnithologist and the finest collection of East African birds anywhere. We have now the two volumes of "The Birds of Kenya" by Mackworth-Praed and Grant. The Museum has a very fine and extensive ollection of insects and a first-class entomologist, while the small mammals are rapidly being built up under the mammologist. The same applies to snakes. The Botany Section is just as good, while the Palæontological and Archæological Sections are known all over the world. Again, the Fish Division of the Kenya Game Department has a very great knowledge covering the past twenty years on these matters and has published a great deal of it. The Jinja Fisheries Research Station has begun publication of "The Fresh Water Fishes of Uganda", and Kenya also has ready the manuscript for a like book on the fresh-water fishes of the Colony. With reference to the marine fishes, this is the work of Prof. J. L. B. Smith, and shortly to appear is a publication covering marine fisheries of Kenya. The Natural History Society of Kenya has published a report on the "Fauna of Tanganyika"; and its volumes are full of such papers. This brief list shows that the information exists, and work is being done.

The need for faunal surveys in the Colonies has been realized for at least the past twenty years; but we have never had the money, and unless this is forthcoming, these surveys cannot be undertaken. We work in co-operation with the British Museum and with their specialists, and rightly so; and get much help from them. However, the crux of the matter is that there is no co-ordination between the various services in East Africa and the scientific workers there. This lack is proved by the article describing the conference. It is one of the most serious problems in East Africa. Scientific officers work in isolated places, cut off from associates both in a Colony and with men working on the parallel problems in other Colonies. There is no free exchange, either oral or written, of work being done or even written reports of work being done, and although heads of scientific and development departments realize this, yet very little has been done to make things easier. I speak from many years experience of Africa.

HUGH COPLEY

Game Department,
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Nairobi.
April 10.

No one would wish to fail to acknowledge the work being done at the Coryndon Museum: the difficulties under which the Museum labours are brought out by Mr. Copley in his final paragraph. Formal surveys of the type asked for have not, in fact, been possible. They were called for at the Kampala conference by East African biologists. It was these same East African biologists who spoke of the difficulties they encounter in getting birds, mammals and insects identified. It is perhaps significant that the more confident note was struck by a visiting American speaker; but he was referring to the British Museum. All concerned in biological and medical work in East Africa would be happy to see the staff of the Coryndon Museum in a position to afford the services so urgently called for. The organization of the conference was itself an effort to overcome the isolation and lack of contact which Mr. Copley mentions.

J. N. P. DAVIES

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Kampala.

FORTHCOMING EVENTS

Wednesday, July 25

Society for the Promotion of Nature Reserves (in the Lecture Room, British Museum (Natural History), London, S.W.7), at 4 p.m.—Lieut.-Colonel J. Vincent: "Game Reserves of Natal"; also colour film, "Zululand Sanctuary".

Society for Visiting Scientists (at 5 Old Burlington Street, London, W.1), at 7.30 p m.—Discussion Meeting—"Visit of the Royal Society Delegation to the U.S.S.R". Chairman · Prof. A. V. Hill, F.R.S. Speakers: Dr. Mary L. Cartwright, F.R.S., Dr. H. G. Thornton, F.R.S., and Dr. D. C. Martin, F.R.S.E.

Thursday, July 26

Royal Society of Tropical Medicine and Hygiene (at the Hospital for Tropical Diseases, 4 St. Pancras Way, London, N.W.1), at 7.30 p.m.—Clinical Meeting.

Thursday, July 26—Saturday, July 28

Royal Meteorological Society (at the Pantycelyn Hall of Residence of the University College of Wales, Aberystwyth)—Meeting in honour of Sir David Brunt, Sc.D., F.R.S.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Agronomist (with a university degree in agriculture) to assist in field experiments dealing with grassland and arable crops—The Secretary, The Grassland Research Institute, Hurley, Maidenhead, Berks (July 28).

Director (scientist of established reputation under 60, with outstanding research work to his credit, and administrative experience) of the Indian Association for the Cultivation of Science—The Registrar, Indian Association for the Cultivation of Science, Jadavpur, Calcutta 32, India (July 28).

Research Assistants (with good honours degrees) for research in the following fields. heterogeneous catalysis; corrosion reactions; plastics materials; organic synthesis; physics; or electronics—The Registrar, College of Technology, Suffolk Street, Birmingham (July 28).

Physicist (with an honours degree in physics) for work on the clinical applications of radioactive isotopes—The Registrar, The University, Leeds 2 (July 30).

Assistant Lecturer (with special qualifications or interests in radio astronomy) in Physics—The Registrar, The University, Manchester 13 (July 31).

Director (with an intimate knowledge (preferably with actual experience) of tsetse fly control operations, and sound scientific knowledge of the ecology and biology of the tsetse fly, together with proved administrative ability of a high order) of the Department of Tsetse and Trypanosomiasis Control and Reclamation, Federal Ministry of Agriculture, Federation of Rhodesia and Nyasaland—The Public Service Attaché, Rhodesia House, 429 Strand, London, W.C.2 (July 31).

Demonstrator (with an honours degree in chemistry or biochemistry) in the Department of Chemistry and Biochemistry—The Dean, St. Thomas's Hospital Medical School, London, S.E.1 (August 1).

Assistant (with an honours degree in botany, preferably with postgraduate experience in plant pathology) in the Advisory Plant Pathology Department—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh 8 (August 10).

Lecturers (3) (with a degree or equivalent qualification) in Crop Production; and a Lecturer (with a degree or equivalent qualification) in Animal Production, at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (August 16).

Chair of Botany at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, August 31)

Chair of Mineralogy and Geology at the University of Cape Town, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, August 31)

Lecturer (with an interest and experience in biophysics) in Physiology—The Secretary, The University, Aberdeen (August 31).

Senior Lecturer (graduate from a recognized university school of mines, with the minimum qualification of bachelor's degree in mining engineering or equivalent, wide experience in the practice of mining, and preferably experience in lecturing) in Mining Engineering at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, August 31).

Reader in Applied Thermodynamics in the University, and Head of the Department of Mechanical Engineering, in Robert Gordon's Technical College—The Secretary, The University, Aberdeen (September 25).

Reader in Pure or Applied Mathematics—The Secretary of Faculties, University Registry, Oxford (October 31).

Experimental and Assistant Experimental Officer (preferably with experience with transient oscillography or vacuum techniques, and at least H.S.C. (science) or equivalent), for interesting work on problems involving high energy electrical discharges through gases over a wide range of pressures—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting Ref. B.795/34.

Extraction Metallurgist or Chemist (preferably with a physicochemical background and some industrial experience), for research and development on treatment of slags—Dr. F. D. Richardson, Nuffield Research Group, Royal School of Mines, London, S.W.7.

Lecturer or Assistant Lecturer in Physical Chemistry—The Registrar, The University, Nottingham.

Lecturer (with research interests in either inorganic or physic chemistry) in Inorganic Chemistry—Northern Polytechn Holloway, London, N.7.

Librarian (qualified male librarian with experience of technic libraries)—The Secretary, The Institution of Mining Engineer 3 Grosvenor Crescent, London, S.W.1.

Medical Laboratory Technician (with either A.I.M.L.T. or B.Sc in the Research Department—The Group Secretary, c/o Gener Hospital, Sunderland.

Physicist (male, with a good honours degree or A.Inst.P), f research on servo-control mechanisms—The Wool Industries Researc Association, Torridon, Headingley, Leeds.

Professor of Anthropology and Sociology at the College o Arts and Sciences, Baghdad, Iraq—The Cultural Attaché, Roya Iraqi Embassy, 22 Queen's Gate, London, S W.7.

Senior Lecturer in Electrical Engineering; a Lecture in Electrical Engineering; and an Assistant, Grade B, to teac mathematics up to higher National Diploma standard—The Registra Hatfield Technical College, Hatfield, Herts.

Senior Lecturer in Physics to teach up to B.Sc. (Special) Degre standard and to share in the postgraduate work of the Department—Northern Polytechnic, Holloway Road, London, N.7.

REPORTS and other PUBLICATION

(not included in the monthly Books Supplement)

Great Britain and Ireland

Aero Research Technical Notes. Bulletin No. 158: The Place o Metal Bonding in Modern Aircraft Structures. Pp. 4. (Duxford: Aer Research Limited, 1956.) [2

Heating and Ventilating Research Council. Bulletin No. 1 (Apr 1956). Pp. 12. (London: Heating and Ventilating Research Counc (J. Duncan Ferguson, Acting Secretary, 9 Clarges Street), 1956) [2

Scottish Marine Biological Association. Collected Reprints, 195 (Nos. 185–208). (Millport: Scottish Marine Biological Association 1955.) [2

Admiralty Bulletin No. 77: The Hydrographic Department of th Admiralty. Part 3: The Oceanographical Branch. By Commande G. P. D. Hall, R.N. Pp. 5. (London: Admiralty.) [2

Other Countries

British Territories in Borneo. Annual Report of the Geological Survey Department for 1955. By F. W. Roe. Pp. vii+241+50 plates (Kuching: Government Printer, 1956) 3 Malayan dollars; 7*s*. [1

El Atomismo de Gassendi · La ley de Inercia, los Albores de l Quimica y la Teoria Cinética de los Gases. Da Francisco Solano d Aguirre. (Monografica Cosmológicas. Serie Renacimiento.) Pp. 105 (Barcelona: José Porter, 1956.) [1

Canada · Department of Mines and Technical Surveys. Publication of the Dominion Observatory, Ottawa. Vol 14: Bibliography o Seismology. No. 15: Items 8547–8772 (January to June, 1954) Pp. i+313–336. (Ottawa. Queen's Printer, 1956.) 25 cents. [1

Kungl. Svenska Vetenskapsakademiens Handlingar. Fjärde Serien Band 6, Nr. 3. Studies on Naturally Occurring Ionizing Radiations with special reference to Radiation Doses in Swedish Houses of Variou Types. By Bengt Hultqvist. Pp. 125. (Stockholm: Almqvist an Wiksells Boktryckeri AB.; London: H. K. Lewis and Co, Ltd 1956.) 16 kronor. [1

Institut Royal Météorologique de Belgique Contributions No. 22 Éléments de Météorologie. Chapitre 6: l'Eau dans l'Atmosphèr Par Dr. L. Dufour. Pp. 32. No. 29 · Interpretation of Ionospheri Results during Eclipses. Par Dr. M Nicolet. Pp. 2. No. 30 L Métrologie par les Interférences. Par Dr. A. Descamps. Pp. 23 Publications. Série A, No. 12: Les Hivers à Bruxelles-Uccle (1833–1951). Par Dr. A. Vandenplas Pp. 46. (Bruxelles: Institut Roya Météorologique de Belgique, 1956.) [1

Institut Royal des Sciences Naturelles de Belgique. Exploratio Hydrobiologique du Lac Tanganika (1946–1947). Résultats Scientifiques. Vol 3, Fasc. 5 B: Poissons Cichlidae. Par Max Poll. Pp 620+10 plates. (Bruxelles: Institut Royal des Sciences Naturelle de Belgique, 1956.) [1

Engineering News: Quarterly Journal of the West Pakistan Engineering Congress. Vol. 1, No. 1 (February 1956). Pp. 64 Annual subscription, Rs. 5; Single issues, Rs. 2. (Lahore: West Pakista Engineering Congress, 1956.) [2

Publications of the Allegheny Observatory of the University o Pittsburgh. Vol 10: Photographic Determinations of the Parallaxe of 823 Stars with the Thaw Refractor. Pp. vii+169. (Pittsburgh Allegheny Observatory of the University of Pittsburgh, 1956.) [2

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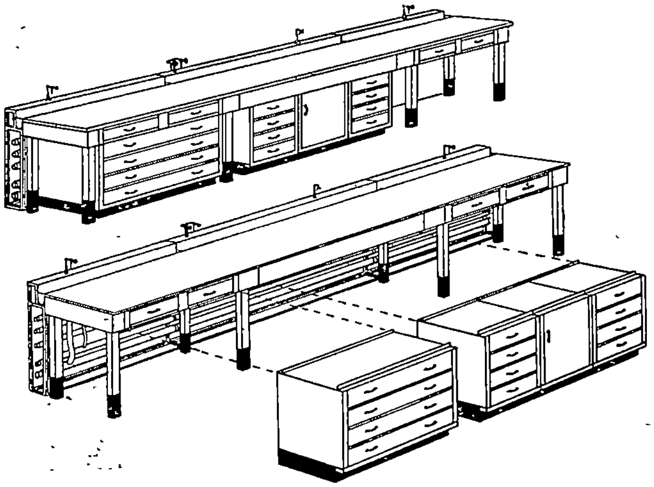

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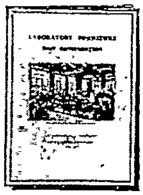

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LECTURES AND COURSES

UNIVERSITY OF BRISTOL

DIPLOMA IN HORTICULTURAL SCIENCE
DIPLOMA IN PLANT PATHOLOGY AND PROTECTION

The above postgraduate Diploma Courses will be available during the session 1956-57. Conducted in part at the Long Ashton Research Station, they are intended primarily for those with good honours degrees in science who seek careers in horticultural research at home or overseas

The Horticultural Science course commences on September 10, the Plant Pathology course on October 1. Both extend over a full session of three terms, ending in June or July, and include some additional practical work during the vacations.

Early application should be made to the Registrar, from whom full particulars may be obtained.

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Courses are also held for the B.Sc. internal special or honours degrees in Botany, Chemistry (full-time only), Geology, Mathematics, Pharmacy, Physics, Physiology (evening only) and Zoology.

Facilities are available for research and postgraduate study and short courses of lectures are held on special topics.

Full-time courses are arranged for professional qualifications in Pharmacy and Chiropody. There are special evening courses in Food and Drugs, Gemmology, Industrial Microbiology, and Surgical Technicians' work.

Applications for enrolment for the Session 1956-57 may now be made on forms to be obtained from the Principal.

OFFICIAL APPOINTMENTS

ST. THOMAS'S HOSPITAL MEDICAL SCHOOL

Applications are invited for the post of Demonstrator in the Department of Chemistry and Biochemistry. Candidates should hold an honours degree in chemistry or biochemistry and should be prepared to engage in research in biochemistry with a view to obtaining a higher degree in this subject. Salary £450 per annum.

Applications, giving details of qualifications and the names of two referees, should be sent before August 1, 1956, to the Dean, St. Thomas's Hospital Medical School, London, S.E 1, from whom further information may be obtained.

UNIVERSITY OF NOTTINGHAM

DEPARTMENT OF CHEMISTRY

Applications are invited for the appointment of a Lecturer or Assistant Lecturer in Physical Chemistry, appointment to date from October 1, 1956. Salary scales: Lecturer, immediate appointment in the range £650 to £1,050, with possible advancement to £1,350 per annum; Assistant Lecturer, £550 to £650 per annum. Superannuation and family allowance.

Conditions of appointment and form of application from Mr. H. Pickbourne, Registrar.

SCUNTHORPE HOSPITAL MANAGEMENT COMMITTEE

LINCOLNSHIRE RADIOTHERAPY CENTRE
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Immediate vacancy in the expanding department including developments connected with rotational therapy and radioactive isotopes—previous experience desirable but not essential. Probationary period of two years for new entrants to Health Service. Salary scale (first- or second-class honours) £525 by £25 to £625—others £475 by £25 to £575. Scale after probationary period £650 by £30(3) by £35(3) to £845 Postgraduate experience considered in fixing entry point. Superannuation scheme.

Application forms from Group Secretary, War Memorial Hospital, Scunthorpe.

UNIVERSITY OF ABERDEEN

Applications are invited for the post of Lecturer in Physiology. Candidates should have interest and experience in biophysics. Salary, scale (c), £1,750 to £2,050 if medically qualified, otherwise £1,350 to £1,550; or scale (b) £1,200 to £1,700 if medically qualified, otherwise £950 to £1,350. Placing on scale according to qualification and experience. Superannuation (F.S.S U.) and children's allowance. Part of removal expenses refunded.

Conditions of appointment and forms of application should be obtained from the Secretary, The University, Aberdeen; with whom applications (8 copies), giving the names of three referees, should be lodged not later than August 31, 1956. Applicants outside the British Isles may submit one copy only.

UNIVERSITY OF DURHAM

KING'S COLLEGE, NEWCASTLE-UPON-TYNE

Applications are invited for the following Research Assistantships in the Department of Physics commencing October 1, 1956 1. Senior Assistant to help in design and supervision of the electronic controls of a high precision mass spectrometer now being built. Preference given to a graduate in electrical engineering 2 Senior Assistant to work on the ferromagnetic aspects of rock magnetism. Preference given to a graduate in physics with some research experience. 3. Assistant to work on palaeomagnetism, concerned mainly with operating an astatic magnetometer. Minimum qualification a pass degree in physics. Appointments are for three years in the first instance, with salary scales of £600 to £700 plus F.S S.U. contributions for the first two positions and £450 to £600 for the third.

Further particulars may be obtained from the undersigned, to whom applications should be addressed not later than July 31, 1956

G. R. HANSON
Registrar of King's College.

REGIONAL RADIUM INSTITUTE

BRADFORD

Assistant Physicist (Basic Grade) required for duties in the above Radiotherapy Centre. The position offers wide experience in hospital physics Previous hospital experience not essential Salary in accordance with Whitley Council Scales.

Applications, stating age, qualifications and experience, together with the names of two referees, to the Secretary, Royal Infirmary, Bradford.

HILL FARMING RESEARCH ORGANIZATION

Applications are invited from honours graduates in botany or agricultural botany for appointment as Scientific Officer on the staff of the Organization's Department of Botany. The appropriate salary scale will be £458 to £835 per annum (male), plus pay supplement of £69 to £118 per annum, according to placing on salary scale. The post will be superannuable under F S S.U.

Applications, which should include the names and addresses of two referees and should be accompanied by copies of two recent testimonials, should be submitted, not later than August 4, 1956, to the Secretary, Hill Farming Research Organization, 48 Palmerston Place, Edinburgh, 12, from whom further particulars may be obtained

MENTAL HEALTH RESEARCH FUND FELLOWSHIP

Applications are invited for Mental Health Research Fund Fellowships from suitably qualified persons wishing to pursue full-time research work bearing on problems of mental health, whether in clinical psychiatry or in one of its supporting sciences. Both senior and junior fellowships are offered in the salary ranges of £700 to £1,200 and £1,300 and £2,000 (inclusive of superannuation). The appointments will be for up to three years in the first instance.

Further information from the Secretary, Mental Health Research Fund, 43 Queen Anne Street, W.1.

UNIVERSITY OF MANCHESTER

Applications are invited for the post of Assistant Lecturer in Physics with special qualifications or interests in Radio Astronomy Salary scale £550 to £650 per annum, with membership of the F.S S U and children's allowance scheme.

Applications should be sent not later than July 31, 1956, to the Registrar, the University, Manchester, 13, from whom further particulars and forms of application may be obtained.

COMMONWEALTH of AUSTRAL

DEPARTMENT OF SUPPLY
PROTECTIVE CHEMISTRY DIVISION
DEFENCE STANDARDS LABORATORIE
MARIBYRNONG, VICTORIA

Applications are invited for a temporary p tion of Scientific Officer, Grade 1, at the ab Laboratories. Salary: £A.1,263 to £A 1,578 annum. Duties. Research on the spectrosc of the solid state, with particular reference soft X-ray spectroscopy of metals and all Qualifications: Degree of high standard physics as a major subject. Whilst the posit is a temporary one, the tenure of employmen not limited. However, the successful applic may choose to enter into an agreement fo three- to five-year contract of employment Australia In this case, the Commonwealth bear cost of return fares, together with cost removing each way the appointee's furniture effects up to a maximum cost of £A.500, £A each way. Under specified conditions, first-c boat fare (if first class berth available) for appointee and dependants (wife and depend children) will be paid by the Commonwealth.

Application forms obtainable from Se Representative (AP.50), Department of Sup Australia House, Strand, London, W C.2, whom applications should be lodged by July 1956.

UNIVERSITY OF MALAYA

SINGAPORE

Applications are invited for appointment to first Chair of Agriculture Salary in range £2, to £2,548 according to qualifications and expence Allowances expatriation £378 per ann cost of living in range £210 to £560 per ann All paid in Malayan currency. Passages for pointee, wife and children under 12 years P. furnished quarters at reasonable rent. Provid fund scheme.

Applications (six copies), naming three refer and detailing qualifications and experience, September 30, 1956, to Secretary, Inter-Univer Council for Higher Education Overseas, Woburn Square, London, W.C.1, from wh further particulars may be obtained.

UNIVERSITY OF LEEDS

RESEARCH FELLOWSHIP

Applications are invited from chemists or chemists with research experience in protein polysaccharide chemistry for an appointment Research Fellow to work in collaboration Dr. D. A Hall, of the Nuffield Gerontolog Unit in the Department of Medicine. The Fel will be expected to assist in the research p gramme of the Unit, which is concerned ageing and with the inter-relationships of structural components of connective tissue. initial salary would be in the range £700 to £ and the appointment would be in accordance the normal conditions appertaining to Univer appointments.

Applications should reach the Registrar, University, Leeds, 2, not later than July 27, 1

UNIVERSITY OF WESTERN AUSTRALIA

The Senate of the University of West Australia has decided to establish a Chair Mechanical Engineering, and applications are vited for this position. The salary of the Pro sor will be £A.3,000 per annum, and an all ance is made towards travelling expenses.

Further particulars and information as to method of application may be obtained from Secretary, Association of Universities of British Commonwealth, 36 Gordon Square, L don, W C.1. The closing date for the rec of applications in Australia and London, September 29, 1956.

UNIVERSITY OF THE WITWATERSRAND

JOHANNESBURG, SOUTH AFRICA

Applications are invited for appointment t post of Lecturer on the staff of the Departm of Physics Duties are to be assumed on Ja ary 1, 1957, or as soon as possible therea Preference will be given to a candidate with search interests and experience in the physics solids. The substantive salary scale attached the post is £850 by £50 to £1,150 In additio married man will receive a temporary cost living allowance at the rate of £234 per annu

Applicants are advised to obtain a copy of information sheet relating to the above vaca from the Secretary, Association of Universi of the British Commonwealth; 36 Gordon Squ London, W.C.1. Applications close on Septem 1, 1956.

CHEMICAL LABORATORY SCIENCE COLLEGE Date 10.9.56

A NEW OUTLOOK ON COAL

ON p. 171 of this issue is given a summary of the recent report issued by the Organization for uropean Economic Co-operation (O.E.E.C.) entitled Europe's Growing Needs of Energy : How can they e Met ?" The report gives a detailed review of the nergy supplies and requirements of the twelve uropean nations that support the Organization. It is he work of a Commission of Experts who have gone o great pains to consult the pertinent authorities that ay be able to give a realistic view of the probable equirements of the future. The resultant estimates rovide an attractive picture of the possible future rowth in productivity and the standards of living Western Europe as a whole, provided no abnormal vents such as wars or economic upheavals intervene. t the same time, the Commission raises some useful arning signals as to the magnitude of the gap etween the probable production of energy and the equirements associated with an expanding world conomy. Many of these caveats apply particularly o the position of Great Britain, in regard to which he gaps between supply and consumption already ring a strain upon the national economy. Examination of the graphs provided in the report shows he prospect of more serious gaps between production nd consumption developing at an increased rate etween 1956 and 1975, which can only be met by nports of coal and oil.

The primary energy requirements of Western urope by the target year of 1975 are likely to mount to 1,200 million equivalent tons of coal ; but he primary energy production, represented by coal, ndigenous oil, natural gas and nuclear fuels is likely o amount to only 750 million tons. If this gap is o be bridged entirely by imports of coal and oil, heir cost in 1975, based on present prices, would mount to some £1,800 million, to be paid for by quivalent exports of manufactured and other goods.

Looking particularly at the position of Great ritain, the energy consumption from various primary ources in 1954 was : solid mineral fuels, 80 per ent ; petroleum, 13 per cent ; hydro-power, 1 per ent.

Great Britain is the largest importer, the largest efiner and the largest consumer of petroleum products in Western Europe. Thanks to the abundance f coal resources and the high level of industrialization, the *per capita* consumption of energy in the Jnited Kingdom is one of the highest in Europe. Nevertheless, the prospects that the gap between the roduction of indigenous fuels and the required consumption are to be met in the twenty years between 956 and 1975 by any other means than imports of ndigenous fuel are small. We have to face the ituation that only one-fifth of the output of the oal industry in Britain in 1947 came from mines hat had been sunk during the preceding thirty ears. The gathering of the fruits of the more recent cceleration in investment must necessarily be delayed, because new mines and major constructions take many years to complete. British potential in hydro-electric development is small, and cannot be expected to cover more than 1 per cent of the present energy requirements. The recognition of this situation has been responsible for the special drive which has been made in the development of the industrial use of nuclear energy.

Such is the position. What are the warnings and the remedies ? The world's reserves of oil for the immediate future, and indeed in the period under review, are likely to be adequate to bridge the gaps envisaged. But what are the economic dangers ? The increase of consumption is based on the maintenance of the competitive position of the member countries in an expanding world economy, and from it stems the raising of their standard of living. The rapid increase in the dependence of Western Europe on imported energy brings in its train the inherent risks of availability of supply and certainty of rising prices for the imported fuels. A competitive position arises as to the demands of each of the member countries, and as to their economical production of raw or manufactured exports, whereby to pay for the imported fuel. The Commission emphasizes the warning and multiplies the exhortations as to the practicable means of limiting such requirements of imported fuels by developing further the indigenous production of all forms of imported energy. It is emphasized that coal will be the mainstay in Western Europe for many years. There has been a tendency to look upon coal as a back number. This situation is dangerous for the above reason. The view that nuclear energy is also 'round the corner' has also been overdone. The Commission is outspoken in its condemnation of a too optimistic attitude in this respect. False impressions as to the practicable contribution of nuclear energy to Western Europe's needs in the next twenty years have been created by the headline publicity given to developments of relatively small importance in this new field, and to the popular enthusiasm aroused by this new form of energy, a sentiment resembling the interest of a child in a new toy, and the inherent wonderment of man in the apparent magical.

Compared with some of the over-statements on fuel and energy policy that have appeared in many published utterances in recent years by would-be authorities, the conclusion of this report may be likened to a healthy fresh wind blowing through the narrow alleys of an overcrowded city on a hot day. Full note should be taken of the caveat that the public should be made to realize the need for a new outlook on coal. Coal is essentially a long-term industry lacking the flexibility of other industries. So far as Britain is concerned, the economic well-being of the country must still for many years depend upon coal. In effect, a shake-up of the public attitude towards research and development in the use of coal is needed. Not only in these directions is an acceleration of interest and activity necessary, but also in the enhancement of the economic and competitive position of coal by improvements in distribution and marketing methods as well as in processing and coal-burning appliances. Finally, the general question of fuel efficiency, in regard to which the industrialist has possibly in recent years been over-exhorted to the point of passivity, is raised as a matter of great importance. Essentially the rate of progress in this field must depend primarily on the provision of the means of technological progress, the advancement of knowledge and of its means of application. The history of past performance in such fields in Britain has shown noteworthy advances. They can only be continued at an enhanced rate if the means in personnel, equipment and encouragement are provided.

PROPERTIES OF MATERIALS FOR ATOMIC ENERGY

Reactor Handbook

Materials—General Properties. Prepared by the United States Atomic Energy Commission. (Selected Reference Material on Atomic Energy.) Pp. xiii+610. (London: McGraw-Hill Publishing Company, Ltd., 1955.) 79*s*.

THIS handbook on materials is part of the general "Reactor Handbook" which has been issued in accordance with the overall programme for the organization and publication of information developed by the United States Atomic Energy Commission. Following the first chapter, in which the functions of reactor materials are described, the handbook attempts to put within one volume a summary of material selected as useful for metallurgists, ceramic technologists and other workers in the field of materials and related topics of reactor technology. No attempt is made to deal with other than solid materials which have been considered for use in reactors. The chapters, arranged alphabetically, deal with aluminium and its alloys, beryllia, beryllium and its alloys, beryllium carbide, bismuth, carbides, cements and concretes, graphite, hydrides, lithium and its alloys, magnesium and its alloys, molybdenum and its alloys, nickel and its alloys, plutonium and its alloys, rare earths, silicon carbide, stainless steel, thorium and its alloys, titanium and its alloys, tungsten, uranium and its alloys, vanadium and its alloys, and zirconium and its alloys. Materials of high cross-section and cobalt-base alloys are separately treated.

The method of presentation is similar throughout. After a general description of reactor application, availability and cost, extraction and purification are briefly dealt with, followed by sections on physical and chemical constants, mechanical properties, melting and casting, forming, fabrication, machining, joining and heat treatment. Corrosion behaviour and metallography are generally briefly treated.

The information presented refers to American practice, and if the handbook is judged from the British point of view omissions are apparent, as, for example, in the development of reactors cooled by carbon dioxide. In the United States this ha received much less attention than in Britain, an thus the potentialities of magnesium as a reacto material have not been developed.

In general, for atomic energy applications, thre main classes of material can be distinguished. First suitable either as fuels or breeders, come uranium thorium and plutonium. Secondly, the high- or low absorption cross-section of materials like boro cadmium, hafnium, beryllia, beryllium, bismuth vanadium and zirconium make them suitable fo specific atomic energy purposes. The third clas contains the materials such as aluminium and stainless steel which have for years been in norma engineering use, and with which no effort on th part of the Atomic Energy Commission is require to determine relevant information. With this clas there has been a greater dependence on existin publications—in particular, data sheets from manufacturers. It is difficult to select in a handbook jus the right and appropriate amount of informatio from a large background of engineering literature For that reason the chapters on such materials a steel and aluminium suffer so much by compariso with the chapters on materials specifically for atomi energy that the handbook would gain if they wer omitted, except to point out, where appropriate, tha certain features make them suitable for particula parts of power circuits.

With the first two classes, in which the materia has been obtained from sources within the atom energy project, the treatment and coverage are complete except where, as a result of security requirements, as with plutonium, the deletions hav seriously affected the value of the information. Wit uranium the information given is restricted becaus of security requirements and also because the dat of preparation is 1952. The all-important techniqu of canning is barely mentioned, even althoug uranium customarily requires protection for use in reactor. A useful collection of equilibrium diagram is reproduced. Much information about thorium i given, although the significance of the impac properties of the metal is not made clear.

Full information, given on beryllia, graphite hydrides, cements and carbides and elements of hig cross-section based on material developed fro Atomic Energy Commission sources, is not readil available elsewhere. Although the effect of attac by liquid metals is not generally treated, its inclusio in the chapter on beryllium makes this more complete. The value of the chapter would have bee greater if, instead of references, selected constitutio diagrams had been given.

The chapter on bismuth is a useful reference whic indicates its possibilities as a fuel-carrying vehicl and liquid-metal coolant.

As a reactor construction material, the potentialitie of vanadium are noted, although the metal is sensitiv to gaseous contamination and embrittlement.

For zirconium, the potentialities, once the metal i free from hafnium, are dealt with fully. Materia containing as little as 50 p.p.m. of nitrogen is noticeably less resistant to corrosion in water than materia containing 10 or 20 p.p.m. The resistance of zirconium sponge to water corrosion is decreased wit increase of nitrogen content. A useful compilation o physical and mechanical properties and notes on th melting and casting, forming and fabrication, joining machining and heat treatment enhances the value o the chapter.

The corrosion resistance of the metal is improved he purer the metal. A zirconium specimen may ometimes fail after a long time in water at 600° F. 316° C.), even though its composition cannot be lifferentiated from that of material which continues o have a low corrosion-rate for a much longer time. mpurities such as cobalt, molybdenum, tungsten, ead, zinc, thorium, vanadium, beryllium and oxygen ppear to have little effect on the corrosion resistance, but tantalum and niobium and tin appear to have a beneficial effect. Notes are included on the corrosion of zirconium by solution and by gases such as air, hydrogen, oxygen and nitrogen and by liquid metals and fused salts. The chapter ends with notes on various zirconium systems, including zirconium, aluminium, carbon, chromium, iron, hydrogen, nickel, nitrogen, oxygen, thorium, tin, titanium and uranium, and is in general a useful contribution to the literature on reactor technology.

The chapter on graphite is informative but makes no mention of the behaviour of graphite in a neutron lux other than a passing reference to its susceptibility to irradiation damage at low temperatures. Useful comments are made on protective techniques for graphite.

The handbook was originally a classified volume for use in the Commission only, and the volume available to the general public suffers from limitations and reservations. In many instances a large number of the references quoted are classified. On the assumption that the list will eventually be declassified, it is wise to include such references ; but this will not reduce the sense of frustration of a reader anxious to read further in the subject and denied access to the classified literature. As more information becomes declassified, this effect should be minimized.

There are a useful appendix of selected physical constants of the elements, and a table of thermal neutron absorption cross-section of the elements arranged in order of increasing magnitude. Tables of temperature conversions, engineering conversion factors, a metallurgist's periodic system, a glossary of metallurgical terms, a nomograph for interconversion of weight and atomic per cent, and a vapour pressure chart of metals are included.

Throughout the handbook a number of important observations occur representing the results of lengthy investigations. These will be recognized by the reader with personal experience of investigations in the field of atomic energy. A. B. McIntosh

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TIME AND LIFE

Evolution of the Vertebrates

A History of the Backboned Animals through Time. By Prof. Edwin H. Colbert. Pp. xiii+479. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1955.) 72*s*. net.

A Guide to Earth History

By Richard Carrington. Pp. xv+240+16 plates. (London: Chatto and Windus, Ltd., 1956.) 21*s*. net.

THERE are many reasons why vertebrate palæontology should be attractive, the principal being that the materials are macroscopic and the elucidation of them leads to the clarification of the sources and development of man himself. Furthermore, in Britain, France and the United States there is a long and interesting personal history attached to the growth of the subject. It may be significant that from these three countries there have recently come important contributions to the teaching literature on the vertebrate groups. These two books are of differing purpose, each of which reflects important aspects of approach.

Dr. E. H. Colbert's "Evolution of the Vertebrates" naturally takes precedence both in time and purpose, for the work is said to be designed for the general student and the lay reader, and the writing is certainly precise and lucid enough for both; but it will appeal most strongly to the advanced or graduate student who is already familiar with the zoological and physiological facts of vertebrate life.

Dr. Colbert sees the subject in the round, with all his experience as collector, museum conservator and university professor. He also knows the difficulty in deciphering much of the evidence and the ease with which the sensational rather than the conservative inference can be made. He therefore writes informatively but restrainedly.

The book covers the whole of the vertebrate field, individual groups being dealt with factually, but the overall, ecological, picture is not forgotten. It is made clear that the story of vertebrate evolution in time is not a series of changing geological scenes working up to a climax but rather a bubbling up of life that pervades the barriers of geological formations and overflows the boundaries of continents. Wisely, there are chapters on the relationships of faunas and tables of stratigraphical comparisons.

It is here that the European student will be more at a disadvantage than his American counterpart, for the richness of American discovery overshadows that of other countries and limits of space inevitably demand the omission of many interesting European forms. One feels that some of the references to European stratigraphical divisions are a little vague. Apart from this, there are very few lapses, though the student should observe that the word Oligocene does not mean "many recent" forms.

The production of the book and the illustrations by Mrs. Lois Darling are excellent. The latter are nearly all restorations, and some readers would have welcomed a few more factual or diagnostic illustrations of parts of animals. The phylogenetic diagrams are especially useful and attractive. The book as a whole will be a valuable addition to the class library and should be of great help to many British students as an additional source of information.

Mr. Richard Carrington's book, "A Guide to Earth History", covers an even wider field and is frankly addressed to the general reader rather than the student. Its author is a gifted writer and an amateur zoologist who has many qualifications for the task he essays, but he must depend on others for many of the facts in a book that covers the evolution of the Earth as well as that of the forms of animal and plant life that precede, and some of which lead to, the emergence of man. Sometimes this more vicariously acquired information betrays itself or dates itself as, for example, when the author writes that "fossils, for the last fifty or sixty years have been universally recognized for what they are". The repetition of the recapitulation theory is also probably an error of this kind.

But such things apart, the rest of the book makes a good introduction to the world of fossils and the evidence they provide of the history and progress of life. The generally accepted facts are well, and sometimes finely, portrayed, and a large series of illustrations by Maurice Wilson help to round off the story. There is an especially good bibliography. Furthermore, the work is written from the European point of view. Many non-geologists will find this a highly satisfactory statement, and quite a number of geologists can use it as a stepping-stone to further, more academic, studies. W. E. SWINTON

ASPECTS OF MARINE SCIENCE

Papers in Marine Biology and Oceanography

Dedicated to Henry B. Bigelow. By his former Students and Associates. (*Deep-Sea Research*, Supplement to Volume 3.) Pp. xx+498. (London and New York: Pergamon Press, Ltd., 1955.) 75*s*. net; 10.50 dollars.

IN 1927 the United States National Academy of Sciences set up a committee, with Henry B. Bigelow as secretary, to report on the part which the United States should take in a world-wide programme of oceanographic research. One of the major results of the inquiry was the foundation of a new research institute at Woods Hole, Massachusetts, in 1930 with Bigelow as its first director, a post which he held for ten years, before asking to be relieved in order to devote more time to his own researches. To commemorate the twenty-fifth anniversary of the Woods Hole Oceanographic Institution, which now enjoys an outstanding reputation throughout the world, this volume has been prepared and dedicated to Dr. Bigelow by his former colleagues and students.

The forty-eight contributions to the volume comprise both original research papers and review articles. It would be impossible to review them individually or even refer to the names of all the authors or the titles of their papers. The impression which one gets from the volume as a whole is how well it bears out Bigelow's own view in 1931, expressed in his book, "Oceanography: its Scope, Problems and Economic Importance", of the essential unity of the science of the sea and the close interrelationships between all its aspects—biological, geological, chemical and physical. Many of the papers themselves deal with such relations, and others, while confining themselves to work in one field, can be seen, at the same time, to fall into a general pattern.

The zoological papers range from systematic studies, such as that by P. L. Kramp on medusæ, to those on the behaviour of animals in the sea. A review of the recent researches on hearing in fishes and cetaceans is given by D. R. Griffin. A. S. Romer, in "Fish Origins—Fresh or Salt Water ?", examines the fossil evidence from European and American sources. Several papers are concerned with the relations between one kind of marine organism and another. C. E. Lucas's paper on external metabolites and E. Steemann Nielsen's on plankton algæ and bacteria are examples. Studies relating to the productivity of the sea and to problems of fisheries research are also represented.

A large group of papers is concerned with surveys of physical conditions, particularly water movements, and their relation to the circulation of nutrients and to the distribution of plant and animal life. Regional accounts are given of the Gulf of Venezuela by A. C. Redfield and of Long Island Sound by G. A. Riley. Discussing coastal currents and fisheries, C. O'D. Iselin refers to a new programme for the investigation of coastal currents which has been started at Woods Hole. G. Wüst contributes a study of current velocities in the deep and bottom waters of the Atlantic.

A number of papers deal with the geology of the ocean floor or the relation of sediments to the chemical or biological features of the water above them. A paper by the late H. C. Stetson discusses the differences between the Atlantic and Gulf terraces of the United States. An account of new instruments, by which they have taken water samples within 5–50 cm. of the bottom, is given by J. Brouardel and L. Fage. There are papers by F. B. Phleger and by Frances L. Parker on foraminifera, and by H. Pettersson on manganese nodules and oceanic radium.

This volume gives a stimulating impression of the position of marine science to-day and of some of the lines along which one may expect future advances to be made. K. F. BOWDEN

EARLY SCIENCE IN MEXICO

Montaña y los Origenes del Movimiento Social y Cientifico de Mexico

Por Prof. José Joaquin Izquierdo. Pp. xvi+442. (Mexico, D.F.: Ediciones Ciencia, 1955.) n.p.

THE colonization of the New World by Spain in the sixteenth century was carried out on an ambitious scale. In Mexico, then known as Nueva España, the Royal and Pontifical University was founded in 1553, and various types of medical institutions were also set up. At that time these establishments were as good as those of the Old World, but during the next two centuries, the many advances in science and medicine that were made in Europe did not reach or were not accepted in Mexico, and towards the end of the eighteenth century the courses in medicine taught in Mexico City had not changed in any way since they were instituted in the sixteenth century.

In this most interesting volume, Prof. J. J. Izquierdo has taken as his principal subject the life of the Mexican-born doctor, botanist and social reformer, Luis José Montaña (1755–1820); but interwoven with details of his life is a carefully documented account of the contemporary knowledge and teaching of science and medicine in Mexico, so that it is in effect a study in the history of science rather than a biography.

Montaña was a child of unknown parentage, reared in an orphanage, whose intelligence and aptitude for study took him to the University of Mexico, where he first graduated B.A. in 1771 and then took up the study of medicine. At that time the five chairs in medicine at the University included one in astrology, and Hippocrates and Galen were still the revered masters. There was no connexion with the hospitals and no clinical teaching. It was not until at the end of the eighteenth century that the advances made in Europe began to be recognized and accepted in Mexico; and in their gradual introduction Montaña played an important part.

Montaña was interested in botany and the pharmacological uses of the native plants. The dispatch in 1787 of a scientific expedition from Spain so collect and study Mexican plants, and the opening in 1789 of a Royal Botanic Garden in Mexico City itself, furnished Prof. Izquierdo with material for a particularly interesting botanical chapter, which includes some account of the herbal knowledge of the Aztecs.

Montaña's belief that medicine should be scientific, and studied in conjunction with the natural sciences, brought him into association with the progressive party. The story is an involved one, linked with a particularly stormy period in Mexican politics, and the reforms he sought to establish were not achieved until some thirteen years after his death.

This well-printed book, illustrated with many reproductions from contemporary literature, has an appreciative preface by Prof. H. E. Sigerist. It is a welcome addition to accounts of scientific progress in the Americas. An English translation would be valuable and enable it to reach a larger circle of readers.

J. M. EYLES

MAGNETIC AMPLIFIERS

Magnetic Amplifiers

By H. F. Storm. (Contributors: E. F. W. Alexanderson, H. H. Britten, W. D. Cockrell, F. J. Ellert, E. A. Harty, H. W. Lord, W. Morrill, H. M. Ogle and P. A. Vance.) (General Electric Series.) Pp. xix+545. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1955.) 108s. net.

THE early development of the magnetic amplifier was slow, probably because of the competitive influence of the electronic valve. During recent years this early neglect has been remedied, and there is now a great mass of technical articles describing developments of this robust and useful piece of apparatus. There have, however, been very few books published on this subject, and most of them have not been major works.

The issue of a 550-page book by Dr. H. F. Storm and his colleagues of the General Electric Co., Ltd., is both welcome and opportune. The advantages of having parts of a subject covered by different specialists in one book is normally obtained at the expense of some lack of continuity in the treatment, and this book is no exception; but Dr. Storm has written Chapters 4–20, covering the whole theory of the amplifiers, so that a large part of the book forms a satisfactory unit.

The first three chapters include the theory of magnetism, a description of magnetic materials and methods of testing them. Then follow Dr. Storm's chapters, and finally there are chapters on core and coil assemblies, metallic rectifiers and various applications of amplifiers.

Dr. Storm's treatment of the magnetic amplifier emphasizes the difference between operation with free even harmonics and suppressed even harmonic currents. Not all readers will agree that this is the best approach to the subject; but his treatment is clear and thorough, and he deals with both the steady-state operation and transient operation with resistive and inductive loads in considerable detail. He then covers the operation of feedback, including the amplistat and the bridge amplistat. Some aspects of the subject are not adequately covered, as, for example, the use of push–pull amplifiers and high-speed amplifiers, but this is a minor blemish in an otherwise excellent work.

Dr. Storm's mathematical arguments are often made needlessly difficult to follow by references to earlier equations which are spread over several chapters. A little judicious repetition of these equations would simplify the reader's task without adding unduly to the volume of the book. The figures are clear and well chosen, and there is a remarkable freedom from misprints in both text and figures in the chapters written by Dr. Storm; but the standard is rather less high in the other chapters.

This is a book which all serious students of the magnetic amplifier will need to have, but it is of postgraduate standard and is not easy reading. The highly glossed paper on which the text is printed is tiring to the eyes.

TEXT-BOOK ON HEAT ENGINES

Technology of Heat

By Prof. H. Wright Baker. Pp. xiii+427. (London and New York: Longmans, Green and Co., Ltd., 1956.) 36s. net.

WITH few exceptions, the contents of this book fall within the compass of what has until recently been called heat engines. There are various approaches to the theory of heat engines, and the author, Prof. H. Wright Baker, is to be congratulated on the line which he has followed in this work.

Although much is already familiar from Prof. Baker's edition of "William Inchley's Theory of Heat Engines", a broader background is given to the material. This has been arranged to introduce the diagrammatic representation of states, processes and working cycles at the earliest possible opportunity. Armed with this knowledge, the student (used in the generally accepted sense) is in a position to tackle the succeeding chapters on air compressors, steam engines and turbines, internal combustion engines, the gas turbine, and refrigerators and heat pumps, because all these chapters include a copious supply of cycle diagrams. As a direct consequence of the diagrammatic approach, steam and gas turbines appear as separated items.

Fuels and combustion are not confined to the chapter with that heading, additional information being given throughout the book. Both the title "Technology of Heat" and the preface heading "An Introduction to the Industrial Uses of Heat" give the impression that these aspects receive more detailed attention than they in fact do. For example, little is said of liquid fuels, and notable omissions are mentions of heat of formation, liquid fuel burners, and kinetics of combustion. Perhaps a little space could be found for mention of these at the expense of some of the matter referring to the reciprocating steam engine.

The chapter on heat transfer is welcome for the amount of information it contains on the radiation, conduction and convection processes. The final chapters deal with more practical aspects, namely, waste heat recovery and heat balances, and notes on testing. Example questions are appended to most chapters.

Although not including any innovations, this book is to be recommended to students working for degrees, Higher National Certificates, etc. As a general introduction to a very broad field of study, it requires additional references to more specialized books and articles.

T. D. PATTEN

Rectangular-Polar Conversion Tables

Designed and compiled by E. H. Neville. (Royal Society Mathematical Tables, Vol. 2.) Pp. xxxii + 109. (Cambridge: At the University Press, 1956. Published for the Royal Society.) 30*s*. net.

THE problem of determining the polar coordinates (r,θ) of a point with Cartesian coordinates (x,y), according to the equations $x = r\cos\theta$, $y = r\sin\theta$, is a common one presenting no theoretical difficulty. In particular, the solution of algebraic equations by root-squaring necessitates the conversion in complex form (that is, $z = x + iy = re^{i\theta}$), and (to quote the author's words) without a quick passage between corresponding pairs of values, the process is a flight of fancy rather than a technical revolution.

Almost all the tables hitherto available for the above conversion have been single-entry in character, employing the argument $t = y/x$ and then working in terms of arc tan t and $\sqrt{(1 + t^2)}$. The use of two independent variables, for which purpose this volume is primarily designed, clearly facilitates the calculations and obviates the danger of serious numerical errors.

The table covers the triangular range $1 \leqslant y \leqslant x \leqslant 105$, the upper limit 105 being chosen as convenient for typographical purposes. The arrangement of the entries is extremely ingenious, each page containing exactly 106 pairs of entries to 15 decimal places. To explain the detail of the arrangement, it is sufficient to take a page at random, say p. 35, and to describe its contents. These are $x = 35$, $y = 1(1)35$, with values of r and θ in degrees, followed by $y = 35$, $x = 35(1)105$, with values of $\log_e r$ and θ in radians. As will thus be seen, the logarithm table not only provides symmetry but also avoids repetition.

A substantial introduction precedes the main table just described and is mainly concerned with methods of interpolation required in using the table. Many illustrative examples are provided, and no effort has been spared to clarify the details of the numerical computation involved.

A bibliography of relevant and collateral tables is also provided, and the volume concludes with six supplementary tables, which include page-indexes for r and $\log_e r$ and the first 1,688 integer-denominators of the Farey series of order 105, the use of which is required in the interpolation methods.

J. H. PEARCE

Second Thoughts on Radio Theory

By "Cathode Ray" of *Wireless World*. Pp. 409. (London: Iliffe and Sons, Ltd., 1955. Published for *Wireless World*.) 25*s*. net.

THIS collation of articles contributed by "Cathode Ray" to the *Wireless World* during the past twenty-five years forms a kind of running commentary on the development of radio theory during the period. The impenetrable pseudonym might stand for a synthetic figure, made up of experts of the panel; but the characteristic manner of writing suggests that one person, and a very forceful person, too, is the author of them all. In any event, one feels that during this period few individuals can have done more to encourage and browbeat radio engineers to face fundamental difficulties and think out the solutions for themselves.

The book contains some forty articles on basic ideas, circuit elements and techniques, and calculations. Each article starts in a simple fashion; but the topic is dissected and discussed so thoroughly in detail that towards the end the reader is being piloted skilfully through the deeps. The light conversational style which is "Cathode Ray's" own way of driving his points home may not appeal to everybody; but there is wisdom and sound judgment behind it. Intolerance of jargon and slipshod thinking and an irreverence towards the pundits who frame definitions in a spirit of confusion, flash out fiercely from time to time. It is good to see so many o these articles together in permanent form, and the publishers are to be congratulated on an excellent volume.

G. R. NOAKES

The Biology of a Marine Copepod

Calanus finmarchicus (Gunnerus). By Dr. S. M Marshall and Dr. A. P. Orr. Pp. vii + 188 + 18 plates (Edinburgh and London: Oliver and Boyd, Ltd. 1955.) 21*s*. net.

NEARLY two hundred years ago *Calanus* was discovered in northern Norwegian waters and classified by its discoverer, Bishop Gunnerus o Trondheim, as *Monoculus finmarchicus* among the "Insecta Aptera". As an important link in the marine food chain, especially as a staple food of th herring, this copepod has become the object of study of workers in a great variety of branches of biology

The authors, having themselves worked on *Calanus* for many years, have written a well-produced and eminently readable survey of knowledge concerning the systematics and distribution, the anatomy, reproduction, development and life-cycle of the animal Chapters dealing with biometrical data, the animal's chemical composition, its food and feeding mechanism lead to a summary of work on its respiration, vertica migration, and its relation to inorganic and organic environment.

An extensive list of references and a most carefully prepared index add to the value of a book which should prove to be an asset to zoologists, marine biologists and naturalists alike.

Clays and Clay Minerals

Proceedings of the Second National Conference on Clays and Clay Minerals, University of Missouri October 15–17, 1953. Edited by Ada Swineford and Norman Plummer. (Sponsored by the Committee on Clay Minerals of the National Academy of Sciences—National Research Council; University of Missouri State Geological Survey of Kansas.) Pp. viii + 504 (Washington, D.C.: Publication 327, National Academy of Sciences—National Research Council 1954.) 4 dollars.

DURING recent years the study of clays and clay minerals has received much attention, and th widespread interest in the subject has been fostere by the establishment of national and internationa groups and committees. In the United States, National Conference on Clays and Clay Minerals, th second of its kind, was held at the University c Missouri in the autumn of 1953, and this volume i a record of the proceedings. It contains thirty-seve separate contributions from authors with a wid variety of experience, dealing with the geology genesis, chemistry, mineralogy, crystal structure and physical and mechanical properties of clay deposit and clay minerals, and includes a number of X-ray studies. The volume is well printed and illustrated and adequately indexed, and forms a valuable contribution to the literature of clays.

ENERGY REQUIREMENTS OF EUROPE

THE report on Europe's future needs of energy recently issued* by the Organization for European Economic Co-operation contains a most interesting examination of the position and includes a number of important recommendations which have been derived from a detailed study by a group of experts. This study has comprised the collection and examination of data and opinions emerging from international organizations and professional circles able to provide the pertinent information.

The report reveals that the consumption of all forms of energy in Europe, which in 1955 was equivalent to 730 million tons of coal, is rising so rapidly that in 1975 it is likely to reach a figure equivalent to 1,200 million tons of coal. This forecast is based on a maintenance of the competitive position of the member countries of the Organization for European Economic Co-operation in an expanding world economy, and the consequent raising of their standards of living.

According to the report, the share of the total requirements expected to be covered in 1975 by the production of primary energy in Western Europe will amount to an equivalent of 750 million tons of coal, as against 580 million tons in 1955. It emphasizes that it would be erroneous to believe that nuclear energy will make large contributions to the supply of energy available in Western Europe in the next twenty years. Rather is the limit of this contribution put at 80 million equivalent tons by 1975, or only 8 per cent of the total requirements. Unless a special effort is made to promote the indigenous production of primary energy, the remaining gap between energy requirements and indigenous supplies would have to be bridged by imports of coal and oil, the cost of which would amount in the target year 1975 to about £1,800 million at present prices. This may well present a formidable problem for some member countries in its effect on the balance of payments. The dependence of Western Europe on imported energy, with its inherent risks as regards matters of both economics and security, and the certainty of rising prices, must imply the serious need for a determined effort on the part of all member countries to develop further their indigenous production of all forms of energy. All reserves of energy will be needed in the future, and it is important to note that coal will be the mainstay of the energy economy in Europe for many years to come. Further, an increased output of coal must depend on long-term investment, on the development of improved mining methods, and on adequate terms of miners' pay and employment. In effect, coal must be given the outlook of a modernized and stable industry, which will attract able young men to join it. No doubt in time the competitive position of the coal industry may be affected, for after 1975 nuclear energy is expected to free the coal burnt in thermal power stations to an increasing extent. Nevertheless, this coal will be needed for other purposes for which nuclear energy cannot replace it. Meanwhile, the ultimate importance of nuclear energy and the difficult and novel problems involved in its development should induce member countries, both jointly and individually, to make a large and technological effort in the nuclear field. Additional effort will be necessary in the harnessing of undeveloped sources of hydro-power and for new sources of oil and natural gas.

The share of oil in supplying the energy needs of Western Europe must also rise rapidly. The concomitant factors governing this rise are the increasing consumption of oil for transport of all kinds, the advantages of oil for certain purposes and its increasing use as a substitute for coal owing both to its lower cost and to the shortage of coal. The world's reserves of oil will be adequate for this requirement, but large investments must be made by the oil companies in Western Europe as well as abroad.

Special importance is attached to the up-grading of primary into secondary forms of energy, such as gas and electricity. These latter are essential to a rise in productivity of many industries and are associated with improvements in the standards of living. These secondary forms of energy are the means of utilizing with the greatest efficiency the limited supplies of primary energy, and contribute to their greater adaptability. The fact that they can be produced with the aid of different forms of primary energy introduces an element of flexibility into the energy economy, which serves to lessen the rigidity inherent in the coal industry.

A potent factor in reducing the menacing gap between indigenous production and the overall requirements of energy resides in the still existing possibilities of saving energy by economies at every stage, from its winning and conversion in the energy industries to its final utilization in industry and in the home. The European Productivity Agency of the Organization for European Economic Co-operation is called upon to render assistance in this field, and member countries are urged to institute organized efforts for the purpose of energy saving.

The report urges Governments to give competition full play, in order that the consumer may be able to have maximum choice between the different forms of energy. This requires Governments to establish energy policies suited to their own circumstances, needs and resources in order to deal effectively with the urgent problems in the demand for and the supply of energy. The establishment of such policies should include some co-ordination between the different forms of energy, and be followed by the recommended co-ordination of the separate Governments' energy policies. This would result in increased co-operation at international level. At the same time, it is recommended that Governments should endeavour to avoid legislative or administrative restrictions likely to retard the development of sources of energy, or to jeopardize their efficient utilization. Further, in the framing of overall social, economic and financial policies, due consideration should be given to the effects of taxation, price maxima and wages structures on the efficient production and use of energy.

Other means of co-operation are recommended in this report. There are important chapters on the financial aspects of the energy problem; thus in energy prices, the impact of such prices on the balance of payments, and the investment needs of the energy industries in the period under review, are considered. In this context, there is recommended the mutual supply of capital needed for the production of energy as well as the pooling of research and development programmes. Again, it is considered to be of mutual benefit for member countries to increase their co-operation in the fields of exchange of energy, of man-power for the production of energy and of information and experience.

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* Europe's Growing Needs of Energy: How can they be Met? A Report prepared by a Group of Experts. Pp 120. (Paris: Organization for European Economic Co-operation; London: H.M. Stationery Office, 1956.) 400 francs; 8s.; 1.25 dollars.

In the final chapter of the main report, it is pointed out that only a cursory examination of the many important general problems envisaged was practicable. More detailed examination was therefore necessary, and it proposes the setting up of a new committee of individuals selected for their experience in this field, to act as advisers to the Organization. Not only should this new committee examine the conclusions of the present report and follow their implementation, but also it should review periodically both energy statistics covering the pertinent factors, and, with the help of the economic and other technical committees, the forecasts of energy requirements and supplies. The terms of reference should also include the search for problems which need further investigation.

Extensive appendixes are attached to the report. They indicate the sources of the information obtained, which covered an authoritative field concerned with trade union and managerial responsibility. The forecasts on which the main conclusions have been based were derived by four independent methods. Assumptions were made as to the anticipated level of employment, the standard of productivity, the level of working hours and, most important of all, that no abnormal events would intervene, such as a war.

Most valuable to the general interested reader are the reviews of the energy situations in the individual countries concerned, some twelve in number. They give the individual statistics for the various sources of energy as to production, the reserves and future prospects, the most important of the pertinent factors as to imports and exports of energy, and the developments in the nuclear field.

Of the primary sources of energy in the period 1956–75 in Western Europe, the annual production of coal may increase, according to present plans, from 480 million tons, as at 1955, to 520 million tons; but some further capacity must be provided to replace exhausted pits, to the extent of 190 million tons per annum. These additions will call for investments in the neighbourhood of £3,000 million, exclusive of coke ovens, pithead power stations and briquetting plant. Lignite, mostly in Germany, will require £570 million. Water developments to result in an increase of about 150 per cent capacity in 1975, as compared with 1955, may cost some £7,600 million. Indigenous sources of oil and natural gas are less tangible factors to assess, but are expected to require a sum equivalent to that of coal, namely, £3,000 million.

For the provision of secondary energy, coke and coal gas will require a sum slightly in advance of this last figure, and for thermal electricity the overall investments may amount to the considerable figure of £17,700 million. This is exclusive of the provision for transmission and distribution of electrical energy. The total investment to cover all requirements in the period 1955–75 could reach the astronomical figure of £50,000 million, or an annual average of £2,500 million. The investment provided in 1955 was £1,580 million. Thus an increase by some 60 per cent of outlay is included in the present plans for development.

The report is illustrated by a number of graphs, relating to the position and the prospects in the United Kingdom, France, Switzerland and Sweden, which emphasize clearly the importance of coal to Great Britain.

R. J. SARJANT

THE MEASUREMENT OF BODY RADIOACTIVITY

CONFERENCE AT LEEDS

THE problem of measuring the radioactivity of the human body is exciting interest in many countries. A conference, the first of its kind devoted to this problem, was held during April 16 and 17, in the Department of Medical Physics of the University of Leeds. Delegates attended from Denmark, Sweden, Germany, the United States, Canada, Australia and Great Britain, and they included representatives from almost all the groups known to be engaged in this field.

In a short introduction, Prof. F. W. Spiers outlined the aims of the conference. Of first importance was the bringing together of as many as possible of those actively working on the problem of body radioactivity and others interested directly in it. It was intended to consider particularly the external methods of measuring body γ-ray emission and their possible limits of sensitivity. High-pressure ion-chamber techniques are already adequate, he said, to measure amounts of γ-emitters in the body of the order of 2 ng. radium equivalent (1 ng. = 10^{-9} gm.), that is, well below the recommended maximum permissible levels[1]. An improvement in γ-sensitivity of ten times appears to be feasible with scintillation techniques, but perhaps the special importance of the latter is in their possible application to measuring very low levels of β-emitters in the body. The conference would also include consideration of techniques other than external detection giving data on body radioactivity.

Papers were read by representatives of each of the three groups who have used high-pressure ion-chamber methods. Dr. B. Hultqvist (Institute of Radiophysics, Stockholm) discussed results obtained at Stockholm using two arrays each of twelve high-pressure chambers in a laboratory which, being at 55 metres depth below solid rock, is well shielded from cosmic rays. To exclude local radiation, walls, floor and ceiling are lined with tanks containing Thames water (since this has a considerably lower radioactivity than Stockholm water) and the radon content of the air is reduced by forced ventilation. With these precautions to reduce the background, the maximum uncertainty of a single measurement on a human being, taking 3–4 hr., is ± 1 ng. radium equivalent. Published results[2] include investigations of 306 normal individuals divided into three age groups, and it appears that differences are due to potassium content rather than radium, and that for uncontaminated persons the radium content is well below 1 ng. Differences in the radium content of drinking water supplies are insufficient to account for all the differences in radium content. Dr. Hultqvist also described a survey of the radon and thoron content of air in Swedish homes of various building materials[3], and showed that the accumulated radioactivity is greater in the lungs than in any other part of the body, a factor to be borne in mind in whole-body measurements.

Mr. J. Rundo (Atomic Energy Research Establishment, Harwell, formerly at the Finsen Laboratory, Copenhagen) next described the apparatus at Copenhagen[4] which was designed at Harwell following the pattern of that at Leeds. It uses four measuring cylinders together with four 'backing-off' chambers and a vibrating-reed electrometer feeding into an automatic recorder with an averaging device. Its chief application has been in the study of thorium burdens, a complex problem involving such unknown quantities as the fraction of each daughter product that might be present and, in many cases, the duration of the burden. By calibrating the apparatus with bottled samples of thorium dioxide at different known fractions of radioactive equilibrium and also by means of a model in which the thorium is realistically distributed, it is possible to make reasonable interpretations of the body measurements. Some use of the apparatus has also been made in bremsstrahlung measurements on phosphorus-32 administered to patients.

Experience with the Leeds apparatus was described by Dr. P. R. J. Burch (Department of Medical Physics, University of Leeds). Dr. Burch spoke of the basic considerations concerning the sensitivity and calibration of a body γ-ray monitor. In the case of high-pressure integrating ion-chambers, the cosmic-ray component of the background contributes most of the statistical error. A chamber design was described which should enable errors to be reduced by a factor of from two to three by ensuring that most penetrating cosmic-ray particles would produce roughly equal amounts of ionization both in the register and the backing-off chambers. The principle is being incorporated in an apparatus for recording the γ-ray intensities from the atmosphere and ground, together with the cosmic-ray intensity. Application of the idea to a body γ-ray monitor should enable the normal body γ-ray emission to be measured with a probable error of ± 5–10 per cent in an observation period of 2 hr. By using different wall materials, different gases and different gas pressures in chambers above and below the body, a considerable measure of discrimination of radiation quality would be possible. However, for clinical studies an apparatus is needed capable of giving a standard error of about 2 per cent in a short (¼-hr.) measurement, and the apparatus under construction designed to achieve this was described. Five tank units containing a liquid scintillator and each viewed by two photomultipliers will be mounted around a chair on which the patient reclines. The components of this apparatus, the steel-shielded room in which it is to be used and also the original high-pressure ion-chamber apparatus[5] were available for inspection.

In the discussion following the three papers on high-pressure chamber techniques, mention was made of the importance of avoiding errors due to contamination from clothing and from radon or thoron in patients' breath, and even due to the potassium-40 content of reading material used by the patient during measurement.

The first afternoon session (with Dr. K. Z. Morgan, of the Oak Ridge National Laboratory, United States, in the chair) was devoted to scintillation techniques. Dr. E. C. Anderson (University of California, Los Alamos Scientific Laboratory) described work with the Los Alamos scintillator[6]. He pointed out that the principal advantage of the large liquid scintillator lies in its high sensitivity, permitting the use of short observation times. This greatly increases the scope and capacity of the apparatus. Moreover, with liquid scintillators, almost the entire solid angle around the patient may be filled, as compared with the 10^{-2} or 10^{-3} convenient with sodium iodide crystals. Since sensitivity is dependent on the ratio $(\text{sample})^2/\text{background}$, the advantage of high counting-rates is obvious. The present Los Alamos apparatus has a cylindrical space 18 in. in diameter in which the patient lies. The surrounding 500 litres of liquid scintillator is viewed by an array of 108 photomultiplier tubes, each 2 in. in diameter. The whole is screened by 5 in. of lead, with 2 in. of lead at the patient's head. An exposure of 2 min. is adequate to estimate the normal potassium content of the body with a standard error of ± 10–20 per cent. Statistical stability of the background is better than 1 per cent, which corresponds to 5 per cent in the normal body measurements. Measurements of body activity against age and sex give essential agreement with those described earlier by Dr. Hultqvist. An improved correlation has been found if the potassium-40 activity of each patient is plotted not against gross, but against lean, body-weight. The latter is found by a tritium determination of body-water, which is assumed to be 70 per cent of lean body-weight.

It was a disappointment that Mr. Marinelli's group (Argonne National Laboratory), which has made such notable contributions to the subject, could not be represented. Dr. Anderson was able to include in his paper a description of the work being carried out at Argonne with a single large sodium iodide crystal in conjunction with a room lined with 8-in. steel. The extreme sensitivity of the apparatus was indicated by its detection of what may be traces of cæsium-137 from radioactive fallout, the emission of 0·66 MeV. radiation from tested humans corresponding to a level of 0·005 µc. of cæsium-137 if this interpretation is confirmed.

A joint paper on scintillation techniques by Dr. Denis Taylor and Mr. R. B. Owen (Atomic Energy Research Establishment, Harwell) was read by Mr. Owen after a brief reference by Dr. Taylor to preliminary scintillation work done in connexion with the Copenhagen project. It described an apparatus utilizing four sodium iodide crystals (1¾ in. in diameter, 2 in. thick) giving a standard error for normal body radioactivity of 10 per cent for a 10-min. observation. In its application to phosphorus-32, the standard deviation was equivalent to 30×10^{-9} c. of the isotope. It is proposed to use larger crystals (4½ in. in diameter × 2 in.) with a reduced potassium impurity, when the standard deviation on a 10-min. exposure should be only 3 per cent. A further reduction may be possible if still purer crystals combined with top-channel analysis are employed. Mr. Owen considered the sensitivity to be expected with the proposed apparatus in the detection of americium-241 and plutonium-239 in the body. He believes that it may be possible to measure 6 × 10^{-8} c. of americium-241 from the 59-kV. emission and amounts of the order of the maximum permissible level of plutonium-239, utilizing its 17-keV. X-rays.

In the discussion which followed, it was suggested that the location of plutonium in bone may reduce Mr. Owen's estimate, while Dr. Roesch (G.E.C., Richland, Washington) quoted measurements of transmission of plutonium-239 radiation through patients which suggested a factor of 30–40 for absorption from centre to surface of the chest. Although on present evidence it seems that the measurement of a fixed skeletal burden of plutonium would be difficult, the detection of a recently inhaled burden while still in the lungs appears feasible. In closing the scientific session of the first day, Dr. Morgan stressed the need for applying, if possible, the methods of measuring body radioactivity to the determination of the distribution fractions and effective rates of elimination for various organs for cases of single ingestion as well as for continuous exposure.

The second day's scientific programme was devoted to indirect methods of measurement of body burdens. The morning session, under the chairmanship of Dr. Katharine Williams (Atomic Energy Research Establishment, Harwell), was opened by Dr. Wright H. Langham (University of California, Los Alamos Scientific Laboratory) with an account of the application of urine excretion studies to the determination of plutonium in the body. The urinary excretion curve for plutonium is best fitted with a power function; fæcal excretion is similar but with different parameters. Measurements of urine samples taken on different occasions may be matched to the theoretical power-law curve and the effective limits of exposure deduced. Where the ratio of fæcal to urinary excretion is very high, it is suggested that unabsorbed particles from the lung have found their way up the trachea and have thence been swallowed. Dr. Langham suggested a division of hazard according to the solubility of the plutonium particle and proposed a model of lung mechanism on the basis of which, in the case of insoluble particles, the lung burden is ten times the systemic burden, agreeing fairly well with calculations based on the fæcal/urinary ratio. However, the difficulties inherent in excretion analysis emphasized the desirability of whole-body measurement for plutonium if feasible.

In answer to a question, Dr. Langham said that there is remarkable uniformity in the excretion patterns of different individuals, possibly a consequence of plutonium being chemically unlike any element naturally found in the body.

Dr. J. B. Hursh (University of Rochester) then spoke of the radium content of cremation ashes, natural waters and some common foods. His results[7] for whole-body cremation ashes based on radon assay are about 1/100 of Krebs's earlier value[8] of 10^{-8} gm. average radium content, and Dr. Hursh reviewed other American work giving results in agreement with the lower value. He next described measurements on the radium content of natural and filtered waters in various parts of the United States and showed that they do not bear out the theory that drinking water is the main source of radium burden. The radium content of several common foods has been analysed and suggests that they are a possible source of at least a part of the norma burden.

It was apposite that the next paper was read by Dr. H. Muth (Max-Planck Institute for Biophysics Frankfurt-am-Main) on measurements of norma radium burdens, for he and his colleagues have likewise measured the activity of cremation ashes of German subjects, and their results are in agreement with those of Hursh and Gates[7]. They measured the radon content by a dual ion-chamber system and also by α-pulse counting. In addition, measurements were made of the activity of various tissue samples which were consistent with the total-body results Dr. Muth described determinations of radioactivity of drinking water supplies, wells and thermal springs and also gave preliminary figures for the radium content of some foodstuffs. The general agreement with Dr. Hursh's results was very satisfactory.

In the discussion, Dr. K. Z. Morgan stressed the importance of a knowledge of the radium content in the gonads, Dr. Muth having included some relevant data in his paper.

The final afternoon session, under the chairmanship of Dr. M. Faber (Finsen Laboratory, Copenhagen), was opened by Mrs. M. M. Hindmarsh (Nuffield Institute for Medical Research, Oxford) presenting studies by herself and Dr. Janet Vaughan on α-track measurements of radium in bone. She described photomicrographic and autoradiographic studies of sections of bone from a man, much of whose working life had been concerned with the handling of radium. In general, radium in the shafts was associated mainly with the Haversian systems, whereas in the ends it was concentrated in regions of high calcification. The calculation of body burden from α-track counting was described[9]. Emphasis was laid on the non-uniformity of distribution and it was pointed out that the dose in a small cavity (5μ) might be twenty times the average assessed on the basis of uniform distribution.

Prof. F. W. Spiers described a joint investigation with Dr. Burch in which γ-ray measurements on the same case were compared with α-track results reported in the previous paper. It had been possible to measure the γ-ray emission from the cadaver eight hours after death and afterwards to measure a number of representative bones in sealed containers after radioactive equilibrium between radon and radium had been attained. The total radium burden (0·48 μgm.) estimated from the bone measurements indicated that at the time of death the radon excretion in breath was 65 per cent. A body radium burden of 0·39 μgm. deduced from the α-track studies is in reasonable agreement with the γ-ray assay in view of the limited number of sections counted. It has been shown that the total life-dose to osteocytes in a 5-μ canal is of the order of 1,20 rad and not very dependent on the assumptions on period of intake. An estimate was also given of the distribution of dose to the bone marrow.

In a paper on the importance of radon and its decay products for the normal radiation dose in humans, Dr. A. Schraub (Max-Planck Institute fo Biophysics, Frankfurt-am-Main) considered the influence of geological and meteorological factors on the distribution of radon and its products in the soil the atmosphere and water supplies. Figures wer given for air concentrations in various sites and conditions, and the dose to the lungs of city dwellers estimated on the basis of measurements of air content of closed rooms.

The final paper, by Dr. W. P. Grove (Radiochemical Centre, Amersham), described experience with the measurement of radon in breath, a method which is specific to radium. The procedure for obtaining a representative sample of breath was described and details given of a technique for collecting the charged active deposit electrically on a metal foil coated with a phosphor for scintillation counting. Several cases had been sent to Leeds for total γ-measurement, and comparison with the exhaled radon suggested an excretion of about 60 per cent.

Reviewing the whole meeting with special reference to external methods of measuring body radioactivity, it could be concluded generally that scintillation techniques have reduced the limits of detection of 'hard' γ-emitters from figures of the order of 2×10^{-9} c. in a 2-hr. observation with ion chambers to about 10^{-10} c. obtainable in 15 min.; and that β-emitters such as phosphorus-32 can be detected at levels of the order of 3×10^{-8} c. Detection of levels of this latter order appears to be possible for a weak γ-emitter such as americium-241.

It was generally agreed that the success of the conference was in large measure due to its informality and to the many opportunities for discussion it afforded. Delegates were entertained by the Board of Governors of the United Leeds Hospital during the scientific sessions held in the Leeds General Infirmary, and also by the University of Leeds at a dinner at which the vice-chancellor, Sir Charles Morris, presided.

It is hoped in due course to publish in full the proceedings of the conference in a single volume.

G. W. REED

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ECOLOGY AND NATURE CONSERVATION

A MOST successful meeting was held in Edinburgh during June 20–28 by the International Union for the Conservation of Nature and Natural Resources, hitherto known by the misleadingly restricted title of International Union for the Protection of Nature. There was an excellent attendance both of animal and plant ecologists, and of administrators, engineers, town-and-country planners, foresters and other interested professions. More than thirty countries were represented. Among the visiting scientists were: Prof. Roger Heim (president of the Union), director of the Paris National Museum of Natural History, and Profs. J. G. Baer (Neuchatel), E. Beltran (Mexico), H. Gams (Innsbruck), T. Monod (Dakar), and Dr. Ira Gabrielson (United States) (all members of the executive board), and also Profs. J. Berlioz and F. Bourlière (Paris), Prof. G. P. Dementiev and Dr. L. K. Shaposhnikov (U.S.S.R. Academy of Sciences), Dr. W. Engelhardt (Munich), Dr. E. H. Graham (United States Soil Conservation Service), Dr. A. Marcello (Italy), Prof. G. J. Van Oordt, Mr. M. F. Morzer-Bruyns, and Dr. V. Westhoff (Netherlands), Mr. Fairfield Osborn (president of the U.S. Zoological Society and the Conservation Foundation), Mr. Roger Tory Peterson (United States), Mr. Hugh M. Raup (director of Harvard Forest, U.S.A.), Mr. F. N. Ratcliffe (Australia), Prof. L. G. Romell (Sweden), Prof. R. Sparck (Copenhagen), Prof. W. Szafer (Poland), Prof. V. E. van Straelen (Belgium) and Dr. E. B. Worthington (Africa).

A number of directors and other officers of national parks, nature reserves, forests, and interested societies also attended, including: Mr. J. H. Baker (executive director of the U.S. National Audubon Society), Mr. H. H. Bennett (recently chief of the U.S. Soil Conservation Service), Mr. M. C. Bloemers (director of the Netherlands Government Nature Protection Department), Mr. H. J. Coolidge (director of the Pacific Science Board), Mr. R. de Vilmorin (president of the French Société d'Acclimatation), M. F. Edmond-Blanc (secretary general of the Conseil Internationale de la Chasse), M. J-E. Harroy (Governor of Ruanda Urundi), Mr. R. Knobel (director of national parks, South Africa) and M. F. Vidron (secretary general of the Conseil Supérieure de la Chasse, France).

The United Kingdom was represented, among others, by Profs. W. H. Pearsall, P. W. Richards, M. L. Anderson and R. Matthew, and by Mr. A. B. Duncan, Sir Basil Neven Spence, Mr. E. M. Nicholson, Dr. F. Fraser Darling and a number of members of the staff of the Nature Conservancy, and representatives of the National Coal Board, the National Parks Commission, the North of Scotland Hydro-Electric Board, the Forestry Commission, and a number of other public authorities and government departments, together with Lord Hurcomb (president), and other representatives of the Society for the Promotion of Nature Reserves, Mr. Peter Scott (director) and members of the research staff of the Wildfowl Trust, Capt. Keith Caldwell and Lieut.-Col. C. L. Boyle (Fauna Preservation Society), and others.

The meeting was notable in bringing together for the first time picked representatives of so many different professions, whose activities affect land use and management, and who are increasingly feeling the need for a concerted approach to their problems. For this purpose the agenda of the technical meeting consisted of four topics, three of which related to land use:

(1) Management of nature reserves on the basis of modern scientific knowledge. This subject elicited several important papers. Ecologically, one of the most interesting was Mr. Raup's reconstruction, based on nearly fifty years of organized studies by Harvard University, of the relation of present to past woodlands in eastern North America. Briefly, he held that the conception of a stable climax forest is an illusion (even where there is no human interference), and that natural catastrophes, particularly wind-throw during storms, and also fire, occur within the life-span of most trees on most areas—while climatic and other environmental changes keep the

vegetation from settling down on any one consistent pattern. He compared the process with the similarly drastic effects of frost action on the arctic tundra, and he demonstrated techniques of tracing, through woodland soil profiles, storm havoc going back so far as four hundred years.

Dr. Ira Gabrielson gave an excellent summary of United States techniques in nature reserve management, and Mr. E. M. Nicholson submitted a detailed review of the principles of management of natural areas, based on a comparison between European and North American practice.

Brief mention must also be made of Prof. Romell's valuable analysis of the extensive man-made elements in Scandinavian habitats, and the Wildfowl Trust's review of aspects of the management of wildfowl refuges in Britain.

Mr. Fairfield Osborn presided over these sessions, with Dr. F. Fraser Darling as *rapporteur*. Unfortunately, the number of participants in this section was too large to permit adequate discussion.

(2) The second theme was devoted to an international comparison of the course and repercussions of myxomatosis in rabbits, and a critical review of factors affecting its future development. Mr. F. N. Ratcliffe, who presided, described the ecological consequences of myxomatosis in Australia, and Prof. Bourlière, the *rapporteur*, ably summed up the remarkably consistent experience of different countries, as shown by the papers describing the effects on the French, British and Netherland flora, and on predatory and competing animals, particularly in Britain.

Mr. H. V. Thompson (Ministry of Agriculture, Fisheries and Food) expressed the personal view that in England the rabbit population may, provided there are sustained efforts at control, be held down to roughly a fifth of its level before myxomatosis. The relationship between the more virulent and less virulent strains of the virus, and the considerations affecting possible repeated use of the virus among rabbit populations which have already been attacked by it, were fully reviewed.

(3) The third theme was a return to land-use problems, with special reference to the rehabilitation of areas biologically devastated by human disturbances. Dr. R. Lessing (London) initiated a lively discussion on colliery refuse and mining subsidence. He stated that the present method of surface disposal of colliery refuse means waste, nuisance and damage, and that the National Coal Board will soon be sterilizing nearly 1,000 acres a year, worth between £50,000 and £100,000, by covering it with some 40 million tons of mined refuse containing an estimated fuel value equivalent to that of nearly 10,000,000 tons of coal; much of this could be utilized by the design and installation of suitable plant, which has now been shown to be technically practicable. At the same time, compensation for subsidence resulting from the bringing of this material to the surface is estimated at £3,000,000 a year; this could be prevented or minimized by storage underground of solid material. Naturally these conclusions proved controversial and were in particular criticized by a representative of the National Coal Board. The meeting concluded that, after reviewing a wide range of specialized evidence on the practice, the time has come for all governments concerned to initiate official technical investigations in order: (*a*) to determine whether this type of spoil should not in future be disposed of underground in order to avoid the serious waste of land, fuel and other natural resources which it involves; (*b*), to fix time limits within which either the practice of dumping should cease or the matter should be further reviewed; (*c*) to examine the possibility of dealing by legislation or otherwise with existing spoil heaps of this type.

In contrast, the North of Scotland Hydro-Electric Board was warmly congratulated by delegates for its successful efforts to reconcile hydro-electric development with preservation of amenities, and of the fauna and flora. The Board's work was inspected on the ground during a visit to the Pitlochry and Tummel areas.

The joint consideration by ecologists, engineers and land planners of a number of problems arising from large civil engineering works produced some of the most interesting discussions, and it was generally agreed that much greater efforts should be made in future to ensure that the knowledge and advice of ecologists were sought at an early stage by governments, and by agencies undertaking works capable of altering the landscape.

The chairman for this theme was Prof. W. H. Pearsall, and the *rapporteur* was Dr. W. Engelhardt.

(4) The fourth, and closely related, theme dealt broadly with the relationship of ecology with landscape planning, with Mr. R. J. Bentham, chief of the Landscape Department of the Netherlands State Forest Service, as *rapporteur*.

Dr. E. H. Graham contributed an important paper on Nature protection as part of land development, based on extensive American experience. Some interesting papers were contributed from Germany on ecological landscape management in torrent catchment areas, and on the protection of Nature in relation to structure of landscape.

Mr. A. Glikson, an architect from Israel, contributed a thoughtful review of the relationship between landscape planning and ecology, and discussions also took place on other aspects, such as the making and use of vegetation surveys, and the part played by shelter belts in land use, on which the discussion was opened by Prof. M. L. Anderson (Edinburgh).

So far as it is possible to summarize in a few words the results of so much diverse discussion, it may be said that a start has at last been made towards creating the long-needed link between ecology and the various technologies, arts and industries concerned in or affecting its application to landscape. Aesthetic, scientific and economic considerations all have to be reconciled in any satisfactory treatment, and hitherto they have been largely isolated from one another. We are still a long way from being able to formulate any theory to reconcile these conflicting approaches; but we can at least now see that the methods in general use to-day fall far short of the best modern practice and are in too many cases producing serious or even disastrous long-term consequences. The first remedial steps must be to educate the authorities and individuals concerned not to cling to a few favoured methods (such as burning of heather, surface dumping of mining refuse, or shooting of predators), but to turn their attention to the desired results (for example, improved grazing, getting rid of unwanted materials, or maintaining game populations) and to rely on trained scientists to find the best methods for getting these results. There is a close parallel here to the role of research in the Defence Services, where again it has been necessary to show that victory only comes from readiness to replace preconceived and cherished methods by newer and more appropriate ones. World-wide comparisons are particularly fruitful in the conservation field, and they show clearly that even government agencies and large undertakings are still clinging to methods equivalent to the bow-and-arrow stage in warfare. Both the International Union and national conservation agencies will need to be strengthened to find the right answers and to see that they are put into practice. The high technical quality of the Edinburgh meeting and the impressive representation of the various professions concerned gives encouragement to believe that they will not fail.

The meeting was accompanied by an international film week, at which a wide range of films was shown from countries as far apart as India, Japan, the U.S.S.R., South Africa and Canada, illustrating the increasing potentialities of colour films for scientific as well as education and propaganda purposes. The effects of fire, erosion, pollution and destruction of plant and animal life were vividly illustrated. One general comment was that in too many cases the skill and thoroughness exhibited in obtaining the pictures was not yet matched when it came to cutting and editing the material As a result of these comments, progress in this direction can be confidently expected.

About 180 photographs of mammals, reptiles, birds, insects and plants were exhibited from the British National Collection of Nature Photographs, newly formed by the Nature Conservancy, and the Royal Scottish Museum arranged an interesting exhibition on "Man and the Balance of Nature" which included a good deal of material from the recent International Exhibition organized by the International Union for the Conservation of Nature and Natural Resources in Paris.

The papers and discussions of the technical meeting will be published as soon as possible, but in the meantime the Nature Conservancy would be glad to reply to any inquiries, addressed to it at 19 Belgrave Square, London, S.W.1.

INTERNATIONAL UNION OF CRYSTALLOGRAPHY

MEETINGS IN MADRID

THE meetings of the International Union of Crystallography held in Madrid during April 2–7 were a departure from the previous practice of the Union in several ways. For the first time, the main interest of the symposium was not focused on structure on a molecular scale, but on structure on a scale intermediate between molecular and optical-microscopic. Also for the first time, two of the Commissions of the Union organized an extended series of open meetings. The programme was very crowded, and even with the help of colleagues I am able to give only an incomplete account.

Teaching of Crystallography

The Congress of the Union held in Paris in 1954 saw the beginning of the present general interest in the teaching of crystallography and the establishment of a Commission[1] on such teaching. In preparation for the Madrid meetings, this Commission had circulated a questionnaire, and from the replies and the statements given by several national representatives it was obvious that crystallography, though it grew suddenly out of the morphological stage as long ago as 1912 and has made swift progress since, has not received full academic recognition even yet. Full courses in crystallography at the undergraduate level are extremely rare, and most of the undergraduate teaching given elsewhere is slight and incidental to studies in the older sciences. The best opportunity for serious study of, and training in, crystallography is postgraduate, and the prior training in other subjects is a great advantage. For crystallography embraces a field far wider than is often realized—even by those engaged in other sciences—and far wider than its name suggests. In just over forty years we have gained an insight into the variety of structures, perfect and imperfect, and into the structural reasons for the chemical and physical properties of solids, that far outstrips our knowledge of liquids and gases. This new insight is being rapidly exploited by industry, but scarcely any use has been made of it in modern presentations of the established sciences.

It was generally agreed that, instead of trying to squeeze formal courses on crystallography into the already overcrowded degree courses, it would be both easier and more natural to introduce it incidentally and gradually, thus making the student structure-conscious even from his school days. The preciseness of crystal models and the directness of this approach could transform completely much of the teaching of the basic chemical laws, and at the university degree level could simplify the presentation of material in many subjects. In some subjects, such as physics, the emphasis would be less on the diversity of structures and more on the relations between structure and physical properties (especially anisotropic properties), and on diffraction phenomena in two and three dimensions. Mineralogy has had, of course, the closest academic relation with crystallography, but it is remarkable how many departments still concern themselves mainly with morphological and petrological techniques, paying scant attention to structure and its connexions with geochemistry—and (so it would appear from the discussions in Madrid) even less to the techniques of structure analysis. On this point, contributions at the meeting from the U.S.S.R. were especially interesting. The bias of Russia has been traditionally mineralogical, but for the few who undertake the very extensive courses the training is comprehensive and modern. In Europe generally there is great variety in the approach, and the extent of training is dependent on local educational tradition and personal initiative. In North America there are a very few, and very good, schools of crystallographical research and postgraduate teaching, but very little is done at the undergraduate level. Japan is worthy of mention for the scale and quality of its post-war work in crystallography, but it is not clear how far the subject has penetrated into undergraduate teaching.

The ideas exchanged at Madrid on the order of presentation and on teaching aids were valuable, and showed that, despite the variety of contexts in which the subject is introduced, geometrical concepts are the most important and usually the earliest topics treated, with crystal chemistry a close second. Crystal physics, except perhaps for crystal optics, is usually a poor third.

There is no shortage of good text-books for the specialist student, but there is an urgent need for the provision of new or revised text-books for college, school and, indeed, general use. These should rely much more on the structural approach to chemistry, physics, metallurgy, mineralogy and biology.

Apparatus

The papers on crystallographical apparatus were mainly concerned with advances in techniques in powder diffractometry and with the development of X-ray tubes and associated equipment. The properties of the various quantum-counting devices used in diffractometry have now been investigated in detail over the X-ray range of wave-lengths, and it appears that the thallium-activated sodium-iodide scintillation counter, used with a pulse-height analyser, has considerable advantages over the Geiger or the proportional counter[2]. The analyser, when set to accept the proper range of pulse amplitudes, is very effective in reducing background from diffuse scattering of the continuous spectrum, from specimen fluorescence, and from radiation other than X-rays. The high quantum efficiency of the scintillation counter, and its uniform response over the range of X-ray wave-lengths normally used, gives it a uniformly high figure of merit (based on equal weights for observed counting rate and peak-to-background ratio), and makes it very suitable for fluorescence analysis as well as for powder and single-crystal diffraction work.

The application of focusing monochromators to the improvement of powder diffractometry has also received a good deal of attention. In one of the more promising arrangements the specimen is used in transmission with a reflecting monochromator placed in the divergent diffracted beam; a standard diffractometer can readily be adapted for this. Though the peak intensity (for values of 2θ between 15° and 85°) is lowered by a factor of about two, the non-characteristic background is eliminated, and the lines are considerably sharper than with the standard arrangement set for maximum resolution. Since preferred-orientation effects are reversed in transmission, this arrangement, in conjunction with the standard one, provides a sensitive means for detecting preferred orientation in a given specimen. In another arrangement the monochromator is placed between the source of X-rays and the specimen, which is examined in transmission. This method has advantages for low-angle work.

The development of fine-focus X-ray tubes has given rise to new problems in the design of both tubes and auxiliary apparatus. A focal spot of ideal shape and brilliance is difficult to obtain, and when a line focus is required, various aberrations arise very readily. The design of line-focus tubes was discussed, and characteristic examples of aberrations and their correction were illustrated. It was emphasized that, to use these tubes to the best advantage, the tube and the diffraction camera need to be designed as a single instrument. A Weissenberg camera with film radius 1 cm., and an axial retigraph with specimen-to-film distance 1 cm., were noteworthy examples. Improvements in the design of rotating-anode tubes were also described.

Single-crystal counter diffractometry continues to develop, and some account was given of an arrangement in which the mechanical precision required is less than in earlier equipment, so that its construction is practicable in small workshops.

Analysis of biological specimens can be carried out on the electron microscope by taking photographs with three different beam velocities; these photographs are used to produce a composite coloured image of the specimen. The different colours are characteristic of the atomic numbers of the elements present and indicate their distribution in the specimen.

A simple analogue computer[3], based on two d.c. bridges, was described. In its general form the machine will give the product of three sine or cosine terms, so that it can be used for calculations of structure factor, Patterson function or electron density, although the computer that has actually been constructed was specially designed for the calculation of structure factors.

Structure

Individual papers in the symposium on structures on a scale between the atomic and microscopic dimensions were of great interest. Perhaps because it was a first attempt to organize a symposium in this dimensional range, it was a little difficult to discern a 'structure' in their order of presentation, and one was left with a somewhat scrappy impression of the field. The most impressive were the papers on proteins and sub-proteins, investigated both by electron microscopy and by X-ray diffraction. There was an interesting group of papers on the structure of collagen, including a demonstration of the equivalence of the results obtained by the two methods. Another group of papers was devoted to viruses[4]. Consideration of the structure of molecular viruses led to some interesting applications of point-groups, including a cubic point group, 532, possessing a five-fold axis[5].

The papers on metals showed extreme diversity, from surface films through tin whiskers to more conventional structure work on phases with very large unit cells. Work on field-emission microscopy[6] was noteworthy. The investigation of structure and structural imperfections in metals at 5° K. was interesting both for its results and for the ingenuity of the apparatus, which provided for cold-working the specimens in the spectrometer at the low temperature.

The work on proteins and metals formed two reasonably consistent groups, although the arrangement of the programme somewhat obscured this. There were, in addition, a large number of papers difficult to classify, on topics ranging from commercial greases to orientation of cellulose in filamentous algae. One was led to wonder if a number of smaller meetings, more restricted in scope, with a single subject only claiming attention at any one time, would not be more valuable than a large conference with several simultaneous sessions.

A. J. C. WILSON

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OBITUARIES

Prof. C. van Riet Lowe

THE death of Prof. C. VAN RIET LOWE in Johannesburg, South Africa, on June 17 is a severe loss to rchæology not only in South Africa but also to the cience as a whole.

Prof. van Riet Lowe trained as a civil engineer at he University of Cape Town, but interrupted his tudies to serve with distinction in the First World War, first with the South African Artillery and later with the Royal Horse Artillery, in East Africa, Egypt, Palestine, Italy and France. In 1940 he gain donned uniform to take command of the Witwatersrand University Training Corps Battery.

In 1920 he entered the Civil Service as an engineer n the Public Works Department and reached the op of his profession in 1931, when at the age of hirty-seven he became chief engineer of the Department.

During 1923–28 he was in charge of bridge construction in the Orange Free State. He was quick to eize the opportunities this presented for archæological field-work in his spare time. He discovered a arge number of Stone Age sites, began the long eries of research publications which at the time of is death exceeded 130, and rose rapidly to the forefront of South African archæologists. In 1929 he ollaborated with Prof. A. J. H. Goodwin in publishing "The Stone Age Cultures of South Africa", which still is the most comprehensive account of outh African prehistory.

In 1935 the Government established the Bureau f Archæology, which later became the Archæological urvey of the Union of South Africa, and van Riet Lowe was the obvious choice as its first director. The University of the Witwatersrand provided ccommodation for the new institution and appointed he director to a chair of archæology. At this time, oo, the Commission for the Preservation of Natural nd Historical Monuments, Relics and Antiques was econstituted under a new Act of Parliament, and Prof. van Riet Lowe became a member and secretary f that body. He was thus entrusted with building p these new institutions from their beginnings and cquitted himself of all three tasks with great istinction.

Prof. van Riet Lowe's contributions to archæology annot be reviewed in a brief note. One of his first rojects as director of the Archæological Survey was geological and archæological study of the gravels f the Vaal River, undertaken jointly with the Geological Survey of the Union, which for the first ime gave us a climatic sequence and cultural corelation in the south of the continent. A similar tudy of the Little Caledon River has just been published. He directed the important excavations t Mapungubwe undertaken by the University of Pretoria, and the excavation of the Cave of Hearths n the Makapan's Valley, which proved to contain a omplete Stone Age sequence from the end of the Earlier Stone Age to modern times.

He was assiduous in recording and studying the great wealth of prehistoric art which adorns the South African rock shelters, on which he became the eading authority, and welcomed the collaboration of he Abbé Breuil, who was invited by the late General Smuts to join the staff of the Archæological Survey during the Second World War.

Van Riet Lowe travelled widely in the pursuit of his researches. In 1931, when he represented the South African Association for the Advancement of Science at the centenary meeting of the British Association, he made a study of the important archæological collections in England and France and visited many sites in company with such authorities as Burkitt, Henry Balfour, Breuil, Harper Kelley and Henri Martin. In 1937 he undertook a long journey of archæological exploration through Egypt and the Sudan, East Africa, the Belgian Congo and the Rhodesias, and two years later was invited by the Government of Uganda to describe the prehistory of that important territory in collaboration with Mr. E. J. Wayland. This work was published as Part 2 of a memoir of the Geological Survey of Uganda; Part 1 on the Quaternary geology of the area, by Mr. Wayland, is in preparation. He twice paid official visits to Mozambique to advise the Government of that territory on the organization of archæological research and the preservation of monuments.

His long service in many spheres brought him many honours. He was a past president of the South African Association for the Advancement of Science, the South African Archæological Society and the South African Museums Association. He was awarded the South Africa Medal by the South African Association for the Advancement of Science in recognition of his distinguished research, and the medal of the Historical Monuments Commission for his work in that field. He received the degree of D.Sc. from the University of Cape Town and was a Fellow of the Society of Antiquaries and the Royal Society of South Africa. He represented the Government of South Africa on the International Historical Monuments Commission of the League of Nations and later became a member of the International Commission on Monuments of Unesco. He took an active part in the Pan-African Congresses on Prehistory in Nairobi, Algiers and Livingstone and was invited by the Governments of Iraq and Spain to visit their countries.

Dr. C. E. Eddy

CECIL ERNEST EDDY, whose death at the age of fifty-six following a heart attack has been reported from Perth, Western Australia, was one of Australia's best known and best loved scientists. Born in Albury, in New South Wales he crossed the State border and was educated in Victoria at Colac High School and the University of Melbourne, from which ultimately he received the degree of D.Sc. However, it was to the whole of Australia that Eddy's services were rendered as director of the Commonwealth X-ray and Radium Laboratory since 1935.

Following graduation, he took the M.Sc. degree at Melbourne in 1924 and became research physicist in the Department of Natural Philosophy in 1927. In 1927, also, he was awarded a Rockefeller Fellowship, and studied in England during 1927–28. Cambridge, as was to be expected, left its mark on him, as on many great figures in the world of physics. It is worthy of note that by 1929 Eddy was reporting the use of the Geiger counter for the detection of β-rays transmitted by aluminium. In the next few years, in collaboration with his chief, Prof. T. Laby, he published in the *Proceedings of the Royal Society* papers on the analysis of materials by means of X-ray emission spectra.

In the 1930's and 1940's Eddy was a not infrequent contributor of articles to the *British Journal of Radiology*. From these can be deduced not only his native interest in the fundamentals but also his administrative acts in introducing methods of modern dosimetry into the Australian practice of radiology.

Indeed, as a scientific administrator, Eddy was outstanding. His battles to bring all that was best in the world to his own country will probably only be known and appreciated there. But in recent years he was to become more widely known in international scientific relations. With the introduction after the Second World War of radioactive isotopes, it fell to Eddy to negotiate abroad for materials and equipment with which Australian physical, biological an medical research could keep in step with the mos advanced countries of the world. In the field o personal and public protection against radiations an radioactivity he was an active participant in th deliberations of the International Commission o Radiological Protection, and lately he had repre sented his country on the committee of the Unite Nations Organization called on to evaluate th world problem of radioactivity. Of this notable bod he was elected chairman; his loss at this stage, afte such a successful start of this Committee's delibera tions, will be deeply felt.

In addition to his membership of Australia scientific societies, Eddy was a Fellow both of th Physical Society and the Institute of Physics i Britain.

J. F. LOUTIT

NEWS and VIEWS

Geology in Edinburgh: Prof. Arthur Holmes, F.R.S.

PROF. ARTHUR HOLMES, who shortly retires from the regius chair of geology in the University of Edinburgh, has been distinguished for his contributions in two main fields of his science. In his early days at the Imperial College of Science and Technology, London, his association with Lord Rayleigh led him to pioneer the investigation of the geological implications of radioactivity. Major contributions to the problem of the age of the Earth and to the assessment of the Earth's thermal history have come from his pen; for example, he first directed attention to the importance of potassium as an emitter of radiothermal energy. It is not too much to say that his work revolutionized previous conceptions of geological time and of the history of the Earth. At the same time, he continued the interest in igneous petrology first manifested in his account of his explorations in Mozambique with a series of outstanding studies which have included such diverse subjects as the alkaline igneous rocks of North-west Angola, the Arctic basalts, the Whin Sill and the North of England dykes, the petrography and chemistry of the potash-rich lavas of Uganda, and the origin of kimberlite. He has never been content with mere petrographical description; through all his work there has run the search for a fundamental mechanism capable of producing the diversity of rock types which the Earth's crust exhibits, leading him far in the direction of syntexis and metasomatism under the influence of emanations.

In 1924, Holmes went to Durham as first head of the newly founded Geology Department; there he remained until his translation to Edinburgh in 1943. His great gifts as a teacher and his lucid text-books on petrography and physical geology have made his influence on the science profound and lasting. His later years have been full of honours; he was elected to the Royal Society in 1942; a foreign member of the Royal Swedish Academy of Sciences and of the Royal Netherlands Academy of Science in 1947 and of the Paris Academy of Sciences in 1955. This year he received the Wollaston Medal, senior award of the Geological Society of London, and is to be the recipient of the Penrose Medal of the Geological Society of America.

Prof. F. H. Stewar

DR. F. H. STEWART, senior lecturer in geology i the Durham Colleges, is to succeed Prof. Holmes i Edinburgh. An Aberdonian, Dr. Stewart wa educated at Fettes College, Edinburgh, and in th University of Aberdeen, where in 1937 he gained first-class honours B.Sc. in geology. Having bee awarded the Kilgour Research Studentship, he com menced investigations of igneous petrology unde Prof. T. C. Phemister; these he continued at th Department of Mineralogy and Petrology at Cam bridge under Prof. C. E. Tilley during 1939–41. H was then appointed to the physico-chemical researc establishment of Imperial Chemical Industries a Billingham. Here he became interested in the potash bearing salt deposits, and began his studies on th cores of Eskdale No. 2 borehole, the first boring t find potassium evaporites in Britain. In 1943 h was appointed lecturer in petrology in the Universit of Durham, and here the work begun in Scotlan and at Billingham has been brought to fruition.

Dr. Stewart is chiefly known in the field of igneou petrology for his study of the layered basic comple of Belhelvie, probably the best example in Britain o a type which includes also the great Bushveld bod in South Africa. After completing this work, h began a revision of part of the Tertiary volcano o Skye, which is still in progress. His contributions t the petrological study of the saline deposits hav been many and varied, but they have serve especially to reveal the numerous and comple mineral substitutions which have taken place in th evolution of potassium-rich zones. The publicatio of his work on the borings undertaken for Messr. Fisons around Robin Hood's Bay, Yorkshire, awaited with much interest. In the meantime, D Stewart's petrological investigations have foun recognition in the award of a moiety of the Lye Fund, by the Geological Society of London in 195. and of the Mineralogical Society of America Awar for 1952. In following Arthur Holmes from Durha to the Edinburgh chair, Frederick Stewart take with him a broadly-based reputation in mineralog and petrology; but these subjects do not represe the sum of his interests. His enthusiasm for fiel geology in all its aspects, his skill as a collector o fossil fishes and his knowledge of ornithology reve him as a naturalist in the best sense.

esearch Medicine, University of Pennsylvania: Prof. Colin M. MacLeod

DR. COLIN M. MACLEOD, professor of microbiology nd chairman of the Department of Microbiology at ew York University College of Medicine since 1941, as been appointed John Herr Musser professor of search medicine and chairman of the Department f Research Medicine of the School of Medicine of the niversity of Pennsylvania. He succeeds Dr. William . Stadie, who has been made emeritus professor. . Canadian by birth, Dr. MacLeod is a graduate of cGill University Medical School, and during 1934–1 he was a member of the staff of the Rockefeller nstitute for Medical Research in New York. Dr. acLeod's special fields of interest are infectious iseases, microbial genetics and immunology. He is member of the Armed Forces Epidemiological oard and was president of that Board during 947–55. He is a member of the Executive Committee f the Division of Medical Sciences of the National esearch Council, and last year was a member of ie Special Committee on Medical Research of the ational Science Foundation. Since 1945 he has been ssociate editor of the *Journal of Immunology*. Dr. acLeod is a member of the U.S. National Academy f Sciences, the American Association of Immuno- gists (president 1951–52), the Harvey Society resident 1955–56), and the Society of American acteriologists, among others.

urricane Research in the United States

THE Woods Hole Oceanographic Institution, assachusetts, supported by the United States eather Bureau, the United States Navy and the ffice of Naval Research, is to trace the hurricanes, hich bring disaster to the eastern seaboard of the nited States, to their birthplace over the ocean. hey are formed in summer between about latitudes ° and 8° N., and so far as is known at present they ccur after a period of abnormally light winds across ie northern half of the trade-wind belt. The Woods ole scientists suggest that these conditions lead to nusually high sea-surface temperatures and abnorm- lly high humidity in the lower layer of the atmo- here—probably because fewer sea-salt nuclei are rried up from the surface and less rain is initiated. hen there is sufficient instability to produce winds raise whitecaps, more nuclei will be carried up, nd under extreme conditions the condensation, elease of latent heat and increased convection will row into a hurricane.

To make the basic observations and to test such eas, a 125-ft. ex-coastguard cutter has been con- erted for research in marine meteorology. In dition to the usual meteorological and upper-air bservations, detailed measurements will be made of ie temperature and state of the sea surface. The ork will be done in close collaboration with an air- orne team supplied by the U.S. Weather Bureau. better understanding of the physical processes hich produce the hurricanes will facilitate pre- iction, and there is a hint in the plans that it may e practicable to prevent the formation of a large ganized disturbance by using rain-making tech- iques at scattered points before the conditions ecome critical. The new research ship *Crawford* rries eight scientific workers and a crew of fourteen. he carries supplies for a month, and fuel for 6,000 iles at 12 knots. She sailed from Woods Hole for ie hurricane-generating region on July 3.

Atoms in Industry

P.E.P. (Political and Economic Planning) has recently issued two pamphlets entitled "Atoms in Industry", which provide an excellent appreciation of the British nuclear power plan and of the problems associated with its implementation. The first pamphlet gives estimates drawn from recent publications of the probable cost of the electricity to be generated in the early gas-cooled, graphite-moderated stations; deals with the increased importance relative to coal-fired stations of capital costs and the likely impact of the operation of sources of nuclear power on the national economy; and outlines the organization of the United Kingdom Atomic Energy Authority and its present and possible future relationship to manufacturing industry. The second discusses the factors governing the location of nuclear-power stations and the safety and insurance of these stations; and summarizes the steps which are being taken to establish effective international co-operation. It also incorporates a section dealing with radioactive isotopes, the techniques and economics of their application in industry, and the arrangements which the Atomic Energy Authority has made for their exploitation. It is stated in the conclusion that the account has been written strictly in the context of the present state of commercial developments, so that no attempt has been made to outline and compare the more advanced forms of power reactor which may emerge as alternatives to the gas-cooled, graphite-moderated type within the next decade, or to consider the prospects of nuclear propulsion.

The pamphlets will be found useful both by those directly concerned and those to whom developments in the peaceful utilization of nuclear energy are only of general interest. They would have been even more valuable to both classes of reader, however, had attention been given to the extent to which these developments may be hampered by the present shortage in Britain of scientists, technologists and technicians, as was made very clear in an article in *Nature* of December 24, 1955.

Technical Education and Industry

THE Federation of British Industries has issued a memorandum welcoming the White Paper on Technical Education but is reserving overall appraisal until the universities have published their plans for technological education for the quinquennium 1957–62, pointing out that account must also be taken of the 'bulge' in population which now has its peak among those entering the secondary schools. In the view of the Federation, the plans are not specific enough. No attempt has been made to specify the time within which the proposed increases in the numbers of technicians and technologists is to be achieved, nor is it indicated how the Government proposes to secure the essential co-operation from the public, parents, teachers and industry. While suggesting curtailment of the development of new colleges of advanced technology in the London area, the Federation appears to accept the Government's target figure and merely queries the distribution. It emphasizes the value of co-operation between industry and technical colleges at the level of the governing bodies, but stresses also the value of advisory committees of industrial specialists and teachers. The White Paper is regarded as too complacent in regard to the recruitment and training of teachers ; but while calling for concrete Government plans in this field, the Federation's memorandum gives little indication of concrete support from industry in the release of staff for part-time teaching. The Federation regards the day-release system as a valuable method of providing further training for potential technicians and technologists, and urges its member firms to increase the volume of day-release for this purpose. It agrees that many women could be trained in technological subjects, and holds that industry provides ready openings for women who are technically qualified on appointment. The adoption of 'sandwich' courses by more firms is urged, and such courses are discussed in some detail, particularly in regard to the importance of background information, co-operation between technical colleges and firms, amenities, finance, and the relevance of the proposals of the National Council for Technological Awards.

International Council of Museums : Conference in Switzerland

THE fourth general conference of the International Council of Museums was held in Switzerland during July 2–9 under the presidency of Dr. George A. Salles, director of the French museums. Some 250 delegates from more than thirty countries attended, including at least four from Great Britain. The conference was held in Basle, Zurich and Geneva, and French and English were used as the working languages. Working groups dealing with specified subjects replaced the usual lectures and discussions. Dealing mainly with display and museum technique, this arrangement was eminently satisfactory and stimulating to those who took part. This was especially the case where broad principles of museology were discussed rather than when a particular exhibit or room was the subject for the working group. A series of five public lectures was delivered under the central theme of "The Museum in our Time". These were given by Dr. George Salles, Sir Gavin de Beer, Dr. Bengt Thordeman, Dr. Karl Bassler and Mr. Francis Taylor. The programme of lectures and working groups was liberally interspersed with visits to museums and to art galleries and receptions with very generous hospitality. The International Campaign for Museums, to be held in the week commencing October 8 next, was formally proclaimed by M. André Leveille, director of the Palais de la Découverte, Paris, and it was decided to hold the next conference in 1959 in the Scandinavian countries with headquarters in Stockholm.

Products of Starch Hydrolysis

Messrs. Vittorio, Krotkov, Nelson and Bidwell have examined the products of starch hydrolysis and their metabolism, using tobacco leaves in which the starch content is very high after photosynthesis (*Canad. J. Bot.*, 34, No. 2, 209 ; 1956). Carbon-14 labelled tobacco leaf starch, digested with *N* sulphuric acid in a boiling water bath, was not completely hydrolysed to glucose even after 24 hr. After three hours hydrolysis, paper partition chromatography with butanol–ethanol–water solvent revealed that besides glucose there were four carbon-14 labelled products with R_F values lower than glucose. When these bands were fed individually to tobacco leaves in light, they were incorporated into sucrose, glucose, fructose and starch, and were better starch formers than glucose, glucose-1-phosphate or maltose.

Tropical Tuna Resources of the Eastern Pacific

THE tropical tunas which inhabit the high seas of the shores of the Americas from California to Peru and northern Chile support the most valuable fishery of the eastern Pacific Ocean. This consists o populations of two species, the yellow-fin tuna *Thunnus* (*Neothunnus*) *macropterus*, and the skipjack (barrelete), *Katsuwonus pelamis*. In 1953, 14 million pounds of yellow-fin and 134 million pound of skipjack were produced from the eastern Pacific The preponderant share of the catch is taken by fishing vessels based on the west coast of the United States—very modern, long-range craft forming one of the most specialized fishing fleets in the world. A small but appreciable share of the catch is taken by vessels based in Peru. Most of the landings in countries other than the United States are transhipped frozen to the United States for processing as canned tuna. A scientific investigation of the tuna resources of this important fishery has been undertaken by the Inter-American Tropical Tuna Commission. A description of its work was given by it director, Milner B. Schaefer, at the United Nations conference in Rome during April 18–May 10, 1955 dealing with the Conservation of the Living Resources of the Sea.

Effects of Radiation on Dielectric Materials

A CONFERENCE on "The Effects of Radiation on Dielectric Materials" was held at the United States Naval Research Laboratory, Washington, D.C., during December 14–15, 1954, under the joint auspices o the Naval Research Laboratory and the Office o Scientific Research of the Air Research and Development Command, and the report of the proceedings has recently been published (No. PB111863 ; pp. 169 Washington, D.C. : Office of Technical Services Department of Commerce, 1956 ; 4.25 dollars). The object of the conference was to provide an exchange of information on the research programmes and progress of the various laboratories engaged in the study of the effects of radiation, and also to examine and discuss the general aspects of the wide variety of disciplines involved in this field of investigation Representatives of many United States government laboratories and of university and industrial laboratories participated in the conference, and survey talks on various aspects of radiation effects were delivered by Drs. M. Burton (Notre Dame University) R. Smoluchowski (Carnegie Institute of Technology) K. H. Sun (Westinghouse Electric Corporation) and D. Billington (Oak Ridge National Laboratory) The article by Dr. Sun, entitled "Effects of Atomic Radiation on High Polymers", is particularly valuable because of its extensive bibliography, compiled by F. A. Pecjak and the author, which consists of 217 references. The proceedings consisted of four sessions and twenty-one papers were presented. They include in addition to the survey talks, a description of research and radiation effects in insulating materials carried out at the Brookhaven National Laboratory "Radiation Effects on Glass", by N. J. Kreid (Bausch and Lomb Optical Co.) ; and several discussions of the effects of atomic radiation on polymers including polyethylene and 'Teflon', at low temperatures, and of general radiation on crystals, including diamond.

University of Leeds : Gifts

THE following gifts have been received by the University of Leeds : £2,000 from an anonymous member of the Clothworkers' Company to the Department of Biomolecular Structure, to be devoted to the furtherance of cancer research carried on under the direction of Prof. W. T. Astbury; £2,000 from the Central Electricity Authority to the Department of Agriculture, to continue during 1956–57 research on the reclamation of ash lands; £6,000 a year for two years from the Nuffield Foundation to the Department of Medicine, in support of the gerontological research unit.

Institution of Electrical Engineers: Officers

THE following will take office on the Council of the Institution of Electrical Engineers on September 30 next: *President,* Sir Gordon Radley; *Vice-Presidents,* T. E. Goldup, S. E. Goodall, Dr. Willis Jackson, G. S. C. Lucas and Sir Hamish D. MacLaren; *Honorary Treasurer,* Rt. Hon. Viscount Falmouth; *New Members of Council,* J. A. Broughall, B. Donkin, A. H. Mumford, D. P. Sayers, H. Watson-Jones and H. West.

The Night Sky in August

NEW moon occurs on Aug. 6d. 11h. 25m., U.T., and full moon on Aug. 21d. 12h. 38m. The following conjunctions with the Moon take place: Aug. 3d. 13h., Venus 3° S.; Aug. 7d. 22h., Mercury 6° N.: Aug. 8d. 03h., Jupiter 6° N.; Aug. 13d. 21h., Saturn 3° N.; Aug. 23d. 21h., Mars 12° S. In addition to these conjunctions with the Moon, Mercury is in conjunction with Regulus on Aug. 5d. 04h., Mercury 0·9° N., and is also in conjunction with Jupiter on Aug. 9d. 18h., Mercury being then only 0·2° S. of Jupiter. Mercury is too close to the Sun for observation during August. Venus rises at 1h. 35m. at the beginning of the month and at 1h. 15m. at the middle and end of the month; its stellar magnitude varies between −4·2 and −4·4 and the visible portion of its illuminated disk increases from 0·297 to 0·492, its distance from the Earth increasing from 44 to 65 million miles. Mars rises at 21h. 45m., 20h. 50m. and 19h. 50m. on August 1, 15 and 31, respectively, and during the month its brightness increases in magnitude from −1·8 to −2·5, the visible portion of its illuminated disk increasing from 0·930 to 0·991 and its distance from the Earth decreasing from 43 to 35½ million miles. Jupiter is too close to the Sun during August for favourable observation. Saturn can be observed for a short time after sunset, its times of setting being 23h. 25m., 22h. 30m. and 21h. 30m. at the beginning, middle and end of the month, respectively; its stellar magnitude remains about 0·7, while its distance from the Earth varies from 896 to 942 million miles. It has a slow eastward movement in Libra, and at the end of the month it is about 5° south-east of γ Libræ. The Perseid meteors attain a maximum about August 10–13, the radiant being at R.A. 3h. 8m., Dec. 58° N.

Announcements

THE Scottish Agricultural Industries, Ltd., post-graduate studentship at the University of Aberdeen has been awarded to R. Bain, who will work on the sorption of polyelectrolytes on mercury and on clay mineral surfaces.

THE Alvarenga Prize for 1956 of the College of Physicians of Philadelphia has been awarded to Dr. George N. Papanicoloau, director of the Papanicoloau Research Laboratory of Cornell University Medical College, for his outstanding work in the early detection of cancer.

DR. ALBERT H. MOSEMAN, formerly director of crops research in the United States Department of Agriculture Research Service, has been appointed associate director for agriculture of the Rockefeller Foundation. Dr. Moseman's activities will be associated with Foundation grants to institutions in the United States for fundamental research in agriculture, and agricultural programmes in foreign countries. He will work in association with Dr. J. George Harrar, director for agriculture.

THE University of Oxford has received from the Medical Research Council a grant of £3,655 for the continuation of research into the effects of the injection of radioactive substances being carried out in the Nuffield Department of Medicine by Dr. J. M. Vaughan, principal of Somerville College, and £2,000 for the equipment of a hutted laboratory for use by Dr. Vaughan.

THE Chemical Research Laboratory, Teddington, will hold its open days this year on October 2 (afternoon only) and October 3–4. Applications for tickets should be made to the Director before August 31. Those already on the mailing list need not re-apply.

THE second of the congresses on theoretical and applied mechanics, sponsored by the Council of Scientific and Industrial Research, India, will be held during October 15–16 in the National Physical Laboratory, New Delhi, under the presidency of Sir K. S. Krishnan. Research papers may be contributed on any of the following topics: elasticity, plasticity and rheology; fluid mechanics (aerodynamics and hydrodynamics); mechanics of solids (ballistics, vibrations, friction and lubrication); statistical mechanics, thermodynamics and heat transfer; mathematics of physics and mechanics, and methods of computation. Such papers, with three copies of abstracts, must be sent before August 15. All correspondence should be addressed to the secretary-treasurer of the congress, Dr. B. R. Seth, Indian Institute of Technology, Kharagpur.

THE Society for Water Treatment and Examination will hold its autumn meeting in the Wills Hall, University of Bristol, during September 19–21. In view of the great interest shown as a result of the publication of the third edition (1956) of "The Bacteriological Examination of Water Supplies" (Report No. 71), the Society will hold another meeting in London on November 20 (5.30–8.30 p.m.) in the Library of the Royal Society of Health, to which the Society of Applied Bacteriology, the Microbiological Section of the Society of Chemical Industry and the Institution of Water Engineers have been invited. Further information on both these meetings can be obtained from the honorary secretary of the Society, A. W. H. McCanlis, 41 Carshalton Road, Sutton, Surrey.

THE Department of Medical Chemistry of the Australian National University (with Prof. Adrien Albert in charge) will be transferred from London to the newly built John Curtin School of Medical Research in Canberra on August 10.

ERRATUM. In a communication entitled "Dependence of Snowfall on Temperature", by L. W. Gold and G. P. Williams, in *Nature* of June 16, p. 1137, it was erroneously implied that Prof. M. Bossolasco correlated frequency of occurrence of snowfall with mean daily temperature; in fact, his correlation was between frequency of occurrence of snowfall and the temperature at the time of fall.

PHYSICS IN MODERN CHINA

By Dr. E. H. S. BURHOP
University College, London

In the intensive efforts now being made to transform China from a technically backward to an advanced industrial nation, great stress is being placed on the training of scientific and technical personnel. During the course of a recent visit, I therefore took the opportunity to visit universities and scientific institutes and to discuss with Chinese scientists the methods of training employed and the problems being faced. The visit was too short to allow more than a superficial view of the present condition of Chinese science and education; but many of their proposals and practices in this field are so novel that a short account may be of interest.

The impressions reported here were gained in visits to the University of Peking, to Fu Tan University in Shanghai, and to the large technical Tsinhua University in Peking, which seems to be modelled on the Massachusetts Institute of Technology. The same general pattern exists in other Chinese universities, all of which are under the jurisdiction of the Ministry of Higher Education.

The general pattern of student life in the three centres showed many similar features which are also common to other Chinese universities. Entry to a university is determined as a result of a nation-wide competitive examination. There are no fees, and about 60 per cent of the students receive stipends. Payment of a stipend appears to be determined by the financial resources of the student and his parents. The stipend is only small—an average of 12 yuan (about £2) a month—but was said to be sufficient for board and lodging in the hostels in which the students live. A certain number of adult students, who have entered the universities by other routes, receive special stipends of 30 yuan a month, while research students receive between 20 and 30 yuan a month.

Salaries of university staffs vary from 60–90 yuan a month for assistant lecturers, 90–150 for lecturers and 150–200 yuan a month for associate professors and professors. At the Oil Technology Institute of Tsinhua University the numbers of staff in these three categories were 212, 70 and 38, and we were told this was a typical distribution among the different grades.

According to our informants, the basic cost of food for a man, his wife and two children is about 50 yuan a month, while rent of an apartment, together with water and electricity, may require an additional 10 yuan a month. University salaries appear modest if one relates them to the current exchange-rate (6·8 yuan to the pound); but in terms of purchasing power it seemed, from personal observation, that the yuan was much undervalued in relation to the pound. University salaries are being steadily increased—by about 30 per cent during the present five-year plan.

I was particularly interested in the methods of training of physicists, of whom the University of Peking is at present training about two hundred every year, after a four-year course. The whole training of physicists throughout the country is, however, being reorganized, and a five-year course is being introduced, based on a system that has been in use in the Soviet Union for some time, but adapted to Chinese traditions. Within the next few years, the annual entry of physics students to the University of Peking will increase to four hundred, and they will each do a five-year course. At the conclusion of the twelve-year plan, the universities of China will be training seven thousand physicists a year, all of whom are to have completed this five-year course.

With such an ambitious training programme, one might think that the standard of the courses would suffer; but there seemed no evidence of this at the universities visited. The standard now reached in the final year of the four-year course appears to be similar to that of special-degree students in their final year in Great Britain. When the fifth year is introduced, the standard attained will be considerably in advance of

Table 1. Hours per Week devoted to Different Subjects during the Five-year Physics Course

Subject	Semester No 1	2	3	4	5	6	7	8*	9	10†
Physics (general survey)	5	5	6	6	3					
Practical physics	4	4	4	4	6	5				
Mathematics	10	10	8	5						
Chemistry		3	3							
Theoretical mechanics				4	4					
Methods of mathematical physics					5	5	4			
Thermodynamics and statistical physics					3	4				
Electrodynamics						4	3			
Quantum mechanics							4	4		
Mechanical drawing	3									
Radio engineering					3					
Theory of education							3			
Methods of teaching physics }								4		
Experimental techniques in physics }										
Special topics‡						4	4	6	10	
Experiments on special topics							6	6	6	
Russian	4	4	4	4						
Marxism—Leninism	3	3	2							
History of Chinese Revolution				4	4					
Political economy						4	4			
Dialectical and historical materialism								5	5	
Physical education	2	2	2	2						
Total hours per week	31	31	29	29	28	26	28	25	21	

* The eighth semester is of twelve weeks duration only. For six weeks at the end of this semester students do workshop practice and other technical work in factories or institutes.

† During the tenth semester the whole time is spent on practical work for the thesis topic.

‡ Courses on the following special topics are offered at the University of Peking: theoretical physics, electronics, optics and spectroscopy, solid state physics, history of physics.

that reached by British first-degree honours students. In their final year, the students are required to carry out advanced practical work of a semi-research nature, and to write a dissertation. Some of this practical work being carried out in Peking included a number of studies on the Hall effect, magnetic domains, the measurement of the refractive index of gases using an interferometer method, the study of beta-ray spectra using a cloud chamber with magnetic field, and several X-ray crystallographic studies. One of the final-year theoretical physics students said he had just written his dissertation on the influence of detailed well-shape in the 'cloudy crystal' nuclear model.

The curriculum of the proposed five-year course is set out in Table 1. Each year is divided into two semesters of eighteen weeks and seventeen weeks duration, respectively, and the table shows the time devoted to the study of various subjects.

An impressive feature of the instructional system is the care taken of the student as an individual. During the first two or three years of his course, a member of staff acts as tutor to a student, guides him in his course and has the task of teaching him how to study. The supervisor must also ensure that no student spends more than fifty-four hours a week in all studies, including home study. In the fourth and fifth years, the students are organized into groups, under a student group-leader.

From the third year onwards, 'term papers' are set which involve the preparation of answers based on the reading of original papers, and the student is expected to spend about twenty-four hours in each semester working on them. In this way, experience is gained in the use of reference libraries, and the student, by the time his fifth year is reached, should be in a position to work on the problem set for his thesis.

Great care is devoted to the examination of students. All university examinations, including the final, are oral. Each year, three weeks in the first semester, and four weeks in the second, are devoted to oral examining of students. Just prior to the examination, the student draws a number of questions he will be expected to answer from a hat. He then has half-an-hour in which to collect his thoughts and consult references before presenting himself for the actual examination, which is carried out by the teacher who took the course and which may last 20–25 min. This system, which closely follows the procedure long in use in Soviet universities, appears to be working quite satisfactorily. More than 80 per cent of all students examined receive the classification 'excellent' or 'very good'. At the end of his course the student is required to defend his thesis at an oral examination.

This examining imposes a considerable burden on the teaching staff; indeed, owing to the shortage of teachers, those able to teach have had to do so for much longer hours than is desirable. The supply of good university teachers is one of the most difficult problems that is being faced. Now that the first generation of students is graduating, however, some of whom will be offered university teaching posts, it is expected that the strain of excessive teaching will be greatly reduced. Indeed, university teachers have been promised that in future it will be regarded as normal for 25 per cent of their working time to be spent on teaching, the remainder being devoted to research.

Some research in solid-state physics and in crystallography was being carried out at the universities visited; but in this connexion, our visit to the Nuclear Physics Section of the Physics Institute of the Academia Sinica was of greater interest. Although it has been operating for only a few years, it has a staff of more than a hundred scientists and technicians, and work was proceeding with the development of most of the modern techniques used in nuclear physics. There was, for example, a cloud chamber, of diameter approximately 25 cm. with a magnetic field of 10,000 gauss, and a multiplate chamber 50 cm. square which had been operated for two years at mountain altitudes. About 50,000 pictures had been taken with it, and some examples of associated production of hyperons and K-mesons, as well as other interesting events obtained. The quality of the work was impressive.

A pressurized Van de Graaff machine, together with acceleration tube to yield particles of energy 2 MeV., has been constructed, together with a high-tension generator employing a Cockcroft–Walton circuit. For work on beta-ray spectroscopy, a two-lens spectrometer has been constructed. A large group was working on problems of the production and use of scintillation counters, while another group was using nuclear emulsions which they themselves had made. Although not as good as the Ilford Company's electron-sensitive emulsions, plates had already been produced which were able to detect particles of twice minimum ionization.

Many of the present workers at the Institute have been trained in Europe or the United States and are well informed about new developments. But more physicists are greatly needed at the Institute and throughout the country. It says something for the insistence on quality of training that, faced with this position, resort has not been made to dilution of courses; and in the research work in nuclear physics, too, great stress is being placed on building a sure and solid foundation so that eventually one may expect work of the highest quality to issue from the Institute.

The scientific problems of China are immense. But they are being approached with such energy and intelligence that there seems little doubt that the China of the future will have much to contribute to world science.

STUDY OF FERTILITY

THE seventh annual conference of the Society for the Study of Fertility was held during June 14–15 at the meeting house of the Zoological Society of London and at the National Institute for Medical Research. Eighteen papers were read, and nine of these dealt chiefly with clinical aspects of human infertility. The remaining nine papers were of more general scientific interest and were communicated by the following investigators.

Dr. J. W. Goldzieher (San Antonio, Texas) described recent work on stallion semen at the South-west Foundation for Research and Education, in which it was found that the semen from some infertile stallions contained apparently normal spermatozoa. Further investigation showed that the motility and fertility of spermatozoa depended as much upon properties of the seminal plasma as upon the vitality of the spermatozoa themselves, and that the quality of the plasma varied greatly between different animals. This was demonstrated by separating the cells from the plasma by centrifugation and then suspending the spermatozoa from one stallion in the plasma from other stallions. Seminal plasma from some animals supported motility better than that from others, and this property was inversely related to the concentration of sulphydryl compounds. The incidence of pregnancy also was inversely related to the concentration of these substances in the semen.

Dr. J. Hammond (Cambridge) reported investigations on the degeneration of fœtuses during the later stages of pregnancy in the rabbit. The occurrence of fœtal atrophy and the proportion of fœtuses lost were evidently related to a maternal character that could be selected for by appropriate breeding experiments. The inheritance of the character took place in the manner of a genetic recessive and found more obvious expression in animals in which larger numbers of eggs were shed. There was evidence for the operation of the same mechanism in sheep when the number of eggs shed was increased by the administration of hormones. Dr. Hammond believes that fœtal atrophy is not a reflexion of limited space within the uterus but can be ascribed to the relative deficiency in the uterus of some substance required for normal fœtal development. The nature of the substance is as yet unknown.

Dr. A. Walton (Cambridge) described an apparatus developed in collaboration with Mr. H. M. Dott wherein a semen sample is held within a 'Cellophane' tube around which an artificial medium can be circulated. The properties of the medium can be varied at will so that the influence upon the spermatozoa of temperature, hydrogen-ion concentration, gas tension and diffusible substances can be studied without the need for dilution of the spermatozoon suspension directly with the artificial medium. When spermatozoa derived from the epididymis were placed in the apparatus, it was possible to show that the initiation of motility was due to the presence of both oxygen and fructose in the surrounding medium. The effect of the accessory secretions could be ascribed to their content of these substances. Nitrogen inhibited the motility and this inhibition could later be reversed by supplying oxygen.

Dr. I. G. White (Sydney) gave an account of investigations on the effect on spermatozoon motility of composition of the medium, concentration of spermatozoa, and temperature. The buffering of diluting media was particularly important under anaerobic conditions owing to the production of lactic acid. The output of lactic acid varied with the amount of phosphate present, because high concentrations of phosphate decreased the ability of the spermatozoon to oxidize lactic acid. Potassium tended to improve motility, and traces of copper and iron were probably not detrimental. Most chelating agents tested were toxic; cobalt decreased the toxicity of some. The 'dilution effect' was referable to the loss of substances from the spermatozoon, and these may include biotin and cytochrome *c*. The presence of lipo-protein in egg-yolk mitigates the loss. 'Cold-shock' was associated with a drop in the adenosine triphosphate content of the spermatozoon. Some protection was afforded by egg-yolk owing probably to the presence of lecithin and similar compounds. Antibiotics were in general well tolerated by spermatozoa. When spermatozoa were rewarmed after deep-freezing, some metabolism of the added glycerol occurred under anaerobic conditions. Ram semen contains 1 or 2 per cent of glycero-phosphatyl choline.

Miss Clare Harvey (Exeter) said that detailed and systematic examinations of early and late fractions of human semen showed that the early fraction, though often very small, contains the majority of the spermatozoa. She believes that in the pre-ejaculatory phase of excitement a dense mass of fresh spermatozoa passes into the vas deferens and ampulla, where it is met by back-flowing prostatic secretion. The seminal vesicles then discharge, washing the rest of the spermatozoa through the ejaculatory duct. The function of prostatic citric acid in man may be to inhibit coagulation and permit the ready escape of spermatozoa in the female tract, and the function of coagulation in the late fraction may be to prevent dilution of the early fraction.

Mr. G. A. Harrison (Liverpool) reported that mice kept in a hot environment (dry bulb 90° F., wet bulb 84° F.) bred normally; but the females failed to suckle unless they had been brought up under the same conditions. There was thus evidence of adaptation to the high temperature. Adapted animals also survived longer when exposed to temperatures (dry bulb 104° F., wet bulb 84° F.) that generally proved fatal in about 12 hr. Survivors from such an experiment also showed no loss of fertility. Rats exposed to a dry-bulb temperature of 100° F. suffered little or no damage to the testis. When water at 107° F. was applied to the scrotum the testis temperature became constant at 103° F. An environmental temperature of 107° F., however, did not raise the testis temperature above 96° F., although the abdominal temperature was 102° F. The scrotum is therefore an important and efficient heat-disposing surface. This property was removed by covering the scrotum with paint, whereupon an environmental temperature of 100° F. led to testicular damage.

Mr. J. H. Grant (Liverpool) said that he had studied the effects on the remaining testis of unilateral castration in rats. Following the operation, there was a compensatory increase in the growth-rate of the testis, and the final volume reached was greatly in excess of normal. The total number of tubule cells, however, was not increased, nor was the amount of interstitial tissue. The ratio of the diameter of the lumen to the diameter of the whole tubule was also unchanged. The larger size reached by the testis is therefore imputed chiefly to hypertrophy of the tubule cells, although the Leydig cells, after an early decrease, did show some increase in number. Testosterone administration was found to inhibit the testis hypertrophy if applied in the first five weeks after the operation.

Prof. R. G. Harrison (Liverpool) described experiments in which solutions of chorionic gonadotrophin were injected into mature rats. In a control series, rats received injections of sterile distilled water. No effect was seen in the tubular epithelium, in the number of Leydig cells or in the amount of interstitial tissue; but there was an increase in the quantity of tissue fluid. 'Phytoid' vacuoles appeared in the spermatogonia, connoting an increase in cell fluid, and there was enlargement of spermatocyte nuclei. In addition, spermatogonia appeared to be reproducing spermatogonia in large numbers, for several layers of these cells were observed. These changes were seen in both experimental and control groups of rats and are interpreted as evidence of a stress reaction evoked by the injections.

Dr. M. W. H. Bishop (London) gave a short account, illustrated by colour transparencies, describing the application of fluorescent dyes, notably acridine orange, to the study of morphology in living spermatozoa. When the preparations are subjected to ultra-violet irradiation the spermatozoa exhibit a brilliant fluorescence, the acrosome appearing red or orange and the rest of the cell green. The large variations in the form of the acrosome in several species of mammals were thus clearly demonstrated. With the dye primuline a striking colour contrast is obtained between living and dead spermatozoa.

Demonstrations provided by the Division of Experimental Biology at the National Institute for Medical Research illustrated aspects of work on mammalian gametes and fertilization, reproduction in mice after ablation of the thyroid by iodine-131, gonadal grafts in the rat, production of aspermatogenesis in the guinea pig with testis antigen, and the effects on fœtal development of exposure of the mother to severe hypothermia. C. R. AUSTIN

EFFECT OF VARIOUS STIMULI ON TISSUES OF DIFFERENT AGES

A MEETING of the British Society for Research on Ageing was held at the Ciba Foundation, London, on June 8, and a series of papers dealing with the effects of various stimuli on tissues of various ages was read

The initial three papers were introduced by Prof. K. J. Franklin, under whose direction the work had been carried out. In the first paper, Dr. Sheila B. Carter, of the University of Bristol, dealt with the reaction of the gingival epithelium to friction in rats at different ages. She pointed out that, although some human experiments have been carried out in this field, work on animals may be more satisfactory since they may be kept on a standard diet under standard conditions and the amount of friction applied can be controlled. Dr. Carter used the merion rat (*Meriones libycus*) and three experimental groups: 5–4 months old; 9–12 months; and 14–16½ months. In all groups the gum of the diastema between incisors and molars of the right side of the upper jaw was rubbed with a brush consisting of a single nylon tuft about 4 mm. long, for one minute twice daily for 4 weeks, the other side of the jaw being left as a control. The thickness of the cornified layer was afterwards measured in histological sections of the gum. The minimum width of the epithelium and the depth of the epithelial papillæ were also measured. The brushing caused a marked though variable increase (5–280 per cent) in the thickness of the cornified layer. At the same time, the minimum width of the epithelium tended to increase though not significantly; but there was a significant increase in the depth of the epithelial papillæ. It was of interest that there was no correlation between age and any histological change.

It is hoped to extend this work to a study, in the Physiology Department of St. Bartholomew's Hospital Medical College, London, of the clinical effects of mechanical friction on the human gum, and in this connexion Dr. F. J. Aumonier gave an account of his preliminary studies of the human gum. He demonstrated a striking variability in the pattern of the epithelium in human jaws which varied enormously from one side to the other in the mouth, at various levels near the teeth and in the projections of gum between the teeth. Before these clinical studies can be commenced, therefore, a very full study will have to be carried out on the variations in average thickness of gum, minimum and total thickness of the cornified epithelium, resistance to infection, etc., of the human gum in different parts of the mouth.

Dr. Patricia Lindop, of the Nuffield Gerontological Unit at the Department of Physiology, St. Bartholomew's Hospital Medical College, described three pilot experiments used in the study of the roles of whole organs in the process of ageing. The first of these dealt with the rabbit kidney, which was studied in relation to the weight of tissue and blood content at various ages. The latter was determined by using a perfusion method—washing out red cells which had been labelled *in vitro* with radioactive phosphorus. The renal blood content was determined within an accuracy of 2 per cent, and was found to be remarkably constant for animals of the same proportionate weight of renal tissue. In the rabbit Dr. Lindop also demonstrated that there is a distinct correlation between the weight of renal tissue and the whole body weight—that is, the smaller the animal the larger is the proportion of renal tissue. The normal renal blood content shows a parallel decrease ranging from 50 per cent in the neonatal period to 41 per cent between weaning and puberty, and thereafter 31 per cent in adult life with no definite decrease even at three years.

The second experiment carried out by Dr. Lindop was a study of the uptake of radioiodine in 246 rats of different ages (1 day–47 weeks old). No significant difference in rate of uptake nor in the total amount of iodine taken up by the gland was recorded, although if older animals had been studied a change might have been found.

In the third series, eighty-five elderly patients between sixty-five and ninety-five years of age were studied in relation to their renal function following a period of hypotensive anæsthesia for prostatectomy. The aim of this study was to determine whether hypotension with vasodilatation, as occurs with vasomotor paralysis, is less harmful to the senile patient with reduced cardiac, cerebral and renal reserves than hypotension with vasoconstriction occurring during hæmorrhage at operation. It was found that a fall in blood pressure to a level of 80 mm. (of mercury) systolic was optimum. There was no impairment of renal function unless the pressure was dropped below 60 mm., when there was a transient oliguria and a rise in blood urea post-operatively.

The final paper was read by Dr. Honor B. Fell, who pointed out that early work had shown that vitamin A deficiency had caused mucous membranes to undergo a squamous metaplasia and to keratinize. Previous work by Dr. Fell and the late Sir Edward Mellanby had shown that, whereas epidermis from the trunk and limbs of 6–7-day chick embryos differentiated into squamous keratinizing epithelium in a normal medium, it formed a mucus-secreting, often ciliated, membrane when grown in medium to which excess vitamin A had been added. Dr. Fell then went on to describe experiments designed to discover whether explants of older, more highly developed, skin would undergo similar transformation in response to excess vitamin A. The scaly skin of the shank and feet of 13- to 18-day chick embryos was used.

When grown in normal medium, the 13-day skin keratinized and maintained its normal structure; but in the presence of excess vitamin A, it underwent mucous metaplasia as readily as the 7-day epidermis. The 18-day skin had a fairly thick stratum corneum when first explanted; in normal medium the keratin increased in thickness, but in the high vitamin A medium it became detached by swelling and subsequent disintegration of the upper layers of epidermal cells. The deepest, least-differentiated cells survived, and scattered excretory cells and sometimes areas of true metaplasia appeared in this region; metaplasia was less frequent and usually less extensive than in explants of 13-day skin. When transferred from high vitamin A to normal medium, both the 13- and 18-day skin eventually reverted to the squamous keratinizing type. Dr. Fell suggested that, in the organ cultures, the skin was subjected to conditions which probably could not be reproduced in the intact animal; thus experiments *in vitro* with excess vitamin A involved developmental potentialities which perhaps could not have been demonstrated *in vivo*. G. H. BOURNE

PHYSICAL STRUCTURE AND ENGINEERING PROPERTIES OF CONCRETE

T. C. POWERS, who is in charge of fundamental research on the properties of concrete at the laboratories of the American Portland Cement Association, is well known for his work in collaboration with T. L. Brownyard on the distribution of water in set cement. Taking advantage of Mr. Powers's attendance at the Stockholm Conference on Winter Concreting, the Cement and Concrete Association asked him to give a lecture to an invited audience in London on March 1 at the Institution of Civil Engineers. More than seven hundred persons attended, covering a wide range of interests in civil engineering and concrete technology. It is a tribute to Mr. Powers's skill and enthusiasm that the highly specialized subject-matter of his talk was nevertheless received with absorption by his large audience, who were obviously stimulated by the many original observations.

Mr. Powers began by narrowing the field of discussion to the paste of cement and water which binds together the sand and larger aggregate. In his view, the major properties of concrete are largely determined by the paste alone, and the over-riding factor controlling the quality of the paste is the ratio of water to cement in the original mix. As hydration of the cement proceeds, some of the water becomes chemically combined, some is adsorbed in the gel resulting from the hydration, and some remains as free water in the capillaries present in the set mass. The properties of the gel, as quoted by Mr. Powers, are: density, 2·15 gm./c.c.; porosity, 26 per cent by volume; and coefficient of permeability to water, 2×10^{-15} cm./sec. The last is a remarkable figure for a substance of 26 per cent porosity, being less than is obtained with natural rocks of only 2–3 per cent porosity.

Mr. Powers then went on to elaborate a theory which caused a considerable controversy. It is well known, he said, that Portland cement is composed principally of tricalcium silicate, dicalcium silicate and various aluminates. Cements high in tricalcium silicate hydrate more rapidly and gain strength more quickly than others. This is usually explained by the fact that the aluminates react quickly with water, followed by the tricalcium silicate, while the dicalcium silicate hydrates react only slowly. Nevertheless, the evidence shows that in practical cement there is no preferential hydration of the different minerals. The evidence is threefold: constant specific surface of the gel from 1 day to 14 years; constant heat of reaction per unit of combined water from 1 day to 14 years; constant ratio of tricalcium to dicalcium silicate, as determined by the X-ray method, from the original cement up to 28 days. Mr. Powers did not offer an alternative theory to account for the differing reactivity of cements of different mineralogical composition.

The strength of the cement paste, on Mr. Powers's theory, is determined by how much of the capillary space is filled with gel. This gel/space ratio can be calculated from the original volumes of cement and water and the degree of hydration of the cement. A good relation was shown, graphically connecting the compressive strength of neat paste and the gel/space ratio. Mr. Powers then went on to use his theory to explain the variable coefficient of thermal expansion of concrete and to consider the bulk permeability and the frost resistance of concrete; especially in dealing with the latter property, it is necessary to allow for the accidental or deliberate entrainment of air during the mixing operation.

The discussion that followed the lecture mostly centred around the question of the differential hydration of cement minerals, and it is clear that this question will exercise the minds of cement technologists for some time to come. In replying to the vote of thanks, Mr. Powers made it clear that his work is not complete and that he had offered it for discussion in the hope that any errors or weaknesses might be repaired. R. W. NURSE

MOISTURE BALANCE OF THE ATMOSPHERE

FOR his presidential address to the Royal Meteorological Society, given on April 25, Dr. R. C. Sutcliffe chose for his subject "The Moisture Balance of the Atmosphere". With so much expression of opinion, both informed and uninformed, regarding the possible effects of nuclear explosions on weather and the possibility of artificially - inducing precipitation from clouds, the subject was clearly a topical one; however, Dr. Sutcliffe, who is deputy-director of the Meteorological Office, had very little to say about the narrow 'rain-making' aspect and concentrated on presenting a broad picture of the various inter-related processes going on in the atmosphere, without an understanding of which attempts to tamper with the weather may lead to confusion and, possibly, disappointment.

After lamenting the tendency for new specialist branches of meteorology and applied meteorology to channel-off research energy from the main stream, which should be concerned with atmospheric processes as a whole and which has been very much neglected, Dr. Sutcliffe made the point that the circulation of water and water vapour in the atmosphere is but one aspect of the 'general circulation' of the air which carries it. The transport of water vapour is governed by the 'macro-dynamics'—that is to say, by the equations of fluid dynamics applicable to large-scale movements of air—though processes such as condensation and evaporation affect the application of mechanical principles by reason of alterations produced in the air-density. Precipitation, produced by the coalescence of cloud particles, also reacts back on the motion since it affects future evaporation and condensation. If there were no coalescence of cloud particles, there would be clouds everywhere and the behaviour of the atmosphere might be expected to be different in many ways.

Dr. Sutcliffe classified the macro-dynamical processes, that is, processes on the scale of weather systems, as orographic, convective and cyclonic. Cyclonic developments occur mainly in middle latitudes, and he was curious to know why they have the size they are observed to have. It was unfortunate that he could not spare time to discuss theories which purport to explain this fact. In low latitudes a slow circulation of air in the planes of the meridians (the 'Hadley' circulation) evidently plays a large part in the transport of water vapour, as it does in the transport of heat and momentum; however, we also observe relatively small but intense disturbances called tropical cyclones. Dr. Sutcliffe wondered if a type of general circulation is possible in which the tropical cyclones play a part in low latitudes similar to that played by the extra-tropical cyclones (depressions) in middle latitudes. He claimed that, with the use of some imagination, one could see indications on climatic mean charts supporting this view.

A fact of some significance concerning the relation between rainfall and other processes going on in the atmosphere is the relatively small 'capital' of water vapour in the atmosphere as compared with the 'turnover'. Dr. Sutcliffe pointed out that there is, on the average, in the whole atmosphere, a total water content equivalent to only about ten days supply of rain. It follows that the total rate of rainfall must be rather closely controlled by the total rate of evaporation. Evaporation requires not only a supply of water but also a large supply of energy, and for control of weather over longer periods we have to look to those large reservoirs of both water and thermal energy, the oceans. The amount of energy required for evaporation is actually comparable with the infra-red radiation from the Earth's surface, and this led Dr. Sutcliffe to a discussion of the rather complicated energy-budget of the atmosphere. In drawing up a balance-sheet we have to use information derived in a variety of ways, some direct and some indirect, and little of it completely reliable. We are concerned not only with evaporation and precipitation and the convective transport of heat by air motions but also with radiative transfer in both the visible and infra-red regions. Various workers have attempted to draw up such a budget; but in many cases some entry has been made which is based more or less arbitrarily and uncritically on the work of others, and sometimes it is difficult to discover by whom and on what evidence a particular estimate was originally made. Dr. Sutcliffe paid special attention to some very recent calculations by Budyko of the energy balance of the atmosphere as a whole. Finally, he produced an estimate of evaporation and precipitation over land and over sea as a function of latitude. There appears to be only a very rough agreement between the estimates produced by different people at different times.

Appropriately, in view of the close inter-relation between different processes going on in the atmosphere, Dr. Sutcliffe ended by considering the relation between the local energy balance and weather systems. Energy supply to the atmosphere is deficient in anticyclones because less latent heat of condensation is released. It seems reasonable to suppose that they act as energy 'sinks', towards which energy is transported by air motion, and a more detailed analysis might indicate that their existence actually controls the development of new motions. It is not evident that the large anticyclones need always remain, even on average, in the same places, and Dr. Sutcliffe considered it possible that the atmosphere has more than one pattern of 'general circulation'. The idea is intriguing, and it is to be hoped that it will be followed up in the series of discussions on 'general circulation' problems, which, Dr. Sutcliffe announced, is being planned by the Royal Meteorological Society. One such discussion has already been held after the presentation to the Society of a brilliant theoretical paper by Dr. N. Phillips, of Princeton (see *Nature*, July 21, p. 129). Dr. Phillips has shown that very many observed features of the behaviour of the atmosphere are reproduced in the numerical integration of the equations governing a very simple model of the atmosphere. The prospects of transforming meteorology into an exact science are very much brighter now than they have ever been in the past.

E. T. EADY

UNIVERSITIES OF GREAT BRITAIN

1955 CONFERENCE

AT the 1955 Conference of the Universities of Great Britain and Northern Ireland, held during December 16–17, a number of topics were discussed, one of which, the age-group 'bulge' and its possible effect on university policy, has been reported in these columns (*Nature*, January 21, p. 115). The full report of the Conference proceedings, which has now been published*, summarizes the speeches and discussion at this session, and also those of the two preceding sessions on, respectively, the transition from the sixth form at school to the university and the financing of research in universities by outside bodies.

The first session was opened by speeches from Mr. H. D. P. Lee, headmaster of Winchester College, Miss K. Anderson, headmistress of the North London Collegiate School, and Prof. N. F. Mott, of Cambridge. Mr. Lee, starting from the findings of the report on university entrance requirements, claimed that we must not specialize at the expense of general education and that the latter includes, first, a certain minimum of academic achievement such as a certain standard in elementary mathematical operations, a certain ability to understand and write good English and some knowledge of a foreign language, as well as, secondly, at the level of the sixth form, an awareness of the place of specialized study in the field of human knowledge as a whole. He maintained that general education could not be provided at the university itself; it must be given in the schools. Miss Anderson outlined the problems of girls' schools more particularly, and referred to the growing tendency for consultation between the schools and the universities. She suggested that the schools could do more to develop individual responsibility for work. Prof. Mott stressed the importance of framing university entrance requirements and entrance scholarships to encourage the schools to provide time in the sixth forms, along with specialization, to look at other fields of endeavour and see their relation to the main cause of study, and also the value of making it easy to change from the arts to the science side, or vice versa, later than the usual age of fourteen. In the discussion, Prof. J. L. Montrose, while welcoming much of Mr. Lee's address, dissented emphatically from the view that general education could only be given at school, suggesting that it comes late in a university career, even in postgraduate study, and in this he was supported by Dr. F. M. Brewer. Mr. S. R. Woods referred to the need for some method of assessing general education, and Dr. G. N. Burkhardt suggested that specialist study in the sixth form would be reduced if the syllabuses on which Advanced Level and Scholarship papers of the General Certificate of Education are set were reduced to two-thirds of their present size. This idea of pruning was supported by Mr. Lee and Miss Anderson; but Miss Anderson did not believe that general education could be examined.

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* Report of the Proceedings of the 1955 Conference of the Universities of Great Britain and Northern Ireland. Pp. 112. (London: Association of the Universities of the British Commonwealth, 1956.) 3s. 6d.

Dr. V. E. Cosslett's paper on the financing of research in universities by outside bodies was read, in his absence through illness, by the chairman, Prof. J. L. Montrose. Basing his remarks on a recent investigation of the Association of University Teachers, Dr. Cosslett said that about 20 per cent of the research resources of university departments of science and technology are engaged on work of direct interest to industry and that about 5 per cent of university income is derived from industrial support for research. Grants from charitable foundations and learned societies provide a further 2 per cent, and research grants from government sources amount to about 7 per cent of university income. Dr. Cosslett raised the questions whether limits should be set to the amount of outside grants received by a university and to the proportion of sponsored research within this amount, and, if so, what principles should guide the universities in discriminating between grants. He suggested a limit of 50 per cent for outside grants and that not more than 50 per cent, preferably not more than 30–35 per cent, of research projects in a department should be sponsored projects.

Prof. H. W. Melville, who followed, dealt more particularly with the functions of the Department of Scientific and Industrial Research and the connexion between university scientists and government defence establishments; but he also commented on the relations with private industry, which is likely to become the largest contributor to the support of university research, and stressed the value of seconding industrial personnel to work in a university. Sir Harold Himsworth, who dealt largely with medical research, put the government contribution to university research at about £3 million, of which £1·17 million is from the Medical Research Council. He thought the device of establishing research units in association with universities has proved an elastic and effective way of dealing with special problems of common interest, but that there is a natural tendency for successful units to be taken over by university departments. Government support of research by non-academic bodies is, however, increasing and is likely to increase further. Sir William Slater was in general agreement with Sir Harold's remarks, as was Prof. A. R. J. P. Ubbelohde, who discounted some of Dr. Cosslett's statistics. Prof. N. F. Mott also did not share Dr. Cosslett's concern about support from industry, and Prof. J. A. Pope challenged the adequacy of the grants for postgraduate work by the Department of Scientific and Industrial Research.

NATIONAL FOUNDATION FOR SCIENTIFIC RESEARCH, BRUSSELS

REPORT FOR 1954–55

BESIDES the lists of recipients of grants for 1955–56 and the subjects of research, the eighteenth annual report of the National Foundation for Scientific Research, Brussels, covering the year 1954–55*, includes an inventory of microfilms and a list of publications by recipients of grants during the year under review. The Special Commission for Clinical Research received subsidies of 345,000 francs for the work at the University of Brussels on the effect of suprarenal-cortico hormones on the renal reabsorption of proteins, on the effect of suprarenal hormones on the metabolism of fructose in normal subjects, diabetics and patients suffering from hepatic deficiency, and on the inhibiting effect of plasmatic hypertony on the liberation of hormones of the suprarenal cortex provoked by a standard dose of adrenocorticotropic hormone; other work reported relates to the depressive action of cortisone on thyroid activity and to human suprarenalectomy. A grant of 350,000 francs for the State University of Ghent was for work on the influence of cortisone on the respiration of cardiac and diaphragmatic tissues, the stimulation of the suprarenal cortex by adrenocorticotropic hormone, the effects of the latter and cortisone on lipoproteins and the hydrolysis of corticoid urinary reducers. The State University of Liège received a subsidy of 520,000 francs for a comparative pharmacodynamic study of the effects on the organism of the injection of sodium salicylate and other compounds, and the Catholic University of Louvain 456,000 francs for its work on the hormonal inter-relations during gestation.

Grants to research workers for 1955–56 totalled 3,515,000 francs, while for the years 1956 and 1957 a total of 3,000,000 francs was allocated to the National Centre of Aeronautical Studies and Research. The first electronic calculating machine designed and constructed in Belgium was completed in Antwerp in February 1955. A special credit of 200,000 francs was made to enable M. Velghe to complete his astronomical work at the Boyden station of Harvard University at Bloemfontein in South Africa. Prof. M. de Hemptinne and M. Migeotte received a grant of 135,000 francs for their infra-red spectroscopical work, and Prof. J. Morelle, Ch. De Muylder and P. De Temmerman received 150,000 francs for their research on experimental coarctation and its retention and on vascular peripheral resistance.

Radioisotopes distributed in Belgium under the authority of the Foundation have been used in the following proportions: medicine, 31; industry, 25; agriculture, 6; physics, chemistry, biochemistry and applied sciences, 28; public services, 5. At the University of Brussels, the exchange of calcium between the bony tissues and the general organism has been studied in the dog with calcium-45; and the isotope phosphorus-32 has been used to study certain aspects of the dispersion of organic phosphorus compounds in the organism and their fixation on cholinesterase, the anti-cholinesterase activity in certain organo-phosphorus insecticides, including the synthesis of di*iso*propyl chlorophosphate and di*iso*propyl fluorophosphate, and the assimilation of carbon dioxide by micro-organisms by means of carbon-14 dioxide. At the University of Ghent the isotope zinc-65 has been used for establishing the distribution constants of zinc bromide in liquid–liquid extraction with diethyl ether and di*iso*propyl ether, carbon-14 has been used to study the influence of dinitro*cyclo*pentylphenol on the metabolism of alcohol in mice, and radioactive iodine has been used for studying the metabolism of iodine in infants suffering from lipoid nephrosis. At the University of Liège, carbon-14 has been utilized for preparing methyl iodide and L-methionine in studying the biological origin of the methyl group of adrenaline and of creatine; iodine-131 has been used for studying a number of toxic goitres, phosphorus-32 for studying the role of inhibitors of cholinesterase on the penetration of the phosphate ion in respiratory organs of the mussel, and carbon-14 for examining the metabolism of œstrone in the rabbit.

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* Fonds National de la Recherche Scientifique. Vingt-huitième Rapport Annuel, 1954–55. Pp. 269. (Bruxelles: Fonds National de la Recherche Scientifique, 1956.)

At the University of Louvain rubidium-86 has been used in studies of the beta–gamma angular correlation of this element, carbon-14 in studies of the decomposition of organic matter in the soil, and at the Royal Military School various studies, by means of chlorine-36 and iodine-131, have been made of heterogeneous reactions in the gaseous phase. At the State Agronomic Institute at Gembloux phosphorus-32 has been used in research on its eventual toxic effect on the development of the mycelium of mushrooms and in the chemical separation of phosphorus compounds such as phospholipoids, nucleoproteins, mineral compounds soluble in water and mineral compounds soluble in acids. In clinical work, gold-198 was utilized in three cases at the Centre for Tumours and Physical Medicine, iodine-131 in the treatment of thyrotoxicosis, while in industry iridium-192, cobalt-60 and cæsium-137 have been applied in the radiography of steel and in the detection of welding faults, and thallium-204 has been used in experiments on the elimination of static charges.

THE AFRICAN WILD DOG

THE African wild dog, or hunting dog, *Lycaon pictus*, is a distinct species and is neither related to any domestic breed nor does it appear to be the forerunner of any known type of domestic dog: there are certain structural differences, such as the absence of dew-claws. According to R. M. Bere, the dogs stand about twenty-six inches at the shoulder and measure about four feet from nose to tip of bushy tail (*Oryx*, 3, No. 4; May 1956). The colour is variable, but is similar to that of a normal 'Alsatian' (German shepherd dog), the animal being covered to a greater or lesser degree with black, yellow or white blotches. A notable feature is the large upstanding, rounded ears. There are recorded cases of wild dogs having been successfully tamed; but an objectionable smell renders them somewhat unpleasant as household pets.

Wild dogs hunt in packs, killing wantonly far more than they need for food, and by methods of the utmost cruelty: *Lycaon* does not kill quickly as the lion does, but often starts to devour his antelope victim before life is extinct. They do more damage than almost any other of the Carnivorae; when they enter a particular stretch of country the disturbance they cause is so great that, for the time being, all the buck are driven out. The absence of antelope from an area is often the first sign of the wild dogs' presence. A particularly unpleasant characteristic is that they will, without hesitation, turn upon any member of the pack that falls by the way through wound or sickness and show no reluctance to consume their own kind.

When the Uganda National Parks were established it was considered necessary, as had been the case elsewhere, to shoot wild dogs in order to give the antelope opportunity to develop their optimum numbers. Fortunately, only a few wild dogs have had to be destroyed, and their number in the parks does not seem to be particularly large. Their habits do not allow them to stay for long in any one place, for they would starve if they did so: the wild dog packs create their havoc and move on.

The shooting of wild dogs has been questioned recently on the ground that, if persisted in, it would result in a disturbance of the balance of Nature. It was argued that should the antelope increase beyond a reasonable limit, the inevitable result would be starvation due to over-stocking and over-grazing. On balance it appears clear that, provided the packs do not increase beyond a reasonable size, they should not be interfered with. With wild animals generally, the rate of breeding and the percentage of those born to reach maturity is, in the absence of predators, largely controlled by the food supply. Generally speaking, the infant mortality among the Carnivorae seems relatively high, so that unless the food supply becomes abnormally easy, numbers just about maintain themselves.

THE SWEDISH FOREST SERVICE

THE forests of Sweden have played almost as important a part in Britain as in Sweden itself during the last half of the nineteenth century and the first half of the present, and it is not inappropriate, therefore, that the Swedish Forest Service should have published in English a handsome booklet on the development of the forests in relation to the Service*. It was the change in materials used for construction in Britain, especially for ships and buildings, which gave rise to a large demand for coniferous timbers, and Sweden seized the opportunity to exploit its large areas of coniferous virgin forests; until then the chief commercial home demand was for charcoal for the mineral industry. Swedish exports to Britain largely increased after the latter took off the import duty on softwoods in 1866. In fact, with its increasing industrial activity and increasing demands for pit wood for the coal mines, building timbers and paper pulp, Britain was lulled into a false sense of security; plans for starting afforestation in Britain, the subject of royal commissions, committees, etc., came to nothing, and by the end of the nineteenth century Sweden had built up a very prosperous export trade.

The early history of Swedish forests, though on a much larger scale, was similar to that of Britain to a great extent. In early times the king owned large areas, which were used for hunting purposes, and claimed all waste land. Then came a period in the

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* The Swedish Forest Service. Pp. 44. (Stockholm: Swedish Forest Service, 1956.)

Middle Ages when the Church and the nobles owned much of the forests. At length, with the Reformation, Gustavus V confiscated all the Church property, and gradually it became the rule that all forests not in private ownership and used for the estates belonged to the State. When the foreign demand arose during the past century, the State again gave away large areas of forests to private people and timber merchants, and heavy unrestricted exploitation took place. A Forestry Institute had been founded in October 1828 by Israel Adolf von Strom, regarded as the 'father' of Swedish forestry, with the object of arousing interest in forestry throughout Sweden. The Institute became known later as the Swedish State College of Forestry, which held its centenary in 1928.

Sweden is divided for forestry purposes into three parts—northern, central and southern. The greater part of the State forests are in the north, where the soils are much poorer and, for climatic reasons as well, the growth is much slower. The Forest Service dates back to the seventeenth century, the duties then being to supervise royal hunting and to keep to the regulations as regards felling and selling forest produce by the people. In 1859 a Board of Forestry was established and six forestry schools were founded. Private forests were still outside any legislation. In 1883 the agricultural sections of State lands were placed under the Board of Forestry, and the name of the Board was changed to Board of Crown Lands and Forests. Under the Board came forests, the Forest Research Institute founded in 1902, and forest education, both higher and lower.

The most rapid progress was made in forest administration from the beginning of the century, one of the chief steps being the reorganization of the accounting system. Separate accounts officers were established in different parts of the country, and this allowed the forest officer, now relieved of much 'paper' work, to devote more time to his forests in the open, instead of chiefly in the office. The Forest Service had been a trading department, and this was changed by the formation of the Royal Swedish State Forestry Industries, Ltd., which is owned by the Forest Service; the supervision of private forests and public non-State forests was placed under a Royal Board of Private Forestry. The staff of the Forest Service is very much on the lines of that in Britain, as also is the forestry education. One difference is that a much greater latitude is given to the district forest officer, who is made responsible, within the administrative policy laid down, for all the work within his charge and has not constantly to refer to superior authority. E. P. STEBBING

THE ROSS GLACIER

By RICHARD BROWN

IN view of the forthcoming work in the areas around the antarctic during the International Geophysical Year of 1957–58, it may be appropriate to review some observations on the Ross Glacier in South Georgia, Falkland Islands Dependencies, which date back to the first International Polar Year.

The island of South Georgia, some 120 by 25 miles (the long axis lying north-west–south-east), lies some 1,000 miles east of Cape Horn, between latitudes 54° and 55° S. It is entirely mountainous, the axial chain rising to almost 10,000 ft.

The Ross Glacier (lat. 54° 33′ S., long. 36° 05′ W.) is the chief feature of Royal Bay, a large inlet on the north-east coast of the island. It presents a wide front of ice cliff approximately 120 ft. high, calving into the water at the head of the bay, and rises to a low pass (the Ross Pass) which leads downwards by equally gentle slopes on the far side as the Brogger Glacier, to meet the sea on the south-west coast, where it calves into the waters of Undine South Harbour. The distance from coast to coast is almost 15 miles.

The German Transit of Venus Expedition had its base hut and observatory on the north side of Royal Bay during the years 1882–83. The party was a very hard-working one, for, in addition to the astronomical observations, work was also carried out in the fields of geology, zoology and botany. A survey of the area was made, and plots of the position of the ice front were made on four occasions: August 1882, December 1882, May 1883 and August 1883. There was recession between these dates, particularly the last two, amounting to a total of almost half a mile[1].

The next visitor to Royal Bay was Otto Nordenskjold in 1902.

Before work in the Cumberland Bay area farther to the north, the surveyor of the Expedition, S. A. Duse, plotted the new position of the snout in April 1902. It was found that the ice-front stood in a position in advance of that of August 1882. The advance had been in excess of the total retreat noted by the German party. Nordenskjöld summarized his own and the German expedition's findings in his book "Antarctica"[2].

In December 1951 the area was visited by the South Georgia Survey, led by Duncan Carse. The true left bank of the glacier was used as a sledge route to the Ross Pass and the interior. The area was accurately mapped; but no glaciological work was undertaken[3]. In January 1955 the position of the snout was plotted by members of the British South Georgia Expedition, as part of the glaciological programme. This new position showed a large embayment near the south edge, and a considerable retreat of the north part of the snout. So far as comparison of the plans (on varying scales) permits, it would appear that the cliffs occupied a somewhat intermediate position between those of May and August 1883, and a considerable retreat from the 1902 position. On the south side of the glacier, recent moraines exist up to 600 ft. from the snout, and it may be that there was further advance after the 1902 maximum, for the 1882–83 and 1902 positions show little variation of the glacier's position on the shoreline, the main variation being in the position of the ice-cliffs in the water.

The glacier is derived from two main accumulation areas: that to the north from the peak ('Sunset Peak'; not an officially recognized name) at the south end of the Allardyce Range and the Ross Pass snowfields, and that to the south from the Salvesen Range, including a separate lobe which produces a large area of complex crevassing on the south side of the main stream of the glacier near the snout.

These two areas are of different altitude; that of the Allardyce is of a lower altitude than that of the Salvesen side by some 1,500 ft. on average.

In late January 1955 the summit of the Ross Pass (1,800 ft.) was surfaced with large irregular patches of firn, with intervening areas of bare hummocky ice. Ablation was proceeding (and continued elsewhere in the island at similar altitudes until March) and it seems likely that in some seasons at least the firn line rises above the level of the pass. This means that in some years the net accumulation of the 'Allardyce part' of the glacier will be very small, confined to the slopes of 'Sunset Peak' above approx. 2,500 ft. The Salvesen accumulation areas, being generally much higher, will not come below the firn line, and any amelioration of climate will be less immediate in its effect on the volume of ice[4]. These areas are further fed from the surrounding cirque of peaks of more than 7,000 ft., from which large amounts of ice fall as avalanches.

It is interesting to note, in connexion with the 1902 position, that the greatest advance was in that part of the ice front associated with the Salvesen accumulation areas. The phenomenon of sudden considerable advance of a glacier is further exemplified by the recent advance of the Harker Glacier in Moraine Fjord, near the administration centre at King Edward Point in Cumberland Bay. There are two glaciers calving into the fjord; the Harker is the one at the head. Photographs taken during the Shackleton Expedition of 1914 compared with those taken up to 1952 show little difference in the position of the snout[5]. At some time after early 1952 there has been an advance of considerable dimensions and the snout has moved forward over flat ground at the head of the fjord for some 300 yards, as well as occupying a more advanced position in the fjord. The nearby Hamberg Glacier has remained quiescent. The position of both these snouts was plotted in December 1954, and their proximity to the settlement makes them very suitable for observations in the future.

South Georgia lies in the unstable area of the Scotia Arc. Whether these glacial surges are derived from ice avalanches of great magnitude caused by earth tremors is not certain, although a few earthquakes have been recorded in the island[6]. Further investigation of this factor might bring to light interesting data; but it would seem, at the present, that these surges occur only when the glacier is fed from some hanging ice-fall system, as is the case in both the Harker and the 'Salvesen accumulation area' part of the Ross Glacier. Prof. A. Desio has recently described the much larger (though apparently similar in character) advance of the 'Kutiàh Glacier' in the Karakorum Himalaya[7].

Thanks are due to the Governor of the Falkland Islands and to the Falkland Islands Dependencies Survey authorities for the opportunity to carry out this and other glaciological work in South Georgia.

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GROWTH AND SEXUAL MATURITY IN AQUATIC MAMMALS

By Dr. R. M. LAWS

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In mammals growth is determinate, and there is an average adult size for individual species. The rate of growth is a specific phenomenon presumably fixed by heredity, and different species grow at different rates in the same circumstances and pass at different times through similar phases of development[1].

Owing to the practical difficulties there are few records of weights of aquatic mammals, and length is generally used as a measure of size. It is also a more accurate measure, being less subject to fluctuations than is weight. The average length of the female at puberty and physical maturity is known with some accuracy for the eleven cetaceans and twelve pinnipeds listed in Table 1, being based in most cases on a large number of specimens; but the length at puberty in the male is known with less accuracy. If we convert the length of the female at puberty to a percentage of the size attained when growth ceases it is seen to be remarkably constant, averaging in cetaceans 85·1 per cent (range 80·0–88·5, $\sigma = 3{\cdot}14$, $V = 3{\cdot}69$) and 86·6 per cent in pinnipeds (range 80·8–92·3, $\sigma = 4{\cdot}10$, $V = 4{\cdot}73$). This agreement is the more remarkable when it is observed that for several of the species considered the average lengths at these epochs in the life-cycle are known only approximately. The general shape of seals and whales shows marked resemblances, being fusiform with short appendages, and the length/weight relationship is probably similar in the two groups. This would help to explain the close similarity in the percentage length at puberty in these two unrelated groups; but clearly there is a fundamental and precise connexion between growth and sexual maturity.

We have little accurate information on the rates of growth of the various species of cetaceans, chiefly because no accurate method of determining age has yet been applied. Ageing by dentine layers in the teeth shows promise[11,12], and the use of incremental layers in the ear plug of the Mysticeti is being investigated[25].

In the teeth of Pinnipedia annual dentine layers[13] or external ridges[28] have been used with some success for determining the age of specimens, and mass-growth curves can be drawn up for several species (data from refs. 13, 14, 15, 18, 19, 21, 22, 26, 27). It can be shown that for this group the percentage increment in length during the first year may be used for comparative purposes as a measure of the rate of growth. When this increment is plotted against the average age at sexual maturity (Fig. 1) they are seen to be inversely proportional. In other words, the slower-growing species take longer to attain the level of about 86 per cent of the final length and so mature later than the precocious species. Since precocity in seals affects the embryonic growth-rate, the length at birth is also a reflexion of the rate of growth and bears a similar relationship to the age at puberty. A similar rule holds for the males, though maturity tends to be attained at a later age, and owing to the great variation in growth-rates (the polygynous species have a double sigmoid curve[13,22]) the percentage length at sexual maturity is not so constant. Likewise, in the species of whales for which we have

Table 1. Records of the Average Length of the Female on attaining Sexual Maturity and Physical Maturity

Species	Length in feet at		Length at sexual maturity as per cent of final length	Authorities (ref. No.)
	Sexual maturity	Physical maturity		
Cetacea				
Balaenoptera musculus	77	87	88·5	2, 3
B. physalus				
N. Atlantic	61·5	*c.* 70	87·8	4
Antarctic	65·5	74	88·5	2, 3
B. borealis	47·5	*c.* 54	87·9	5
B. acutorostrata	*c.* 24	*c.* 29	82·7	6
Megaptera novaeangliae	38·5	45	85·5	7
Berardius bairdii	33·5	<40	>83·7	8
Hyperoodon ampullatus	*c.* 21·2	*c.* 26	81·5	9
Physeter catodon	*c.* 30·5	*c.* 37	82·4	10
Globicephala melaena	*c.* 12	*c.* 15	80·0	11
Prodelphinus [*Stenella*] *caerulo-albus*	7	*c.* 8	*c.* 87·5	12
Pinnipedia				
Mirounga leonina	97	115	84·3	13
Lobodon carcinophagus	87	95	91·5	14
Leptonychotes weddelli	90	100	90·0	14, 27
Hydrurga leptonyx	105	125	84·0	15
Erignathus barbatus	79	98	80·6	16, 17
Phoca groenlandica	60	65	92·3	18
P. hispida	43	50	86·0	19
P. vitulina	*c.* 56	64	87·5	20
Odobenus obesus	106	118	89·8	14, 21
Callorhinus ursinus	45	51	88·2	22
Arctocephalus pusillus	53	63	84·1	23
Otaria byronia	59	73	80·8	24

precise information, the male attains sexual maturity at a later age than the female. The sparse evidence available suggests that in general the faster-growing species of whales are those which mature early.

Whales and seals, being aquatic mammals, are able to bear young which are very much larger, both absolutely and relatively, than the young of the large terrestrial mammals. In the bear, for example, the weight of the new-born young in relation to the mother is 1 : 600, in the lion 1 : 160 [1], whereas in the elephant seal it is of the order of 1 : 30 and in the fin whale about 1 : 17. In the elephant this ratio is about 1 : 20 but the gestation period is greatly prolonged. During pregnancy, energy is required for fœtal growth and maternal growth, and reserves must be accumulated for the lactation period. To take an extreme example, the elephant seal pup weighs about 100 lb. at birth and gains about 350 lb. in the following three weeks, while the female probably loses about 700 lb.[13]. In the female it is therefore an advantage (speaking teleologically) to have completed or almost completed growth before bearing young, as otherwise the maternal and fœtal needs would compete for nutritional requirements.

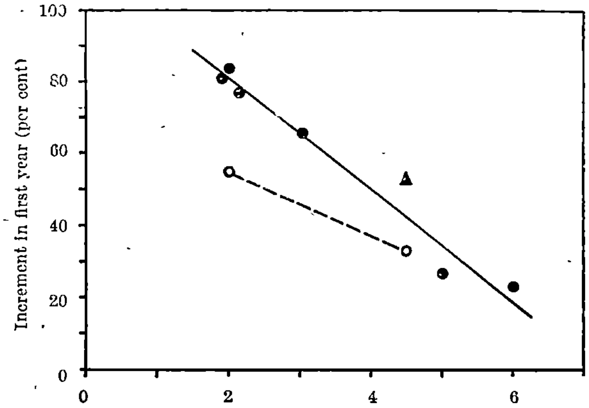

Fig. 1. Percentage increment in length during first year of life, related to age at puberty of the females of nine pinniped species: ●—●—, *Phocidae*; ▲—▲—, *Odobenus obesus* (walrus); ○—○—, *Otariidae*

If this relation between the rate of growth and the age of puberty proves to be a general rule, then it should be possible to predict the age at sexual maturity from the growth-rate, or vice versa. In the harbour seal (*P. vitulina*), for example, the length increment in the first year is about 30 per cent. This suggests that sexual maturity is attained at about 5–6 years of age instead of three years as usually given. It is more in line with the age at maturity of other members of the genus (*P. groenlandica* and *P. hispida*) and is also in closer agreement with recent population census figures for *P. vitulina*.

It would be interesting to examine the admittedly sparse data on growth-rates and relative lengths at puberty in other groups of mammals. It is possible that each group may have a specific relative size at maturity (determined perhaps by interactions between growth and gonadotrophic hormones of the anterior pituitary) of the same order as that shown to hold for whales and seals.

The nutritional level is probably the most important single variable affecting the shape of the growth curves, improved nutrition resulting in more rapid growth, especially in the younger stages. Improved nutritive conditions appear to lead to the precocious attainment of sexual maturity[29,30]. This could be a direct effect, since fertility is in general higher when food is readily available, or it might well be an indirect result of a higher level of nutrition stimulating bodily growth so that the size threshold for reproduction is reached at an earlier age.

I am indebted to Dr. F. H. Fay, Mr. A. W. Mansfield, Mr. I. A. McLaren and Dr. D. E. Sergeant for permission to use their unpublished data on pinniped growth-rates.

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POLYPLOIDY IN BLUEBELLS (*ENDYMION NON-SCRIPTUS* AND *E. HISPANICUS*)

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WITH the exception of occasional variations in heteroploid varieties of *Endymion non-scriptus* (*Scilla non-scripta*) mentioned by Darlington[1], all previous cytological studies[2-4] on this and the closely related species *E. hispanicus* (*S. hispanica*) have revealed only the diploid plant, and no record seems to have been made in the literature about polyploidy in this genus as found in the allied one, *Hyacinthus*[5].

During cyto-genetical studies on the English bluebell, *E. non-scriptus*, in three Cambridgeshire woods a number of odd 'giant' forms was noticed. When these were examined cytologically in both root-tip mitosis and pollen mother-cell meiosis, some of them were found to be still merely diploid, while others were triploid ($3n = 24$) (Fig. 1*A*). None of them has been found to be tetraploid.

In the Spanish bluebell, *E. hispanicus*, some huge forms were found in gardens, and these on similar examination proved also to be triploid ($3n = 24$) (Fig. 1*B*).

The two species have essentially the same complement of chromosomes ($2n = 16$), and attempts have been made by Sato[2] and Margherita and Maugini[4] to compare them. The former author reported that the only difference was that the satellite attached to chromosome *D* in *E. non-scriptus* was lacking in the corresponding chromosome in *E. hispanicus*; the latter authors, apart from what must be a confusion between chromosomes *B* and *C*, noticed that only one of the *D* chromosomes in *E. hispanicus* carried a satellite. My own observations show that the satellite could show all degrees of contraction and may even be torn off, so that a distinction between the chromosomes of the two species is not always possible with reference to this structure.

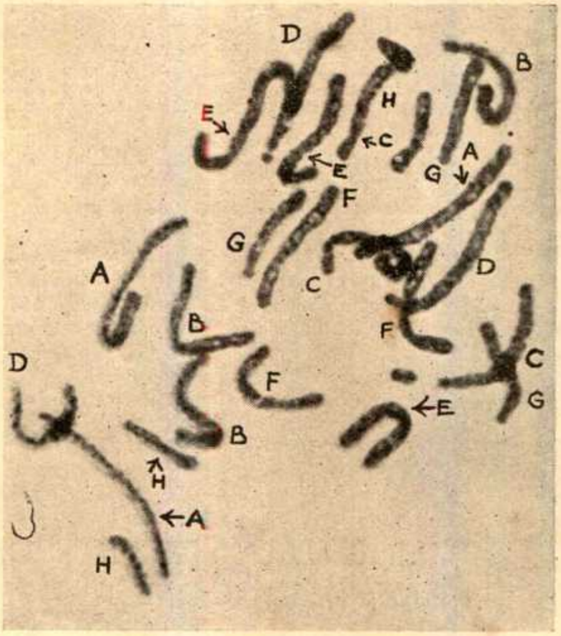
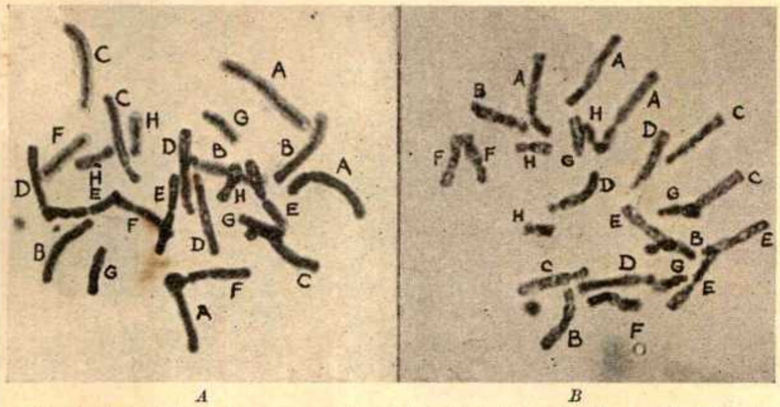


Fig. 2. Chromosomes of triploid ($3n = 24$) with characters intermediate between *E. non-scriptus* and *E. hispanicus*. Metaphase chromosomes of root-tip mitosis (× 1,500). The arrows indicate roughly the position of the centromeres, which are not shown owing to difficulty in focusing

This great similarity in chromosome complement would be expected to facilitate hybridization between the two species; but strangely enough what has recently been given as 'hybrids' by de Mol van Ould Loosdrecht[6] and Turrill[7] are extraordinarily large forms. The former described a 'giant scilla' which he claimed to be a cross-bred form, while the latter has given a drawing of what he considers a hybrid that arises in gardens when the two species are together; he does not describe it, but from his drawing this 'hybrid', like that of the former author, is apparently also a 'giant', being about twice the size of the normal parental forms. These rather robust forms, apart from their huge size, really show characters that appear intermediate between the two species. Cytological examination has shown them also to be triploid ($3n = 24$) (Figs. 2 and 3*A* and *B*).



A *B*

Fig. 1. *A*, metaphase chromosomes of root-tip mitosis (treated with oxyquinoline) of triploid ($3n = 24$) *Endymion non-scriptus* (× c. 1090); *B*, metaphase chromosomes of root-tip mitosis (treated with oxyquinoline) of triploid ($3n = 24$) *E. hispanicus* (× c. 1090)

But, owing to the difficulty stated above, the possible hybrid origin of this triploid form could not be readily determined from chromosome morphology. Other cytological examinations like pairing at meiosis (Fig. 3*A*) do not

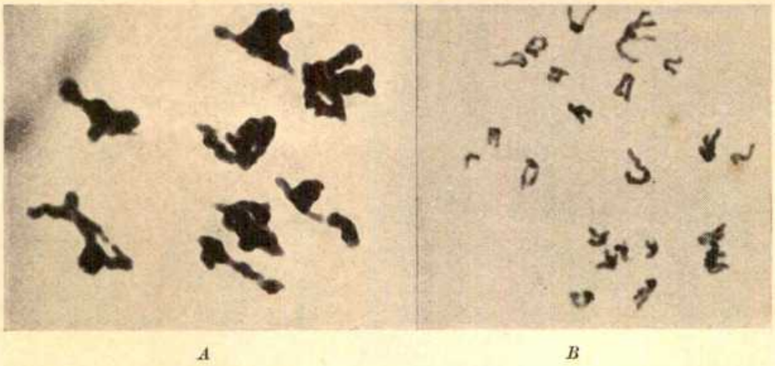


Fig. 3. *A*, same as Fig. 2. Metaphase chromosomes of pollen mother-cell meiosis showing eight trivalents (× *c.* 900); *B*, meiotic anaphase showing twenty-four chromosomes (× *c.* 540). N.B. In Figs. 1 and 2 the chromosomes are numbered according to Darlington[1]

indicate a hybrid origin, although full pairing in hybrids is unknown[5].

In many gardens there is a great variation in forms of bluebells with all gradations of characters which make them appear like 'hybrid swarms'; but unlike this triploid form, they are diploid ($2n=16$) and are in no way larger than normal. So far back as 1872, Baker[8] had described a number of such forms which Turrill[7] considers as hybrids apparently only from the morphological point of view; but without making crosses between the two species, one would require adequate cytological and other examinations to verify the hybrid origin of any of them.

It may be mentioned here that one of these diploid intermediate forms, often found in no small quantity in gardens, agrees rather well with what Baker described and assigned to *Scilla patula*; except for size this also compares favourably with this triploid form in question. Thus in view of the apparent absence of any cytological and other evidence to justify the hybridity of this, it may well be that Turrill's 'giant' hybrid is a non-hybrid triploid of this variety of bluebell.

I am indebted to Dr. H. L. K. Whitehouse for placing his garden of *E. hispanicus* at my disposal for this work.

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EXPERIMENTAL INFECTION OF TURKEY POULTS WITH *EIMERIA ADENOEIDES* (MOORE AND BROWN, 1951) ISOLATED FROM A NATURAL CASE IN GREAT BRITAIN

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SEVEN species of *Eimeria* have been identified in turkeys in the United States[1]. The oocysts of three species (*E. meleagridis*, *E. gallopavonis* and *E. adenoeides*) are so similar that they cannot be distinguished from one another in the fæces of infected birds[2]. All three are localized in the terminal small intestine, cæcum and rectum, and mixed infections cannot therefore be separated into species by their distribution in the host. *E. adenoeides* is believed to be the most pathogenic, its distinguishing feature being that it undergoes development in the deep glands of the mucosa and not only in the villi.

Coccidiosis is common in turkey poults in Great Britain[3] and is believed to be due to *E. adenoeides*[4]; but this species has not to our knowledge been identified with certainty or studied as a pure infection in Great Britain. This communication reports the preliminary findings with a pure strain of *E. adenoeides* derived from a single oocyst.

Oocysts were obtained from clinical cases of coccidiosis in poults where oocyst measurements and microscopic lesions suggested *E. adenoeides* infection.

From a sample of intestinal contents from one such poult, three single oocysts, previously sporulated in 2·5 per cent potassium bichromate, were transferred by the use of a simple micromanipulator[5] to pieces of 'Cellophane' about 1 cm. square. After examination

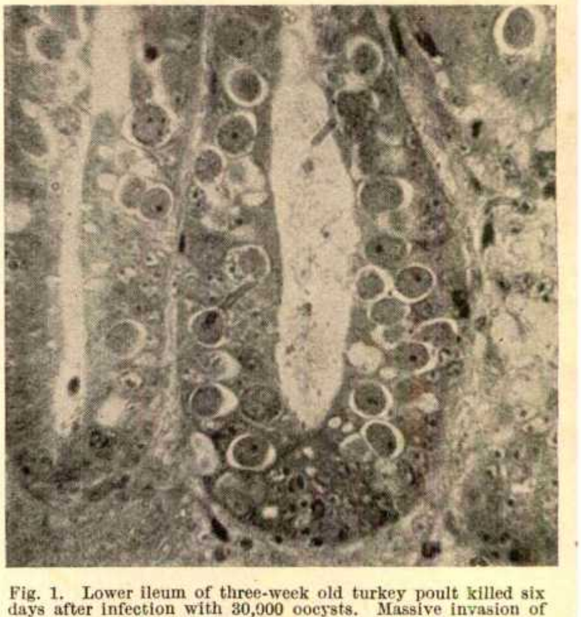

Fig. 1. Lower ileum of three-week old turkey poult killed six days after infection with 30,000 oocysts. Massive invasion of epithelial cells of deep glands by sexual stages of *E. adenoeides*. (Heidenhain's iron hæmatoxylin, × 470)

Table 1

	Site of infection	Measurements (μ)	Sporulation time (hr.)	Prepatent period (hr.)	Refractile body	Pathogenicity
E. adenoeides Moore and Brown, 1951	Lower ileum, cæca and rectum Deep glands as well as villi	Length 18·95–31·26 Width 12·60–20·94 Average 25·60 × 16·59 Ratio length : width 1·54 : 1	24	112 (approx.)	Present	+ +
Strain *A*	Lower ileum, cæca and rectum Deep glands as well as villi (Fig. 1)	(150 oocysts) Average length 25·68 Standard deviation 1·81 Average width 16·25 Standard deviation 1·21 Ratio length : width 1·58 : 1	24	120 (approx.)	Present	+

under the microscope, each was transferred to a gelatine capsule, and inserted into the crop of a fourteen-day old turkey poult which had failed to show oocysts in its fæces by a sugar flotation technique when examined daily since hatching. This procedure was repeated with three single oocysts from a natural case of coccidiosis in another flock. To prevent extraneous infection, the most stringent precautions were taken, such as heat sterilization of apparatus, utensils and cages, the use of a small isolation room which was disinfected with gaseous ammonia, and the changing of clothing and boots on entering this room. Six control birds of the same hatch, in the same room and given the same food and water, failed to show oocysts in the fæces, which suggests that the precautions taken were adequate.

Two birds, one from each group of three, became infected, oocysts being first detected in the fæces on the sixth day. Fæces were collected separately for the next 72 hr., and the oocysts sporulated. The material from one contained a total of some 150,000 oocysts (strain *A*), of which 95 per cent sporulated after 24 hr. in 2·5 per cent bichromate at 26° C. This material has been used for further work; material from the other infected bird will be studied later to see whether it is the same species as strain *A*.

Each of five coccidia-free poults, given 10,000–30,000 oocysts of strain *A*, showed oocysts in the fæces five days later. Further experiments with the large stock of sporulated oocysts derived from the original single oocyst showed that this species possessed the characteristics indicated in Table 1.

These characteristics agree closely with those given by Moore and Brown[2], and identify the coccidium as *E. adenoeides*. It will be seen that the only differences were a slightly longer prepatent period and a lower pathogenicity. Moore and Brown refer to 100 per cent mortality in birds up to five weeks of age, whereas using only a small number of birds we have had no mortality, though the poults refused all food and passed blood and cæcal plugs in their droppings. Further confirmatory tests as to specificity will be made later by immunity studies.

The relative ease of obtaining single oocysts with a simple micromanipulator which can be constructed in a few minutes, the success that followed the administration of single oocysts to poults, and the identification of the species as *E. adenoeides* suggest that the use of this technique may enable the species of *Eimeria* that occur in turkeys in Great Britain to be identified, and their relative importance in causing outbreaks of coccidiosis in poults to be determined. A study of the life-cycle of *E. adenoeides* is now in progress.

This work is being conducted with the help of a grant from the Agricultural Research Council.

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FLOW OF GASES THROUGH PACKED BED OF SILICA POWDER AT LOW PRESSURES

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THE relationship between the permeability of a packed bed and the pressure of the flowing gas is linear at low flow-rates of gas. It has been observed that in the case of flow through capillaries at low pressures, say, smaller than 1 mm. mercury, the gas flow-rate assumes a minimum value and then rises to a limiting value at zero pressure (Knudsen, Gaede and Smoluchowski), which was found to be higher than the value expected from the slope of the line.

In the low-pressure region, where the mean free path is larger than the average diameter of the capillary, both the molecular and surface diffusion flows are responsible for the existence of the minimum in the flow-rate. The absence of such a minimum in the case of flow through powders was said to be characteristic[1], the reason being that all types of flow, molecular and surface diffusion, can occur simultaneously in pores of various diameter and thus obscure the individual types of flow[2].

The change of slope has been found to occur at pressures where the length of the mean free path approached the diameter of the voids[3].

In our work, permeation through a bed of fine silica powder at the lower range of pressures, particularly 0–10 microns mercury, was studied, at low flow-rates and ambient temperature. When considering the resistance to flow offered by a powder it is convenient to use the term specific conductance K which, in effect, is the conductance of 1 c.c. of the powder

$$K = \frac{CL}{At} \quad (\text{cm.}^2/\text{sec.})$$

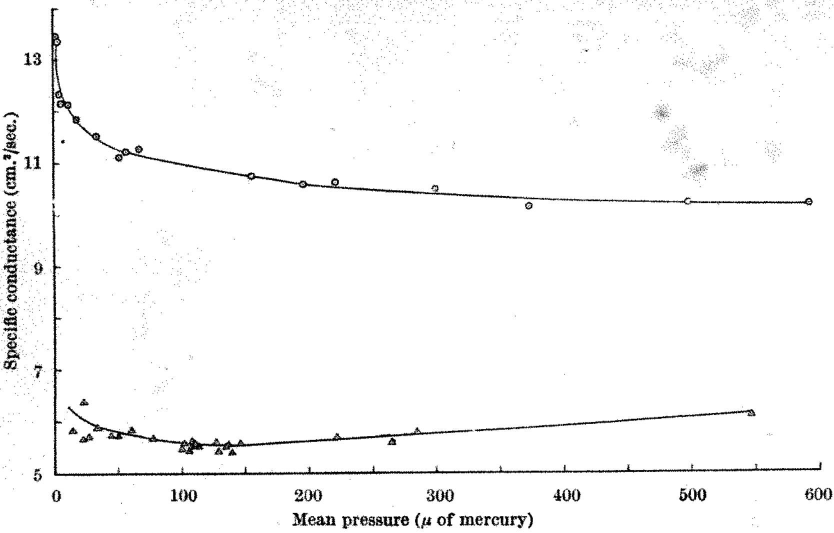

Fig. 1. ○—○—, Air (carbon dioxide-free); △—△—, 'Freon' (commercial purity)

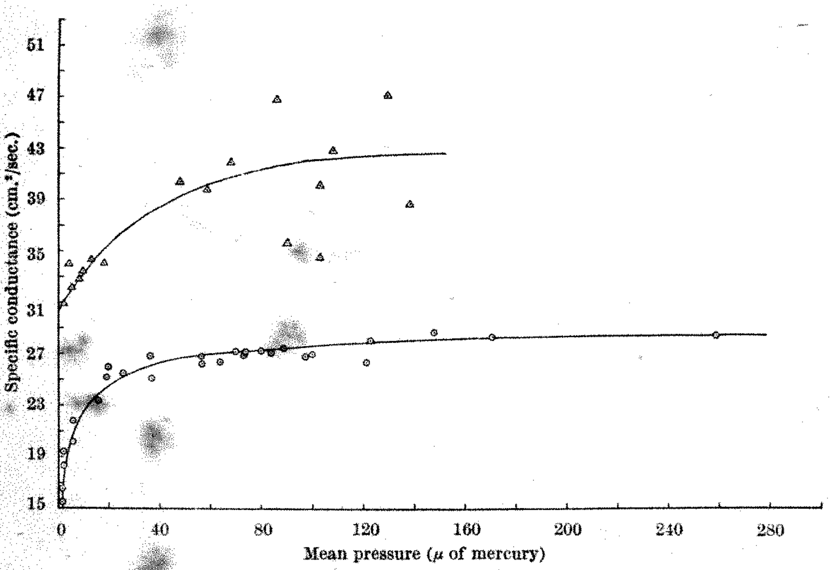

Fig. 2. △—△—, Hydrogen (oxygen-free); ○—○—, helium (spectroscopic purity)

where C is flow-rate/pressure drop; L is bed-length; A is bed cross-section area; t is time.

The specific conductance investigated in this work varied from 5 to 50 cm.²/sec. Four gases were investigated, namely, hydrogen, helium, air and difluorodichloromethane ('Freon') vapour, in order to cover a wide range of densities. The purity of hydrogen was 99·95 per cent; helium was spectroscopically pure, the total amount of impurities being not more than 8 p.p.m.; air was free of carbon dioxide and dry, the amount of water being less than 1 p.p.m., and 'Freon' was of commercial purity 99·99 per cent CF_2Cl_2.

The silica powder used in our experiments had a grain size of the order of 4×10^{-6} cm. and specific surface area of 100 sq. m. per gm., thus falling in the category of adsorbents. Pressure-drop was measured with a precise differential manometer described elsewhere[4] and gas-flow by a flow meter developed specially for the very low flow-rates.

The results presented in Figs. 1 and 2 show that the relationship between the specific conductance and gas pressure maintains its linearity to a certain low value of pressure, below which further trends are not uniform by any means. The two heavier gases, 'Freon' and air, show increase in specific conductance at zero pressure, while the lighter ones, helium and hydrogen, show the opposite. It is thus apparent that there is present a new mechanism of flow which, so far as the experimental evidence has shown, is related only to molecular weight of the gas and not to its mean free path.

It is expected that surface adsorption plays a part in the transport of molecules across the silica bed. The mobility of molecules adsorbed on a solid surface is now generally recognized[5] as against rigid concentration of sorbate on fixed sites which amounts to chemisorption. Surface diffusion is responsible for the free thermal motion of molecules adsorbed on the solid surface.

This should be distinguished from 'interstitial diffusion' encountered when a gas is sorbed by a medium, the pore diameters of which are comparable with the sizes of the molecules, for example, dehydrated zeolites[6]. It is thus not possible to speak with certainty of 'adsorption' or of 'internal surface' when the state of the molecules is more akin to solid solution than to pure adsorption. The kinetics of interstitial adsorption are governed primarily by the variations of molecular size, and in some cases it is possible to arrange molecular sieves which would allow for permeation of molecules below certain sizes.

In contrast to both Knudsen and interstitial diffusion, surface diffusion tends to be more marked in the case of larger and heavier molecules. Gas flow through micropores takes place by molecular streaming through the gas space. When using a very fine powder and condensable gases or vapours, surface flow is also expected to take place. As a result of it, the rate of flow is enhanced, that is, surface flow takes place in parallel with the flow in the gaseous phase.

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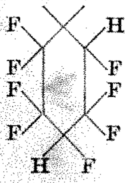
LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Hexafluorobenzene

THE application of gas–liquid partition chromatography to organic fluorine chemistry[1,2] has enabled us to extend our studies on dehydrofluorination to a nonafluoro*cyclo*hexane (I) (b.p. 92°) which has been obtained[3,4] by passage of benzene vapour over cobaltic fluoride at about 150°. With concentrated aqueous potassium hydroxide, this polyfluoride (I) gave a complex mixture (b.p. 60–90°) which was shown by analytical gas-chromatography to contain nine individual components. These were separated by use of the preparative-scale gas chromatographic column, and the structures of some of them have been determined by spectroscopic examination, oxidative degradation, addition reactions, etc.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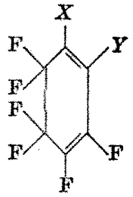
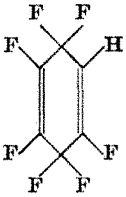


(II) X=H, Y=F
(III) X=F, Y=H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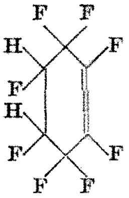
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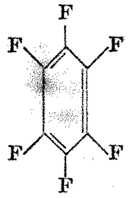
(VI)

Two heptafluoro*cyclo*hexa-1 : 3-dienes (II) (III), a heptafluoro*cyclo*hexa-1 : 4-diene (IV), and an octafluoro*cyclo*hexene (V) were thereby identified. Also, as one of the major products, the important fluorocarbon hexafluorobenzene (VI) was isolated and characterized. The great value of the gas-chromatographic technique in effecting the separations, on a relatively small scale, of complex mixtures such as this is readily apparent. Hexafluorobenzene was prepared in amounts sufficient to carry out a preliminary study, and we have shown that chlorine will add to the ring system to give hexachlorohexafluoro*cyclo*hexane, and that attack by nucleophilic reagents is relatively easy. Thus, with methanolic sodium methoxide, pentafluoroanisole and a tetrafluorodimethoxybenzene were given. These reactions are being actively pursued at present, for a wide field of investigation has been opened up.

The nonafluoro*cyclo*hexane precursor is shown by the products II–VI to be a 1H : 2H : 4H-compound (I). The isolation of hexafluorobenzene upon dehydrofluorination suggests that the hydrogens on carbons 1 and 2 are both axial. Since *trans*-elimination of hydrogen fluoride between these two >CHF groups cannot then occur, the more difficult 'outwards' elimination, with fluorine being lost from the —CF_2— groups, can operate. Similar conclusions apply to the 1H : 2H-decafluoro*cyclo*hexanes, where the *cis*-compound gives exclusively 1H-nonafluoro*cyclo*hexene on dehydrofluorination[5], but the *trans* gives, besides this, some octafluoro*cyclo*hexa-1 : 3-diene[4].

Hexafluorobenzene has been reported before. McBee, Lindgren and Ligett[6] made it from hexachlorobenzene; their product was probably slightly impure and no reactions were given. Désirant[7] claimed to have obtained it by pyrolysis of tribromofluoromethane; but no experimental details were reported.

Experimental. 1H : 2H : 4H-*Nonafluoro*cyclo*hexane*. Benzene was passed in the vapour phase over cobaltic fluoride in a stirred reaction vessel at 150°. The reactor and the conditions described earlier[3] have been improved[4] to give increased yields of polyfluorides with no benzene remaining. Further fractionation, controlled by gas-phase chromatography, of the material having b.p. > 87° gave 1H : 2H : 4H-*nonafluoro*cyclo*hexane*, b.p. 92·0–92·5°, m.p. 44–46°, n^{45} 1·3016 (found: C, 29·2; H, 1·2. $C_6H_3F_9$ requires C, 29·3; H, 1·2 per cent). Yields were 10–15 per cent of the original polyfluoride mixture.

Hexafluorobenzene. The trihydro-compound (50 gm.), potassium hydroxide (85 gm.) and water (250 c.c.) were refluxed together until analytical gas-chromatographic examination showed a large peak due to the desired compound (17 hr.). The organic layer was separated, dried (magnesium sulphate), distilled, and subjected to gas-chromatographic separation. The hexafluorobenzene (5·0 gm.) had b.p. 80°, n_D^{18} 1·3746 (found: C, 38·6; F, 62·0. Calc. for C_6F_6: C, 38·7; F, 61·3 per cent). McBee *et al.*[6] gave b.p. 81–82°, n_D^{20} 1·3760, and Désirant[7] b.p. 80·5°, n_D^{20} 1·3777. Infra-red spectroscopic measurements (on the pure liquid) showed three bands at 1,702, 1,761 and 1,802 cm.$^{-1}$. A band was found in the ultra-violet at λ 2300 A., ε approx. 770 with an inflexion at λ 2500–2550 A. (c, 0·11 gm./l. in ethyl alcohol).

Reactions of hexafluorobenzene. (*a*) *Chlorine addition.* Chlorine (1·2 gm.) and the compound (1·0 gm.) were sealed together in a hard glass tube which was irradiated with ultra-violet light for 48 hr. The product was washed (aqueous sodium metabisulphite), dried (P_2O_5) and distilled to give *hexachlorohexafluoro*cyclo*hexane* (1·24 gm.), b.p. 137°/30 mm., m.p. 101–102° (found: F, 28·8. $C_6Cl_6F_6$ requires F, 28·6 per cent). This compound showed no absorption in the infra-red due to unsaturation over the range 1,890–1,580 cm.$^{-1}$.

(*b*) *Action of sodium methoxide.* Hexafluorobenzene (4·8 gm.) was refluxed with methanolic sodium methoxide (40 c.c.; 1 N) for 1 hr. The mixture was poured into water and the product extracted with ether. The extracts were washed, dried (magnesium sulphate), and evaporated and the residue distilled to give two fractions: (i) b.p. 145–160° (2·9 gm.) and (ii) b.p. 160–180° (0·7 gm.). Fraction (i) was re-distilled to give *pentafluoroanisole*, b.p. 155–157°, n_D^{18} 1·417 (found: C, 42·5; H, 1·8. $C_7H_3F_5O$ requires C, 42·4; H, 1·5 per cent). Fraction (ii) on being kept deposited crystals which were recrystallized from aqueous ethanol to give a *tetrafluorodimethoxybenzene* (0·15 gm.), m.p. 51·5–52·5° (found: C, 46·0;

H, 3·1. $C_8H_6O_2F_4$ requires C, 45·7; H, 2·9 per cent).

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Organophilic Montmorillonite Gels

INFRA-RED absorbance measurements on hydrocarbon gels of dimethyl dioctadecyl ammonium montmorillonite[1] indicate that polymeric-type hydrogen bonding is significant in systems containing this clay mineral derivative. For example, Fig. 1 shows free hydroxyl and bonded hydroxyl absorbances in the 3-micron region for a 20 per cent dispersion of dimethyl dioctadecyl ammonium montmorillonite in a mixture containing 75 per cent cumene and 25 per cent cetane.

We suggest as one possible gelation mechanism that water, present in small amounts in the organophilic clay, forms bridges which hold montmorillonite platelets together, causing a network that leads to gel formation. This explanation appears to account for the unusual properties of these systems. Thus, they are affected by dehydration and, after standing in a desiccator, they are converted by working from gels to viscous liquids. If they are then put into another container over water, they recover their gel status as water vapour is absorbed. These gels lose consistency, as working causes montmorillonite platelets to approach parallel positions. This is apparently because bridging through the solvated layer of organic material is more difficult in the tactoid arrangement which results from working.

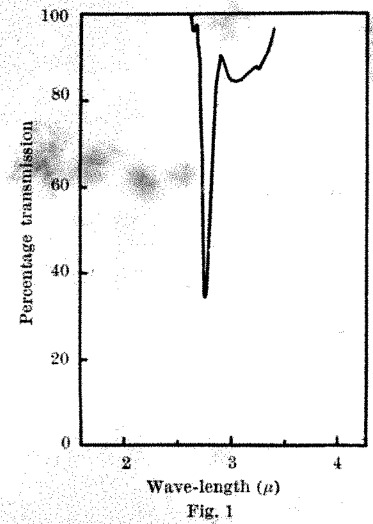

Fig. 1

But the turbulence which accompanies treatment in a sonic generator, colloid mill, paint mill or homogenizer causes platelet edges to force through the solvated layer of other platelets and make bonding contact with the underlying silicate portion of these, thus stiffening the network and explaining the increase in consistency which accompanies such treatment. At high temperatures (>150° C.), a rather firm network can form, apparently because thermal turbulence and loss of solvation in the organic layer permit a closer approach of the inorganic core of particles. This explains the unusual effect observed, that a system in the viscous liquid state changes to a gel when heated. Less water is required for network formation at these higher temperatures, and possibly no water at all, since the approach of the inorganic parts of different platelets may be so close that attractive forces between aluminium ions at the edges of the octahedral layers and negative spots on the faces of other platelets may be large enough to account for network formation.

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An Ambiguity in the Variable-Solvent Solubility Test: Homogeneity of β_1-Lactoglobulin

IN the variable-solvent solubility test (see, for example, Falconer and Taylor[1], Derrien[2], Smithies[3]) a constant amount of protein is brought to a series of different concentrations of a salt, the volume, *p*H and temperature being constant. The equilibrium concentration of protein remaining in solution is then plotted against the concentration of salt. A single protein is expected to give a curve like that in Fig. 1. Here *AB* represents the exponential solubility relationship of the protein[4]. Under conditions represented by the horizontal part *PQ* of the curve (the position of which depends on the amount of protein and

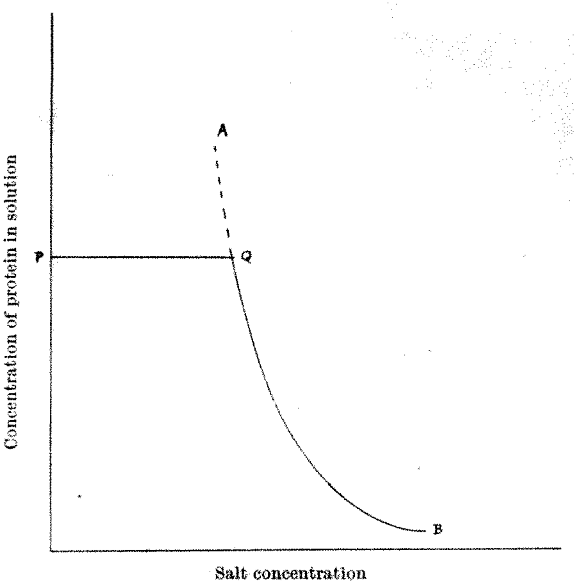

Fig. 1

the volume chosen) all the protein remains in solution; solid phase first appears at Q where PQ cuts AB, and from this point the curve follows AB as the concentration of salt is increased.

The occurrence of more than one discontinuity is normally interpreted as showing the presence of more than one protein in solution. The case of two proteins, which do not interact in solution or in the solid phase, is illustrated in Fig. 2. Each protein has its own solubility curve A_1B_1 and A_2B_2. A_sB_s, the sum of A_1B_1 and A_2B_2, is the combined solubility curve when both solid phases are present. If, for example, the proportions of proteins 1 and 2 in a mixture are as 1 : 2 (P_1, P_2 total concentration P_s), then each protein is independently salted out along $P_1Q_1B_1$ and $P_2Q_2B_2$. The combined curve is the sum of these, namely, $P_sQ_sR_sB_s$, Q_s corresponding to Q_1 and R_s to Q_2. If the amount of protein P_s is changed to P'_s or P''_s, leaving the proportions of 1 and 2 unchanged, curves $P'_sQ'_sR'_sB_s$, $P''_sQ''_sR''_sB_s$ are obtained. Two important characteristics of these curves should be noticed: (i) if Q_1 and Q_2 should happen to have the same abscissa value, then Q_s and R_s coincide; but it is very unlikely that this will happen for all values of P_s; (ii) the position of R_s on A_sB_s changes as P_s is changed.

The occurrence of more than one discontinuity in the salting-out curve may, however, result from a quite different situation, namely, when a single protein in solution is in equilibrium with different solid phases, according to the concentration of salt.

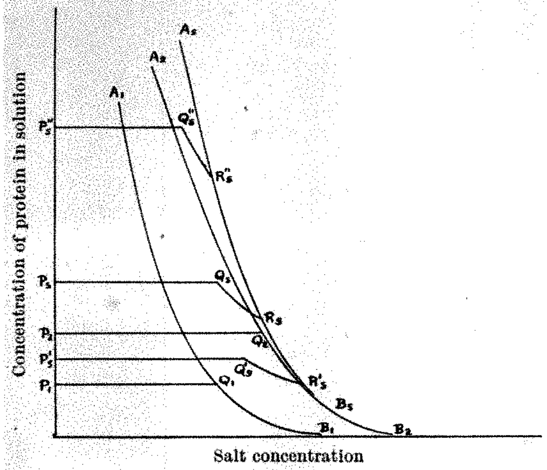

Fig. 2

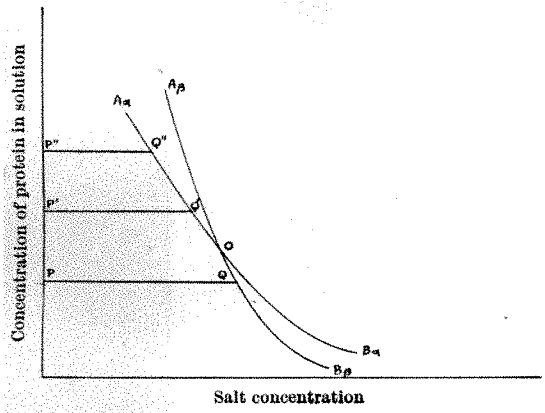

Fig. 3

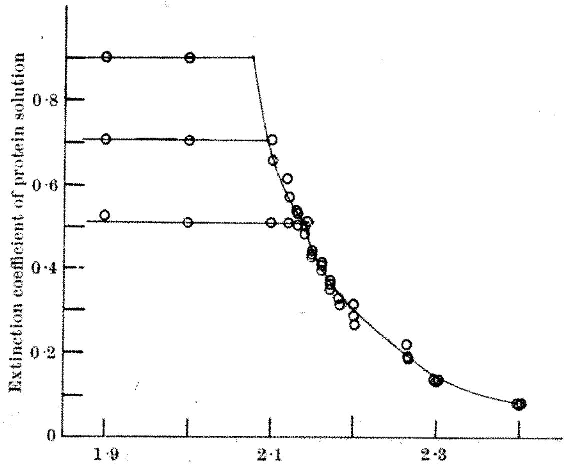

Fig. 4. β_1-lactoglobulin, pH 5·0, 25° C., 0·2 M sodium chloride, 0·2 M acetate–acetic acid buffer

Fig. 3 illustrates this case for two solid phases α and β which have solubility curves $A_\alpha B_\alpha$ and $A_\beta B_\beta$. To the right of the transition point O, β is the stable solid phase; to the left of O, α is stable. If the amount of protein is chosen so that PQ cuts $A_\alpha OB_\beta$ below O, there is only a single discontinuity q; but at higher values of P, curves $P'Q'OB_\beta$, $P''Q''OB_\beta$ are obtained, each having two discontinuities at Q' or Q'' and at O.

It would be wrong to interpret the curves of Fig. 3 as proving the presence of two protein components in solution. Fortunately, distinction between the two cases is easy. For, if the amount of protein used is changed, the position of O is unaffected, whereas that of R_s moves. It is therefore desirable that experiments of this sort should be done with at least two different amounts of protein.

Fig. 4 shows preliminary results obtained with β_1-lactoglobulin[5], which indicate that solutions of this protein contain only a single chemical component in equilibrium with two different solid phases, according to the salt concentration; similar results have been obtained with β_2-lactoglobulin.

This work was aided by a grant from the Agricultural Research Council.

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A Critical Technique for Enzyme Cytochemistry

THE accurate localization of an enzyme at the cellular level by a cytochemical technique requires a full investigation of artefacts due to diffusion of enzyme, reagents and reaction products. The classical superimposed-section technique does not have a sufficient resolving power to evaluate diffusion artefacts over the small distances inside a cell. A technique has been developed which enables the enzyme in small areas inside a cell in a tissue section to be

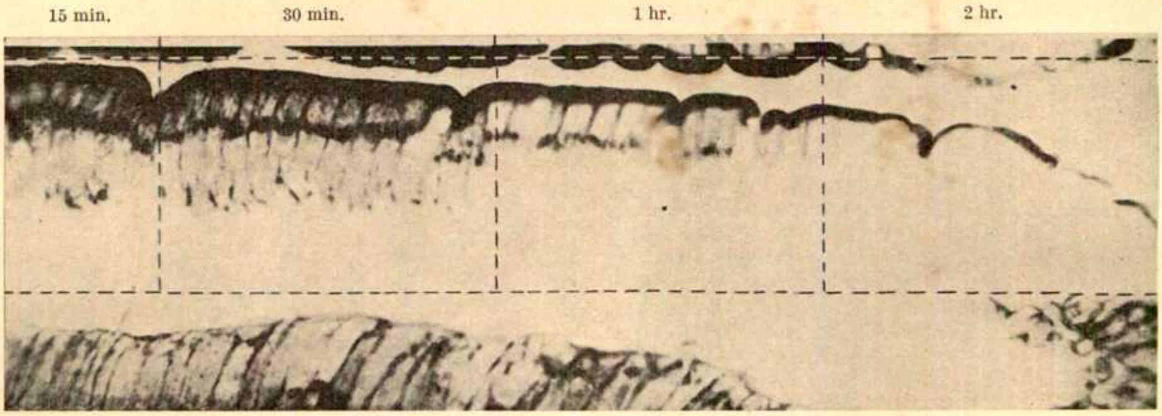

Fig. 1

inactivated. In this way diffusion during a cytochemical reaction can be investigated. The method makes use of the enzyme-inactivating action of the long wave-length ultra-violet light obtained from a glass-jacketed 250-watt B.T.H. mercury lamp. This is focused on the section mounted in water between two coverslips by an 8-mm. apochromatic objective. A mask in front of the lamp acts as the light source, and in this way slits or patterns of small holes can be focused on the section.

In this way areas of a few square microns, for example, a nucleus, can be inactivated. A suitable mask is made of heavy tin foil pricked by a fine glass needle, and mounted on a heat-resisting glass filter. Between the mask and the lamp are several heat filters and a removable intensity filter. Between the mask and the objective acting as a condenser is a cover slip at 45° to the optical axis which reflects in an auxiliary lamp used for taking a photograph of the section and the 'inactivated' spots. Such photographs are taken at intervals during the inactivation to check on movement of the spots. The coverslips holding the section must be firmly mounted and only a small area left unsupported around the section, otherwise the image of the mask may move during the period of irradiation, which for alkaline phosphatase may be 1–2 hr. Several sections besides the inactivated one are mounted on the coverslip and serve as controls. Studies on alkaline phosphatase have been carried out in collaboration with Prof. J. F. Danielli and Dr. J. H. Fodden, and will be published elsewhere. The technique has been to flatten frozen and dried tissue sections on to a coverslip using 95 per cent alcohol. The slip is dried in a desiccator, the wax removed by xylene, the section fixed in absolute alcohol for 15 min. and again dried in a desiccator. The section is then placed directly in water for the inactivating process, thus avoiding concentrations of alcohol likely to dissolve alkaline phosphatase.

The procedures described above should be applicable to many critical enzyme studies at a cytochemical level.

The apparatus is simple to set up, but needs critical adjustment. The coverslips should be the correct thickness for the condensing objective and the mask should be at a distance from the condenser corresponding to the correct tube-length for the lens. The numerical aperture of the illumination beam is kept at, or below, 0·6 to reduce scattered light in the specimen.

Fig. 1 shows a 4-μ section of frozen and dried rat duodenum, with a portion of one villus irradiated with a wide slit as indicated by the dotted line and for the times shown. After irradiation the section was incubated for 5 min. in the Gomori technique for alkaline phosphatase. The details appearing in black in the figure are caused by deposition of calcium phosphate: no counterstain was used.

I acknowledge the helpful interest of Prof. J. F. Danielli in this development.

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Crystalline Xylanase

XYLAN is hydrolysed in animals, plants, and by a large number of micro-organisms. Sørensen[1] recently gave evidence that certain bacteria act on xylan to produce xylose-containing oligosaccharides and D-xylose. Whistler *et al.*[2] reported that an enzyme preparation from the medium of *Aspergillus foedidus* hydrolysed corn-cob xylan primarily to xylobiose with no production of D-xylose. An extract of the mould mycelium was separated into two fractions:

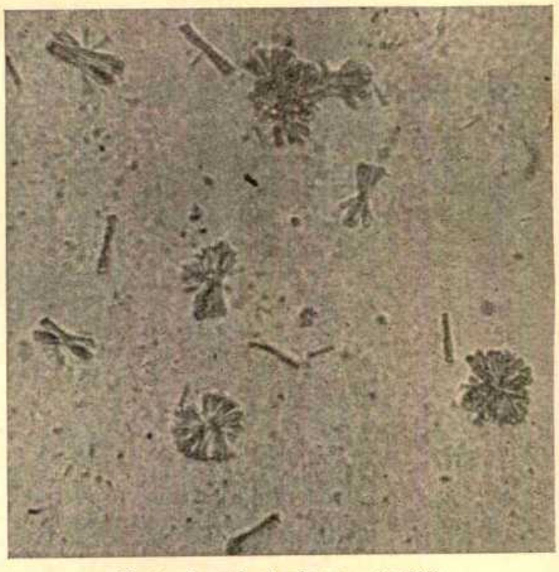

Fig. 1. Crystals of xylanase. (× 600)

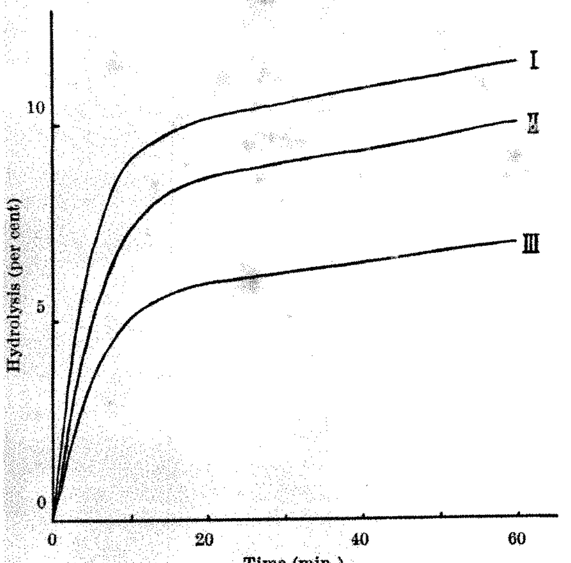

Fig. 2. Hydrolysis of xylan by crystalline xylanase: I, calcium and magnesium ions added; II, calcium ions only added; III, calcium and magnesium ions not added

one which hydrolysed xylan and the oligosaccharides to D-xylose without producing significant amounts of oligosaccharides, and one which hydrolysed xylan to a mixture of D-xylose and oligosaccharides.

From a medium of a *Bacillus* sp. we have crystallized an enzyme which hydrolysed xylan to xylobiose, xylotriose and higher xylose-containing oligosaccharides but produced no noticeable D-xylose.

The bacilli were grown in a medium containing xylan, meat extract, peptone and salts for seven days. 5,000 c.c. of the culture medium was collected and concentrated to 1,000 c.c. and 10 c.c. of 20 per cent basic lead acetate added. After centrifuging, ammonium sulphate was added to the supernatant solution to bring its concentration to 70 per cent saturation. The precipitate was dissolved in 250 c.c. of $M/15$ phosphate buffer (pH 6·0), and dialysed against distilled water. 25 c.c. of 1 per cent rivanol solution was added to the dialysed supernatant solution and the precipitate produced was discarded. The enzyme was precipitated from the supernatant solution by the addition of 500 c.c. of acetone and dried *in vacuo*. 520 mgm. of white powder was obtained. 300 mgm. of this powder was dissolved in 10 c.c. of distilled water and 3 c.c. of acetone was added. After removing the precipitate produced, another 2 c.c. of acetone was added and the solution held at 5° C. Crystals shown in Fig. 1 appeared within one day. The yield was about 30 mgm.

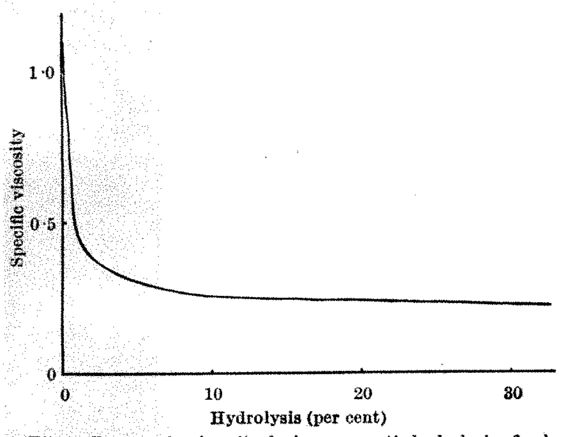

Fig. 3. Decrease in viscosity during enzymatic hydrolysis of xylan

The enzyme was activated by the presence of Ca^{++} and Mg^{++}. If the action of this enzyme on xylan was determined reductometrically and the degree of hydrolysis was plotted against time, the curves in Fig. 2 were obtained. The reaction evidently resolves itself into two phases with widely different velocities: an initial, rapid phase in which about 9 per cent of the xylosidic linkages of the substrate are ruptured and a second, considerably slower, phase showing no definite limit within a reasonable time. The initial phase is accompanied by an extremely rapid decrease in viscosity as shown in Fig. 3.

Paper-chromatographic analysis of the hydrolysates of xylan by this crystalline xylanase showed that xylobiose, xylotriose and higher xylose-containing oligosaccharides were the principal products. Xylose was not produced.

We wish to express our thanks to Prof. K. Yamafuji, of Kyushu University, for guidance.

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Radon Content of the Atmosphere

RECENTLY we reported raised levels of atmospheric radon during smoky or fog conditions[1]. It was also pointed out that radon was released into the atmosphere during the normal burning of coal. We have now carried out estimations of the radium contents of a series of representative samples of coals as used in Great Britain. The results of this analysis are shown in Table 1. The methods of estimation were the same as described previously.

Table 1

Source of coal sample	Purpose for which coal is used	Radium content (gm. × 10^{-13}/gm. coal)
South Wales	Power stations	2·56
South Wales	Closed stoves	0·50
Durham	Blast furnace coke	3·16
Durham	Gas-making	2·02
Yorkshire	Domestic	1·65
Yorkshire	Gas-making	3·25
Northumberland	Power stations	2·20
Warwickshire	Domestic	0·70
Nottinghamshire	Domestic	2·10
East Fife	Power stations	0·55

The radium contents of the coals are in a narrow range of values and are similar to those described in the preliminary work. The absence of levels of a higher order suggests that the contribution of radon from this source does not represent a significant addition to the total atmospheric level.

Adsorption of radon on certain fractions of the atmospheric dust nuclei might be suggested as a possible mechanism for its retention in the surface atmosphere. Our experience with samples of atmospheric dust, however, has shown that the associated radioactivity corresponds, in terms of half-life, to the daughter products of radon and not to the active gas itself. The explanation of the raised levels of activity is most likely to be made in terms of the special meteorological conditions associated with fog or smoke-laden atmospheres.

We are indebted to the National Coal Board for the coal samples and to Mr. A. M. Wandless for much useful information on the samples.

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Occurrence of Cæsium in Fossils

The possibility of potassium-argon dating of fossils led to the spectrographic examination of a brachiopod (*Lingula*), a lamellibranch (*Gryphaea*) and a trilobite (*Calymene*) for potassium. The alkali metal spectra of *Calymene* showed such marked cæsium enrichment, relative to rubidium and potassium, that a rapid survey was made of the phylum Arthropoda. Two arachnids, four insects, four crustaceans and twenty-eight trilobites were analysed by a semi-quantitative method. To compare different species and genera of trilobites from a single horizon, collections were made from the Upper Silurian Wenlock Limestone at Dudley, Staffordshire. In order to check whether the sediment associated with the trilobites might have an unusual cæsium content many matrices adjacent to the fossils were analysed, collections of sediment also being made for this purpose at Dudley.

From inspection of the potassium and rubidium lines, the K/Rb ratio is not significantly different in the trilobites and enclosing sediments and is about the same as in sediments and igneous rocks. The Rb/Cs ratio was estimated with fair accuracy. This ratio gives a clearer indication of relative cæsium enrichment than the absolute amounts present, for which the reproducibility was poor ($\lambda' = 2$, Ahrens[1]). The Rb/Cs ratio is markedly lower in the trilobites (arithmetical mean = 3·9 ; geometrical mean = 2·4) than in the enclosing sediment (arithmetical mean = 19 ; geometrical mean = 15). Modes determined from histograms are approximately 2·5 for trilobites and 15 for matrix. No significant difference was noted in the ratios of different parts of the same trilobite. Particularly low ratios were recorded for *Deiphon* (Rb/Cs 0·36) and *Paradoxides* (Rb/Cs = 0·26), both spinose forms. The maximum (absolute) amount of cæsium recorded was in *Deiphon*, which contained ~ 250 p.p.m. This striking enrichment is shown in Fig. 1*A*. The matrix associated with *Deiphon* is shown in Fig. 1*B*.

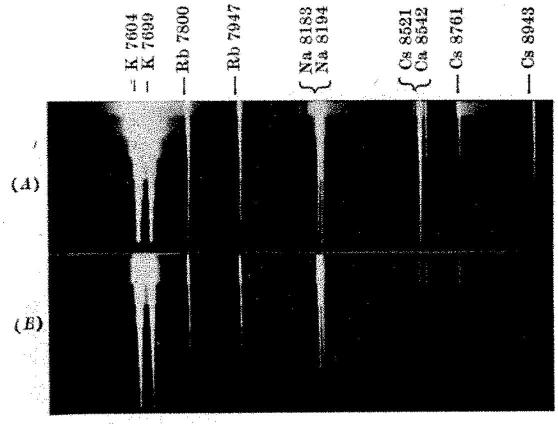

Fig. 1. Alkali metal spectra of (*A*) *Deiphon* ; (*B*) matrix surrounding *Deiphon*

Canney[2] found an Rb/Cs ratio of 15 (arithmetical mean) for 323 sedimentary rocks. Thus the Rb/Cs ratio of the matrix surrounding the trilobites does not differ appreciably from the average for sediments. Cæsium may have been concentrated by the trilobites during growth, or it may have become selectively absorbed after death, in which case the matrix might be expected to be distinctly impoverished in cæsium. The results obtained tend to support the former view, or, if the cæsium enrichment of the trilobites was post-burial, the enclosing sediment was not affected.

While it has frequently been observed that certain metallic elements, for example, copper, are enriched in organisms, it is interesting to note, in the present case, strong enrichment of one alkali element relative to the others with similar chemical properties. The cæsium enrichment is perhaps connected with its large size (Cs^+ : 1·67 A.) and consequent low degree of hydration.

A spectrographic examination was also made of five genera of the phylum Brachiopoda. Of these, *Lingula* (the only chitinous form analysed) showed some cæsium enrichment.

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Palæomagnetism of Chemical Sediments

Since previous observations of remanent magnetism of sedimentary rocks have been mainly confined to detrital deposits, we would like to report on new significant results obtained with chemical deposits. In the case of detrital sediments, the question has arisen sporadically as to whether the inclination of the remanent vector is changed by the realignment of the magnetic particles upon meeting the bottom surface in the settling process and also by movements later in the compaction process. This question does not hold in the case of chemical deposits. Perhaps of more importance, these particular rocks exhibit a desirable stability of magnetization.

Some of the rocks sampled consisted of large ellipsoidal, calcareous concretions occurring in the Barnett shale of Mississippian age. These concretions appeared to be syngenetic (or nearly so). Nine locations were sampled at outcrops of the Barnett on the north-west, north, north-east and south-west sides of the Llano uplift in central Texas. The maximum distance between locations is 73 miles.

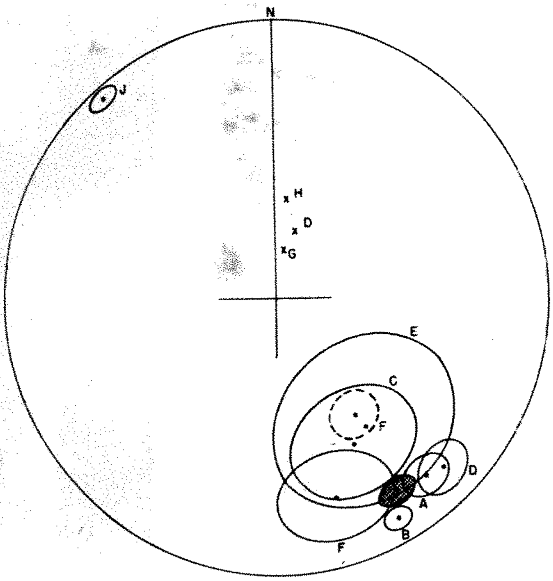

Fig. 1

Fig. 1 shows a lower hemisphere plot on a Schmidt projection of the magnetic polarization directions for the various locations labelled with capital letters; the Fisher circles of confidence at the 5 per cent significance-level are indicated with the corresponding letters. At locations *A*, *D* and *F* two concretions each were sampled; at *B*, three concretions and a limestone bed; at *C*, two limestone beds; at *E*, one concretion; and at *J*, one limestone bed. The crosses indicate averages as follows: one measurement from a weathered shale at *D*; two measurements from a concretion (not typical) at *G*; and three measurements from a limestone bed at *H*. These points are not considered in the analysis since they obviously indicate instability of magnetization of the rocks. The dashed circle is obtained from twenty-two measurements from ten shale samples at *F*. These data are also not considered since the magnetizations were weak and the vectors scattered; also, the shale is of detrital origin. The cross-hatched circle of confidence is found from a total of more than sixty measurements for all the samples indicated by solid circles in the south-east quadrant. Thus, from this average direction of magnetization and the usual dipole relationship, the position of the south (not seeking) magnetic pole is found to be at 39° N. latitude and 124° E. longitude. From eight measurements of the reversely magnetized limestone at *J*, the north pole is located at 42° N. latitude and 142° E. longitude. These positions are in good agreement with Carboniferous pole locations by others: Belshe[1], 36° N. latitude and 137° E. longitude, found from Carboniferous sediments in England; and Runcorn[1], 49° N. latitude and 120° E. longitude, found from Pennsylvanian sediments in Arizona.

As to the stability of magnetization of the Barnett in geological time, we present the following favourable evidence: (1) The direction of magnetization is drastically different from that of the present Earth's field. (2) With a few exceptions, the data from widely separated locations in the uplift area agree. (3) The pole positions agree with those found by others from more widely separated locations. (4) When sense is disregarded, the direction of reverse magnetization at *J* agrees with the direction obtained from the other samples (we are not committed to a 'normal' direction). (5) There is an indication of stability, though not conclusive, obtained from two samples of sharply tilted strata[2] near faulting thought to have occurred in Pennsylvanian time. (6) With a few exceptions, there is good agreement between the results obtained from a variety of lithology: limestones, shales, limy shales and concretions. Regarding point (4) above, a study of thin sections of the Barnett samples, including those reversely magnetized, indicates that the most likely ferromagnetic mineral present is hæmatite, which is formed as a result of oxidation of syngenetic pyrites. No differences were noted which might give credence to a magnetization of the rock in the reverse direction to the Earth's field in one case and not in the other.

Both the field evidence and the petrographical observations support the conclusion that the calcareous concretions are syngenetic. They are certainly formed as a result of chemical processes and they contain very little detrital matter. Therefore the amount of detrital ferromagnetic minerals that could be present must be very small indeed and could scarcely account for the magnetic intensities observed. This seems to be excellent evidence that the ferromagnetic minerals are formed through chemical processes and probably acquire their remanent magnetism during these processes. This we feel to be a significant conclusion.

Other Carboniferous rocks have been sampled, and we hope to give a more detailed report in a later publication.

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Angle of Spread of Free Jets

THE value of the angle of spread of free turbulent jets has been of great interest to theoretical workers, and its practical application has become important to engineers in the field of combustion engineering. When such a jet of fluid is injected into quiescent surroundings the original kinetic energy of the jet is gradually dispersed in the turbulent mixing region of the jet. The pressure in the jet is very nearly the same as in the surroundings; but a surface of discontinuity separates the stream and the neighbouring fluid. The boundary is well defined apart from slight local instability. Surrounding fluid is entrained at the boundary so that the velocity of the jet decreases while the mass of fluid increases, the momentum remaining constant. In this way the jet spreads in the form of a cone having a well-defined angle. Measured values of the jet half-angle have been variously reported from 7° to 20°. Using Prandtl's hypothesis, Tollmien calculated the jet half-angle to be 12°. Recently, a new measurement of this angle was made at Sheffield, and the influence of jet fluid density investigated.

During the development of a technique for introducing a buoyancy effect into furnace models, as previously reported[2], a jet of magnetite slurry was injected into a large, slowly moving mass of water in a 'Perspex' box. The slurry, being intensely black,

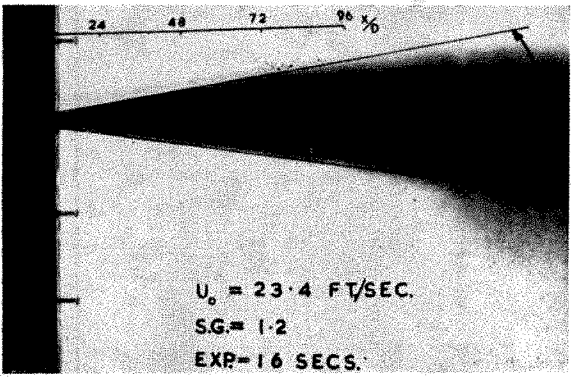

Fig. 1. Angle of spread of free jet; density ratio 1·2

provided excellent photographs of turbulent jets, such as the one shown in Fig. 1, from which the jet half-angle was deduced to be 8·5°. This agrees with the value reported by Binnie[3] for a water jet, but is less than the results quoted for gaseous systems. This result was constant for several values of the nozzle velocity and the exposure time of the photographs. Although the jet was fired horizontally, the density difference between nozzle fluid and surrounding fluid did not affect the early trajectory, where the angle was measured, as the half-angles measured above and below the horizontal were found to be equal.

In the theoretical analysis of the path taken by jets of initial density different from their surroundings, it is important to know if the jet angle, and hence the spread functions of velocity and concentration, vary with the density ratio. Measurements of the jet angle were made with nozzle fluid of specific gravity ranging from 1·0 to 2·0, and no variation in the jet angle was found (Fig. 2). This contradicts the results of Keagy and Weller[4], who measured the jet angle for vertical streams of carbon dioxide, nitrogen and helium expanding in air and found a considerable variation.

By writing down the conservation laws, it is possible to derive the following approximate expressions for axial values of velocity and concentration in a free jet at large values of x.

$$U_m = K_1 U_0 \frac{D}{x} \sqrt{\frac{\rho_0}{\rho_s}}$$

$$C_m = K_2 C_0 \frac{D}{x} \sqrt{\frac{\rho_s}{\rho_0}}$$

where U_m, C_m are, respectively, axial values of velocity and concentration of tracer inserted in the nozzle fluid; U_0, C_0 are the initial values of velocity and nozzle fluid tracer concentration respectively; K_1, K_2 are derived from the particular radial functions of velocity and concentration used, respectively; D is the nozzle diameter; x is the distance along the axis in the direction of projection; ρ_0, ρ_s are the densities of nozzle fluid and surrounding fluid, respectively.

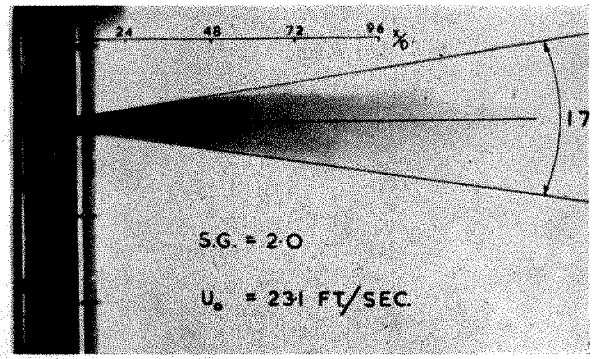

Fig. 2. Free jet; density ratio 2·0

If the angle of spread is affected by density differences then K_1, K_2 will be a function of ρ_0/ρ_s. On the other hand, if the jet angle is unaffected by density, as suggested by the magnetite slurry experiments, then K_1, K_2 will be constant and identical to the values determined for constant density systems.

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Comparative Rates of the Slow Combustion of Coke in Oxygen and Nitrogen Dioxide

MAINLY to assist in understanding the reactions of carbons with oxygen, there have been a number of studies of the kinetics of the reactions of solid fuels with nitrous oxide[1-3]; but we are unaware of any comparable work with nitrogen dioxide. This compound, which has been shown to influence the decomposition and smoke-producing tendencies of coals[4,5], is of special interest as an oxidant in view of the comparatively easy thermal dissociation probably producing oxygen atoms in the primary stage:

$$NO_2 \rightarrow NO + O$$

It is also well known as a sensitizer of several gas-phase combustion reactions[6], and it is conceivable that, when introduced into the carbon/oxygen system, it could act as a catalyst and/or react separately with carbon.

Preliminary studies in these laboratories have shown that the additions of up to 1 per cent by volume of nitrogen dioxide to an air stream fed to a column composed of a high-temperature metallurgical coke maintained at 480 ± 2° C. produced a marked increase in the rate of gasification of the sample (Fig. 1). At 1 per cent nitrogen dioxide addition, the rate is about 56 per cent greater than in air only, although the 'available' oxygen in this amount of nitrogen dioxide is only 0·024 of that contained in the air stream. Further experiments indicated that the

Table 1. RELATIVE RATES OF REACTION OF COKE WITH SEVERAL GAS MIXTURES (480° ± 2° C.)

Reaction of coke with	Relative rate
Air	1·00
Air + 1 per cent NO_2	1·58
99 per cent N_2 + 1 per cent NO_2	0·57

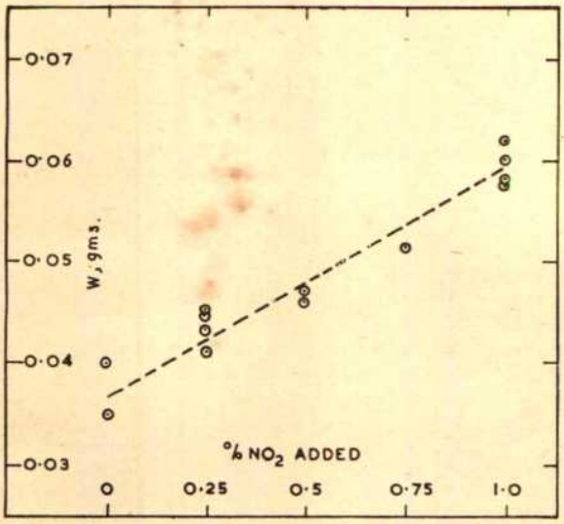

Fig. 1. Influence of NO_2 additions on the weight loss (*W*) of coke samples exposed to an air stream for 30 min. Initial weight of coke, 2·45 gm.; air velocity, 600 c.c./min.; coke size, 10–14 B.S.S.; coke temperature, 480 ± 2° C.

increased rates of reaction shown in Fig. 1 are due to a separate reaction between nitrogen dioxide and the coke, that is, the addition of nitrogen dioxide does not appear to influence the rate of the carbon/oxygen reaction; this was shown by a comparison of the reactivity of the three mixtures, air, air + nitrogen dioxide and nitrogen + nitrogen dioxide, towards the coke, the relative rates of reaction in each case being given in Table 1.

Consideration of the rate measurements of Bodenstein and Ramstetter[7] for the homogeneous thermal decomposition of nitrogen dioxide in the temperature-range 320–380° C. leads to the conclusion that in the present experiments at 480° C. with a catalytic surface (coke) present, freshly formed oxygen is the effective gasifying agent. Since this oxygen reacts so rapidly compared with the normal gas, it is probable that it is in the atomic form.

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Instability of Uniform Concentration Conditions in Suspensions under Shear

In an earlier paper by one of us[1] it was shown theoretically that in a suspension under shear the action associated with an isolated suspended particle will be a minimum when the particle follows the streamline characterized by minimum velocity gradient. The principle of least action requires that a particle initially situated at a point in a velocity field at which the gradient is not a minimum should move with a component of motion normal to the direction of flow towards regions of lower velocity gradient. In a subsequent paper[2] direct evidence of this component was adduced from a study of the motion of streams of suspended particles.

The existence of this component points to the conclusion that, during the shearing of a suspension, the motions of the suspended particles lead to a progressive increase in their concentration in those regions where the rate of shear is least and a diminution of concentration where the highest rates of shear prevail. Preliminary experiments designed to investigate variations of concentration during shear have now been carried out, and evidence of the effect predicted is given below.

The apparatus used in these experiments consisted of a co-axial glass cylinder arrangement in which the inner cylinder was fixed and the outer was rotated by means of a variable-speed motor. The inner cylinder, which was a glass rod of 0·6 cm. diameter, was arranged with its lower end beneath the surface of a shallow pool of mercury contained in the outer cylinder. The latter cylinder was a glass tube of internal diameter 4·9 cm., and throughout the experiments its rate of rotation was 2·1 rev./sec. The values of these quantities are, however, in no case critical.

The suspension employed consisted of sieved polystyrene beads of mean diameter 181μ and of range ± 30μ, suspended in an aqueous sucrose solution of the same density. The concentration of the suspension was 0·025 gm./cm.³ and that of the solution 0·155 gm./cm.³ of distilled water. The depth of the suspension used was 21·0 cm. and its temperature during the experiment was 13° C.

Fig. 1 shows the appearance of the suspension two and a half hours after switching on the apparatus. It is clear from this that the effect of shearing the suspension is to develop concentration gradients across the annular space such that the concentration falls to a very low value near the outer wall of the apparatus. This condition remains stable indefinitely.

The concentration variations which gradually develop during the shearing of a suspension in a non-uniform velocity field, it is suggested, are fundamental to the phenomena associated with anomalous viscosity. It would appear that the condition of uniform

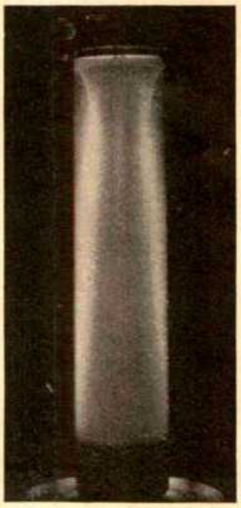

Fig. 1. Concentration variations in a suspension under shear

concentration of such disperse systems under shear is unstable.

We are indebted to Dr. J. J. P. Staudinger, of Messrs. British Resin Products, Sully, Glam., who provided the polystyrene beads, and to Mr. R. L. Powell, of the staff of this College, who took the photograph.

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Electron Bombardment of Counting Diamonds

The response of six diamonds as conduction counters for α- or β-radiation was determined, using as a criterion the maximum pulse-height versus applied-field curve obtained under conditions of minimum polarization. Without removal from their holders, the diamonds were then exposed to electron bombardment from the 15 MeV. linear accelerator at St. Bartholomew's Hospital Medical College, the counting response being redetermined after each successive bombardment. The electron beam from the accelerator passed through a water collimator. The diamond holders were cooled by water, and the overall temperature of the diamonds was kept below 70° C. during the bombardment. Radioactivity induced in thin strips of copper was used for the routine electron flux dosimetry, the absolute flux estimates being obtained by comparison with calorimetry measurements.

In each of the six counting diamonds bombarded the counting pulse heights progressively decreased with increasing bombardment flux. After a total flux of about 4×10^{16} electrons per cm.^{2} delivered at a rate of 3×10^{13} electrons per cm.^{2} per sec., the counting response was barely detectable, and the diamonds were perceptibly bluish-green in colour. In some specimens the insulation resistance also decreased after bombardment. Two non-counting diamonds were also bombarded and became bluish-green after about the same total electron flux.

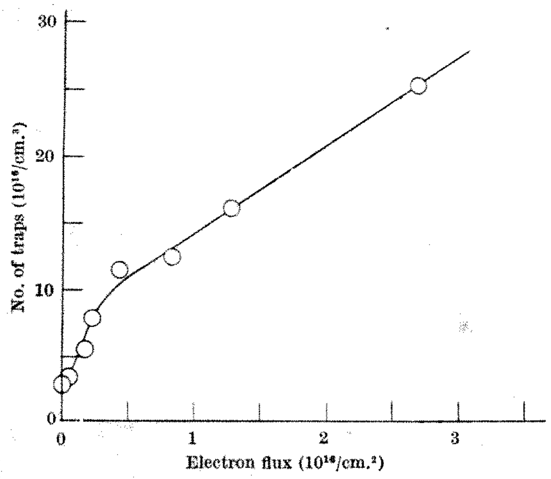

Fig. 1. Formation of additional traps in diamond by electron bombardment

The reduction in counting response is attributed to the trapping effects of additional vacant sites and interstitial carbon atoms introduced into the lattice by electron bombardment. Making certain assumptions, estimates of the number of traps introduced can be obtained from the counting response curves. Fig. 1 shows the typical increase in trap concentration with total bombardment flux. In each instance it was found that the initial rate of trap production was significantly higher than the subsequent rate. There is at present no direct experimental evidence of the causes of this effect; but some form of radiation annealing and the formation of clusters of defects, perhaps preferentially in the vicinity of barrier layers, may be suggested as possible factors. A small amount of thermal annealing at room temperature could also be detected after the lower total bombardment fluxes.

The effect on the counting response of high-energy electron bombardment is generally similar to that of neutron bombardment as reported by Benny and Champion[1]. However, the primary damage produced by electrons should be single or small groups of vacancies and interstitial atoms, whereas neutron bombardment can also give rise to larger disordered regions.

A fuller account of these experiments will be given elsewhere.

We are indebted to Dr. F. C. Champion for helpful advice and to Prof. J. Rotblat for facilities provided at St. Bartholomew's Hospital Medical College.

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A New Complex Phase in a High-Temperature Alloy

The grain boundary phase (Fig. 1) in Allegheny–Ludlum Steel Corporation's A-286 alloy has been separated electrolytically and examined by X-ray diffraction. (The nominal composition of this alloy is 0·05 per cent carbon, 15 per cent chromium, 26 per

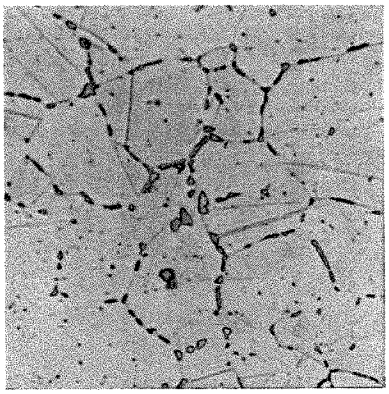

Fig. 1. Etchant: 92 per cent hydrochloric acid, 5 per cent sulphuric acid—3 per cent nitric acid. (× 500)

cent nickel, 1·15 per cent molybdenum, 0·50 per cent silicon, 53·5 per cent iron, 2·0 per cent titanium, 0·17 per cent aluminium, and 0·2 per cent vanadium.) This new constituent has been arbitrarily designated *G* phase.

Residues from several alloys having various heat treatments below the solution temperature (1,000° C.) contained *G* phase, which gave identical inter-planar spacings and intensities.

Semi-quantitative chemical analyses indicate the predominant element to be nickel with appreciable amounts of titanium and silicon and some of iron. This phase is more acid-resistant than TiC, presumably owing to the silicon content.

Microscopic studies show a direct relation between the silicon content of the alloy and the abundance of *G* phase, which together with the chemical results indicate that silicon plays a fundamental part in its existence.

Table 1. DIFFRACTOMETER DATA ON *G*-PHASE POWDER USING COPPER $K\alpha$ RADIATION

G phase ($a = 11·20$ A.)			$Cr_{23}C_6$ ($a = 10·64$ A.) intensity
$h^2+k^2+l^2$	Interplanar spacing (A).	Intensity (c.p.s.)	
4	5·60	14	—
8	3·98	34	—
16	2·80	66	*VW*
20	2·50	79	*M*
24	2·285	134	*M*+
27	2·154	635	*VS*
32	1·977	556	*MS*–
35	1·890	162	*MS*–
36	1·865	101	*M*
40	1·770	34	*VW*
43	1·708	66	*W*
44	1·688	45	*MW*+
59	1·458	21	—
64	1·399	16	*W*–
72	1·320	86	*S*–
75	1·292	56	*MS*
83	1·229	43	*MW*
84	1·220	23	—
91	1·174	23	—
96	1·142	34	*MS*
99	1·125	79	*M*
107	1·082	22	—
108	1·077	23	—

The accompanying table lists the interplanar spacings measured from a diffractometer recording and integrated intensities above background (240 c.p.s.) determined by the time to register 2^{16} counts. The $(h^2+k^2+l^2)$ values are those of a face-centred cubic lattice with parameter $a_0 = 11·20$ A. The photographic powder patterns with copper $K\alpha$ radiation are unusually clear and contain as many as fifty-five lines, all of which can be indexed on the face-centred cubic lattice. There are evidently no systematic absences other than those imposed by face-centred symmetry; hence, the possible space groups are F_{23}, Fm_3, F_{432}, $F_{\bar{4}3}m$, and Fm_3m. This space group limitation rules out the η-carbide structure (Fd_3m), but not that of the $M_{23}C_6$ carbide (Fm_3m); however, the lattice parameters and X-ray intensities of the latter, which are also listed in the table, do not compare favourably with those of *G* phase. This phase, then, appears to have a new structure.

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Primary Action of X-rays on Lysozyme

THERE is a number of unsolved problems concerning the effect of irradiations on smaller structures of living systems, such as proteins and protein complexes. Many researches have recently been carried out by irradiating enzymatic and non-enzymatic proteins; but most of the results obtained are not quite clear and are of only relative interest, especially if we consider the following points: (1) the effect of irradiations has been studied on diluted and concentrated protein solutions; (2) when proteins have been irradiated in the dried state, the preparations employed contained some impurities which have a protective action.

Rajewsky[1-3] has worked on these problems for some years; and, at present, we are carrying out in his Institute some investigations with the aim of finding out how X-rays act primarily on protein and amino-acid molecules.

The results given in this preliminary communication are concerned only in what follows on the direct action of X-rays on lysozyme. The reason why we have chosen lysozyme is that this protein is very easily purified and crystallized, it is one of the smaller protein molecules and it possesses well-known biological activity. To prevent complications by the action of free radicals of the solvent, all irradiations have been carried out on dry material.

Lysozyme, crystallized according to Alderton and Fevold[4], has been irradiated with soft X-rays in 'Dermopan' apparatus (beryllium window; 45 kV.; 25 m.amp.; at distance of 2 mm. from the window, 1 million r. per minute) and different times of exposure were made to give doses between 2 million r. and 5 million r.

After irradiation the protein was hydrolysed with 5 *N* hydrochloric acid at 100° C. for 18 hr.; the hydrochloric acid was removed in vacuum and the composition was examined with the aid of high-voltage paper electrophoresis. The technique was essentially that of Wieland[5].

A typical pherogram obtained from control (not irradiated) and irradiated lysozyme is shown in Fig. 1.

Here there is good evidence of the modifications induced on lysozyme after irradiation: it is clear that significant changes occur in composition of the acid fraction of irradiated lysozyme; but the most interesting result is the occurrence of several fractions on the basic side of the pherogram, which are moving faster than the fastest basic amino-acid (lysine). In Fig. 1 it is also possible to observe a decrease of lysine in the irradiated lysozyme.

To learn something about the neutral amino-acids of the irradiated lysozyme, in some experiments, after

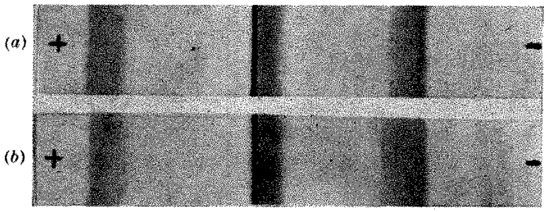

Fig. 1. Electrophoretic behaviour of control (*a*) and 5 × 10^6 r. irradiated (*b*) lysozyme hydrolysate. Equal amounts of nitrogen content for both samples. *p*H 6·0 buffer; pyridine 10 per cent, glacial acetic acid 1 per cent in water. 1,500 V.; potential gradient 40 V./cm. Running time 60 min. The fractions have been revealed with ninhydrin

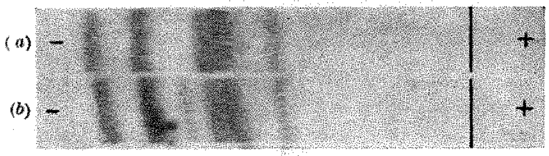

Fig. 2. Electrophoretic separation of neutral amino-acids from control (*a*) and 5×10^6 r. irradiated (*b*) lysozyme hydrolysate. Equal amounts of nitrogen content for both samples. 1,500–2,000 V.; potential gradient 40–55 V./cm. Running time 80–60 min. The fractions have been revealed with ninhydrin. *p*H 1·9 buffer; glacial acetic acid 15 per cent, formic acid 5 per cent in water

separation of the basic and the acid fractions, we eluted the neutral fraction from the paper. The amino-acids of this fraction have been separated again by high-voltage paper electrophoresis; Fig. 2 shows the results obtained in one of these pherograms.

It is of interest to note the occurrence of at least one single new compound between the neutral amino-acids of irradiated lysozyme.

From the results reported above it is evident that after irradiation of a protein like lysozyme the amino-acids are changed in some very complex way, for example, α-ketoacids and lactones of α-amino-acids have also been found in the hydrolysate of irradiated lysozyme.

Detailed results on the chemical composition of irradiated lysozyme, its physicochemical properties and its enzymatic activity will be published elsewhere.

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Prevention of Psychological Effects of *d*-Lysergic Acid Diethylamide (LSD 25) by its 2-Brom Derivative (BOL 148)

IN view of the blocking effect often exerted by the close chemical analogue of a pharmacologically specific agent, we tried to determine whether the psychological symptoms induced by D-lysergic acid diethylamide (LSD 25) could be influenced by one of its psychologically inactive derivatives. The 2-brom derivative of LSD 25 (BOL 148) exerts no psychological effects[1].

Six volunteers who showed definite mental symptoms when given 50 or 75 μgm. LSD 25 in the preceding control experiment were pretreated with 2–3 mgm. BOL 148 by mouth daily for one or two days. On the day of the experiment they received one further mgm. BOL 148 1–3 hr. before LSD 25 (50–75 μgm.) was administered. Psychological symptoms were completely absent in those three cases who received two days pretreatment with BOL 148, and reduced to abortive and short-lasting changes in the other three cases who were treated only on the day preceding the experiment. The latter showed some subjective difficulty in concentration only, which could not be established objectively. In all cases, euphoria, depersonalization and all marked sensory symptoms observed in the control experiment did not appear.

In contrast, 0·5 mgm. or 1·0 mgm. BOL 148 injected intravenously in another four volunteers at the height of LSD 25 symptoms did not produce any noticeable or persistent changes in the symptoms of the LSD intoxication.

The fact that a substance closely related to LSD 25 can block the mental disturbances induced by it may throw some light on the mode of action of the drug.

We are indebted to Dr. H. Holgate, of Messrs. Sandoz Products, Ltd., for a generous supply of drugs LSD 25 and BOL 148.

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A Method for following Lipolysis induced by Heparin

THE heparin clearing effect on postprandial lipæmic turbidity of blood serum has been demonstrated by Hahn[1]. Recently, it has been shown that heparin clearing is accompanied by the formation of a new electrophoretic component[2] and by an increase in free fatty acid[3]. That this process is of an enzymatic nature is now beyond doubt[4]. Since higher fatty acids are known to cause a depression of the second part of the polarographic protein double wave of albumin[5,6], the effect of heparin clearing on the polarographic behaviour of human blood serum was investigated because it has been shown that the polarographic effect of higher fatty acids on human blood serum can be accounted for only by the interaction of serum albumin with the fatty acids[6]. It was found that the intravenous administration of 0·5 ml. of 5 per cent heparin to six postprandial lipæmic humans as well as to six fasting subjects causes a marked depression of the second part of the polarographic protein double wave. Tables 1, 2 and 3 give the heights of the second wave in one individual which is representative of the entire group. In all cases the results were qualitatively identical.

Table 1

	Height of second wave in mm. (from cobalt wave)
Fasting	48
3 hr. after fatty meal	50
5 min. after 0·5 ml. of heparin *in vitro*	29
Fasting	58
5 min. after 0·5 ml. of heparin *in vitro*	44

Heparin added *in vitro* to blood serum does not show such an effect. The onset of the heparin effect is extremely rapid and its polarographic result can still be demonstrated in blood samples drawn 15 min. after heparin injection (Table 2).

Table 2

	Height of second wave in mm. (from cobalt wave)
Fasting	54
3 hr. after fatty meal	55
5 min. after 0·5 ml. of heparin *in vitro*	44
10 min. after 0·5 ml. of heparin *in vitro*	41
15 min. after 0·5 ml. of heparin *in vitro*	41

The technique of this procedure is extremely simple, consisting in taking a polarographic recording of a blood serum dilution 1 : 400 in Brdička's cobaltic solution (0·001 *M* $[Co(NH_3)_6]Cl_3$, 0·1 *M* NH_4Cl, 0·1 *M* NH_3). The effect of intravenous protamine

Table 3

	Height of second wave in mm. (from cobalt wave)
Fasting	60
3 hr. after fatty meal	66
5 min. after 0·5 ml. of heparin *in vitro*	42
5 min. after 5 ml. of 1 per cent protamine *in vitro* (that is, 10 min. after heparin)	55
Fasting	54
5 min. after 5 ml. of protamine	56

following heparin administration is also quite striking (Table 3).

Protamine given by itself does not show any effect. The *in vitro* effect of heparinized individuals on lactescent blood serum can also be demonstrated by this method. Since the existing methods of studying heparin-induced lipolysis are rather tedious and cumbersome, the method reported here may prove of some value. A considerable advantage for the physiological application of this method is the minute amount of blood serum required for polarographic measurements.

The mechanism of the phenomena described and the results of their application in the study of the physiology and pathophysiology of lipid transport will be reported in detail elsewhere.

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Osmotic Pressure in the Intestine of the Cow

Many investigations of the osmotic pressure in the intestine have been carried out. In those performed on laboratory animals it always turned out that, in the small as well as in the large intestine, there is isotony with the blood.

In our investigation the osmotic pressures of the press-juice of the faeces and of the intestinal content of the cow have been determined. The faecal juice was obtained by pressing the faeces in a membrane press. The freezing-point depression method was used for measuring the osmotic pressure.

With fifty cows the mean value of the freezing-point depression in the press-juice of the faeces appeared to be 0·350 deg. C., the extremes being 0·240 and 0·430 deg. C. The freezing-point depression of the cow's blood is 0·560–0·590 deg. C. The press-juice of the cow's fæces is therefore rather strongly hypotonic with regard to the blood. From the data in the literature, however, isotony with regard to the blood had been expected.

Table 1

	Freezing point depression (°C.)
Experiment 5	
b, rennet-stomach (abomasum)	0·549
a, duodenum	0·684
c, middle small intestine	0·714
j, caecum	0·620
h, beginning of large intestine	0·530
f, middle of large intestine 1	0·489
g, middle of large intestine 2	0·449
d, end of large intestine	0·398
Experiment 6	
f, rennet-stomach (abomasum)	0·490
a, duodenum	0·588
b, middle of small intestine 1	0·951
c, middle of small intestine 2	0·822
d, end of small intestine	0·628
n, caecum	0·606
m, beginning of large intestine	0·549
l, middle of large intestine 1	0·388
k, middle of large intestine 2	0·364
j, middle of large intestine 3	0·339
g, end of large intestine	0·375

Afterwards, with six cows, the osmotic pressure in different parts of the intestine was determined. In Table 1 the results of two of these determinations are given.

The content of the abomasum is slightly hypotonic with regard to the blood. In the small intestine, however, mostly rather strong hypertony occurs; but in the end of the small intestine and in the caecum isotony with regard to the blood is practically re-established. In the large intestine the contents gradually become hypotonic. It is clear that this last-mentioned fact may be of great importance for the mineral balances and the mineral metabolism of the cow.

We conclude, therefore, that the generally accepted tendency of the intestinal content towards isotony with the blood does not hold for the cow.

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Deficient Water-binding in Pathological Horny Layers

The pathogenesis of most scaling skin conditions is obscure. Although it has been often assumed that abnormal processes of keratinization play a major part, recent work has emphasized the importance of the water-soluble components of the horny layer. These components contribute to the water-binding ability and pliability of the normal skin surface[1]; their amounts are reduced in psoriatic scales[2] and skin[3].

We have determined the water-uptaking capacity at 100 per cent relative humidity and the amino-nitrogen content of normal horny layer (callus) and of scales from six patients with psoriasis and two patients with ichthyosiform erythroderma, a congenital scaling skin disease. Determinations were made in pulverized, ether-defatted, non-hydrolysed horny material, in the aqueous extracts and the water-insoluble residue. Callus took up about 50 per cent more water than the pathological specimens (28 per cent versus 19 per cent). After extraction with water, the water-binding ability of all the residues became practically the same (17–19 per cent).

The assumption that the water-soluble components were responsible for the decreased water-binding ability of the pathological specimens was further supported by precipitating these substances from the extracts with an excess of acetone and determining their water-binding capacity. The acetone-precipitable material from the pathological scales took up considerably less water than their normal counterparts (47–49 per cent versus 114–116 per cent).

The most important dialysable water-binding components of the horny layer are free amino-acids[4,5]. The diminution of the free amino-nitrogen in pathological scales is confined to the water-soluble portion

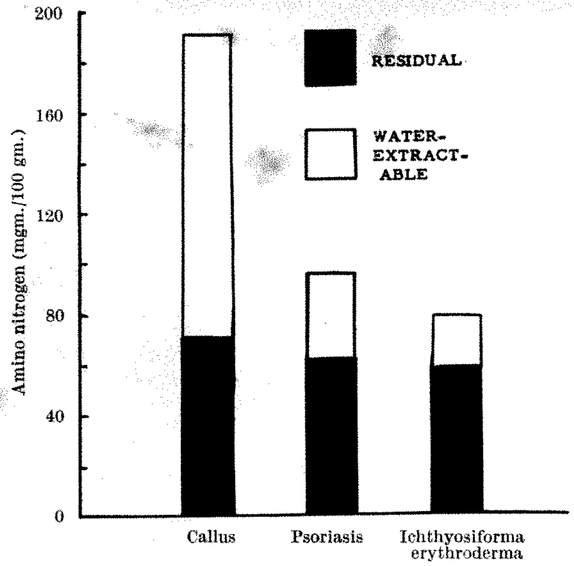

Fig. 1. Free amino-nitrogen in non-hydrolysed calluses (3 specimens), psoriatic scales (6 patients) and scales from a congenital scaling disease (2 patients)

of the scales. The amino-nitrogen content of the residue, obtained by calculation and, in most cases, by actual estimation, was virtually the same in normal and pathological specimens (Fig. 1).

These findings suggest that in these scaling conditions the main fault may not lie in the keratinous portion of the horny layer or in the process of keratinization. The decrease in the free amino-acids may result from an abnormal protein metabolism in the differentiating epidermal cells. The previously reported high —SH content of psoriatic scales[6,7] may also be an expression of such an abnormal metabolism in the non-keratinizing portion of the cells, because these groups can be extracted with water or detergents.

Removal of the major hydrophilic component of the horny layer by a combination of lipid solvents and water results in decreased water-binding capacity and brittleness[1]. When, in certain pathological conditions, these substances are diminished, the horny layer may have a different appearance. Although the reported changes are not in themselves specific for any scaling disease, their combination could be distinctive for certain conditions, for example, in psoriasis with the simultaneous occurrence of high —SH values and low water-extractable amino-nitrogen. Further identifying features may be revealed by studying the amino-acid composition of the water-soluble portion of various pathological cornified epithelia. Studies of this nature are in progress. This study was supported by U.S.P.H.S. Grant *G*-4257 *C*.

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Mitosis in Migrating Epithelial Cells

IT is generally believed that the absence of mitotic activity in migrating epithelial cells is one of the characteristic features of repair in epithelia. Migration alone is held to be responsible for epithelialization in the early stages of healing. Increased mitotic activity occurs later at some distance from the wound margins, and spreading cells are considered to exhibit mitosis only after they have become firmly fixed to the underlying tissues.

Recent studies in the cat have shown that certain epithelial cells do undergo mitotic division when migrating. Observations on regenerating transitional epithelium in the urinary bladder[1] revealed that, within two days of creating an excision ulcer in the mucosa, increased mitotic activity was present not only in the epithelium of the undisturbed mucosa surrounding the lesion but also in the cells that were spreading in a single or double layer over the floor of the ulcer. When a similar lesion was made in the gall bladder[2], a very striking increase in proliferative activity was noted in the columnar epithelium within twenty-four hours of operation. Again, nuclei in all phases of the mitotic cycle were found in the spreading cells, as well as in the epithelium at and near the ulcer margins.

Migration of the stratified epithelial cells in the urinary bladder may be responsible for the epithelialization of the defect, and mitosis may be concerned only with increasing the number of layers of cells. However, in the simple epithelium of the gall bladder, it is difficult to maintain that mitosis in spreading cells is not playing some part in covering the lesion. Both types of epithelia display a very early onset of increased proliferative activity, which would appear to be well established before the cells can be said to be firmly attached to the underlying tissues. In a study of the regeneration of tracheal epithelium in the rat, Wilhelm[3] also found some evidence of mitosis in migrating cells.

These findings are clearly at variance with current concepts of epithelial activity during wound healing. It is to be noted that the majority of investigations on wound healing have been carried out on skin and cornea, and generalizations derived from these two tissues may be misleading when applied to others that have received less attention.

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The Juvenile Hormone of Insects

SINCE the pioneering researches of Wigglesworth[1] the corpora allata have been known as the source of a 'juvenile hormone' which opposes or prevents the metamorphosis of immature insects. The presence of this hormone exerts a biochemical restraint on the cellular transformations responsible for the metamorphosis of the insect as a whole. These facts have been ascertained by biological procedures such as parabiosis and the transplantation of living corpora allata[2]. The hormone itself has apparently not been extracted or obtained apart from the living insect or endocrine organ.

Studies of the Cecropia silkworm (*Platysamia cecropia* L.) have recently revealed a rich depot of the corpus allatum hormone in the abdomen of the adult male of this moth. By the extraction of abdomens with organic solvents it has been possible to prepare the first potent extracts of the juvenile hormone. The latter, when injected into previously chilled pupæ of *Platysamia cecropia* or *Telea polyphemus*, duplicate the results obtained by the implantation of living, active corpora allata; that is, the formation of the adult moth is blocked and the pupa is forced to transform into a second pupa. The hormonal extracts from Cecropia have also been found active when tested on *Pieris brassicae* (Lepidoptera), *Tenebrio molitor* (Coleoptera), *Rhodnius prolixus* (Hemiptera) and *Periplaneta americana* (Blattaria).

The hormone is readily extracted when one or more adult male abdomens are blended at room temperature with ether, petroleum ether, ethanol or methanol. Ether appears to be the solvent of choice. After evaporation of the solvent in a water bath, the hormone is recovered as a residual, golden-yellow, non-toxic oil of low viscosity. Each abdomen yields approximately 0·2 ml. of the active oil, and it is therefore possible to obtain a manageable volume of extract from even a single abdomen. When injected into Polyphemus pupæ weighing 5 gm., 0·025 ml. of the oil gives a clear-cut effect.

The hormone is insoluble in distilled water, and at all stages in extraction can be washed repeatedly with water without loss of activity. The hormone resists extraction when fresh abdomens are blended at room temperature with acetone, chloroform, benzene or carbon tetrachloride; but after initial extraction with ether, the hormone is soluble in acetone.

In addition to the above-mentioned solubilities, preliminary studies show that the hormone is a heat-stable substance which, at room temperature, is resistant to aqueous alkali (5 N), acid (0·2 N), and anionic and cationic exchange resins.

Only a trace of hormone is extractable from the heads and thoraces of male Cecropia moths, even though the corpora allata are located in the head. Evidently, little hormone is present at any one time in the corpora allata or the blood. But the hormone is easily eluted from any of a number of tissues in the abdomen of the male moth. The abdomen and its contents apparently act to extract the hormone continuously when the latter is secreted in the adult moth and during the final week of adult development. If one excises the corpora allata before this period, then no hormone is recovered later on from the abdomen. For reasons which are not understood, it has been impossible to extract any hormone from the abdomens of female Cecropia moths or from any part of male or female Polyphemus moths.

Endocrine studies making use of the extract have already revealed that the hormone is inactive when injected into isolated pupal abdomens or into other preparations where the prothoracic gland hormone is absent. The juvenile hormone intervenes in reactions to the prothoracic gland hormone which occur early in adult development, that is, during the first few days of the twenty-one days required for adult development at 25° C. It has no effect when injected after the fourth day. In the experiments performed thus far on silkworm pupæ, even the highest doses of hormone have failed to cause the reappearance of any trace of larval characteristics.

Extracts prepared from petroleum ether have been found active when applied topically to the outside of the pupal cuticle. The result is an insect which is a mixture of pupa and adult. Individuals of this type show a low viability and soon die without completing their development. Therefore, in addition to the theoretical interest of the juvenile hormone, it seems likely that the hormone, when identified and synthesized, will prove to be an effective insecticide. This prospect is worthy of attention because insects can scarcely evolve a resistance to their own hormone.

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A Humoral Stimulus to the Secretion of the Brain-Hormone in Lepidoptera

IN insects, growth and moulting depend on the activity of a number of endocrine organs. It is known that a group of neurosecretory cells in the brain secrete a hormone which induces the thoracic glands to produce another hormone, and that this second hormone probably stimulates growth of the body through yet other links[1]. However, the processes which precede and control the initial secretory activity in the brain are still largely unknown. Lees[2] has set out evidence in favour of the theory that secretion of the brain hormone is induced by nervous stimuli. On the other hand, Andrewartha[3] thought that the brain might respond to a humoral stimulus linked with nutrition.

The results reported here of some experiments done with the vine-moth *Phalaenoides glycine* Lew. (Noctuidae) do not seem to fit into Lees's theory. This insect over-winters as a diapausing pupa, but may have several non-diapausing generations during summer. At 25° C. in non-diapausing pupæ the brain did not appear to secrete the hormone necessary for adult development until 3–7 days after pupation. Removal of the brain before this critical period produced 'permanent' pupæ which survived for up to ten months. Unoperated control pupæ became adult in about three weeks.

'Permanent' pupæ were prepared by removing their brains less than 24 hr. after pupation. They were divided into two groups. In one group each of the pupæ received one or two brains from larvæ of *P. glycine* which had spent less than 24 hr. in the final instar and had not eaten any food since the previous instar. The larval brains were implanted immediately after the host's brain had been removed. In the other group of pupæ nothing was implanted. It seems safe to assume that the larval brains implanted in this experiment had not been stimulated before the operation, because they had just completed a secretory cycle and previous observations had shown that final instar larvæ needed at least eight days of 'obligatory' feeding to induce pupation. Seven out of twenty-four of the pupæ with implanted brains became adult within 40 days. Of twenty-two brainless controls, none became adult.

This suggests that in *P. glycine* the stimulus to the brain is humoral rather than neural. The possibility of stimulus through stray regenerating nerve fibres cannot be ruled out; but it seems unlikely. The condition of the pupal body which induced neurosecretion was not transient but persisted for at least seven months. This was shown by implanting young larval brains into 'permanent' pupæ at ten days, four months and seven months after pupation. One or more in each class became adult.

Williams[4] implanted the brains of young larvæ of *Platysamia cecropia* into brainless diapausing pupæ and obtained some adult moths. He gave no information on the period of 'obligatory' feeding; but it is probable that these brains had not been stimulated by their own bodies and that his positive results are also explicable in terms of a humoral stimulus. The evidence presented in this communication suggests that in some insects humoral factors alone may be sufficient to stimulate the cerebral neurosecretory cells. In *Rhodnius prolixus* and *Bombyx mori*[2] the central nervous system appears to play an essential part; but it is possible that even in these species nervous control is superimposed on a humoral mechanism.

Thanks are due to Dr. H. G. Andrewartha of this Department for advice, guidance and criticism. This work was carried out during the tenure of a studentship of the Commonwealth Scientific and Industrial Research Organization and of a grant of the University of Adelaide.

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Production of Human Antiglobulin Reagent in Sheep

THE human antiglobulin reagent described by Coombs, Mourant and Race[1] was prepared in rabbits. Later, Eyquem (personal communication), Hill and Haberman[2] and Dunsford (personal communication) produced reagents in goats, and Eyquem (personal communication) in donkeys. I have tried to produce a reagent in a variety of animals, including rabbits, hens, sheep and the horse. Rabbits, of course, have been used in many laboratories; but it seemed it would be an advantage if an animal could be used from which more serum was available when immunization was satisfactorily completed. Sheep were found to be satisfactory animals.

Intramuscular injections of alum-precipitated serum were given and the animals bled at various intervals. The sheep serum was tested as an absorbed and as an unabsorbed diluted reagent against cells sensitized with the incomplete forms of anti-D, anti-K, anti-Fy^a, anti-A, anti-Jk^a and anti-Le^a. Direct tests were also carried out with cells from cases of acquired hæmolytic anæmia and with cells obtained from the cord blood of babies affected with hæmolytic disease of the newborn.

These results were compared with those obtained when standard antisera prepared in rabbits were used, and the results were very satisfactory. Strong positive results were given using the sheep antiglobulin serum. When the absorbed serum was used, if weakly sensitized cells were used as test cells, zoning was detected.

Many examples of each of the antisera listed above were used in the tests, and the appropriate antibodies were readily detected, the most difficult being anti-Le^a and anti-Jk^a. These antibodies require to be freshly collected or to have suitably selected normal fresh serum added to them to give optimum reactions. Certain examples of this antibody series do require a more concentrated antiglobulin reagent than that which is normally used in routine work. Crawford, Cutbush and Mollison[3] consider that anti-Le^a antibodies are of the alpha- and beta-globulin type and that this is the reason why a more concentrated antiglobulin reagent is required. It seems probable that some examples of anti-Jk^a antibodies fall into this class.

These difficulties, of course, are not confined to sheep antiglobulin reagents, but occur with reagents prepared in other animals. More information is required about the action of anti-Le^a and anti-Jk^a and the best methods for their detection and use.

The reagent was tested for avidity, for freedom from false positive results and for efficacy in routine use. In all these tests it was as good as many reagents prepared in rabbits, with which it was compared, and especially noteworthy was its freedom from false positive results.

Full details will be published elsewhere. I wish to thank the Evans Biological Institute, Runcorn, for providing the sheep for injection.

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Cytoplasmic Inheritance

FROM the point of view of cell physiology we can distinguish two distinct levels of gene action. One level is that at which the synthesis of macromolecules is controlled. The second level is that of the organization of macromolecules into physiological units. In differentiated cells it seems probable that the synthesis of macromolecules is normally under rather direct control of Mendelian (chromosome) genes, whereas their organization into functional units is often largely controlled by cytoplasmic inheritance (for reviews, see Lwoff[1], Ephrussi[2], Michaelis[3] and Danielli, Lorch, Ord and Wilson[4]).

Many authors speak simply of cytoplasmic inheritance, without inquiry into its mechanism. Others refer cytoplasmic inheritance to plasmagenes. The use of the term 'plasmagene' necessarily involves associations with chromosome genes; this is undesirable, since the determinants of cytoplasmic inheritance usually differ in their nature and function from chromosome genes. I wish therefore to suggest that a new term should be used for those determinants of inheritance which are themselves organizations of molecules or of processes, and are self-reproducing. Such determinants include centrosomes, chloroplasts, kinetosomes, kinetoplasts and the cytochrome oxidase-containing granules of yeasts. Many such cytoplasmic bodies differ from chromosome genes in containing no deoxypentose nucleic acid, and in having no function of controlling the synthesis of macromolecules. On the other hand, they are self-reproducing, do not arise spontaneously, and control (and may perform) at least one cellular function. They are in fact the homeostatic units responsible for controlling those activities of a cell which are functions of organizations of macromolecules. They are thus self-reproducing homeostatic units, the specific properties of which can only be defined at the level of organizations of macromolecules. I wish, therefore, to suggest, as a first attempt at finding a suitable term for these determinants, the word *homeostat*. A homeostat may be defined as an organization of macromolecules, or of processes, which is self-reproducing and which may also (and usually does) determine and control the expression of one or more characters in a cell lineage.

To illustrate a major possible usage for such a term, we may refer to differentiation. Then differentiation may be regarded as the development of a variety of homeostats which are the characteristic determinants of different cell lineages, against the constant background of Mendelian genes carried by the chromosomes. All cell lineages in one animal normally carry the same chromosome genes, and each cell lineage carries a distinct set of homeostats.

By using quite different terms for genes and for homeostats, it becomes much easier to think of them independently, and to avoid unjustified and unnecessarily limiting associations.

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Diurnal Rhythms of Activity in Terrestrial Arthropods

ATTENTION has recently been directed to the close parallel that exists between the rhythm of biting activity in certain East African mosquitoes and the bimodal flight activity of the Trichoptera, and it is suggested that in insects showing abrupt 'eo-crepuscular' activity the control is mainly microclimatic[1]. If this is so, the diurnal rhythm must be largely 'exogenous' in nature and would not persist under constant environmental conditions as 'endogenous' rhythms do. The majority of animal species, however, show a combination of both types, and such periodicity is designated 'composite'. This type of rhythm occurs in cockroaches and has recently been shown to have a neurosecretory basis[2].

Even innate endogenous rhythms are regulated by changes in environmental factors such as light, temperature and humidity ; but as they are not a direct response to them, such factors have been referred to by me as 'clues', a term which appears to correspond with the German 'Zeitgeber', and their importance lies in the maintenance of rhythm and in keeping it in phase with the environment[3]. Under natural conditions there are probably several 'clues' active at the same time, one of which is generally the ruling factor of an animal's periodicity. In most cases light intensity is the factor that sets its mark on activity as a whole, while others, such as temperature, humidity or wind, which may have even greater ecological importance, are, in the main, responsible for the degree of intensity. Thus in wood-lice, although a composite diurnal locomotory rhythm is synchronized with the environment by alternating light and darkness[4], the intensity of nocturnalism in different species is correlated with the ability to withstand water-loss by transpiration[5].

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A Filamentous Saprophyte from Wookey Hole Caves

AN unusual branched filamentous organism, superficially resembling a water mould, was found growing submerged in complete darkness, by Dr. R. E. Davies, in the ninth cavern of Wookey Hole, near Wells, Somerset, on December 11, 1955. The plant was attached to the insulation of a reel of cable deposited in the caves on June 28, 1953, under about 10 ft. of water.

The felt consisted of a tangled mass of large septate, branching filaments (10–30μ in diameter), many of which were coated with ferric hydroxide in the form of strands (Fig. 1). Branches arise just beneath the cross-walls as in *Cladophora*, and taper to fine septate threads (*c*. 4–7μ across). There was no evidence of pigmentation or of the presence of chromatophores either in the original material or in the organism after culture in daylight for more than three months. The cytoplasm contains minute granules and the cells of the older filaments are extensively vacuolated (Fig. 2). The presence of nuclei has not been established although material has been stained with acetocarmine, hæmatoxylin and by the Feulgen technique. Treatment of the cell wall with chlor-zinc-iodide did not give the typical cellulose reaction, a yellow-brown coloration resulting. Septate hyphal-like threads emerge from broken ends of the filaments, and, when cells of the large filaments die, the protoplasts of the adjacent cells often grow through into the empty cells (Fig. 3), where they may fuse with one another. Cross-connexions may develop between young filaments. No reproductive structures have been seen. Pure cultures of the organism have been obtained on potato extract agar, and the original material has been also maintained in liquid inorganic media.

Only one previous record of an apparently algal saprophytic organism of a branching filamentous type (*Saprochaete saccharophila* Coker and Shanor[1]) is known to us. The specimen from Wookey Hole differs from *Saprochaete* in a number of morphological features and, among the algae, resembles members of the Cladophorales rather than of the Chætophorales. The nutrition and certain morphological characters seem to indicate fungal affinities ; but the very large cell size is uncommon in fungi. Attempts are now

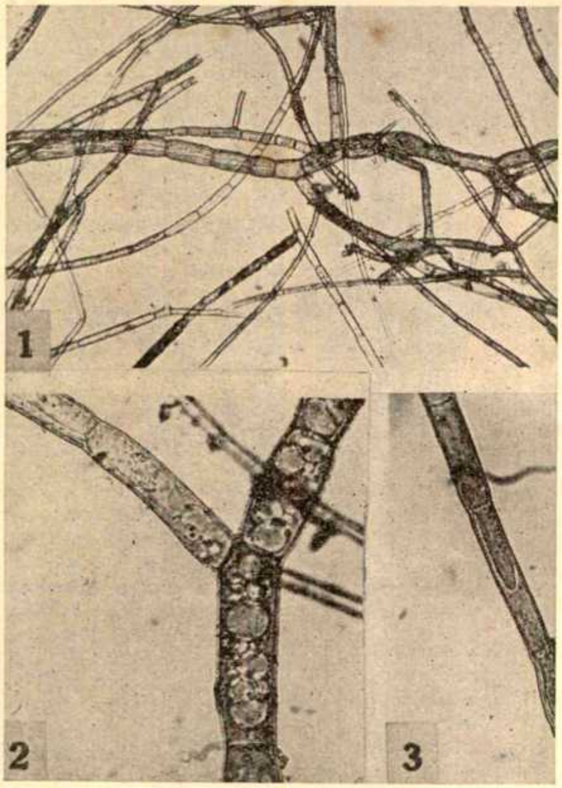

Fig. 1. Photomicrograph showing the range of size of the filaments, the mode of branching and a strand-like coating of ferric hydroxide on the largest filament. (× 90.) (2) The cells contain conspicuous rounded vacuoles and minute granules. (× 360.) (3) The peg-like ingrowth from one cell into the adjacent cell is clear. (× 360)

being made to culture the organism on various media in the hope that further investigation will throw light on the metabolism and systematic position of this interesting plant.

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Occurrence of Apiose in *Hevea brasiliensis*

FRUCTOSE, glucose, quebrachitol, mesoinositol, and (−)-inositol have been detected in the free state in *Hevea* latex serum, and glucose, galactose, mesoinositol, and an unknown sugar (probably a ketose) were obtained on hydrolysis of a latex lipid fraction[1]. The work reported here is an examination of *Hevea* bark tissues for reducing sugars, and, in view of the common 5-carbon branched skeleton unit of the isoprenoid compounds, particular interest lay in the detection of branched-chain sugars.

The plant material used was whole bark, which had been collected fresh and dried at 90°. A powdered sample (50 gm.) was boiled under reflux for 4 hr. with 0·2 N sulphuric acid (500 ml.) and filtered. After saturating the filtrate with barium carbonate, and filtering, the solution was concentrated under reduced pressure to a syrupy residue. This was extracted with boiling 95 per cent ethanol (100 ml.), and the insoluble material removed on the centrifuge. The ethanol was distilled off, and the resulting syrup boiled for 5 min. with water (50 ml.) and animal charcoal (2 gm.) and filtered. After concentration, and extraction with boiling ethanol, as before, the solution was finally concentrated to a thick syrup.

Chromatography of this product was carried out on Whatman No. 1 paper with a solvent system of n-butanol–water–ethanol (50 : 40 : 10 by vol.) in runs of up to 55-hr. duration. Eight compact and fully separated spots were stained by silver nitrate reagent. The fastest-moving component (R_F 0·28) was of greatest interest, since this agreed exactly with an authentic specimen of apiose prepared by hydrolysis[2] of parsley apiin (Merck). By the use of specific spray reagents, and variation of solvent system in one- and two-dimensional runs with comparative mixtures of known compounds, it was concluded that the remaining spots were due to maltose, galactose, glucose, fructose, quebrachitol, mesoinositol, and possibly xylose. Only glucose, fructose and quebrachitol could be detected in water extracts of bark. In order to characterize further the substance resembling apiose, a preparative fractionation of the sugar mixture was carried out on a column of cellulose powder[3]. The authentic apiose, which contained about 5 per cent glucose impurity, was fractionated in the same way. A fraction (I) isolated from the bark mixture yielded 11 mgm. of syrup. This was indistinguishable from apiose when chromatographed separately and in mixtures in a wide range of solvents. With high concentrations of fraction I a faint spot, stained red by aniline hydrogen phthalate, was visible immediately behind, but completely separated from, the suspect apiose spot. Apiose, while not yielding furfuraldehyde when treated with acid, did give faint colours (yellow-brown) when sprayed with aniline hydrogen phthalate or p-anisidine hydrochloride. Identical colours were given with the corresponding component of fraction I.

Phenylosazones were prepared from fraction I and apiose, and recrystallized from aqueous ethanol. These melted at 154°–156°, and the mixed melting point was unchanged. Thus, it was concluded that the main component of fraction I was apiose.

This sugar has the same carbon structure as the skeleton unit of isoprenoid substances, and it has been suggested[4] that apiose could give rise to simple terpenes by condensation and reduction. Such a reaction seems unlikely , but the presence of apiose in *Hevea* does suggest a possible metabolic link between the sugars and the 5-carbon intermediates of isoprenoid synthesis. An interesting connexion was noted between parsley, from which apiose is most readily obtained, and several rubber-producing plants. The carbon tetrachloride extracts of *Hevea* bark, *Taraxacum kok-saghyz* root and *Taraxacum officinalis* root, were saponified, and extracted with ether. After removal of ether each of these extracts possessed the odour characteristic of fresh parsley.

I am indebted to the Dunlop Rubber Co., Ltd., for permission to publish this note.

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Association of a Species of *Itersonilia* with Parsnip Canker in Great Britain

A SPECIES of *Itersonilia* Derx was isolated by Wilkinson[1] in 1952 from cankers on parsnip roots in the United States. He did not publish a species identification, nor did Sowell[2] in a later note on the fungus; but cultures were afterwards lodged by Sowell at the Centraalbureau voor Schimmelcultures, Baarn, under the name *I. perplexans*. Wilkinson demonstrated the pathogenicity of the fungus and showed that it was also responsible for lesions on the leaves. I have made similar observations in Britain.

The fungus was first obtained, with five others, in the autumn of 1954, from tissue taken from the inner margins of parsnip canker lesions. Isolations were made by surface sterilizing, washing and planting small pieces of infected tissue on prune agar. During the winter of 1955–56, several isolates of each of these fungi were tested in the laboratory for pathogenicity to parsnip roots. Of the six fungi tested, only one was found to infect both wounded and unwounded parsnip tissue and this fungus was identified as a species of *Itersonilia* Derx. The Commonwealth Mycological Institute confirmed this identification and reported that in many respects the fungus resembled *I. perplexans*.

During the winter and spring of 1955–56, further isolations were made from cankerous lesions by the spore-dropping technique used by Wilkinson[1]. Pieces of diseased tissue were attached to the lid of a Petri dish with 'Bostik' and suspended over a plate of prune or Waksman's egg albumen agar[3]. When incubated at 21° C., colonies of *Itersonilia* frequently developed on the agar from ballistospores ejected from the pieces of diseased material. Inoculation of parsnip roots in the laboratory with several of these cultures resulted in rotting, similar to that produced by the 1954 isolates, and re-isolation by the spore-dropping technique from the artificial lesions established the pathogenicity of the fungus.

Itersonilia has been obtained from two types of lesion both of which are quite common in the field. The first type was dark brown to black in colour and extended 2–3 mm. into the tissue of the shoulder. Where the surface tissues were ruptured, the underlying parenchyma usually appeared slightly purplish. In the second type the surface of the root was invariably ruptured. The exposed parenchymatous tissue was light brown to orange-brown in colour, but frequently included areas which were darker brown and rotted. When inoculated into parsnips, the fungus produced lesions only of the first type. Thus although it was clearly the cause of this type of lesion, the significance of its association with the other type remains to be determined.

The fungus has been obtained from parsnips grown at the National Vegetable Research Station and at two farms in Buckinghamshire and one in Kent.

Leaf infection of young plants has been demonstrated by single or successive sprayings of a macerated mycelial suspension on to the foliage of potted parsnips in the glasshouse. The lesions developed within six days and appeared as silvery green patches approximately 1 mm. diameter or as larger patches, each consisting of a necrotic centre surrounded by a light-green halo. The re-isolation of *Itersonilia* from the lesions by the spore-dropping technique confirmed that the lesions were caused by the fungus.

The present work fully supports that of Wilkinson and indicates that a fungal pathogen hitherto unreported in Great Britain is associated with parsnip cankers in Britain. Its occurrence is apparently widespread; but further work will be necessary before it can be determined whether *Itersonilia* is responsible for most, or only part, of the somewhat variable symptoms on parsnips at present grouped under the term 'canker'.

Thanks are due to Dr. M. B. Ellis, of the Commonwealth Mycological Institute, for the identification of the culture of *Itersonilia*.

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Control of Coffee Berry Disease in Kenya

A DISEASE of coffee berries, attributed to a form of *Colletotrichum coffeanum* Noack, was first described from West Rift areas of Kenya in 1922[1]. It caused extensive losses and the abandonment of coffee cultivation on many estates, and although by 1939 selections of coffee which showed some degree of resistance had been made, direct attack with a considerable range of fungicides had led to little, if any, control of the disease. A detailed account of the disease and of investigations up to 1950 has been published[2].

Previous work[1] had shown that disease symptoms could be reproduced by the inoculation of the pathogen into wounded or detached berries; but the degree of pathogenicity was not established until symptoms were produced using spore inoculum without wounding[3].

In 1951, the disease appeared for the first time in the East Rift coffee area, the higher-altitude zones being affected. As this area produces the greater proportion of the Kenya coffee crop, investigations on the disease received a considerable impetus. Further fungicide trials were carried out using 'Perenox', phenyl mercury, 'Fixtan', 'Tulisan' and calcium sulphamate; but no degree of control was observed.

Early in 1955, the effects of a wide range of fungicides were tested on an estate in the East Rift area. Fifteen treatments were compared using six replications of a balanced, incomplete block design with three plots per block. Each block consisted of one head of three multiple-stem trees, the trees selected having three equal heads each. In this way, individual tree variations in susceptibility and yield could be statistically controlled. The following fungicides were applied at monthly intervals during the long rains (March–May) and the short rains (November–December), giving a total of five applications; 'Perenox', 'Karathane', 'Verdasan', 'Fermate', 'Zerlate', 'Dithane', 'Actidione', 'Captan', 'Glyoxalidine' and calcium sulphamate. In addition, 'Perenox' was applied at fourteen-day intervals throughout the season.

Only 'Perenox', applied at fortnightly intervals, and 'Verdasan' gave an effective control of the disease. No control could be detected when 'Perenox' was applied at the same frequency as 'Verdasan'. As fortnightly fungicidal application is undesirable, 'Verdasan' affords the best possibility of control as yet. In view of the earlier failure to obtain direct control of the disease with fungicides, the importance of these results is considerable.

Repeated calcium sulphamate treatments at 1, 3 and 6 per cent were all found to be highly phytotoxic although previously a single application at 1 per cent had not produced any adverse effects.

A laboratory technique for testing fungicides on detached berries has given results comparable with those of the field trials. Preliminary tests using 'Griseofulvin' at a concentration of 880 p.p.m. have given results similar to 'Verdasan'.

Further field trials are in progress.

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Suppression of the Sprouting of Potatoes by the Vapour of Alcohols

THE use of a growth-inhibiting vapour for the commercial suppression of the sprouting of potatoes offers certain advantages over the employment of suppressant dusts, though these have been used with success. In particular, application of the treatment can be delayed until signs of sprouting are observed —which in some years, when the onset of sprouting is late, can lead to an appreciable saving in cost— and the farmer need not decide whether or not to employ a sprout suppressant until some time after harvest, when he may be in a better position to know whether it is likely to be advantageous to store his potatoes late. Attempts have therefore been made to use a number of gases and vapours, as, for example, ethylene[1].

The fact that the volatile metabolic products of potato tubers will completely inhibit their sprouting, if allowed to accumulate in the absence of carbon dioxide, led to the discovery that the vapour of *n*-amyl alcohol was a very effective sprout inhibitor[2]. Ethyl alcohol vapour had previously been described as retarding sprout growth[3]. Later, the vapours of both *iso*-amyl and active amyl alcohol were found to be effective at concentrations of about 1 mgm./l., and commercial amyl alcohol (a variable mixture of the *iso* and active alcohols) was used successfully on the sixteen-ton scale[4]. It seemed possible that alcohol vapours in general might retard sprout growth, and the results of a number of tests, given in the accompanying table, seem to confirm this. In most cases no attempt has been made to extend the tests to cover a number of concentrations, although this has been done to a limited extent with nonyl alcohol, which has shown promise of being applicable on a commercial scale[5].

Mr. R. J. Gibbs helped with the work described here. It was carried out as part of the programme of the Food Investigation Organization of the Department of Scientific and Industrial Research.

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Table 1. SUPPRESSION OF THE SPROUTING OF POTATOES BY ALCOHOL VAPOURS

Variety of potato	Alcohol	Conc. (mgm./l.)	Temp. °C.	Duration of expt. (days)	Wt. of sprouts as per cent total wt.	Wt. of sprouts on control as per cent total wt.	Sprouting on treated tubers as per cent that on control (approx.)
Dr. McIntosh	Methyl	18·3	10	68	0·19	0·36	53
Dr. McIntosh	Ethyl	15·1	10	84	0·0	0·76	0
Dr. McIntosh	*iso*-Propyl	8·9	10	84	0·0	0·76	0
Majestic	*n*-Butyl	5·4	10	55	0·02	1·64	1
Majestic	*n*-Amyl	1·5	10	34	0·0	1·05	0
Dr. McIntosh	*n*-Amyl	1·9	10	84	0·0	0·76	0
Dr. McIntosh	*tert.*-Amyl	9·0	10	84	0·0	0·76	0
Majestic	*tert.*-Amyl	0·6	10	51	0·0	1·07	0
Majestic	*n*-Hexyl	2·3	10	55	0·67	1·64	41
Majestic	*sec.*-Heptyl	2·6	10	55	0·0	1·64	0
Majestic	Octyl*	1·3	10	55	0·47	1·64	29
Majestic	Nonyl†	4·8	10	63	0·0	6·81	0
Stormont Dawn	Nonyl	3·7	10	91	0·0	3·85	0
Dr. McIntosh	Nonyl	0·2	10	172	0·0	5·02	0
Dr. McIntosh	Nonyl	0·02	10	109	0·07	2·02	4
Dr. McIntosh	Nonyl	0·06	20	54	4·35	6·74	65
Dr. McIntosh	Nonyl	0·07	20	17	2·74	2·73	100
Dr. McIntosh	Nonyl	0·31	20	21	0·0	2·88	0
Dr. McIntosh	Nonyl	0·87	20	22	0·0	3·50	0
Majestic	*n*-Decyl	1·6	10	55	0·14	1·64	9

* 2-ethyl-hexan-1-ol † 3-5-5-trimethyl-hexan-1-ol

Carbon Dioxide Injury and the Presence of Succinic Acid in Apples

RECENT work in this Laboratory[1] has shown that succinic acid may not only inhibit oxidative processes, as shown by earlier workers[2], but also it may be actually toxic to plant material. Succinate supplied to respiring disks of apple peel (in a suitable buffer system at pH 4·1) at concentrations greater than about 0·025 M reduces oxygen uptake and carbon dioxide output, and in a comparatively short time the respiration falls practically to zero and the tissue becomes brown and 'dead'. At this external concentration of succinate the internal concentration is less than 0·001 M.

In normal healthy apples we have found succinic acid only occasionally and in trace amounts in either the peel or the pulp. This does not necessarily mean

Table 1. THE QUINIC, SUCCINIC AND MALIC ACID CONTENT OF THE PULP OF APPLES STORED UNDER VARIOUS ENVIRONMENTAL CONDITIONS

Treatment	Temp.	Days	Quinic (mgm./100 gm. fresh wt.)	Succinic (mgm./100 gm. fresh wt.)	Malic (mgm./100 gm. fresh wt.)	Condition of tissue
Air	37° F.	31	84·0	—	1,221·7	No damage
10 per cent CO_2	37° F.	31	87·5	6·35	1,228·5	No damage
20 per cent CO_2	37° F.	11	89·5	21·0	1,224·5	CO_2 damage
Air	50° F.	90	84·0	Trace	907·8	No damage
20 per cent CO_2	50° F.	90	96·3	1·10	879·5	No damage

that succinate is not a normal intermediate metabolite in the fruit; its turnover-rate may be so high as to prevent accumulation. It was noticed, however, that on paper chromatograms of the acid fractions from apples suffering from incipient carbon dioxide injury (a physiological disease of fruit stored in hypernormal concentrations of carbon dioxide, and resulting in the death of the affected tissue), there appeared a spot corresponding in position to that of succinic acid. A sample of the acid giving this spot was isolated from an extract of 1 kgm. of affected fruit and it proved to be a dibasic acid having an analysis of: C, 40·6; H, 5·3; O_2 (by difference) 54·1 (succinic acid = C, 40·7; H, 5·1). It melted at 185° C., and when mixed with authentic succinic acid produced no lowering of the melting point. The *p*-nitrobenzyl ester had a melting point of 87·5° C. A similar derivative from authentic succinic acid had a melting point of 88·0° C.

Determinations of the amount of the various organic acids present in fruit stored in air and in various concentrations of carbon dioxide at 3° C. and 10° C. (apples are more susceptible to carbon dioxide injury at lower, than at higher, temperatures) were made and the extent of carbon dioxide injury in affected fruit was recorded. The results are given in Table 1.

These results show that carbon dioxide injury is accompanied by an increase in succinic acid in the tissue. It appears that an abnormality of metabolism is induced in the tissue by hypernormal concentrations of carbon dioxide in the surrounding atmosphere which results in an accumulation of succinic acid. This, in turn, it is suggested, kills the tissue.

Further details of this work and its wider implications will be presented elsewhere.

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Nitrogenous Reserves of Apple Trees

WHEN young apple trees assimilate nitrogen, reserve materials are generally laid down in the tissues of the stem and root[1]. Only part of these nitrogenous reserves can be extracted from the stem by exhaustive treatment with 70 per cent (v/v) aqueous ethanol, and a study has recently been made both of the nature of the reserves and of their extraction from the tissues by different solvents.

Amino-acids were separated chromatographically from the tissue extracts by a modification of the method of Moore and Stein[2,3], using ion-exchange resins 'Dowex 50' or 'Zeo-Karb 225'. In this way, arginine and asparagine were identified as the chief nitrogenous reserves; together, they represented 70–80 per cent of the total soluble nitrogen which could be extracted. Arginine alone accounted for more than 60 per cent of the soluble nitrogen in a typical analysis, and, although most of the amino-acids commonly found in plant tissues were present, none of them exceeded 1 per cent of the total soluble nitrogen.

It has also been shown that a large part of the arginine is bound in the tissue, so that it cannot be readily extracted with 70 per cent ethanol. Successive treatments of the finely divided tissue with hot or cold ethanol gave apparent completion of extraction, since the final extract yielded less than 1 per cent of the soluble nitrogen. Nevertheless, further treatment with hot water removed additional soluble nitrogen, amounting to 20–30 per cent of the total. The analyses, summarized in Table 1, indicated that large quantities of arginine were present in the water extract, despite the previous exhaustive treatment with ethanol.

Table 1. EXTRACTION OF APPLE STEM TISSUE WITH 70 PER CENT ETHANOL FOLLOWED BY WATER

	Total nitrogen in extract (per cent)	
	70 per cent ethanol	Water
Arginine	62·0	66·0
Asparagine	15·0	0·3–1·0
Glutamic acid	1·0	
Serine	1·0	
Histidine	0·3	
γ-Amino-butyric acid	0·2	
Alanine	0·2	
Valine	0·1	
Other α-amino-nitrogen	0·3	
Ammonia	0·8	0·6
Other soluble nitrogen	19·0	32·0

Although asparagine and some of the amino-acids were effectively extracted by aqueous ethanol, it is evident that this solvent should be used with caution for quantitative studies of the nitrogenous constituents of plants. In the present experiments, some direct evidence has been obtained that arginine, when added in ethanolic solution to apple stem tissue, is removed from solution, probably owing to reaction with acidic components. Hot water, or sodium chloride solution buffered at *p*H 7, as used by Danielsson[4], appears to be much more effective than aqueous ethanol for extracting the dialysable nitrogenous constituents, particularly when large reserves of arginine may be present, as in apple stems.

A full account of the investigation will be published elsewhere.

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Interaction between Nickel and Calcium in Plants

In the course of an investigation into the toxic effects of nickel on plants, it was found that the calcium content of nickel-toxic oat plants was consistently higher than that of healthy plants[1]. The absorption of other major nutrients, on the other hand, was reduced in the presence of nickel. In contrast, tomato plants showed a reduced content of all major elements, including calcium, when supplied with nickel in toxic amounts. The toxicity symptoms produced in both plants consist of chlorosis (of young leaves) accompanied by longitudinal necrotic striping (oat) or necrotic areas of the older leaves (tomato). Growth is reduced and root development arrested; the roots become brown, with poor secondary-root production.

To investigate whether the effect of nickel on calcium absorption occurs external to the root, in the root, or in the plant, a split-root technique has been applied using oat and tomato in solution culture and radiocalcium (calcium-45) to identify the origin of the calcium afterwards found in the plant.

Four treatments were employed: (1) Whole root system in complete nutrient solution containing labelled calcium; (2) as for 1, with the addition of 2·5 p.p.m. nickel (as the sulphate); (3) root system divided between two compartments containing (*a*) complete nutrient solution and (*b*) complete nutrient solution with part of calcium as calcium-45; (4) as for 3, except that the (*b*) compartment contained 2·5 p.p.m. nickel.

Seedlings were raised in sand and transferred to the differential treatments, where growth was allowed to proceed for several weeks during which time mild symptoms of nickel toxicity appeared. Excessive reduction in growth due to nickel did not take place, although plants with split-roots were slightly smaller than those left undivided. At harvest, yields were recorded and plants divided into young and old leaves, petioles (tomato only), stems and roots. Major elements, iron and nickel, were determined in the dry matter. Calcium was precipitated as the oxalate for radioactive assay and the results used for calculating calcium absorbed after the start of the differential treatments, and further, to identify the calcium absorbed from the (*b*) compartments. Table 1 summarizes the main findings for young leaves.

For convenience, an increase in calcium content following the addition of nickel is hereafter referred to as positive calcium effect. Thus for oats, a positive calcium effect is found in both whole and split-root treatments, the magnitude of the effect being greater in the latter case. Tomatoes show a negative effect for plants with undivided roots and a positive effect where the roots were split. In comparing treatments 1 and 2, radioactive calcium analysis confirms this greater and lesser calcium uptake by oats and tomatoes respectively.

Table 1. Analysis of Young Leaves

		1	2	3	4
		Whole root		Split root	
		Healthy	Ni-toxic	Healthy	Ni-toxic
Ca (per cent in dry matter)	Oats	0·68	0·89	0·71	2·97
	Tomatoes	2·37	1·21	1·28	5·16
Per cent total Ca as ^{45}Ca labelled Ca	Oats	88·0*	95·0	69·0†	27·0
	Tomatoes	90·0	68·0	19·0	8·0
Ni (p.p.m. in dry matter)	Oats	—	60·0	—	49·0
	Tomatoes	—	106·0	—	25·0

* $\frac{\text{Ca absorbed after transfer}}{\text{Ca in seedling + Ca absorbed}}$

† $\frac{\text{Ca absorbed through } b \text{ roots only}}{\text{Ca in seedling + Ca absorbed through both sides of root system}}$

The relative uptake of calcium through the 'no-nickel' and the 'nickel' half-roots (*b*) can be deduced from a comparison of treatments 3 and 4. Compared with the earlier results for the nickel–calcium interaction, radioactive analysis yields the additional information that for both plants the greater part of the increased calcium content of the leaves was absorbed through the 'no-nickel' side of the root system. As would be expected, the nickel content of the leaves was reduced in the treatments in which nickel was supplied to only half the root system.

The injured appearance of nickel-toxic roots seems to provide a valid explanation for the reduced leaf content of major nutrients; but it is difficult to advance reasons for the increased calcium absorption by such roots, as occurs for oats in treatment 2. In the plants of treatment 4, however, the bulk of the calcium in the leaves has been absorbed through the undamaged part of the root system (although a positive calcium effect still holds for the nickel-toxic part of the root system).

The present results suggest that two opposing phenomena may be occurring simultaneously when nickel is absorbed by plants: (1) the roots are damaged and the absorption and translocation of all major nutrients are reduced; (2) nickel in the leaves, by some unknown mechanism, increases the absorption of calcium by the roots. Different plants may show these effects in differing degree; in oats (2) will be predominant, while in tomatoes (1) predominates until nickel reaches the top of a plant which has not had all its root system exposed to nickel.

Preliminary experiments on a range of about twenty common crop plants have shown the majority to have a zero or a negative calcium effect similar to tomato. Among the cereals, maize shows a positive effect while wheat and barley do not. Certain root crops, namely, red beet, sugar beet and swede turnips, show a positive effect to a marked degree. These plants show an extreme susceptibility to nickel toxicity[2]; but other highly susceptible plants such as sunflower do not show a positive calcium effect. Reversal of the calcium effect from negative to positive has also been shown for mustard, by the split-root technique.

Until now, nickel, in common with other heavy metals supplied in excess to plants, has been recognized to interfere in iron metabolism[3-6]; the tacit assumption being that nickel or other heavy metal replaces iron in some complex essential to normal nutrition. The results now obtained suggest how nickel may affect processes within the plant. It seems possible that organic acid metabolism may be affected in nickel-toxic plants and that the state of solubility of calcium in the tissues may be altered by increased production of oxalic acid, for example.

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A Model for manipulating Spirals

DARLINGTON[1] suggested that the coiling systems encountered in chromosomes are determined by spiral structures at the molecular level. Interest in the replication of spirals and in the separation in double spirals has been renewed recently[2-4] following proposals of helical structures for deoxyribonucleic acid[2] and for various proteins[5]. Some of the difficulties in the disentangling of twin spirals are simplified if the spirals are free to rotate about their axes, as may be demonstrated using the simple model here described.

The model consists of a stand holding parallel glass tubes which are free to rotate. In the model (Fig. 1) the stand is built of 'Meccano' parts and the three glass tubes are stoppered with rubber bungs into which small axles are inserted; they are linked together by a system of gears so that they all turn in the same direction at the same speed. Cotton tape is used for the spirals.

In the simplest manipulation, a single spiral wound about one rod, with its free end attached to an adjacent rod, is transferred to this rod when both are rotated. Other manipulations are based on this principle.

A double spiral on the centre rod, with free ends attached one to each of the side rods, is resolved into two single spirals by simple rotation, as shown in Fig. 1. If this process is thought to apply to structures of the Watson and Crick type, it would be necessary for new complementary chains to form simultaneously on the separating chains in order that two new helices be produced (Fig. 2*A*).

Two double spirals on a single rod can be separated one from another by a manipulation analogous to that shown in Fig. 1, or if the ends are appropriately arranged, they may be separated with exchange of partners as shown in Fig. 2*B*. With exchange of partners, double spirals of different constitution from the originals may be produced.

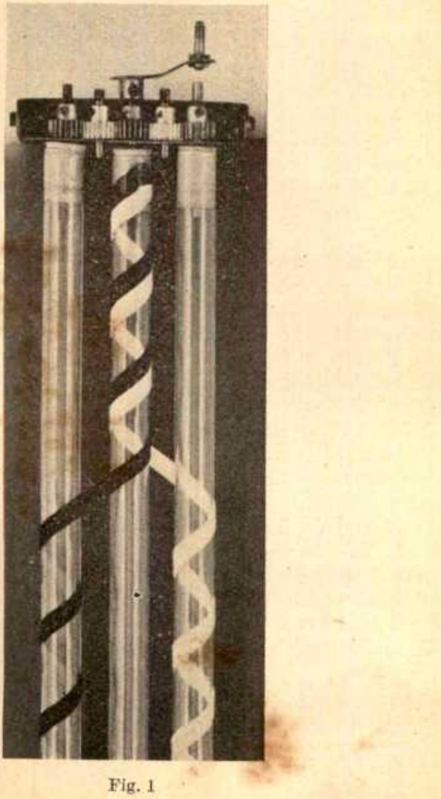

Fig. 1

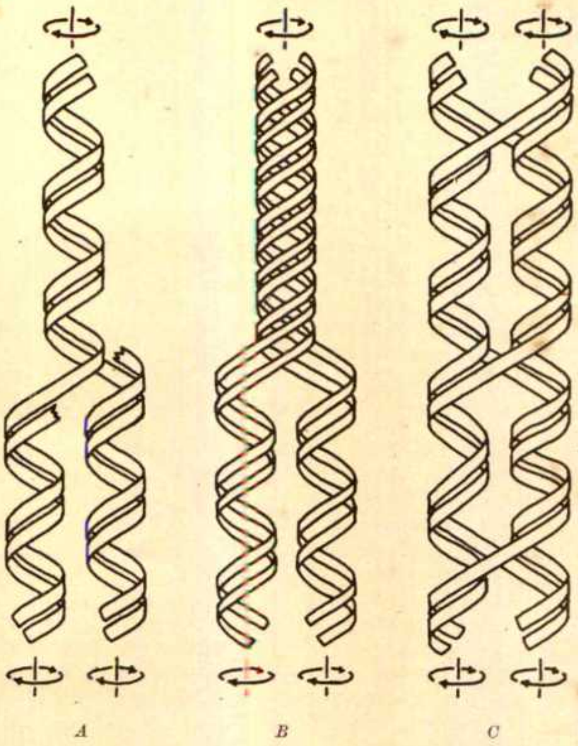

Fig. 2

Double spirals on adjacent rods may be made to change partners by simple rotation. Rotation may be interrupted and the free ends rearranged so that two or more exchanges can be effected (Fig. 2*C*). With the model it is possible to produce spiral systems resembling those postulated by Darlington[1] and others to account for crossing-over in chromosomes at meiosis. In Fig. 2*C*, where all possible exchanges between double spirals are shown, it may be seen that the pitch of the participating spirals must be varied slightly for this to occur. With non-flexible spirals, or with helices of the Watson and Crick type (formed of complementary chains), only certain exchanges are possible.

Continuous formation and separation of products from a template, as proposed by Dalgleish[6], can also be effected when the template and its partially formed products are spirals, by a similar process of rotation.

If it is considered that the original spiral in any of the foregoing examples is not free to rotate, the manipulations are still possible if the new or growing spirals are allowed to turn epicyclically about the original.

Adjacent spirals, with their axes close together so that one fits into the other, may also be manipulated by rotation. With systems of parallel spirals it is conceivable that an interlacing network or mesh may be formed by simple rotation.

Processes of the type here described are reversed when the direction of rotation is changed. With rotation some tendency to forward movement through the surrounding medium is to be expected. Apart from this, rotation permits a wide range of manipulation with a minimum of displacement in the structures concerned.

Financial assistance from the National Research Council of Canada is acknowledged.

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Dislocation Models in 1902 ?

ONE of the attractive aspects of the theory of dislocations is the extent to which simple mechanical models may be used for demonstrating the basic concepts. Of such models the bubble raft assembly of Bragg is perhaps known to the widest lay audience, and, while it is probably stating the obvious to say that such a model is of real value only against the background of the *concepts* of dislocation theory, it is, nevertheless, very interesting to find published illustrations of such a model which date from 1902.

Figs. 1 and 2 are to be found on pp. 12 and 13 of the printed version of the Rede Lecture, delivered on June 10, 1902, by Osborne Reynolds and printed by the Cambridge University Press. Osborne Reynolds was professor of engineering in the Owens College, Manchester (later incorporated in the Victoria University of Manchester), during 1868–1905; during those years he completed the researches—on the mechanical equivalent of heat, on high-lift pumps, on lubrication and, of course, on streamline and turbulent flow in fluids—with which his name will always be associated. Reynolds's lecture for 1902 was entitled "On an Inversion of Ideas as to the Structure of the Universe" and, dealing as it does with the "granular structure of space", seems at first sight to be out of the main stream of contemporary scientific thought.

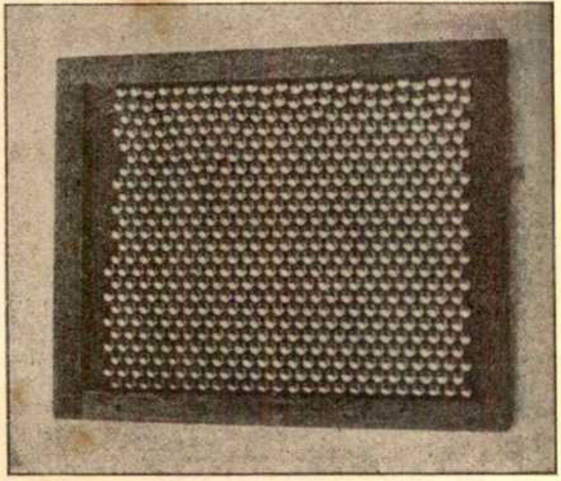

Fig. 1

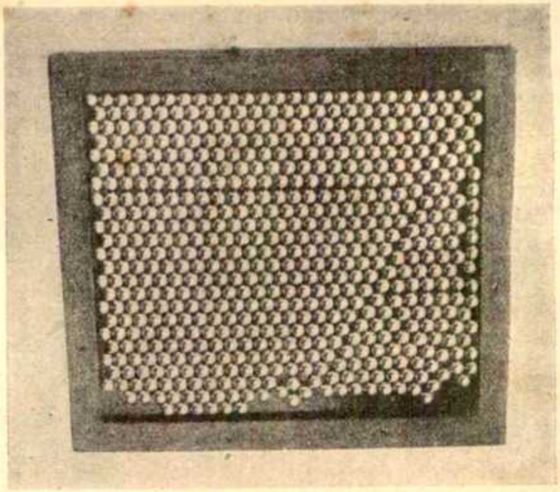

Fig. 2

A close study of the text of the lecture, however reveals that the dislocation models, far from being merely fortuitous, spring from a clear intellectual concept. Reynolds is at considerable pains to distinguish between the close-packed regular piling of Fig. 1, for which the application of a "strain" (*sic*) would not allow any change of neighbours in the array, and the abnormal piling of Fig. 2 in which because of the "abnormal gearing of the grains", an imposed "strain" may produce "relative motion of the grains and render(s) the medium elastic" (pp 12–13). (We should to-day prefer to write "stress" and "plastic" rather than "strain" and "elastic"; but the meaning is clear.)

It is evident that the correlation between Reynolds's models of regular and dislocated close-packed arrays and the bubble models of modern dislocation theory is no merely superficial similarity and, indeed both models stem from the same fundamental idea namely, the great strength which would be expected of a perfectly packed array of spherical particles That Reynolds's particles are not atoms in no way minimizes the validity of his basic concept.

The later pages of the lecture contain assertions on the nature of electricity and gravitation and on the propagation of light which read curiously to-day but there are phrases which bring one up with a start "Such motion has all the character of a wave in the medium ; and that is what the singular surfaces which we call matter, are—waves. We are all waves"

Finally, Reynolds returns to a demonstration of those extraordinary properties of sand which he had first described as "dilatation" in 1875. These phenomena, which were correctly ascribed to the different modes of packing of granular particles, have quite recently sprung into prominence again with the development of the new science of soil mechanics But to Reynolds they had a far wider significance and they led him to those speculations on the nature of the physical world which he described in the Rede Lecture. This, to him, was his greatest work, and when he sat to Collyer he chose to be portrayed holding a bowl of marbles ; perhaps he was right.

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APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Senior Lecturer in Physical Chemistry—The Registrar, Nottingham and District Technical College, Shakespeare Street, Nottingham (August 4).

Scientific Officer (male) at the Brown Trout Research Laboratory, Pitlochry, for duties chiefly connected with salmon research—The Establishment Officer, Scottish Home Department, Room 364, St. Andrews House, Edinburgh 1 (August 4).

Lecturer in Anatomy—The Registrar, The University, Manchester 13 (August 7).

Physicist (with a good honours degree or equivalent) at the National Coal Board's Coal Survey Laboratory in Cardiff, to initiate studies of the physical and mechanical properties of South Wales coal seams—The National Coal Board, Staff Department, Hobart House, London, S.W.1, quoting SS/335 (August 7).

Assistant Lecturer (preferably with interests in applied mathematics) in the Department of Mathematics—The Secretary, University College, Gower Street, London, W.C.1 (August 10).

Lecturer in Education at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, August 15).

Head (with high academic qualifications, preferably an honours degree in mining, practical mining experience, and teaching experience, preferably in a Technical College or a University) of the Mining and Geology Department—The Principal, Wigan and District Mining and Technical College, Wigan (August 17).

Research Assistants (2) (one with a good science degree in physics or physical chemistry) for investigations in selective flotation; (and the other with a degree in science or engineering) for research on the hydraulic transport of coal—The Registrar, The University, Leeds 2 (August 17).

Physicists and Mechanical Engineers (with a good honours degree or equivalent), to lead and engage in research work of national importance to increase coal production, concerned with fundamentals of methods of extracting coal from seams, strata support, conveying coal to the pit bottom and environmental conditions—The National Coal Board, Mining Research Establishment, Worton Hall, Isleworth, Middlesex, quoting SS/348 (August 21).

Professor of Psychology—The Registrar, The University, Reading (August 24).

Senior Lecturer (with experience in research and teaching in one of the following fields: mycology, algology or anatomy) in Botany at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, August 28).

Lecturer, Grade II (with an honours degree in engineering, together with practical engineering experience and an interest in research), in Mechanical Engineering—The Registrar, The University, Birmingham 15 (August 31).

Lecturers (3) in the Department of Pharmacy at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, August 31).

Senior Lecturer in Pharmacy at Rhodes University, Grahamstown, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, August 31).

Senior Lecturer or Lecturer (with special qualifications in mining geology and geological surveying) in Geology at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, August 31).

Chair of Geography at the University of New England, Armidale, New South Wales, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, September 3).

Assistant Librarian (graduate) at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (September 6).

Lecturer or Assistant Lecturer (with qualifications in the realm of mathematical analysis) in Pure Mathematics—The Registrar, The University, Hull (September 15).

Reader in Mathematical Analysis at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, September 15).

Chair of Agriculture at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (September 30).

Reader in Pure or Applied Mathematics at the University of Oxford—The Secretary of Faculties, University Registry, Oxford (October 31).

Assistant (Grade A) to teach pure and applied mathematics; and an Assistant (Grade A) to teach physics—The Principal, Technical College, Queen Street South, Huddersfield.

Assistant (Grade B) in the Department of Mathematics, The Technical College, Bradford—The Director of Education, Town Hall, Bradford

Assistant Lecturer, Grade B (with an honours degree in mathematics and capable of teaching practical mathematics to the standard of the higher national diploma in engineering) in the Department of Mathematics, College of Technology and Commerce, Cardiff—The Director of Education, City Hall, Cardiff.

Assistant Physicist (Basic grade) at the Regional Radium Institute, Bradford—The Secretary, Royal Infirmary, Bradford.

Assistant to the Chief Technician—Prof. T. L. Bywater, Department of Agriculture, The University, Leeds 2

Assistant (with a first- or second-class honours degree in biochemistry or pure chemistry) in the Department of Biochemistry—The Secretary, The University, Edinburgh.

Bio-Physico-Chemical Technician (preferably with preparative and analytical experience), for research on nucleic acid—The Medical Research Council, Biophysics Research Unit, King's College, Strand, London, W.C.2.

Electrical or Mechanical Engineer (with a first- or second-class honours degree or equivalent qualification in electrical or mechanical engineering) at a Ministry of Supply Research and Development Establishment near Sevenoaks, Kent, to assist in the basic development of mechanical and electromechanical devices for projectiles and rockets—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.286/6A.

Graduate Chemists for fundamental and applied research in organic and physical chemistry—The Director of Research, British Rubber Producers' Research Association, 48 Tewin Road, Welwyn Garden City, Herts.

International Tin Research Council Research Scholar (honours graduate in chemistry or with equivalent qualifications) for work on mechanisms of reactions of organo-tin compounds—The Registrar, University College, Leicester.

Joseph Lucas Research Fellow (with an honours degree in metallurgy, chemistry or physics) to investigate the structure and metallurgical properties of electro-deposits—The Registrar, The University, Birmingham 15.

Lecturer (Grade II) in Physical Metallurgy—The Registrar, The University, Birmingham 15.

Lecturer in Agricultural Chemistry—The Principal, Seale-Hayne Agricultural College, Newton Abbot, Devon.

Lecturer (with a good engineering degree and some experience in industry and research) in Mechanical Engineering—The Registrar, Queen Mary College (University of London), Mile End Road, London, E.1.

Lecturers (2) (with experience in some field of applied physics, for example, electronics, solid state physics, vacuum technology, applied) in the Physics Department—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

Physicist or Electrical Engineer (with an honours degree, some research experience, and a working knowledge of electronics) in the Physics Department, for work on a problem in ultrasonic propagation—The Registrar, University College, Leicester.

Research Fellow or Research Scholar (qualified in mineralogy and petrology) in the Department of Geology, to work on specific Antarctic problems and on material provided by the Falkland Islands Dependencies Survey—The Registrar, The University, Birmingham 15.

Senior Mathematics Master—The Headmaster, St. Peter's School, York.

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Telephone Number Whitehall 8831. Telegrams. Phusis Lesquare London

Annual subscription £6, payable in advance,
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Advertisements only should be addressed to
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Telephone Number: Regent 3891

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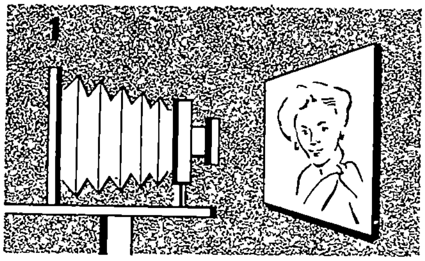

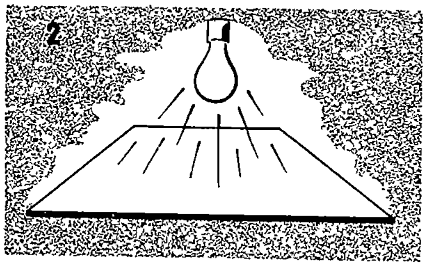

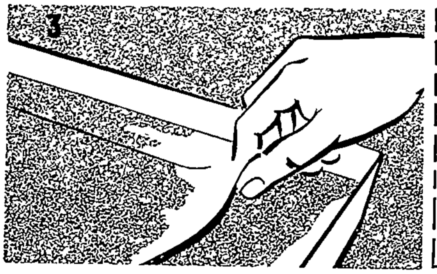

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INDUSTRIAL LEADERSHIP AND EDUCATION

FOLLOWING on an admirable article, "Trade Unions To-day", in the *Round Table* last December, the *Political Quarterly* devoted the whole of its January–March number to the examination of trade union problems, the contributors including some whose work, like that of B. C. Roberts in "Trade Union Government and Administration in Great Britain" and H. A. Clegg in "General Union", has already thrown fresh light on the problems that confront British trade unions in the Welfare State with its full employment. These studies testify o the need for change in the structure and even in he functions of the unions if they are to adapt themelves to serve effectively the needs of the day. They indicate no less emphatically that change and adaptation must come as a result of inquiry and pressure from within and not from without; though criticism from without can point to weaknesses and may advance constructive suggestions for reform, and it can help to create the understanding and limate of opinion which favour reform. The *Round Table*, for example, points out that the need to accept the duties and responsibilities of full employment falls upon the unions, and the passing of power into the hands of the trade unions is a fact that must be accepted. The utterances of responsible trade union leaders regarding automation itself have shown hat this is fully recognized by them, and that they are also aware that there are certain economic laws hat they must not neglect. But while the leaders may have shed doctrinaire views, they have as yet largely failed to induce their members to accept the responsibility for co-operating to the full extent with management in increasing the rhythm of production from which all demands must be met. This co-operation is a prime condition if we are to enjoy he benefits which automation offers, and it is a grave weakness in the report from the Department of Scientific and Industrial Research that it appears o lay the responsibility solely on the side of management. On the contrary, the challenge of prosperity which automation offers must be accepted by the rade unions also, and dealt with by them in terms of efficient production as the *Round Table* suggests.

The *Round Table* outlines a positive policy for the rade unions which contrasts sharply with the silence of the Department of Scientific and Industrial Research. The unions, it suggests, should co-operate o the maximum in acquiring industrial techniques to maintain increased standards of living, and should accept responsibility for introducing modern schemes of reorganization and reconstruction that mean re-deployment of labour, re-assessment of tasks and alterations in the status of jobs. The unions, it is emphasized further, should discard the untenable heory that we can enjoy increased standards of iving with decreased or static production-levels; but hey should insist on the maximum possible share for the producer in our expanding economy. Union policy and constitutions should be examined with the view of eliminating customs and practices which prevent work becoming easier and new production methods being adopted, and should insist on the elimination of malpractices of employers in this sphere. Further, while the trade unions should retain their power to secure the fulfilment of the just and fair demands of their members, they should equally remember that trade unionists are members of the community and that their rights are conditioned by the rights of others.

These ideas are largely reflected in the contributions to the *Political Quarterly*, the most important of which are those which address themselves to the practical problems of the ways in which the trade union organization can be adapted to enable the unions to meet their new responsibilities and to throw up leaders capable of displaying the economic statesmanship of the highest order that is now demanded on so broad a front. Mr. B. C. Roberts, for example, points out how much depends, in a democracy like that of Britain, on the willingness of the trade unions and the employers' organizations to face the issues that the Welfare State has posed. The whole future of the Welfare State depends on the ability to overcome the inflationary spiral which now afflicts the economy by increasing the volume of goods and services or by reducing purchasing power; and there is urgent need to change industrial wage structures in the light of technological developments and in the interest of obtaining higher rates of production. Whether the existing system of collective bargaining is capable of achieving the changes required may be doubted, and Mr. Roberts suggests that possibly a more radical approach may be required, such as agreement by the unions to a less centralized system for determining wage-rates. Again, he points out that technical developments in industry, the growth in complexity of trade union functions and the increase in size of the unions have placed increased responsibilities on trade union leaders, whose task is rapidly becoming a professional occupation, demanding a high degree of skill such as can only be obtained by experience and training. While, however, the selection of trade union officials, their tenure of office, remuneration and opportunities for promotion have become, at least in the large organizations, matters of crucial importance, many trade unionists are still reluctant to examine the implications of these questions. The fear of bureaucratic control is justifiable, and it is clear that there is often a lack of understanding between headquarters and the local branches and rank and file of a union, while the national prestige of the Trade Union Congress is not matched by the power of its General Council, which cannot compel an affiliated organization to follow the policies it wishes to see adopted.

Here again it is a question of influence rather than power, in which the character and personality as well as the administrative capacity of the trade union official are all-important. Increasingly he requires exactly those qualities which, as the Acton Society Trust's recent inquiry has shown, industry is more and more finding in those who have entered from the university or grammar school, rather than among those who have risen from the factory floor to management status.

This tendency is an inevitable consequence of the broadening of educational opportunity, and the present distrust of the college-trained trade unionist and feeling against an educated *élite* must disappear in the unions, as they have largely done in industry, if the unions are to secure the talent they need to render their members and the community the service now required of them.

To this problem Mr. H. A. Turner's article on trade union organization and especially Mr. J. A. Mack's article on trade union leadership are devoted, though particular aspects of it also appear in those in which Mr. Clegg discusses the problem of strikes and Mr. Guy Revitt the structure of collective bargaining. Mr. Turner is concerned with questions of size, and touches on those difficult demarcation issues which automation is likely to accentuate. He indicates the need for regrouping and for decentralization as unions and amalgamations grow in size; but it is equally clear that any such measures make large demands on leadership, both at the national and at the regional or local level. It is brought out even more clearly by Mr. Mack, who, moreover, points out that the present confusion in the British trade union movement is derived directly from the failure of union leadership to exercise the responsibilities which are a condition of the proper use of the growing power of the unions, at least on the theory which has sustained the development of the movement for the past thirty years.

Mr. Mack remarks that the leaders are for the most part singularly unaware of the disadvantages under which they labour. While on the whole the unions get the best men available, he quotes Mr. Roberts's verdict, in "Trade Union Government and Administration in Great Britain", that the work of the union official produces tough, self-reliant, pragmatic individuals, men of courage and determination, who better than most know how to take a decision and stand by it. Their self-confidence makes them determined advocates and excellent negotiators, but contrasts sharply with the more sophisticated approach of the politician to problems, and accounts for the contempt they sometimes display to those who have been trained in a more intellectual school. It also accounts for a disposition to let things run, to solve their problems of organization as they arise and to resist any attempt at a major reconstruction of the relations within the individual unions and between unions.

These practical problems of reorganization, however, are becoming more pressing. The fundamental autonomy of the British trade unions in the wider society is not yet even threatened. The formation of the Peoples League for the Defence of Freedom and the activities of the Free Press Society out of which it has grown, as well as the pamphlet, "Spotlight o Trade Unions", recently published by the *Dail Mirror*, are pointers to which the trade unions woul be wise to pay attention. The preservation of th autonomy of the unions is bound up with thei capacity to maintain internal law and order, and t improve the economic and industrial status of thei members without wrecking the national economy.

While most of the leaders may now be prepared t accept the new responsibilities, that will only b reflected in the policy and practice of the unions i so far as there is closer contact and understandin between the leaders and the ordinary member Education is likewise the key to the removal of thos problems which dissensions among the unions create As the *Round Table* emphasized last December, th leaders must increasingly address themselves to th education of members in the facts of modern life.

To a limited extent some of this educational work the importance of which has become even mor apparent in the recent issues raised by automation could be done outside of the unions. It is only likel to be fully effective if it is also undertaken fro within, and it is one of the most important of th ways in which trade union leaders can help to dea with the problems which automation involves. I they are to do this effectively, however, and assis the unions to make the contribution to the increas of productivity that they alone can give, it is increasingly important that the unions should dra into their leadership a fair share of the best abilit available.

This means, as has been indicated, that the union must give increasing attention to the recruitmen and education of their officials. If closer contact an understanding between the official and the ordinar member are needed, it is no less essential that ther should be close contact and understanding betwee the official and the managers, Civil servants, Minister and others with whom he is increasingly required t co-operate as well as to negotiate. He must be abl to meet them on level terms, and he cannot do s unless he has the scientific and technical knowledg which are demanded in industrial and economi decisions to-day.

Here, then, the question of the function of th trade unions to-day, and their reorganization to mak their full contribution to the welfare of their member and of the community as a whole, is linked up wit the expansion of technical and technological educatio and with educational policy as a whole. In so far a technical and technological education is planne to provide industry with the leaders it needs, it mus provide leadership for the unions as well as executive for industry. Moreover, co-operation as well as th provision of such leaders will be increasingly facilitate in the measure in which leaders in the unions an managers and executives in the factories hav received part at least of their training side by side In the range of courses which are offered, whethe by the university, the college of technology or th technical school, there should be opportunities fo the trade unionist leader to acquire the new knowledge and skills he needs, as well as for the tech ologist or the manager to refresh his mind or extend ıe range of his knowledge. Refresher courses and ourses of training for management should be framed rith such possibilities in mind. Similarly, the trade nions must increasingly seek to attract into their ervice some of the ablest minds which the univerities and other institutions can put at their disposal.

It is with such issues as these that the Government hould be showing concern. There has as yet been ttle sign that it has a concerted policy, or that it is repared to take the measures that will be required o win support for an adequate policy of technical ducation, including education for management as ell as preparation of the community for educational hange. It is a Government responsibility to see hat the educational policy of Britain provides ffective safeguards against the ignorance and rejudice which are the most dangerous saboteurs of evelopment and industrial efficiency and prosperity. 'o dispel misconceptions, to establish confidence and o promote adaptability are the first objectives to hich the Government should now be directing its ducational and its economic and welfare policies. here is much to be done ; but the Prime Minister's tatement on June 5 on economic policy and autoation gave little hint that the Government is aware f the needs.

PLASTIC BEHAVIOUR AND DESIGN OF STEEL-FRAME BUILDINGS

he Steel Skeleton
y Prof. J. F. Baker, M. R. Horne and J. Heyman.
ol. 2 : Plastic Behaviour and Design. Pp. x+408.
ambridge : At the University Press, 1956.) 63*s*. net.

DESPITE the fact that the word 'design' appears in the sub-title of this volume, the steelwork esigner might, at first glance, imagine that there is ttle here for him. This, however, would be an roneous impression, for it has never been the ıstom of Prof. J. F. Baker's team to consider an egant theory as an end in itself. Theory and design re complementary and, in this book, their interlation has been taken for granted—so much so that nportant rules of design are in one instance buried a sub-section. The designer certainly will find lequate guidance in designing steelwork by the lastic method ; but he must be willing to relate ıeory to design, and not expect to find routine rocedures handed to him ready-made.

This volume brings the story of Vol. 1 (see *Nature*, 74, 1026 ; 1954) up to the present day. The Bristol ıd Cambridge researches are fully described ; but any structural engineers, alive to recent developents, must already know the story, as it has ppeared over the years in various technical journals. is an instructive tale to those who have yet to ad it ; but most will turn with a sense of satisfaction Chapters 7 and 8, where fundamental theorems and eneral methods of analysis, respectively, are disussed. Here are the roots of the matter.

The latest developments of plastic design are conidered in the chapters on 'shakedown' and on inimum-weight design. 'Shakedown' refers to colpse under live and dead loads which are independently variable, and the true economy of design is discussed in the second of these chapters. Although it was possible, in the early days, to check plastic theory for shed-type frames by full-scale tests to destruction, it is clearly out of the question to attempt the same procedure with multi-story frames. The behaviour of beams and stanchions in such structures can be predicted only from separate small-scale tests and by logical deduction from the results so obtained.

The 'question marks' or points which are still debatable are, therefore, mostly related to the behaviour of stanchions, and, in the book, a careful survey is made, in three chapters, of all the relevant experimental and theoretical data. The forty-five different types of loading to which a continuous stanchion might be subjected are examined, and nine of the most likely more closely studied. Even this simplification leaves a very wide and complex field in which work remains to be done. Perhaps the other 'question mark'—that of the behaviour of joints—might have had more mention, but knowledge on this point is scarcely yet at the text-book stage.

Few people during the Second World War knew, as they lay in their Anderson table-shelters, that they were taking part in a test of the principles of ductility and continuity, as applied to structural design. Chapter 17 describes how from the early success of these shelters, which were the first practical structures designed by the plastic theory, grew the two hundred buildings that have proved the effectiveness of the method. It was the frame of a cinema in Bristol which raised the early queries in the minds of Prof. Baker and his colleagues, and it is perhaps fitting that one of the first multi-story frames designed by the new method should be erected in London for the firm of Technicolor, Ltd.

We are still in the early stages of this new development. Progress is likely to be slow if steel designers and fabricators remain too conservative. Visiting American architects admired the slender unity of Hunstanton Secondary School—the first multi-story frame by the plastic method. We should remember that the advance described in this volume is a British development : British architects and structural engineers should be the first to use its advantages. Certainly to the architect the plastic method opens wide opportunities for new structural shapes in steel, and, even if he cannot follow the mathematics, he will find the chapters on load factor and on application and design of real professional value. To the structural engineer this book is of vital importance. He neglects it at his peril unless he is close to retirement. This is the stuff of the future.

W. FISHER CASSIE

W. A. LANE: A GUY'S SURGEON

Sir William Arbuthnot Lane, Bt.
An Enquiry into the Mind and Influence of a Surgeon.
By T. B. Layton. Pp. viii + 128 + 8 plates. (Edinburgh and London : E. and S. Livingstone, Ltd., 1956.) 21*s*. net.

THIS is a remarkable little book which will be of interest to the large number of surgeons of this generation to whom Lane is known only because his name is attached to certain beautifully designed instruments, and who must therefore wish to know more of the man and his work. The book is dedicated to all Lane house-surgeons; but it is bound to be welcomed by all old Guy's men who, though they may not have served him as housemen, may have dressed for him or otherwise come under his influence in their student days. It will also be read with care by those who, having listened to Lane's disciples, have been puzzled by a certain reserve or qualification in their tributes to his memory. “He was such a good technician that he was able to get away with methods in which others couldn't follow him, and that's why he was so criticized”—a remark of this nature calls for an explanation, and Mr. T. B. Layton's inquiry is most helpful in elucidating the mystery which has long surrounded Lane's work and even his reputation.

Lane's father was an army surgeon, and his childhood was spent in many parts of the world as the young family followed the regiment on foreign service. It is clear that from his earliest years Willie had to take responsibility and fend for himself; though he grew up rather a shy young man, he must have learned independence and self-confidence from his early experiences. As a student at Guy's Hospital he made few friends, partly perhaps because he never had much money to spare for entertainment and recreation. There must have been some such explanation for his rather isolated existence, because later in life he took great delight in entertaining large parties at home, and was one of the first surgeons in London to welcome visitors to his operation theatre.

He entered surgery through the dissecting room, where he devoted special attention to the structure of bone and the mechanics of joints. He was particularly interested in anatomical changes in spinal joints which resulted from occupational stress; and his study of the handicap which a fracture might inflict upon a working man made him severely critical of the orthodox methods of treatment and provided the incentive to improve the results. This led to his outstanding work on the treatment of fractures by open operation and internal splinting.

As a technician he was supreme, and realizing the harm which antiseptics could do in a wound, he introduced his aseptic methods, using long sterile instruments and never touching anything which went into the wound. Mr. Layton's thoughtful and thorough inquiry into the reasons why Lane adopted this technique has not produced a very satisfactory answer. It is clear that “he did not know much if anything about bacteriology”, and this must account for his persistent inability to distinguish between the risks of operating upon open as distinct from closed fractures. We know that he refused to learn from the past; but it is a shock to read that he was unable to learn from his own experience. His contemporaries must have recognized this failing, and their severe criticism of his practice of operating on every closed fracture is therefore readily understandable since it must have appeared to them to be just another error of judgment.

His interest in fractures arose out of sympathy with the working man, and his interest in the colon arose “out of sympathy with a particularly sad type of female patient whose chief complaint was pain in the lower part of the trunk”. Lane's interest in physiology was “relatively small”, but he was an evolutionist with a great interest in “vestiges” and conceived the idea that the whole large intestine was a “vestige”. At any rate it could be harmless only if it was empty, for its contents made people “toxic”, and it was on this assumption that he based his advocacy of colectomy. Sir Arthur Keith summed up his lack of scientific background in the remark: “I should hardly call him a clever man. He was emotional and highly strung; a man of feeling”.

Lane was distinguished not only for his technical skill but also for his exemplary behaviour toward his assistants, including his nurses who were devoted to him, and to his patients. He was always self-controlled, dignified and honourable. He set very high standards for himself and for his team; bu although he did not overlook faults in others, neithe did he try to shelter himself behind his subordinate when things went wrong. Many of those around him realized that they were being “mesmerized”, but they could forgive him his faults because, as Sir Coope Perry said of him, “with it all he was such gentleman”.

J. Paterson Ross

DIELECTRICS

Dielectrics and Waves

By Prof. Arthur R. von Hippel. Pp. xii+284. (New York: John Wiley and Sons, Inc.; London Chapman and Hall, Ltd., 1954.) 128*s*. net.

Dielectric Materials and Applications

Edited by Prof. Arthur R. von Hippel. (Technology Press Books in Science and Engineering.) Pp. xii+438. (Cambridge, Mass.: Technology Press of the Massachusetts Institute of Technology; New York John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1954.) 140*s*. net.

PROF. A. R. VON HIPPEL is very strongly against the view that as science advances the scientists have to become more and more specialized He is convinced that exactly the opposite is the case as our knowledge grows, old boundaries vanish and no scientist can afford to ignore what happens in fields outside his own. Dielectrics is a particularly suitable subject to demonstrate the interdependence of the various branches of science as it is of interest to so many people—to the physicist, chemist and electrical engineer, to the pure and applied research worker and the development engineer alike. To make these people feel at home with each other is the principal aim of these two books.

The first book, “Dielectrics and Waves”, was written by von Hippel alone, and deals with the fundamental aspects of the interaction of dielectrics with electromagnetic waves. The first part of this volume gives an account of the macroscopic theory of polarization, magnetization and dielectric loss while the second part develops the atomic theory o dielectrics, in particular the foundation of wave mechanics, the structure and energy-levels of the atoms and the spectra of atoms and gaseous molecules.

In contrast to atoms and gaseous molecules liquids and solids are treated in rough outline only a few selected topics, such as ferro-electricity and piezo-electricity, are discussed more thoroughly

The presentation is very good. Although the author often goes into considerable detail, in particular where atoms and molecules are concerned and does not attempt to hide all the difficulties, the book nevertheless makes pleasant reading. There are a few passages likely to lead to misunderstanding There is, for example, a statement at the beginning of Chapter 24, from which those not acquainted with the subject are bound to conclude that in a consider-ble number of molecules the atoms are held together ainly by Van der Waals forces. The reader may lso come to false conclusions concerning the internal eld, as the Clausius–Mosotti equation is given far oo much prominence. Although it is pointed out at there are some objections to this equation and e alternative Onsager formula is also discussed, evertheless many readers may get the impression at the validity of the Clausius–Mosotti formula is uch wider than it actually is. This idea has led to any mistakes in the past and it should be disouraged.

Apart from minor criticisms of this type, a great ariety of readers will find the book instructive and seful. There is every reason for hoping that the uthor will meet with considerable success in his ain aim, namely, in helping the physicist, chemist nd electrical engineer to understand one another nd in making them interested in each other's work.

The second book, "Dielectric Materials and Appliations", is based on papers presented at a symposium. t starts with a theoretical introduction by von ippel which, on the whole, is a very much shortened ersion of the contents of the first book. The rest f the second book, consisting of papers by twentyne different contributors, deals with a great variety f practical aspects connected with dielectrics, ncluding measuring techniques, dielectric materials sed in all sorts of electrical equipment and devices, om power cables to memory devices, and there are so three papers on the dielectric requirements of e American army, navy and air force. The book so contains very extensive tables on dielectric data. nybody who wants to acquaint himself with the roblems arising in the practical applications of ielectrics will find this book an excellent introuction to the subject.

B. SZIGETI

APPLIED SOLAR ENERGY

oceedings of the World Symposium on Applied Solar Energy

hoenix, Arizona, November 1–5, 1955. (Sponsored The Association for Applied Solar Energy, Stanrd Research Institute, University of Arizona.) Pp. 4. (Melno Park, Calif.: Stanford Research Initute, 1956. Copies available from the Association r Applied Solar Energy, Phoenix.) 5 dollars.

THE scope of this first World Symposium on Applied Solar Energy has already been described some detail in *Nature* (177, 110; 1956), and in viewing the proceedings only brief mention will be ade of the contents. The volume consists of twentyur main papers delivered at the Phoenix Conference, d includes the opening remarks by Lewis W. ouglas, the welcoming luncheon address by Sir lward Bullard, and the banquet address by John y Hopkins, "Towards a New Heaven and a New rth". There is also a record of the panel discussions solar house heating, architectural problems, and e future of applied solar energy. A description of e Solar Engineering Exhibition is included.

The general extent of applied solar energy research now well known and includes low-grade heat plications such as water and house heating, cooking, ter distillation, high-temperature solar furnaces, chanical and electrical power, refrigeration, cheml energy conversion and artificial cultivation of algae. All these applications are described in considerable detail by experts who have personally conducted research in the particular field concerned, and together the papers give a comprehensive picture of the present position. It is perhaps the future possibilities that will most interest the general reader. Economics is the controlling factor, and careful design is necessary to reduce the equipment to the most simple form. The introduction of new materials and methods of construction will greatly reduce the capital cost of equipment. Applications are mostly limited to regions of high solar radiation, and in such localities solar energy could be integrated with existing forms of energy supply. The greatest scope lies in countries which are located in lat. 20°–40° N. and S., and which are at present industrially undeveloped. Solar energy must in the future fulfil an essential need in such areas as development and research proceed.

The promoters of the Symposium are to be congratulated on producing in a relatively short time a volume which is very well printed and clearly illustrated, and which comprises so much interesting information on the subject.

H. HEYWOOD

NUCLEAR ENGINEERING

Principles of Nuclear Reactor Engineering

By Samuel Glasstone. Pp. ix+861. (London: Macmillan and Co., Ltd., 1956.) 60*s*. net.

THE earlier work, "The Elements of Nuclear Reactor Theory", in which Dr. S. Glasstone collaborated with Dr. M. K. Edlund, has become a standard text-book for the rapidly growing number of nuclear reactor engineers. To say that my immediate reaction to this newer work by Dr. Glasstone was one of disappointment is not to belittle the book, which is the most complete of its kind yet published. It is aimed particularly at "the practising engineer who wishes to know something of the impact of nuclear energy on his professional activities" and "students in engineering schools at the senior or first year graduate levels". The difficulties in catering for the two classes of reader in the same book are apparent in the text.

After a 57-page summary of the scope of the book, three chapters are devoted to basic nuclear physics and reactor theory. Thanks to a more concise treatment of slowing-down theory, and to the omission of much of a purely mathematical nature, the contents of the earlier book have been compressed with perhaps some gain in lucidity. Enough theoretical and experimental information is now available on fast reactor theory to warrant a much fuller discussion than is given. Wisely the terms 'geometrical buckling' and 'material buckling' have been omitted, as has also (perhaps unwisely) the 'track length' explanation of the misnomer 'neutron flux'. There is an excellent discussion of the effects of variation of lattice parameter.

The chapters on instrumentation and control are very clearly written, though in a book of this scope perhaps the automatic control of reactor systems should be accorded greater importance. Actinide chemistry is dealt with at some length in the chapter on fuel processing and is followed by a discussion of the principles of chemical separation. The build-up of higher isotopes in a reactor justifies a much more comprehensive treatment than it receives here. In the chapter on materials, the extraction and fabrication of uranium and thorium are dealt with briefly, and a few lines are devoted to alloys of these elements. Reactor materials and the effects of irradiation upon them are concisely described. Two chapters follow on radiation protection and shielding. The important field of the disposal of radioactive waste merits a fuller and more quantitative treatment.

The difficulty of aiming at a wide audience is particularly apparent in the chapter on thermal aspects of nuclear reactor systems. Most of the elementary treatment of heat transfer and fluid flow could well be omitted. The resulting space could profitably be devoted to a fuller treatment of the temperature distribution inside a reactor, the problems arising in matching the reactor to a power cycle, and the thermal aspects of the dynamics of reactor systems. The penultimate chapter deals in a rather tedious manner with design variables, and the book is completed by description of a number of reactors.

Perhaps the major criticism of this book is that, although officially sponsored and published at the time of the Geneva Conference, it is based on pre-Geneva information. No doubt steps will be taken to correct this in later editions. W. MURGATROYD

TREATISE OF ZOOLOGY

Traité de Zoologie

Anatomie, Systématique, Biologie. Tome 17: Mammifères. Les Ordres: Anatomie, Ethologie, Systématique. Publié sous la direction de Pierre-P. Grassé. Fascicule 1: Pp. viii+1,170. Fascicule 2: Pp. vi+1,171–2,300. (Paris: Masson et Cie., 1955.) Paper bound, 11,000 francs; cloth bound, 11,800 francs each.

IT is a welcome task to review another volume of the "Traité de Zoologie" edited by Pierre-P. Grassé; and an imposing volume it is, being composed of two fascicles each larger than some of the preceding volumes—it is perhaps unavoidable that the price is also imposing. This is one of the two volumes devoted to mammals; the first, which has not yet appeared, will deal with the anatomy and reproduction of the mammals in general. The present volume is devoted to the systematics, with quite a fair amount of the relevant special anatomy of skeleton, brain, viscera and urinogenital system, and the biology in quite a wide sense.

Throughout the systematic arrangement, adequate weight is given to the fossil forms and to discussions of their relationships with living groups. In this connexion the sections on fossil Proboscidians, on fossil Perissodactyla, on fossil Simioidea and fossil man appear particularly useful. The classification of the Eutherian mammals owes a good deal to that of Simpson (1945) and of Ellerman and Morrison-Scott (1951), but with modifications; for example, the carnivores are subdivided into two orders, the Fissipedia (terrestrial forms) and the Pinnipedia (amphibious forms). There appears to be some confusion in respect to the systematic position of *Tupaia*, a subject that has been much discussed. On p. 1,653 it states that G. G. Simpson (1945) recognizes six superfamilies in the Insectivora, of which the sixth is the Tupaioidea. In Simpson's well-known principles of classification (1945), however, he has eight superfamilies in the Insectivores—three fossil and five recent—and the Tupaioidea are not included. On the other hand, as is stated clearly and correctly o p. 1,646 and again on p. 1,855, Simpson places th Tupaiidae in the sub-order Prosimii of the Primate (a procedure with which the present work does no agree). In checking the references to *Tupaia* in th index, two pages are given, 1,722 and 1,969, on neithe of which is this genus mentioned. Following genera usage, *Oryctolagus* is separated from *Lepus* an *Panthera* from *Felis*; but, as a rule, as is advisabl in a book of this nature, the specialist splitting o genera has not been widely followed, although th separation may be indicated by the newer name i brackets. In some groups, for example, the Rodentia trinominal terminology is often employed.

As in former volumes, the illustrations form a important and valuable feature, and it is claimed tha nearly three-quarters of the genera are illustrated There are more than two thousand text-figures about two hundred half-tones of photographs, thre hundred half-tones of drawings, mostly wash, 1,58 line drawings, six reinforced by colour, and fou full-page coloured plates. As might be expected wit such a large number of illustrations, they are not al of the same quality, although the majority ar excellent. The technique of the line-drawings fo Figs. 349 and 380, for example, is not nearly so goo as the general run and in particular such as Figs. 5 and 1,151, among many others. Fig. 1,711, a line drawing reinforced with colour, is another excellen one. The half-tone of a photograph in Fig. 1,191 i quite poor. Most of the half-tone illustrations o drawings are good; but some, like Figs. 766 and 1,187 are outstanding. This question of the illustrations ha been dealt with at some length because they have bee stressed in the advertisements, and it costs no mor to reproduce a good illustration than a bad one. Fig 278 is upside down, and the legend of Fig. 1,98 states that it represents "mains droites" whereas the are left hands. In most of the figures of fossil form the scale is given so that an idea of the size of th animal can be obtained; but it is a decided disadvantage that this is rarely done in the case of th living creature, so that, unless the reader is familia with the genus, only a vague idea of the size is conveyed. Indeed, when more than one animal is depicte on the same page, no idea of the relative size can b obtained.

As in preceding volumes, experts have contribute the sections dealing with their own fields of study: i all, there are fourteen, including the editor, and the have been drawn from as far afield as Brussels, Daka and Lisbon. This not only means authoritativ treatment but also ensures that each part is up t date; this is shown by the inclusion of severa references to papers published in 1955, the same yea as the volume itself, and in the addenda is a brie account of ultrasonics and echo-location from th proofs of a paper that had not then appeared. Afte the treatment of each order, there is a valuable selected bibliography.

Here, then, is a book that fills a noticeable gap i general zoological literature. Perhaps the neares work, in English, with which it can be compared i Beddard's "Mammalia" in the Cambridge Natura History, which was published in 1909. The "Traité" however, is not only wider in scope but naturally deal with a much larger number of animals and bring home clearly the changes in outlook and knowledg that have occurred in the past half-century. There i no doubt that it will remain an indispensable work c reference for many years. C. H. O'DONOGHUE

Petrographic Mineralogy

By Dr. Ernest E. Wahlstrom. Pp. vii+408. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1955.) 62s. net.

PROF. E. E. WAHLSTROM'S "Petrographic Mineralogy" is intended to bridge the gap which exists between text-books that explain the theory of the polarizing microscope and other instruments used n a petrographic laboratory, and those that describe the classification and properties of rocks and minerals.

The subjects dealt with in the first five chapters are the various petrographic methods and techniques that a student should know how to use, and they range from notes about the correct method of collecting and sampling rocks to detailed instructions for the use of the universal stage. The various optical, physical and chemical methods commonly used in the identification of minerals (excepting the goniometer) are all referred to, the emphasis being on identification in thin slice. The next two chapters describe the rock-forming minerals under two headings—silicates and non-silicates. Chapter 8 contains tables for the identification of minerals. The last three chapters deal with the composition, properties and classification of gneous, sedimentary and metamorphic rocks. All this matter is comprised within a book of rather less than four hundred pages, so that there is necessarily much compression; but the large number of explanatory line-diagrams and of photographic reproductions of rock-sections goes far towards compensation for this brevity.

This book is obviously designed to be placed in the hands of students after a preliminary term or two of instruction in the theory and use of the petrographic microscope. Such students, armed with this text-book, might then be expected to make good progress with a minimum of supervision—a great advantage, no doubt, in large classes. Used inteligently, and with aid of the references to further ources of information placed at the end of each chapter, it should fulfil the author's intention successfully.

Soil Zoology

Proceedings of the University of Nottingham Second Easter School in Agricultural Science, 1955. Edited by D. Keith McE. Kevan. Pp. xiv+512+16 plates. London: Butterworths Scientific Publications; New York: Academic Press, Inc., 1955.) 55s.

THE study of the fauna of the soil has lagged far behind the study of its chemical and physical properties. The aim of the organizers of the second Easter school in agricultural science, held in Nottingham last year, was to direct attention to this deficiency. Those soil workers who had in the past neglected the fauna because they were unfamiliar with the methods of the zoologist had an opportunity at Nottingham to obtain instruction on the principles of animal identification and on various techniques, as well as hearing more specialized papers describing esearch on the soil fauna. This information is now made more widely available by the publication of he proceedings, edited by D. K. McE. Kevan.

There are contributions by workers from the Continent of Europe, including Kuhnelt, Kubiena, Fischler, Haarløv, Overgaard Nielsen and Brauns, s well as workers in Britain. The contents are ivided into two parts. Part 1, which occupies two-hirds of the volume, contains twenty-six papers on dentification, general biology, ecology and applied aspects. Part 2 contains twenty-five papers describing methods of soil sampling, culturing, preserving and mounting animals, soil sectioning after impregnation with agar, and certain physiological techniques.

In an appendix, Mr. Kevan has included a useful key to the major groups of soil and litter animals. This key occupies thirty-six pages of small type, and contains numerous line diagrams. There are a good general index, an author index, and indexes to the genera of animals and plants mentioned in the text.

L. H. FINLAYSON

Introduction to Physical Geology

By Prof. Chester R. Longwell and Prof. Richard Foster Flint. Pp. x+432. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1955.) 40s. net.

IT might be expected that a book from the pens of two such experienced geologists and teachers as Profs. C. R. Longwell and R. F. Flint would be outstanding in quality, and this one does not disappoint. It develops the basic principles of the science by means of a careful examination of field evidence and also with the aid of a very large number of illustrations, including several instructive air photographs, many of which will be new to British readers. An important feature of the book is the care which has been taken to make these illustrations intelligible to the inexperienced readers for whom it is intended.

An unusual feature is the inclusion of brief references to the history of the subject, indicating to thoughtful readers that many of the conclusions which he tends to accept as axiomatic were only arrived at after much hard thought. The authors quote, for example, Shakespeare's lucid exposition of the cause of earthquakes, which expresses, not a playwright's fancy but a view held in his time and for centuries earlier.

The book embodies a wealth of experience, principally that of its authors, but also that of many others whom they consulted while writing it. It will prove a very useful addition to the departmental libraries in universities, and in schools in which geology is taught.

Discoveries and Inventions of the 20th Century

By J. G. Crowther. Fourth edition, entirely revised and rewritten. Pp. xvii+432+64 plates. (London: Routledge and Kegan Paul, Ltd., 1955.) 30s. net.

ALTHOUGH this fourth edition has been entirely revised and rewritten, Mr. J. G. Crowther has retained the general form of the third edition. Some chapter headings have been changed and much new material incorporated, covering inventions and developments of the past twenty-five years. Whether this is now quite appropriate is a matter of opinion; but the treatment of plastics appears to have been prejudiced by the arrangement, and in this edition is quite inadequate. Something should have been included on the advances in medicinals during this period, if only because of the far-reaching effects of the control of malaria, trypanosomiasis and other killing diseases.

Criticism of omissions, however, is invidious and, apart from these two features, the book gives a comprehensive and readable picture of the discoveries and inventions of the past fifty years. Of minor slips, attribution of the invention of chromatography solely to Tswett instead of to Runge and others may be mentioned.

R. B.

THE GEORGE R. AGASSIZ RADIO TELESCOPE OF HARVARD OBSERVATORY

By Prof. BART J. BOK

Harvard College Observatory

ON April 28, two hundred staff members and guests gathered at Harvard Observatory's Agassiz Station in the town of Harvard, Massachusetts, to assist in the dedication of the 60-ft. radio telescope that carries the name of Harvard Observatory's long-time benefactor, the late George R. Agassiz (1862–1951). It was fitting that Dr. Alan T. Waterman, director of the National Science Foundation, should have officiated at the dedication, since the Foundation, with further assistance from friends of the Agassiz Station and from the Research Corporation of New York, had provided the funds for the construction of the new radio telescope.

The Antenna and its Mounting

The 60-ft. instrument was built by D. S. Kennedy and Co., of Cohasset, Mass. Its antenna is a paraboloid of expanded aluminium wire-mesh, each square of the mesh measuring $\frac{3}{8}$ in. on a side; tests by the Kennedy engineers indicate that the antenna surface is a true paraboloid to within $\frac{1}{8}$ in. A horn-feed at the focus collects the radiation received by the antenna.

The mounting of the antenna is of equatorial design and the telescope is motor-driven. Preliminary purely mechanical adjustment produced a position for the polar axis of the instrument to within a fraction of a degree of the true pole, and final adjustment by the usual optical techniques has now been completed. The setting and following accuracy of the instrument required by contract is of the order of ten minutes of arc; the manufacturers have provided for even greater precision of setting and following, with maximum uncertainties in either co-ordinate apparently no greater than two or three minutes of arc. The instrument will be used initially for research at the wave-length of the neutral hydrogen line at 21 cm.; at this wave-length the angular resolution of the Agassiz radio telescope is of the order of seven-tenths of a degree, so that the setting and following accuracy that is attainable with the instrument are more than sufficient for research on discrete radio sources.

One feature of the mounting that is especially worth mentioning is the polar axis of the instrument, which is in essence a single roller bearing with a diameter of 7 ft. The shortness of the polar axis permits the pointing of the antenna to any direction above the horizon.

The Electronic Equipment

The electronic equipment was constructed by the Ewen-Knight Corporation, of Needham, Mass., and it has been designed primarily for research dealing with the radio radiation of wave-length 21 cm. emitted by neutral, atomic hydrogen in interstellar space. The 21-cm. lines received on the Earth from most directions in the sky are widened considerably in frequency caused by the rotation of our galaxy. At the frequency of 1,420 Mc./sec., corresponding to the wave-length of 21 cm., the line-widths produced by galactic rotation alone amount often to as much
2 Mc./sec. We note here that a radial velocity shi
of 1 km./sec. at a frequency of 1,420 Mc./sec. amoun
to a frequency shift of very nearly 5 kc./sec. Rando
turbulent velocities of the hydrogen clouds of o
galaxy also contribute to the observed shapes of t
hydrogen-line profiles. In all of the research to da
at the Agassiz Station, special emphasis has bee
placed upon high resolution in frequency. For t
research of the past three years with the 24-f
steerable paraboloid, we have used apparatus with
frequency band-width of 15 kc./sec., equivalent to
resolution of 3 km./sec. in radial velocity. The ne
equipment is designed for primary operation with
band-width in frequency of 5 kc./sec., or an equ
valent resolution of 1 km./sec., in radial velocit
The new electronic equipment has been designed b
Harold I. Ewen, who, with the present writer, h
from the start been the co-director of the Agass
Station Radio Astronomy Project. The instrume
has been described as follows by its designer:

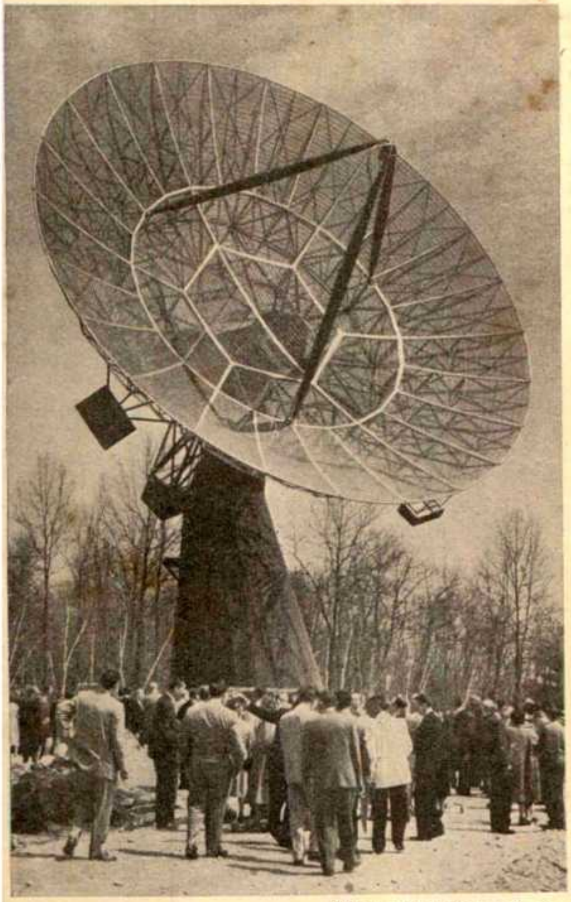
The receiver is a microwave double-conversio
superheterodyne comparison radiometer. Compariso
is achieved by 400 c./sec. switching of the first loc
oscillator between two frequencies spaced 2 Mc./se
apart. As a result, the receiver compares 'signal
band' information to a signal-free 'noise-band' at
rate more rapid than normal gain fluctuations. B
this means the effect of receiver-gain fluctuations
considerably reduced at the receiver output.

The Model 1044 radiometer incorporates som
rather fundamental changes in the normal design f
equipments of this type. A significant departu
from the more conventional approach is the doubl
bank 20-channel comb filter at the second conversio
frequency.

The twenty filters each have a band-width
5 kc./sec. and are spaced 100 kc./sec. apart to cove
a complete 2 Mc./sec. band. Their effect is the sam
as twenty receivers operating in parallel, each tune
100 kc./sec. from the one on either side.

For a particular tuned frequency, all channe
operate simultaneously and store their individu
information in integration networks. The chargi
time or integration time of these twenty networks
110 sec. At the end of the charging time, t
integrated information is 'read out' from ea
channel, in sequence, by an analogue to digit
computer, and recorded by an electric typewriter
the first row of twenty numbers in a 2 Mc./se
scanning sequence. The second local oscillator is the
'step-tuned' 5 kc./sec., which effectively moves eac
of the twenty channels 5 kc./sec. higher in inform
tion-response frequency. The integration sequence
repeated and recorded by the typewriter as t
second row of twenty numbers in the 2 Mc./sec. sca
This sequence is repeated twenty times until t
typewriter output consists of twenty rows of numbe
arranged in twenty columns.

The first column of twenty numbers represents t
first 100 kc./sec. of the desired 2 Mc./sec. of inform
tion. The second column covers the range 100 kc./se



[Photograph by Robert E. Cox

Fig. 1. The 60-ft. George R. Agassiz Radio Telescope, Harvard Observatory

to 200 kc./sec., etc. Each of the four hundred numbers typed represents the average hydrogen temperature above background as measured in an individual 5 kc./sec. frequency-band. The entire 2 Mc./sec. scan is accomplished in 40 min., as compared to single-channel operation requiring 13 hr. 20 min.

Programme of Research and Training

From its initiation, the Agassiz Station project in radio astronomy has had the dual aim of training graduate students and of advancing research in the field. The completion and putting into operation of the 60-ft. radio telescope should serve to strengthen both parts of the programme, since the project will in all likelihood remain one operated primarily for and by graduate students in radio astronomy. Such a policy is in line with that of the National Science Foundation, the organization that has thus far borne a little more than half the expense of operating the project. However, the planning of research and the granting of permission for guest observers to use the equipment will now become more flexible, since we shall have available both the 24-ft. and the 60-ft. radio telescopes. The future may, therefore, well see a considerable extension of the programme outlined below.

The Harvard programme to date has been primarily concerned with astrophysical studies of 21-cm. radiation relating to interstellar neutral, atomic hydrogen. One of the first results with the 24-ft. radio telescope was the discovery by Lilley[1] of excessive concentration of neutral atomic hydrogen in the Taurus Complex of dark nebulosity, which led to the conclusion that the average ratio of densities of gas to dust in the large dust complexes is about 100 : 1. This ratio appears now to be constant as we proceed to the smaller dust units; but obviously the search for and study of small-scale concentrations of neutral atomic hydrogen associated with dark nebulæ presents an important problem for the new instrument with its high angular resolution.

Lawrence[2] and Heeschen and Drake[3], working with the same instrument, have already done some interesting work relating to the fine structure of the interstellar hydrogen medium. Lawrence has studied certain regions near stars for which Münch, at Mount Wilson and Palomar Observatories, had found optical evidence for multiple interstellar lines. Two interesting cases of coincidence between optical and 21-cm. wave-length radial velocities have already been found; the availability of the 60-ft. radio telescope with its high angular resolution and the improved resolution in frequency of the electronic apparatus holds great promise for future research in this field. Heeschen and Drake studied the 21-cm. wave-length radiation in the Pleiades cluster, and here they found evidence for a double-peaked 21-cm. profile, with one component coinciding in radial velocity almost precisely with that of the Pleiades cluster of stars, the other with that of the optical interstellar absorption lines. The completion of the 60-ft. radio telescope makes it profitable to examine the 21-cm. wave-length radiation from many clusters of stars, from associations and aggregates, and from certain diffuse nebulæ and the regions surrounding them. The researches by Menon[4] of the Orion Complex illustrate how much we can learn from a detailed survey on a wave-length of 21 cm. of a section rich in *O* and *B* stars, emission and reflexion nebulosity and cosmic dust. Similar work can now be attempted for smaller sections of special interest. Among regions of the sky that will be receiving special attention with the new equipment are the clusters and associations *NGC* 2244 and 2264 (Menon) and the region of λ Orionis (Campbell M. Wade).

One of the most important fields of research on the 21-cm. wave-length is the study of the spiral structure of our galaxy—a field in which the Dutch and Australian astronomers have excelled. At the Agassiz Station, we have in this area concentrated on investigating in detail a few sections of special interest, stressing at all times the close interrelation that exists between optical and radio research. To date, the principal effort has been for galactic longitudes $l = 60°$ to $135°$, for which we have some results by Matthews[5] and by Davis (unpublished). These researches reveal an amazing degree of fine structure in the portions of the three major spiral arms that are observed in this section. There are several instances of apparent bifurcation, and it is most striking how certain apparently minor features may be traced over a considerable range of galactic longitude and latitude. Matthews and Davis especially directed attention to the great mass of the neutral atomic hydrogen associated with the Perseus arm as compared to the Orion arm—a surprising result in view of the greater distance of the Perseus arm from the centre of our galaxy. With the new equipment we hope to extend these studies with point-to-point analyses for the detailed structure near positions of critical importance from the radio or optical point of view. In addition to the section $l = 60^\circ$ to 135°, we are concentrating on the region of the Cygnus cloud (Mrs. May Kassim), and in the section $l = 335^\circ$ to $l = 15^\circ$ for which Howard and Heeschen[6] have already reported preliminary results.

The study of the absorption features in the 21-cm. wave-length profiles for regions centred upon discrete radio sources is not practicable with our 24-ft. antenna, but it has already been demonstrated by a brilliant investigation at the Naval Research Laboratory in Washington, D.C., that this is an exceedingly profitable research field for radio telescopes of 50-ft. aperture and greater. We plan initially to concentrate on this type of research with the 60-ft. George R. Agassiz radio telescope. The narrow band-width and accompanying high resolution in frequency of Dr. Ewen's equipment will prove invaluable for studies at 21-cm. wave-length of discrete sources and the regions near them.

At the time of the dedication of the Agassiz radio telescope, Dr. Heeschen announced the discovery of 21-cm. radiation from the direction of the Coma Cluster of galaxies at a distance of approximately 75,000,000 light years from the Sun. The shift in frequency of the 21-cm. wave-length feature indicated a recessional radial velocity for the atomic hydrogen in good agreement with the radial velocity of recession found optically for the galaxies in the Coma Cluster. The dispersion in radial velocity suggested by the radio observations is comparable with, though slightly less than, the value found from the optical evidence. Heeschen's results were obtained with the 24-ft. paraboloid. The 60-ft. telescope will assist in localizing the source or sources of radiation of 21-cm. wave-length in the Coma Cluster of galaxies, and with the new equipment several other clusters of galaxies come within reach.

The results of research with radio telescopes of apertures between 24 and 50 ft. have shown already that the 21-cm. wave-length field is a rich one for future research with radio telescopes of larger aperture, especially when the results of optical and radio studies are brought to bear upon the solution of any given problem. For the present we have limited ourselves largely to research in our own galaxy; but already it is obvious that radio telescopes with apertures of 60 ft. and greater have important contributions to make in the study of 21-cm. wave-length radiation from other galaxies and from intergalactic space.

A 60-ft. radio telescope with a precision paraboloid antenna is a versatile instrument and can be used effectively for studies at wave-lengths other than 21 cm. It would be presumptuous to suggest at this time the uses to which the Agassiz radio telescope may be put in the years to come. There are, however, two areas of research in which the instrument is expected to make some contribution in the not too distant future. One is the study of the continuum near 21 cm. wave-length and possibly at other wave-lengths in the range 10–50 cm. The other is in the search for other line emission or absorption features, notably in an attempt to find evidence for the presence of OH at a wave-length near 18 cm. (frequency approximately 1,667 Mc./sec.).

To describe the future programme of a 60-ft. radio telescope is really a very difficult task. For, as radio astronomy is coming of age, it takes its place—along with photoelectric photometry and spectrography—as one of the basic techniques for the study of the physical universe. A 60-ft. radio paraboloid may in the future have as many roles as have in the past the 60-in. reflectors for optical studies of our Milky Way System and other galaxies.

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[5] Matthews, T. A., doctoral dissertation, Harvard (1956); see also *Pub. Astro. Soc. Pacific*, **67**, 112 (1955), and paper presented at Jodrell Bank Symposium, 1955 (in the press).

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THE GOUGH ISLAND SCIENTIFIC SURVEY, 1955–56

By M. W. HOLDGATE, R. W. LeMAITRE, M. K. SWALES and N. M. WACE

THE background and personnel of the Gough Island Scientific Survey, which has recently returned to Britain, and the little that was known about Gough Island prior to its visit, have been described in an earlier article[1]. The expedition left England in September 1955 and landed on Tristan da Cunha on October 1. During a six-week stay there, the vegetation, agriculture and bird-life were studied in detail, and some rock specimens and invertebrate animals were collected. Peat samples for subsequent pollen analysis were obtained from a lowland and an upland bog.

On November 13, 1955, a landing was made on Gough Island. This island lies on the central Atlantic ridge, some 230 miles south-south-east from Tristan, the centre of the island being about 40° 17′ S. and 9° 56′ W. It is about eight miles long and four miles wide, and, like Tristan, is more than 1,500 miles distant from the nearest continent.

Within a few minutes of landing, the Expedition's leader, Mr. R. J. H. Chambers, collapsed with a back injury which necessitated his evacuation three days later. He was succeeded by Dr. M. W. Holdgate. A sectional wooden hut was erected near the landing place, as a base, and after paths had been cut through the forest to facilitate access to the high ground, two tented camps were established on the mountains. The exploration of the island was carried out from these camps, and also from Base, using a dinghy. The Tristan islanders, of whom two pairs were at different times employed by the expedition, proved especially skilled at handling a boat, and landings were made on all except the west coast of Gough.

In February 1956, Mr. J. B. Heaney, the organizer and original leader and surveyor of the expedition, joined the party and became joint-leader with Dr. Holdgate. The expedition was relieved by the South

African frigate *Transvaal* on May 13, 1956. The installations were taken over by the South African Weather Bureau, which will continue the meteorological station on Gough until the end of the International Geophysical Year.

Topography and Survey

Mr. J. B. Heaney, assisted by Dr. M. W. Holdgate and other members of the expedition, surveyed the island on a scale of 1/30,000. A triangulation scheme involving twenty-five stations provided a network of fixed points including the main peaks and many coastal features. The baseline, 1,860 ft. in length, was measured on a plateau 2,000 ft. above sea-level in the centre of the island. The latitude and longitude of a trigonometrical station near the hut was determined from position-line observations on sixteen stars. The detailed survey was carried out using a plane table on which rays were plotted to a large number of features. An 80-cm. rangefinder was used for measuring distances, and the vertical angles from a clinometer enabled these to be corrected to the horizontal in the field. A dense control of spot heights was established, and contours at an interval of 250 ft. were interpolated.

The centre of the island proved to be an undulating plateau some 2,000 ft. above the sea. The highest peaks rise 500–1,000 ft. above this (the summit of the island being provisionally fixed at 2,995 ft.). Peat bogs cover the plateau, but in the north there are extensive areas of bare rock. Along the north and east sides, eight deep valleys cut back into the plateau; these are 1–1½ miles long and are separated by narrow, craggy ridges. On the west the plateau slopes more evenly to the top of the sea cliffs, which, though nowhere sheer, are up to 1,500 ft. high. In the south there is a strip of level lowland about half a mile wide, between the mountains and the sea. Most of the island is surrounded by cliffs, and there is only one landing place which gives easy access to the interior.

Meteorology

A meteorological station was established at Base, 20 ft. above sea-level, and operated continuously from November 20, 1955. The instruments were provided by the South African Weather Bureau, which seconded Mr. J. J. van der Merwe to the expedition as meteorologist.

During the five months December–April inclusive, the mean monthly noon temperatures were 15·2, 14·6, 15·4, 13·9 and 13·7° C., respectively. The highest maximum temperature during the period was 23·7° C. (on February 17) and the lowest minimum 5·5° C. (January 25). The rainfall totals for the five months were 197·7 mm., 304·5 mm., 152·2 mm., 101·0 mm. and 261·9 mm., while the mean daily sunshine figures were 5·4, 5·5, 4·7, 3·2 and 1·8 hr., respectively. The climate was oceanic, and was dominated by a succession of warm and cold front systems.

Orographic cloud was frequent over the island, and standing-wave cloud systems often formed in the lee. Some photographs and notes of these were obtained.

A few tidal readings, on a graduated pole, indicated a mean tide-range of about 3 ft., increasing to 3 ft. 6 in. at springs.

Geology

By R. W. LeMaitre, St. John's College, Cambridge

More than two hundred rock specimens were collected from a large number of localities on the island. These will be worked up in the Department of Mineralogy and Petrology at Cambridge, and it is hoped to publish an account of their petrology in the near future.

In the field it was possible to distinguish four main phases in the structure of the island: (1) an extrusive phase of basalts with minor tuffs, later invaded by dykes; (2) an extrusive phase of trachytes, mainly in the west of the island, preceded by an explosion forming thick local deposits of tuff; (3) another extrusive phase of basalts overlying the two earlier phases; (4) an intrusive phase of trachyte laccoliths and plugs. It is hoped that some of the trachytes will be dated by the radioactive potassium/argon ratio, and that some palæomagnetic work will be possible with the aid of some orientated specimens.

Botany

By N. M. Wace, Department of Botany, The Queen's University, Belfast

No systematic work having been possible during the three previous brief visits of botanists to Gough Island[2–4], collection and description were the first botanical tasks of the expedition. Studies were also made on the dispersal mechanisms and reproductive methods of the vascular plants.

Collections immediately revealed that the number of species is extremely small, the provisional number recognized in the field being thirty-eight angiosperms (of which six are probably human introductions), twenty-five pteridophytes, and about a hundred bryophytes. Freshwater and marine algae, lichens and fungi were also collected. The first set of all the collections will be presented to the British Museum (Natural History).

Studies on the vascular plants emphasized the widespread reliance upon wind as an agent of dispersal and pollination, the almost complete absence of annuals among the native plants, and the general dependence upon vegetative, rather than sexual, reproduction.

Blanket peat covers almost the entire island. Below about 300 m. (1,000 ft.), to the east and south, this supports a dense forest in which a mosaic of communities dominated by *Phylica arborea*, *Blechnum tabulare* and *Histiopteris incisa* are the most important components. At a similar altitudinal range on the western cliff-slopes, tussock-grasses form an almost pure community on dry, stable peat. Above the forest and tussock associations, and up to 450 m. (1,500 ft.), a variety of species, notably *Empetrum rubrum*, *Acaena* spp. and *Apium goughensis*, are the most important dominants in a zone of upland peats. From 450 m. to the highest points in the island (about 900 m.), a zone of thin wet alpine peats dominated by small species of *Agrostis* and *Scirpus*, with numerous bryophytes, covers all but the most exposed rock. Valley bog communities, dominated by *Sphagnum* spp. and other bog bryophytes, occur in all the mountain valleys and on the plateaux above 450 m.

Some descriptive work was also done on the marine algal communities, in which a littoral zonation was very marked despite a mean tide-range of only 0·8 m. (3 ft.). A sub-littoral zone of *Macrocystis* sp.

occurs around much of the east (prevailing lee) side of the island.

Two peat sites were investigated by boring in Tristan and one on Gough Island. Stratigraphical and sampled bores were made in all three sites, and samples also obtained for radiocarbon dating. No definite signs of glaciation were seen on either of the islands, but some evidence of fluctuation in sea-level was noted on Gough Island.

Invertebrate Zoology

By M. W. Holdgate, Queens' College, Cambridge

About three thousand invertebrate specimens were collected during the six months on Gough Island, despite the fact that the author spent half his time in surveying. The sixty-seven main collecting stations were distributed to sample all the chief plant associations, over a wide altitudinal range. Some collections from similar types of vegetation were made on Tristan for comparison. On Gough, some freshwater localities were also sampled, and a study made of the littoral fauna of a typical 200-yd. stretch of rocky shore.

The terrestrial invertebrate fauna of Gough proved to be very poor and it is unlikely that more than a hundred and fifty species in all were collected. Many of the species that do occur are, however, very abundant and occupy a wide range of habitats. A few of the insects proved to be apterous or brachypterous, the most striking example of this condition occurring in an upland Lepidopteran superficially resembling the endemic *Dimorphinoctua cunhaensis* of Tristan[5]. It is likely that many of the species collected will prove to be endemic.

The littoral fauna was somewhat richer in species, and despite the small tide-range showed some zonation.

Vertebrate Zoology

By M. K. Swales, Magdalene College, Cambridge

Twenty species of 'sea birds', mostly of the order Procellariiformes, and none of them new records, were found to occur on Gough Island. Of these, seventeen species were shown to be nesting, some of them in great abundance. More than a thousand of these birds, including some of all species, were weighed and measured. A study was made of the wandering albatross (*Diomedea exulans dabbenena*), a subspecies almost confined in its breeding distribution to Gough Island. The two endemic species of land birds occurred commonly throughout the island and a special study was made of these. The bunting was found to be one species only (*Rowettia g. goughensis*) with five well-marked plumage stages, the youngest a speckled dark brown and the adults green in colour. The rail (*Porphyriornis c. comeri*) has distinct juvenile and adult plumages only (brown and black, respectively). Some live specimens of both species were brought back to England for further study.

More than 10,000 fur seals (*Arctocephalus pusillus*) were counted on the island's beaches. They are most abundant on the west coast, which is more storm beaten and less accessible than the east coast. Estimates were also made of the composition of the herds. The numbers of seals available for exploitation will be calculated from these figures.

A census was made of the elephant seals (*Mirounga leonina*) on the island. The total population is less than three hundred. In contrast to the fur seals, these are found mainly on the east coast on pebble and sand beaches.

Detailed accounts of the expedition's results in these fields of study will appear in the appropriate journals in due course.

We are most deeply grateful to H.R.H. the Duke of Edinburgh for his interest in the expedition and the support he has given it. We would also like to thank the Scott Polar Research Institute, the Royal Geographical Society, and all those other departments, societies, colleges, firms and individuals without whose aid the expedition could not have taken place.

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NUCLEAR MAGNETIC RESONANCE AND ELECTRON SPIN RESONANCE

It is no new idea that most of the advances in the techniques of chemistry have come from the use of apparatus and methods originally devised by physicists. This is particularly true of spectroscopy, where the main applications associated with the different frequency bands have moved over, one after another, from the pure physicist to the chemist. As a result, ultra-violet and infra-red spectroscopy are now considered as subjects belonging to physical chemistry, and even γ-ray spectroscopy is finding considerable application in chemical research.

It would appear that during the past eighteen months a similar move has been taking place with the two new techniques of nuclear magnetic resonance and electron spin resonance. Both these subjects originated in the physics laboratories, and for several years after their initial discovery were applied to purely physical problems such as the determination of nuclear spins and moments. As with all techniques which study the interaction of atoms with external forces, it soon became clear that these new methods also had very great potentialities as tools for chemical investigation, and during the past few years these applications have been brought to light in a very striking way.

The increasing interest among chemists concerning the possible uses of these techniques was reflected by the decision of the Physical Methods Group of the Society for Analytical Chemistry and the Photoelectric Spectrometry Group to hold a joint meeting on the subject in Oxford on May 25. This meeting was timely, as it would appear that there are now quite a large number of chemists in Great Britain who are already aware that a new tool has become available, but many are not yet clear as to the precise applications and limitations of the new techniques. The meeting was divided into two sections with two speakers presenting papers on nuclear magnetic resonance and two presenting papers on electron spin resonance; in this way the apparatus and applications of each technique were brought clearly to light. This careful differentiation was found to be very necessary, as some confusion appears to exist between the two subjects. It was for this reason that the name 'electron spin resonance' was used to describe the resonance absorption associated with electronic transitions, instead of 'paramagnetic resonance'. Although the latter title has been widely used in the past few years, it can, in principle, be equally well applied to nuclear resonance absorption, and hence in order to avoid any confusion it was suggested that it would be wise to use the distinguishing titles of 'nuclear magnetic resonance' and 'electron spin resonance' in future chemical work.

Dr. R. Richards (University of Oxford) presented the opening paper introducing the general theory of nuclear magnetic resonance, and then outlining some of its main applications. He explained how nuclear resonance absorption can be obtained if a strong magnetic field is applied across a specimen containing nuclei with magnetic moments. These will then take up different quantized orientations in the magnetic field and, if radiation is fed to the specimen with a frequency such that $h\nu$ is equal to the energy difference between the quantized states, a resonance absorption will occur, which can be detected by a fall in the radiation transmitted through the system. For hydrogen nuclei in a typical field of ten thousand gauss, this resonant absorption will take place at a frequency of 42·6 Mc./s., and hence all the techniques associated with normal radio and television frequencies are used for generating and detecting the radiation. There are two great advantages of spectroscopy at these frequencies; the first is that line widths from liquid samples are extremely small, corresponding to 1 c./s. or 10^{-11} cm.$^{-1}$, and the second is that the frequencies of absorption can be measured with very high accuracy by normal radio techniques. As a result it is possible to determine nuclear gyromagnetic ratios and magnetic moments with very great precision, and it was soon found that the small changes in magnetic field produced by different electron configurations around the nuclei could be detected and differentiated. In this way it is possible not only to distinguish different elements and isotopes present in a compound, but also to differentiate between different groupings of the same element. The proton resonance of ethyl alcohol was shown as an example, as in this case the absorption is split into three main lines, one corresponding to the hydrogens of the CH_3 group, one to those of the CH_2 group and the other to those of the OH group. The occurrence of this 'chemical shift' often enables a detailed chemical analysis to be made, the whole operation only taking a few minutes. Several well-illustrated examples of this high-resolution work were given as applied to hydrogen, fluorine and phosphorus chemistry. It was also shown how a further splitting of the lines gives information on the positions of groups relative to each other, and hence structural as well as group analysis is thus possible.

Dr. M. Packard (Varian Associates, U.S.A.) then showed a series of slides giving details of the experimental techniques involved in high-resolution nuclear magnetic resonance, and illustrating some of the spectra actually obtained. The way in which the fine detail of the lines could be used to differentiate between various structural formulæ of the same compound was ably demonstrated, and in some cases it was even possible to distinguish excited triplet states. This high-resolution work requires a large and very well stabilized magnet, however, such that the field can be maintained homogeneous to 1 part in 10^8, and it is the cost of such equipment that is the main limitation on this work at the moment.

Dr. E. E. Schneider (University of Durham) then read a paper introducing the theory and technique of electron spin resonance, comparing and contrasting it with nuclear resonance. In electron spin resonance, the applied magnetic field acts on the magnetic moments associated with the unpaired electron spins, and since these moments are about a thousand times greater than those of the nuclei the resulting energy-level splittings, and hence frequencies of absorption, are correspondingly increased. Electron resonance absorption in a field of ten thousand gauss therefore occurs at about 30,000 Mc./s., and all the radio-frequency circuits of nuclear resonance are replaced by waveguides and other radar techniques. There is one great advantage in working at these high frequencies, namely, that the sensitivity of the technique is very much increased. The net absorption that is actually measured in either nuclear or electron resonance is the difference between the energy absorbed by the electrons or nuclei in the ground-state and the energy emitted from those in the excited state. This difference depends on the ratio of the numbers in the ground and excited states and will become larger the greater the energy splitting between the levels and the lower the temperature of the specimen. As a result of the much larger energy splitting associated with the electronic spin changes, the sensitivity is very much greater than that for nuclear resonance; and whereas protons can only be detected down to 10^{16} per gm., it is possible to detect, and measure the concentrations of unpaired electrons down to 10^{13} per gm., or 10^{-11} molar. It is this feature of high sensitivity which offers most promise in the chemical applications of electron spin resonance, as although it cannot compete with the general high resolution of nuclear resonance, it can measure trace paramagnetic constituents to far greater dilutions.

Dr. D. J. E. Ingram (University of Southampton) then presented a paper dealing with more specific and particular applications of electron spin resonance. The systems to which the techniques can be most readily applied are those containing stable unpaired electrons such as normal paramagnetic atoms and organic free radicals. It is possible, however, to obtain atoms or molecules which have been left with an unpaired electron as a result of irradiation or some similar process. Such atoms or radicals can then be studied by the normal techniques of electron resonance and detailed chemical information often obtained. Illustrations of some such systems were then given, including radicals formed by ultra-violet irradiation and then trapped in low-temperature glasses, and others formed by X- or γ-ray irradiation. In these cases, as with all electron resonance spectra, considerable information can often be obtained from the hyperfine splitting of the lines which arises from an interaction with the magnetic moments of the neighbouring nuclei. The distinctive hyperfine structure produced by different elements can also be used in such practical applications as measuring the concentrations of impurity atoms in semiconducting material. Other applications were also mentioned, such as following the progress of chemical reactions which proceed via a transient intermediate, and also the detailed structural information that can often be determined from the angular variation of the spectra in single crystals.

The discussion which followed the main papers was opened by Drs. D. H. Whiffen, C. A. Parker and D. J. Ferrett. One of the main questions raised was that of absolute calibration and reproducibility of results. It was suggested that the most accurate form of quantitative measurement was by comparison with the signal from a small amount of a standard sample placed in the same radio-frequency field. For work with free radicals, the use of auxiliary coils to increase the field around the standard specimen was mentioned, although the more general technique employing a substance such as ultramarine, which has its resonance slightly displaced from the free-electron value, is probably to be preferred. The applications of the relatively less expensive low-resolution nuclear resonance were also described since, although this cannot give the group analysis of the high-resolution work, it can be applied to quantitative determinations of isotope concentrations for more than a hundred different nuclei.

It would appear that there are in fact three distinct types of resonance spectroscope that should be of considerable use to the chemist. The first is that employing very high-resolution nuclear magnetic resonance. This can not only distinguish different isotopes but also differentiate between various groups and bond-types of the same element, and thus provide a detailed structural analysis from a few grams of liquid. The disadvantage of this type of apparatus is purely practical, as a twelve-inch diameter magnet with a very homogeneous field is required, at a cost of several thousands of pounds. If detailed chemical information is not required, however, and only a quantitative determination of the different elements present is needed, then low-resolution nuclear resonance is quite sufficient, and relatively inexpensive magnets can be used. It is also easier to apply more sensitive means of detection to the low-resolution apparatus, and concentrations down to 10^{16} protons per gm. can be measured.

As distinct from both of these, an electron-resonance spectroscope can be used wherever unpaired electrons occur in a chemical system. The sensitivity is very much greater than that of nuclear resonance, and the less expensive magnets can be employed. It should therefore prove a powerful and readily available tool for investigating such systems down to dilutions of 10^{-11} molar. It would appear that the main applications of this technique are going to be in the fields of free-radical and irradiation chemistry, and it will probably find as much use in the medical and biological sciences as in physical chemistry.

D. J. E. INGRAM

OBITUARY

Mr. E. B. Wedmore, C.B.E.

THE name of Mr. E. B. Wedmore, whose death occurred at the age of eighty years on June 16, is widely known in two very different spheres. He was in a very real sense a pioneer in the development of research associations, and he was an apiarist of great repute. Mr. Wedmore can properly be described as the architect of the structure of the British Electrical and Allied Industries Research Association (E.R.A.), which is one of the largest co-operative research organizations in Great Britain at the present time.

Born at Bristol in 1876, Wedmore received his early education at private schools. His first scientific education at the University College of Bristol was followed by a short course in civil engineering at the Finsbury Technical College, and then by the full course in electrical engineering at that College.

He joined the Bristol Corporation Electricity Works in 1895 as an assistant, but returned to Finsbury Technical College during 1896–99 as a lecturer and demonstrator, gaining the City and Guilds Silver Medal in 1896. During 1899–1919 he was design engineer with the British Thomson-Houston Co., Ltd., in London and Rugby, and during this time he took out a number of patents, mainly for switchgear.

A shortage of certain materials essential to the electrical industry arose in 1917 as a result of submarine warfare, and in order to foster the devising of means to minimize the effects of this shortage, an Electrical Research Committee (E.R.C.) was set up under the ægis of the British Electrical and Allied Manufacturers' Association and the Institution of Electrical Engineers; this was the forerunner of the British Electrical and Allied Industries Research Association. Mr. Wedmore was appointed director of the earlier body in 1919, and he became director and secretary of its successor upon the incorporation of that body in 1920. This post he held up to the time of his retirement at the end of 1944. In 1938 he was appointed C.B.E. in recognition of his services.

Wedmore's qualities of character and mind proved to be admirably suited to the task of building up and developing the young research association. He was a good judge of men and quickly gathered about him a group of able engineers and scientists. Scientific judgment and inventiveness he possessed himself in a high degree, and he had an inspiring fertility of mind. With all these qualities was coupled an extraordinary business acumen.

Wedmore's own field of scientific interest was wide; it accommodated such diverse topics as colour photography and the making of models of four-dimensional 'objects' as seen in three-dimensional space. His major contributions were to the art of circuit breaking and to improvements in switchgear. Crucial observations of some of the basic phenomena of circuit breaking were made with a simple high-speed camera devised by Wedmore, and as an outcome of these experiments came the invention, jointly with Dr. Whitney, of the air-blast circuit breaker and of the oil-baffle switch. Wedmore was active in the field of international standardization, and was a member of a number of committees of the International Electro-Technical Commission. He attended the first meeting of the Conférence Internationale des Grands Réseaux Électrique, which was held in Paris in 1921, and he was largely responsible for the establishment of the liaison committee of that conference, from which developed the present British National Committee.

Wedmore communicated a number of papers to the Institution of Electrical Engineers and he was awarded several of the major premiums of the Institution, namely, the John Hopkinson in 1915, the Institution Premium in 1918, and the Kelvin in 1929.

Wedmore was reticent in nature and somewhat austere in appearance. He was, however, under the surface, very human and generous and sympathetic to any in real trouble, and he had a deep sense of loyalty to colleagues. It is a tribute to Wedmore's insight and ability that he should have built up, as a pioneer, a successful co-operative research organization with little to guide him other than his own shrewd judgment and initiative. J. GREIG

THE death of Mr. E. B. Wedmore has removed a well-known and greatly respected personality from bee-keeping circles. Despite his heavy professional responsibilities when director of the British Electrical and Allied Industries Research Association, Mr. Wedmore managed to find time to practise bee-keeping, to which he applied his scientific training and research experience. Since his retirement a few years ago, beekeeping research had occupied an increasing proportion of his time and he was always eager to discuss new results and ideas and to help beekeepers and research workers in any way that he could.

In 1944 the Beekeeping Standards Committee of the British Standards Institution was formed, and Mr. Wedmore was the natural choice for its first chairman, a position he held with great distinction until his death. He also served on other committees of the Institution which dealt with the standardization of honey tins, honey jars, etc.

For many years Mr. Wedmore was a member of the Apis Club, several county beekeepers' associations and of the British Beekeepers' Association, of which he was president in 1946. He was, for some time, chairman of the Research Committee of the British Beekeepers' Association, and was an active member of the Council of the Bee Research Association since its formation in 1949. He was responsible for a number of the Association's researches which were carried out with the co-operation of beekeepers, notably on methods of management of colonies and on queen introduction.

He was also interested in establishing better standards for honey in Britain, and his re-examination of earlier work on the chemical and physical properties of honey led to new tables relating refractive index to water content. Further papers on the accurate determination of the water content of honeys were in preparation at the time of his death.

Mr. Wedmore's books, "A Manual of Beekeeping" and "The Ventilation of Bee-Hives", together with his booklet, "Successful Bee-keeping", will undoubtedly continue to be used by beekeepers for many years to come.

Although rather shy and reserved, Mr. Wedmore gave much time to helping other beekeepers by lecturing and in other ways. His lectures contained a great deal of original, constructive thought. He was always willing to reconsider his own views in the light of new work and was foremost in efforts to encourage beekeepers to do the same.

C. G. BUTLER

NEWS and VIEWS

Linnean Gold Medal: Prof. W. H. Lang, F.R.S.

THE award by the Linnean Society of London of the Linnean Gold Medal to Prof. W. H. Lang will be regarded with much satisfaction by botanists, and especially palæobotanists, throughout the world. Although in the earlier part of his scientific career his attention was mainly directed to the Pteridophyta and Bryophyta, he later concentrated on investigation of early Devonian plants. During the time he taught in the University of Glasgow his contacts with Robert Kidston inspired him with an interest in palæozoic plants and led to that fruitful collaboration with Kidston in the description of the Devonian plants found in the Rhynie Chert in Aberdeenshire. The results of this investigation, published in the *Transactions of the Royal Society of Edinburgh* between 1917 and 1921, have had a profound influence on our ideas about the evolution of vascular plants, perhaps more than any other palæobotanical discovery of this century. Prof. Lang has made many notable contributions to our knowledge of the morphology of the Pteridophyta and, after collaboration ceased with Kidston's death in 1924, he has continued to investigate early Devonian plants and has shown that important information can be obtained from apparently unpromising and fragmentary plant remains. In collaboration with Dr. Cookson, of Australia, he described the Silurian plants which are found in Australia, the earliest indubitable land plants. His published work, like that of Kidston, has always been marked by meticulous attention to accuracy and he rarely, if ever, makes a statement about a plant which is not clearly demonstrated by photographic reproduction. He has carefully avoided entering the field of speculative morphology, to which the discovery of the Rhynie plants added such a potent stimulus.

Pure Mathematics in the Imperial College, London: Prof. W. K. Hayman, F.R.S.

DR. WALTER K. HAYMAN, reader in analysis at the University of Exeter, has been appointed to a newly created University chair in pure mathematics at the Imperial College of Science and Technology, London. Dr. Hayman is a brilliant mathematician with an international reputation in his own field, and the value of the contributions which he has made in this field has been recognized by his election at the early age of thirty to a fellowship of the Royal Society. Since graduating in 1946, he has published a number of papers, largely concerned with the behaviour of the maximum modulus of an analytic function which satisfies certain specified conditions. Perhaps the most striking of his results relate to the celebrated conjectures of Bieberbach and Wiman. On one hand he has proved that, if a given function $f(z) = z + a_2z^2 + \ldots$ is schlicht in $|z| < 1$, then Bieberbach's conjecture that $|a_n| \leqslant n$ does hold for all but a finite number of values of n. By an appeal to the method of symmetrization and the idea of the transfinite diameter, he has shown, moreover, that the above is a special case of corresponding results for p-valent functions. Again, in an earlier paper he disproved a conjecture of Wiman by showing that, if $m(r)$, $M(r)$ denote the minimum and maximum moduli of a non-constant integral function, then the inequality $m(r) > M(r)^{-A \log\log\log M(r)}$ holds for some large values of r if $A = 2{\cdot}2$, but not always if $A = 0{\cdot}09$. In the course of a short career he has already gained many of the distinctions most coveted by mathematicians. These include the Smith's and Adams's Prizes at Cambridge as well as the Junior Berwick Prize of the London Mathematical Society. Dr. Hayman's early education was received at Gordonstoun School, whence he proceeded in 1943 as a Major Scholar to St. John's College, Cambridge. In 1947 he was elected a Fellow of his College and, after a short period as lecturer at King's College, Newcastle, joined the staff of University College, Exeter.

Physical Chemistry at Haifa : Prof. F. Kőrösy

DR. FRANCIS KŐROSY has been appointed head of the Section for Physical Chemistry at the Technion (Technical College), Haifa, Israel. The last two professors in this post were Prof. A. Samuel and Prof. J. Shereshefsky. The Hungarian authorities, in accord with their constant desire to further international cultural co-operation, have given permission to Dr. Kőrosy and his family to leave Hungary for Israel and take up his duties at the Technion, where he is expected to arrive in a few weeks time. Dr. Kőrosy studied at the Technische Hochschule at Karlsruhe and graduated there as Dipl.-Ing.Chem. in 1927. He was awarded a Ph.D. degree with first-class honours at the University of Budapest in 1929 after having worked under Prof. Zemplén in organic chemistry. He returned as assistant to Karlsruhe, working in the Departments of Dr. J. Tausz and Prof. E. Előd on problems of adsorption in connexion with textile chemistry. Returning to Hungary in 1931 he joined the staff of the Tungsram Research Laboratory at the United Incandescent Lamp Co. During his work in this institution he carried out fundamental research on barrier layer cells with the late Prof. P. Selényi and worked with Dr. I. Brody on krypton and on krypton-filled and pressurized incandescent lamps. He published several papers on different subjects of general and inorganic chemistry and invented a buffer preparation against gastric acid disorders. He visited the United States before the War and then returned to Hungary. After the War he became *Privatdozent* at the University of Budapest with applied physical chemistry as his subject and received the degree of *Candidate* in 1953. He has been teaching at the University ever since and has also taught at the evening courses of the Technical University for the past three years. His experimental work and published papers range from pharmaceutical chemistry through organic and inorganic problems, always emphasizing the physical chemist's point of view.

Directorship of the London Museum : Dr. D. B. Harden

THE directorship of the London Museum, which has been vacant since Prof. W. F. Grimes left to become director of the University of London Institute of Archæology (see *Nature*, January 7, p. 16), has been filled by the appointment of Dr. D. B. Harden, who since 1945 has been keeper of the Department of Antiquities and secretary of the Griffith Institute at the Ashmolean Museum, Oxford. Dr. Harden is at present vice-president of the Society of Antiquaries, and during 1950–54 was president of the Council of British Archæology. As honorary secretary of the Museums Association, he has also had much experience of museum problems outside Oxford. He has served on the Council of the British Association and was the recorder of Section H (Archæology) for a number of years. He is an expert on ancient glass. But all these activities, and many more, are of the kind that could be extracted from a book of reference. What would not be mentioned there is his tact and genial personality. It is not easy to be a well-liked and successful recorder of a section at meetings of the British Association. Not only have programmes to be arranged, but also during the meeting itself all the members have got to be kept contented. It may be added that, in this regard, Dr. Harden has always been ably seconded by Mrs. Harden. There can be no doubt that his appointment as director of the London Museum is a wise one, and will be popular.

Institute of Industrial Management : Awards

THE Bowie Medal for 1955 of the Institute of Industrial Administration has been awarded to Mr. E. F. L. Brech, management consultant and senior partner of Urwick, Orr and Partners, Ltd. The Medal, which was established in 1954, is awarded annually to a member of the Institute for a noteworthy contribution to management. Mr. Brech has been chairman of the London Centre of the Institute of Industrial Administration and is at present a member of council; he was founder-chairman of the Association of Supervisors' Discussion Groups.

The Institute has also awarded the Wilson Medal, and special premium of £25, for 1955/56 to Mr. C. R. Perks (Cardiff Branch) for his paper on the establishment of overseas subsidiaries; honourable mention has been given to Mr. N. G. Westcombe (London Branch) for his paper on emotional attitudes in management.

International Geophysical Year : Conference in Paris

THE Third Antarctic Conference of the International Geophysical Year was held in Paris during the past week. The United Kingdom delegation consisted of Sir David Brunt (secretary of the Royal Society), Mr. James Wordie, Dr. V. E. Fuchs and experts in those problems likely to be met in next year's Antarctic programme. The delegation presented a report on what has been achieved by the Royal Society advance party, the advance party of the Trans-Antarctic Expedition and the existing bases of the Falkland Islands Dependencies Survey. Other nations, including Australia, France, the United States and the U.S.S.R., also presented reports. The plans for the programme in Antarctica of the International Geophysical Year were discussed; arrangements for co-operation in radio communications, central weather forecasting services and mutual logistic support were considered.

Hazards of Nuclear and Allied Radiations

A SHORT debate in the House of Commons on July 16 on the report of the Committee on the Hazards to Men of Nuclear and Allied Radiations was opened by Dr. Edith Summerskill, who urged that it is of paramount importance not to increase the scale of the present tests of nuclear weapons and that control of such tests with the object of eventual abolition should be our aim. Mr. Richard Foot stressed the importance of the further research work on the genetic effects of radiation and other matters which the Committee recommends should continue, and Mr. A. Blenkinsop, asking whether research work in Britain is adequate, urged the importance of encouraging vigorously all the international research work proceeding in this field. The Minister of Health, Mr. R. H. Turton, replying in the debate, said that the Government regards the expansion of research as a matter of high priority in order that the potentialities of nuclear radiation may be exploited with confidence and safety; immediate action will be taken when the Committee submits to the Medical Research Council its recommendations for future work. The Atomic Energy Authority would have no difficulty in carrying out the recommendations of the report regarding occupational exposure to radiation. He reiterated the Government's intention to do its best to secure progress in the regulation and limitation of test explosions, and mentioned that the Radioactive Substances Advisory Committee, under the chairmanship of Sir Charles Darwin, has prepared a comprehensive code of practice for use in the National Health Service hospitals. This is under final revision and will be issued shortly. To assist in carrying out the code, as well as in applying existing protective measures in hospitals and in industry, a Radiological Protection Service has been set up and, in accordance with the recommendation that present practice in diagnostic radiology should be reviewed and the use of radiotherapy in non-malignant condition critically examined, the Government is appointing a committee of scientists and professional men, with Lord Adrian as chairman, to examine these essentially clinical matters and make recommendations. Recommendations for collecting more detailed information for genetic studies would be discussed with the Registrar General.

A Winge Festschrift

A VOLUME in honour of the seventieth birthday of the distinguished Danish botanist, Prof. Öjvind Winge, of the Carlsberg Laboratory, Copenhagen, has recently appeared (as Vol. 26 of the *Comptes Rendus des Travaux du Laboratoire Carlsberg*, Sér. Physiologique; pp. 1–443; 1956; 40 kr.). As is appropriate and to be expected, it is concerned almost entirely with the genetics of micro-organisms. It includes a bibliography of Prof. Winge's own scientific publications, these amounting to 120 titles, extending from the year 1907 to date, the whole constituting a notable contribution to a subject of great contemporary interest and increasing importance. The individual papers in the volume have been contributed by eminent exponents in the field of the genetics and physiological genetics of micro-organisms. Some of these relate to specific topics and observations; for example, gigas mutants; others pertain to what is now referred to as the biochemistry of genetics, for example, "The Genetics of Galactose Fermentation in *Saccharomyces* Hybrids"; and yet others deal with more general topics, such as "Genes—their Nature and Function". Altogether, there are twenty-five separate contributions, the overall effect being to provide the reader not only with a representative survey but also to give him a very lively impression of the effort that is being made in different parts of the world in a difficult but rewarding field. Like other publications from the Carlsberg Laboratory, the volume is attractively produced.

Journal of Fluid Mechanics

THE recent increase in the number of investigations, both theoretical and experimental, relating to the study of fluid mechanics has necessitated the launching of a new periodical devoted solely to this subject, the *Journal of Fluid Mechanics*. The *Journal* is to be issued in six parts to a volume of approximately six hundred pages, and the first number has recently been published (London: Taylor and Francis, Ltd.; New York: Academic Press, Inc. 20*s*. or 3 dollars per part; £5 10*s*. or 16.50 dollars per vol.). The editor is Dr. G. K. Batchelor (Cavendish Laboratory, Cambridge), assisted by Drs. T. B. Benjamin and I. Proudman; and Profs. G. F. Carrier (Harvard), W. C. Griffith (Princeton) and M. J. Lighthill (Manchester) are associate editors. The first issue contains eight papers, all of which are of high standard: four relate to aerodynamics, one to oceanography, one to rainfall, and the remaining two, by M. J. Lighthill and M. B. Glauert, respectively, of the Department of Mathematics, University of Manchester, deal with the theoretical discussion of drift and boundary-layer flow on oscillating plates and cylinders, respectively. M. D. Van Dyke (Ames Aeronautical Laboratory, California) obtains a second approximation to the solution of the problem of supersonic flow past unyawed elliptic cones by proceeding from the slender-body theory. L. C. Woods (Sydney) discusses the thrust due to an air-jet flowing from a wing placed in a wind tunnel and establishes that the ideal thrust is almost independent of the jet exit angle; V. Blackman (Princeton) describes a study of vibrational relaxation in oxygen and nitrogen in the range of shock waves of Mach-number speeds 3–10; and N. Rott (Cornell) investigates theoretically the diffraction of weak shock waves near the edge of a sharp wedge. A theory of collisions between small drops in a turbulent fluid, taking into account collisions between equal drops, is given by P. G. Saffman and J. S. Turner (Trinity College, Cambridge), and the results are applied to the case of small drops in atmospheric clouds to test the importance of turbulence in initiating rainfall. Finally, J. Grease (National Institute of Oceanography, Dorking) considers the problem, arising in connexion with the propagation of tides and storm surges in the ocean, of long gravity waves on a rotating Earth approaching a semi-infinite barrier parallel to the wave crests.

Health Education in Factories

THE health committee of the County Borough of Willesden (London) has been considering means of interesting people in health education (*Health Educ. J.*, 14; 1956). During the past seven years, health talks on a variety of subjects have been given to religious, social and political organizations, trade unions, and many clubs. The audiences have varied from about twenty to eighty; but there has recently been a tendency for them to decline. Some talks had already been given in factories by special requests from the managements, and it was thought that here appreciative audiences might be found. At the end of 1954 it was decided to explore the possibility of giving health talks to factory staffs during lunch-hour breaks. Several factory managements were approached and the response was most encouraging. Four talks were given by the Medical Officer of Health to approximately 2,400 factory workers, the attendances ranging from 400 to 1,000. A new drive was made in 1955, and in the first six months of the year fourteen talks were given in factories on subjects including influenza, coughs and colds; cancer; mass miniature radiography; nutrition; accident prevention and sepsis. With the outbreak of poliomyelitis in the beginning of July 1955, a new stimulus was given to the work. Most factories were only too willing to provide facilities for a talk on this subject, and some of them approached the health department direct. Altogether, up to the end of October, ninety-six talks were given in eighty factories to 23,500 workers. The number in the audience varied from 20 to 4,000, with the majority in the range of 100 to 200. Co-operation with the factory management was not easy at first. Personal contact with the personnel or works manager was necessary.

Row-crop System for Grass

THE technique of growing grass in wide rows instead of in broadcast stands was first developed for grass, chiefly cocksfoot, intended for seed production. Coupled with heavy dressings of nitrogen, part of which was applied in late summer, this system was found to give increased yields of seed and, incidentally, to prolong the growing season well into the winter. With the post-war drop in seed prices, the emphasis has changed and the interest now lies in how the row-crop system may best be used by the grazier. Some account of Scottish experiences with the method is given by I. V. Hunt in an article entitled "Rowcrop Grass", published in the autumn number of *Scottish Agriculture* (Edinburgh: H.M.S.O.; 1*s*.). The grass is sown in strips 12–28 in. apart, with inter-row cultivation in the initial stages. In the summer the crop is grazed or cut for hay, silage or dried grass. Fertilizer is then applied and later growth kept for winter grazing. Cocksfoot has so far proved the most suitable grass; but trials are in progress with timothy, meadow fescue and perennial ryegrass. A seed crop should be possible from cocksfoot and meadow fescue without prejudicing the winter grazing, but timothy would ripen too late. Other promising features of the system are the reduction in waste from treading, winter burning, or rotting, earlier growth in spring and considerable reduction in the cost of seed. The method is still in the experimental stage; but it has steadily gained favour on English and Welsh farms and may prove of special use in Scotland where the grazing season is normally short.

Cultivation of Lucerne in Britain

THE acreage under lucerne in England and Wales has now reached some 112,000 acres, half of which lies in East Anglia, Kent and Lincolnshire. The crop requires skill in management and makes heavy demands on soil fertility; but its drought-resistant properties and vigorous growth during the summer make it a valuable plant for the establishment of leys, and it can be profitably grown in all parts of Britain. Memoir No. 1 of the Grassland Research Institute, entitled "Lucerne Investigations 1944–1953" (pp. 81; from the Institute, Hurley, near Maidenhead, 1955; 10*s*.), should help farmers to utilize this crop better, for it gives the results of critical field experiments carried out by the Institute and the National Agricultural Advisory Service in different parts of the country. Information regarding the different strains of lucerne is provided in an article contributed by the National Institute of Agricultural Botany, Cambridge; from the trials at the Grassland Research Institute, the early long-season type appears to have given the most promising results so far. Much attention is devoted to the subject of management, including that of leys where the lucerne is associated with different companion grasses. Remarkable differences in yield can be obtained by changes in timing the cuts, autumn being a specially critical period. A useful bibliography is included in the memoir.

Germination Regulation in Desert Seeds

THE regulation of germination in the seeds of the desert leguminous species *Colutea istria* Mill. has been investigated in some detail by D. Koller and M. Negbi (*Bull. Res. Council Israel*, Sect. D, Botany, **5***D*, 1, 73; 1955). The seeds were found to be largely impermeable to water. This could be remedied either by treatment with concentrated sulphuric acid, or by vigorous shaking in a glass jar. Swelling was more rapid after the former treatment. It was found that, whereas acid treatment removes impermeability by acting all over the surface of the seed coat, the shaking did so only in the micropylar region. Permeable seeds germinated equally well in light and in dark, and their germination was insensitive to temperature between 20° and 30° C. Seedling growth in dark exceeded that in light. The two seed samples investigated, which were collected in different years and locations, differed widely in germination. This was apparently caused by different degrees of maturity which the embryos had attained before fruit ripening. Two separate coats surround the embryo. The inner coat has no influence on germination in the fully 'ripe' sample, but in the 'unripe' sample it affords the embryo some kind of protection against decay. The outer coat in both samples contains a water-soluble growth inhibitor, which retards embryo growth. Successful reseeding of depleted desert pastures was carried out with this species in the Negev Highlands.

Nuclear Differences in Onion Root Tissue

IN former years it was generally assumed that the cells of the various tissues of a higher plant had nuclei the constitution of which was identical with that of the fertilized ovum. Some recent investigations have shown, however, that the nuclei in all cells are not alike. A. L. Chouinard (*Canad. J. Bot.*, **33**, No. 6, 628; 1955) has contributed to this topic by observing the nuclear differences in onion (*Allium cepa*) root tissues as revealed by the induction of mitosis with indoleacetic acid. Treatment with this growth substance was used for stimulating mitosis in differentiated tissues of *Allium cepa* roots in order to establish whether nuclear differences, specifically in chromosome number, exist normally and are merely revealed by treatments, or whether these nuclear differences are produced by the treatment. With the concentrations of indoleacetic acid and durations of treatment used, evidence was obtained that chromosome number differences exist in the differentiated tissues of onion root prior to any treatment, and that the appearance of these differences after treatment is a matter of revelation and not of causation. The evidence obtained in these investigations comes indirectly from observations of nuclear size and structure and directly from rare spontaneous mitoses in untreated roots, and in the treated roots (1) from the absence of nuclear abnormalities which might explain otherwise the origin of polyploid cells, (2) from the uniform occurrence of certain chromosome numbers in specific root tissues, (3) from proportions of diploid and polyploid divisions during mitotic induction, and (4) from the lack of relationship between total mitotic activity and number of polyploid mitoses. A gradient of endomitotic polyploidization exists in certain tissues along the longitudinal axis of the onion root.

Rubber Diseases in the Belgian Congo

R. J. Pichel (with the collaboration of C. Maertens) has produced a monographic study of rubber diseases and their control in the Congo basin (l'Inst. Nat. pour l'Étude Agr. du Congo Belge, Sér. Tech. No. 49 ; pp. 1–450, 1956 ; 400 fr.). The first part of the book deals with the general problem of disease in rubber and the causative agents, the root-attacking fungi *Fomes lignosus* (*Rigidoporus microporus*) and *Armillaria mellea* being of outstanding importance, as they also are in other rubber-growing regions. The attitude of the author to his subject is practical rather than detailed and specialized. The second part is devoted to observations on the biology of root-destroying fungi and the behaviour of *Hevea* under attack. The problem of infection courts is given special attention, and the processes and factors involved in contamination, infection and effective parasitism are considered at some length. In the third section, the epidemiology of the diseases and the efficacy of control measures are described with special reference to the considerable volume of work carried out at Yangambi, the effects of both direct methods and cultural treatments in controlling the pathogens being considered. The fourth section is concerned with control measures and the economic aspects of the problem. The conclusions and recommendations at the end represent a synthesis of the experience and the effort made in this field by the Belgian Congo workers at the Yangambi Research Station during recent years. The work is illustrated by a large number of excellent photographs, coloured plates and diagrams. This monograph contains a great deal of new observation of interest and importance to both pathologist and planter. A bibliography of more than three hundred titles is included.

Breeding of Shags on Lundy Island

During 1954 and 1955 observations were made on the breeding habits of shags on Lundy Island, and these have been described in the ninth annual report of the Lundy Field Society. Sufficient material was collected for some factors to emerge which appear to affect breeding success. The two years showed practically no difference in the pattern of clutch size although the weather was dissimilar. In both years there was a great predominance of clutches of three ; there is a tendency for clutches laid later in the breeding season to be of a size greater, or less, than three. There was a striking similarity of hatching and fledging success in the two years, 93·6 per cent of young hatched during the two years reaching the flying stage—a remarkably high percentage. Even so, the number of young fledged was not sufficient to secure replacement of breeding adults. From the evidence of recoveries the yearling mortality is fairly high, and the species appears not to breed until at least three years old. Adults must average several seasons of breeding in order to replace themselves. All nests found have been divided into those situated under rocks and those open to the sky or with only slight rock overhang : covered nests are significantly more successful than open nests. Young in covered nests have shelter from rough weather and seas, and are not liable to be inadvertently pushed out of the nest and possibly over the cliff. Another significant factor in fledging success is the date of hatching. The earlier nests have a markedly higher rate of success than the late nests. It will be interesting to compare these results with those obtained by E. White and J. C. Coulson, who are studying shag mortality on the Farne Islands.

Zoological Nomenclature

As from December 12, 1956, the International Commission on Zoological Nomenclature will start to vote on the following cases involving the possible use of its plenary powers for the purposes specified against each entry. Full details have already been published (*Bull. Zool. Nom.*, 12, Pts. 1 and 2 ; June 1956). (1) *Paradoxides* Brongniart, 1822, validation ; *Olenus* Dalman, [1827], designation of type species for ; *paradoxus* Linnaeus, 1759 (*Entomolithus*), suppression and Paradoxiden Emmrich, 1844 (wrongly based on *Olenus*) suppression (Cl. Trilobita) ; (2) *munda* Kuhl, 1820 (*Proc.[ellaria]* and *Nectris*), suppression (Cl. Aves) ; (3) *Daira* de Haan, [1833], validation (Cl. Crustacea, Order Decapoda) ; (4) *tuberculatus* Hall, 1859 (*Acidaspis*), validation ; *Acanthaloma* Conrad, 1840, suppression (Cl. Trilobita) ; (5) *Theridion* Walckenaer, 1805 (Cl. Arachnida), designation of type species for ; (6) *Protopeltura* Brogger, 1822 (Cl. Trilobita), designation of type species for ; (7) *punctata* (*Querquedula*), validation of, as from Sclater (P.L.), 1880, as name for the hottentot teal (Cl. Aves) ; (8) *Trinucleus* Murchison, 1839, validation of ; *tuberculatus* Link, 1807 (*Trinucleus*), suppression (Cl. Trilobita) ; (9) *Panulirus* White, 1847, validation ; *commune* Leach, 1818 (*Phyllosoma*) and *rissonii* Desmarest (*Palinurus*), suppression (Cl. Crustacea, Order Decapoda) ; (10) *Illaenus* Dalman, [1827], protection of by suppression of *Cryptonymus* Eichwald, 1825 (Cl. Trilobita). Comments should be sent as soon as possible to the secretary to the Commission, Mr. Francis Hemming, 28 Park Village East, Regent's Park, London, N.W.1.

Ordnance Survey Map of Roman Britain

Britain was under Roman rule for nearly four hundred years, and, though subsequent influences from beyond the North Sea and from Normandy profoundly affected its people and their way of life, yet in many things the Roman pattern remained an ideal. A detailed survey of the various categories of Roman remains is therefore of great interest, and the new, third edition of the "Ordnance Survey Map of Roman Britain" is very welcome (pp. 43+1 map ; paper flat, 3*s*. 3*d*. ; folded, with text, 7*s*. 6*d*. ; text only, 3*s*.). Much has been discovered since the last edition appeared about a quarter of a century ago, and methods of investigation have vastly improved. In every way the present publication is a great advance on the last, and Mr. C. W. Phillips, archæological officer for the Survey, is to be congratulated. It is a pity, perhaps, that such a large map had to be printed on such thin paper. It will not stand much use away from the study table, unless extracted and framed. A map of such general interest might well have been issued on paper of such a quality that it would stand up to use in the field by the investigator and by the amateur when travelling about the country. But it is a fine piece of work, and it will be a long time before another revise is needed.

Distribution of Prehistoric Rock Engravings and Paintings in South Africa

AN up-to-date gazetteer of all the sites in the Union of South Africa and South West Africa where rock-shelter paintings and engravings on rocks occur was prepared by the late Prof. C. van Riet Lowe and has been published by the Archæological Survey of the Union under the title: "Distribution of Prehistoric Rock Engravings and Paintings in South Africa" (Archæological Series No. 7. Pp. 58. Johannesburg: Union Education Department, 1956; 10*s*.). The arrangement is by provinces and districts, which makes it easy to use, especially as there is a foreword where the various groups are described. The publication will be very useful to prehistorians visiting South Africa and wishing to study a number of painted and engraved sites. There is an excellent distribution map.

Measuring the Load on Pit Props

FROM the earliest days of mining the support of the roof of the tunnel driven has been a question of the first importance. With the ordinary handwork at the pit face, it had come to be accepted in Western Europe that the coniferous pit prop was the safest that could be obtained, as it gives warning before breaking to collapse. Metal substitutes have had a brief trial; but they give no such warning. The successful development of mechanized systems of mining have brought other difficulties, and the wooden coniferous pit prop is no longer free from suspicion. This matter is dealt with in *Science Bulletin* No. 4 (Spring 1955) of the Scientific Department, National Coal Board (pp. 24; from the Board, London). Some sound roof control is of paramount importance, if mechanized systems of mining are to be introduced and accepted, to prevent falls of the roof on the coal face, and also to improve the workability of the coal seam. Attempts have been made in the past to undertake a complete study of roof control, entailing the measurement of the forces acting actually within the coal and the surrounding strata, but considerable problems are involved. Information can, however, be obtained from a study of the movements of the roof supports and of the loads they carry. For example, a study of the loads carried by the front row of props will help to show whether a prop-face front can be used. An instrument, called a load cell, has been devised which will register the load carried by a prop when placed between the prop and a roof bar. The load cell is small and robust, so that it can be set easily and will not interfere with the normal behaviour of the prop, and already it has been used for a number of investigations.

Seismic Observations on a Large Explosion in North-East Japan

ON September 13, 1953, at 3h. 4m. 57·074s., the second large explosion at the Kamaisi mine of the Nippon Iron Works (lat. 39° 17′ 39·9″ N., long. 141° 41′ 32·9″ E.) to be observed seismically occurred, this being the fifth explosion to be observed seismically by the Japanese Research Group for Explosion Seismology (*Bull. Earthquake Res. Inst., Tokyo Univ.*, 33, Pt. 4, 699; December 1955). The aim of the blasting operation was to remove dangerous gangue rocks as a safety measure, and the letting off of 42 tons of explosives was operated in seven steps, which took altogether 84 milliseconds from first to last. From a seismic point of view, this method is less effective than if the whole mass had been let off at once. Fourteen seismograph stations for refraction shooting were placed from near the shot point to a distance of 332 km., the most sensitive instruments being placed 170–332 km. distant. Most of the seismographs used were vertical electromagnetic instruments, working at 3 c./s., though the nearest worked at 10 c./s., and an additional one at the most distant station worked at 0·7 c./s. Horizontal electromagnetic seismographs were operating at six stations, working either at 3 c./s. or 1 c./s. The line of fourteen stations was almost parallel with, and near, the east coast line from about lat. 36° 33′ N. to about lat. 39° 18′ N. In addition, a special station was established at Umanokiuti ($\Delta = 4{\cdot}63$ km.) to make observations of reflected waves. *P*- and *S*-wave onsets were read at most stations, and travel-time curves constructed from the results. On the assumption of horizontally disposed layers, the *P*-wave indicated a layer of thickness between 22 and 25 km. in which the velocity was 6·05 km./sec., overlying a layer in which the velocity of *P*-waves was 7·2–7·6 km./sec. Reflexion experiments tended to confirm this thickness for the upper layer. Results from the *S*-wave alone gave a thickness of between 32 and 36 km. for the upper layer in which the velocity of the *S*-wave was 3·46 km./sec., overlying a stratum in which the velocity of the *S*-wave was between 4·5 and 4·8 km./sec. The discrepancy in the estimate of thickness of the upper layer may be due to the influence of a more complicated structure than that assumed. This is to be investigated.

Scientific Instrument Manufacturers' Association: Officers for 1956–57

THE following have been elected officers for 1956–57 of the Scientific Instrument Manufacturers' Association: *President*, G. A. Whipple (Hilger and Watts, Ltd.); *Vice-President*, P. Goudime (Electronic Instruments, Ltd.); *Honorary Secretary*, J. E. C. Bailey (Baird and Tatlock (London), Ltd.); *Honorary Treasurer*, C. H. Warner (W. F. Stanley and Co., Ltd.); *New Members of Council*, F. W. Dawe (Dawe Instruments, Ltd.), P. J. Ellis (R. B. Pullin and Co., Ltd.), J. M. Furnival (Marconi Instruments, Ltd.), D. F. Newstead (Kershaw Division, Rank Precision Industries, Ltd.), J. A. Stafford (Taylor, Taylor and Hobson, Ltd.), W. H. Storey (Unicam Instruments, Ltd.) and N. Trepte (Griffin and George, Ltd.).

University of London

DR. L. A. ELSON, British Empire Cancer Campaign Intermediate Research Fellow, has been appointed to the University of London readership in biochemistry tenable at the Institute of Cancer Research, Royal Cancer Hospital, London. The title of professor of experimental pathology (histopathology) in the University of London has been conferred on Dr. E. S. Horning, in respect of his post at the Institute of Cancer Research, Royal Cancer Hospital, and that of reader in physical organic chemistry in the

University of London on Dr. Victor Gold in respect of his post at King's College. The title of professor emeritus in the University of London has been conferred on the following on their recent retirement from chairs tenable at the institutes indicated: Prof. H. Berry (pharmaceutics at the School of Pharmacy); Prof. V. G. Childe (prehistoric European archæology at the Institute of Archæology); Prof. S. J. Davies (mechanical engineering at King's College); Prof. S. J. Cowell (dietetics at University College Hospital Medical School); Prof. H. T. Flint (Hildred Carlile chair of physics at Bedford College); Prof. L. Hawkes (geology at Bedford College); Prof. W. J. John (electrical engineering at Queen Mary College); Prof. A. Meyer (neuropathology at the Institute of Psychiatry); Prof. A. J. S. Pippard (civil engineering at the Imperial College of Science and Technology); Prof. H. Raistrick (biochemistry at the London School of Hygiene and Tropical Medicine); and Prof. R. A. Webb (pathology at the Royal Free Hospital School of Medicine).

Oversea Service Division, Colonial Office

The following appointments have recently been made in the Oversea Service Division, Colonial Office: C. J. Allen (agricultural officer, Jamaica), senior livestock officer, Department of Agriculture, Jamaica; E. J. H. Berwick (senior agricultural officer (grade A), Federation of Malaya), director of agriculture, North Borneo; A. E. Billington (senior research officer (grade B), Federation of Malaya), senior research officer (grade A), Federation of Malaya; F. B. Brown (botanist, Federation of Malaya), senior research officer (grade B), Federation of Malaya; P. G. Coleman and P. A. Gething (senior agricultural officers (grade B), Federation of Malaya), senior agricultural officers (grade A), Federation of Malaya; C. North-Coombes (agricultural economist, Gold Coast), assistant director of agriculture, Gold Coast; J. K. Coulter (soils chemist, Federation of Malaya), senior research officer (grade B), Federation of Malaya; W. H. Edwards (agricultural officer, Uganda), assistant director of agriculture, Uganda; J. H. Gisborne (assistant director of agriculture (research), Northern Region, Nigeria), deputy director of agriculture (research), Northern Region, Nigeria; W. C. H. Hill (senior agricultural survey officer, Department of Agriculture, Gold Coast), principal agricultural officer, Department of Agriculture, Gold Coast; H. M. James (agricultural officer, Federation of Malaya), senior agricultural officer (grade B), Federation of Malaya; G. B. Kennard (senior field officer, British Guiana), deputy director of agriculture, British Guiana; M. D. ffrench-Mullen (managing director, Berbice Fibre Research Co., Ltd., British Guiana), deputy director of agriculture, British Guiana; H. J. Simpson (senior agricultural officer (grade A), Federation of Malaya), assistant director of agriculture (field), Federation of Malaya; D. Westwood (senior agricultural officer, Gold Coast), principal agricultural education officer, Gold Coast; P. St. J. Matthews (forester (grade II), Kenya), assistant conservator of forests, Kenya; D. S. P. Noakes (deputy director of forestry, Federation of Malaya), director of forestry, Federation of Malaya; B. E. St. L. Stuart (research officer, Forestry Division, East Africa High Commission), assistant conservator of forests, Kenya; L. C. M. Wedderburn (senior assistant conservator of forests, Northern Region, Nigeria), conservator of forests, Northern Region, Nigeria.

Announcements

Prof. Sydney Chapman, visiting professor of geophysics in the University of Alaska, has been awarded by the Accademia Nazionale dei Lincei, Rome, the international prize, on the Antonio Feltrinelli Foundation, for astronomy, geodesy, geophysics and their applications.

Sir Harold Spencer Jones has been appointed secretary-general of the International Council of Scientific Unions in succession to Prof. A. V. Hill, who has retired.

Mr. I. Edward Garrick, chief of the Dynamic Loads Division, Langley Laboratory, Virginia, of the U.S. National Advisory Committee for Aeronautics, has been appointed to the Jerome Clarke Hunsaker chair at the Massachusetts Institute of Technology. This chair, which is for aeronautical studies, is held for a year, and the previous occupant was Prof. W. Hawthorne, professor of applied thermodynamics in the University of Cambridge. Mr. Garrick is a leading authority on aircraft 'flutter'.

The autumn meeting of the Institute of Metals will be held this year in Germany during September 17–25. The meeting will consist of a large number of excursions to engineering works and other places of interest, and will be based in Stuttgart until September 23, and in Frankfurt am Main thereafter. During September 17–18 joint scientific sessions will be held with the Deutsche Gesellschaft für Metallkunde. Registration forms can be obtained from the Secretary, Institute of Metals, 17 Belgrave Square, London, S.W.1.

The fourth instruments and measurements conference and exhibition, organized by the Royal Academy of Engineering Sciences and the Swedish Association of Technical Physicists, will be held in Stockholm during September 15–23. The conference will consist of six sections: nuclear instrumentation; automation; physical methods for chemical analysis; spectroscopy; optics; and computers. Further information can be obtained from the conference secretary, Sven Malmström, P.O. Box 12035, Stockholm 12.

An international congress of clinical chemistry will be held in New York City during September 9–14 under the auspices of the International Federation of Clinical Chemistry and the Commission of Clinical Chemistry of the International Union of Pure and Applied Chemistry. The principal theme of the congress will be the significance of metabolic systems in clinical chemistry. Further information can be obtained from the congress secretary, Dr. John G. Reinhold, 711 Maloney Building, Hospital of the University of Pennsylvania, Philadelphia 4, Pa.

The Department of Civil and Municipal Engineering of University College, London, is offering two courses in photoelasticity. The first is a short refresher course, which will be held during September 3–14 (fee £8). The other is a full course extending over the academic year 1956–57, and comprises weekly lectures on the theory and methods of photoelasticity (fee, £14) with, when possible, one or two days a week practical work in the laboratories (fees, £11 and £16 respectively). Applications should be made to the Secretary, University College, London, Gower Street, W.C.1.

NEW NATURE RESERVES IN BRITAIN

THE Nature Conservancy has announced the establishment of two new nature reserves in England and the addition of further areas to two existing reserves. The new reserves are Lullington Heath (three and a half miles north-west of Seaford, Sussex) and Cothill (five miles south-south-west of Oxford), and the additions are to the Newborough Warren and Ynys Llanddwyn nature reserve, Anglesey, and the Axmouth–Lyme Regis undercliffs nature reserve, Devon.

Lullington Heath is one of the largest areas of unploughed chalk heath remaining on the South Downs. It was under cultivation in prehistoric times, and the boundaries of rectangular fields can still be traced, especially in the north-west corner of the reserve. Fragments of pottery and iron slag show that people not only farmed but lived and worked there. Far from reducing the biological value of the reserve, these traces of long-past soil disturbance add to its interest, and provide a link with agricultural history. The reserve covers an area of 155 acres and is being declared under a sub-lease from the Forestry Commission, which leases the area from the Eastbourne Waterworks Company. It appears that the land has been used only for grazing, without cultivation, for many hundreds of years; the lime has been leached from the surface layers, which are acid, even though the chalk is only a few inches below. In consequence, shallow-rooted plants which need acid soil—for example, bell heather and ling—are mingled with deep-rooted plants such as salad burnet and dropwort, which need limy soil. By April 1954 myxomatosis reached Lullington and almost exterminated the formerly dense rabbit population, and this set in motion changes in the vegetation. Careful records have been made of these changes, which form an important part of the national record of the results of myxomatosis. It is important that the long-term research work which is in hand on this reserve should not be disturbed, and applications for collecting specimens of animals or plants or changing the fauna or flora in any way should be made to the Conservancy's regional officer for the south-east at 19 Belgrave Square, London, S.W.1.

The Ruskin Reserve at Cothill, Berks, has been protected since 1917 by the National Trust in co-operation with the Ashmolean Natural History Society, and it has been declared a nature reserve under a lease with the National Trust. Four and a half acres in extent, it has long been noted for the richness of its flora and fauna and is used for university teaching and research, together with other adjoining areas, for the protection of which the Nature Conservancy is negotiating. The fen occupies a basin, on the edge of the Jurassic (Corallian) Calcareous Grit, which is the meeting point of several streams carrying highly calcareous water; the outflow is at Sandford Brook. It seems probable that much of the valley was flooded in medieval times; two ponds can still be found in the Ruskin Reserve. These show the succession from open water through various swamp associations to woodland of alder, birch, ash and other trees, the development of the vegetation being accompanied by progressive acidification of the surface peat. Access to the reserve will be by permit only, applications for which should be made to the Conservancy's regional officer for the south, at the Furzebrook Research Station, Wareham, Dorset.

The Newborough Warren and Ynys Llanddwyn nature reserve, covering an area of 283 acres, was declared in June of last year, and the present declaration, which is made under a lease with the Glynllivon Estate, adds a further 500 acres extending from Rhosddu Lake up to, but not including, Abermenai Point. Although in Anglesey, it is only some three miles west of Caernarvon across the Menai Strait. Newborough Warren is one of the largest, and biologically richest, expanses of dunes in western Britain. A large-scale encroachment of the land by inundation of sea and sand was recorded in 1331; as a result of the planting of marram grass, the dunes have progressively become more stabilized, and some of them now rise more than 50 ft. above sea-level. It is one of the earliest occupied sites in Anglesey, and Mesolithic flint sites show occupation by man probably between 7000 and 5000 B.C. Stages of sand-dune succession are shown on a large scale, including shifting dunes, willow dunes, and marsh and fixed dunes. There are extensive 'slacks'—damp dune hollows—which are occupied by open communities of creeping willow. The 'slacks' are rich in plant life, some rarities being recorded and some species which are normally associated with mountain habitats. The dunes are important for biological and physiographical research and are much used by workers, especially from the University College of North Wales, Bangor. There will be no restriction on rights of way, but to collect specimens permission is needed from the conservation officer, c/o School of Agriculture, University College of North Wales, Memorial Buildings, Bangor, Caernarvon; the warden for the reserve is Mr. R. D. P. Morgan, Serai, Malltraeth, by Bodorgan, Anglesey.

The Axmouth–Lyme Regis undercliffs nature reserve extends over Bindon, Dowlands, Pinhay and Ware Cliffs, in Devon, and was established by the Conservancy in March of last year. There was then a large gap in the middle of the reserve which has now been filled by the additional area of 86 acres recently declared under a lease with the Governors of Allhallows School. This consists of the Rousdon and Charton Cliffs, and brings within the reserve the whole of the undercliffs stretching along 6½ miles of coast and covering 794 acres. The reserve is the largest and most important landslip area on the coast of Great Britain, records dating from the sixteenth century showing that there have been periodic slips of the Chalk and underlying Greensand on the Gault and Lower Lias Clays which dip towards the sea. The most spectacular slip recorded was at Dowlands on Christmas Day, 1839, when nearly eight million tons of rock subsided from a cliff 375 ft. high, leaving a vast chasm half a mile long and ranging from 200 to 400 ft. in width. The mixture of a wide range of rocks, which are mainly typical of south-eastern England, has led to a great variety of soils. Although between 1839 and 1905 very few trees established themselves on the floor and the sides of the chasm near Dowlands, since 1905 a fine isolated natural ash wood has come to maturity, this being almost the only known instance of the production of a mature ash wood on a virgin site without human interference within a precisely known period of time. Similar, but less striking, growth of natural vegetation has occurred on the Rousdon and Charton Cliffs. Owing to the inaccessibility of much of the ground and the continued risk of further slips, there has been an almost unique freedom from human disturbance there. Permits to collect specimens or to visit parts of the reserve away from the footpath will be needed, application for which should be made to the Conservancy's regional officer for the south-west at the Furzebrook Research Station, Wareham, Dorset; the warden for the reserve is Mr. L. A. Pritchard, Lynch Cottage, Rousdon, near Lyme Regis.

THE MUSEUMS ASSOCIATION

ANNUAL CONFERENCE IN THE NETHERLANDS

THE sixty-second annual conference of the Museums Association was held jointly with De Museumdag in Amsterdam during June 27–30. Owing to the provisions of the Companies' Act, it was necessary to hold the annual general meeting in Britain, and this took place at University College, London, before delegates embarked for Holland. After welcoming some 320 delegates to the conference, the retiring president, Dr. F. S. Wallis (director of the City Museum, Bristol), gave an address on some of the recent activities of the Association. He outlined the negotiations with the Government concerning assistance to museums and more especially to private and trustee museums. The generous help of the United Kingdom Carnegie Trustees was acknowledged, and the great effect of their grants on museum work in Britain over the past twenty-six years was stressed. Dr. Wallis also referred to the value of the various regional federations, the courage of the governing bodies and curators of small museums, and the need for more committees to utilize the provisions of the Local Government Act of 1948 whereby financial assistance may be given to further local efforts of a cultural character.

In Amsterdam, delegates were joined by members of De Museumdag under their president, Dr. J. C. Ebbinge Wubben, and an official welcome was given by Mr. F. P. Th. Rohling on behalf of the Minister of Education, Arts and Sciences and the Burgomaster of Amsterdam. Afterwards, Prof. E. K. Waterhouse read a paper on "British Collections and Dutch Art", in which he reviewed the interrelationships of English and Dutch art with especial reference to the seventeenth-century artists. Another series of papers, by Dr. A. B. de Vries, Sir Philip Hendy, Dr. W. E. Swinton and Dr. D. B. Harden, discussed museum displays in the Netherlands and Britain since 1945. The conference was unusual in that papers were reduced to those already mentioned, and visits to museums and art galleries to study technical and display methods were increased to the maximum possible. During the period the institutions in Amsterdam, Rotterdam, The Hague, the National Park in Otterlo, Arnhem, Leyden, Gouda, Utrecht and Delft were visited. Hospitality was lavish on all occasions.

The president of the Museums Association for 1956–57 is Sir Philip Hendy (director of the National Gallery, London), and the next annual conference of the Association will be held in Bristol during July 8–12, 1957.

METEOROLOGICAL PROGRAMME OF THE INTERNATIONAL GEOPHYSICAL YEAR

A NUMBER of important articles on the meteorological programme for the International Geophysical Year, planned by the responsible Working Group of the World Meteorological Organization, with Prof. J. van Mieghem (Belgium) as chairman, are to be found in the January and April numbers of the Organization's *Bulletin*. The intention of the programme is to increase knowledge of the meteorology of the tropics and of the upper air in all latitudes. Priority has been given to problems which are fundamentally world-wide in character, so that their solution calls for effective international collaboration, and local or regional questions have not been considered.

In synoptic and dynamical meteorology the problems to be attacked are as follows: the redistribution on a planetary scale of momentum, absolute vorticity, energy and momentum, including frictional and topographical effects; exchange of heat and momentum between the atmosphere and oceans; flow patterns in low latitudes, including interaction between the southern and northern hemispheres; and the distribution of precipitation, especially over the oceans, in relation to large-scale flow patterns. The data collected in this work will assist also in such problems as meteorological influences on the Earth's rotation and the 'model' atmospheres used in numerical forecasting. In physical meteorology the subjects for observation are the distributions of ozone and water vapour, the heat balance of the atmosphere, and the large-scale features of the electric field in the atmosphere.

To ensure comparability of records, it is recommended that the instruments to be used should be compared with national standards and that the World Meteorological Organization should arrange a world-wide comparison of national radiosondes. It is recommended that special efforts be made by every country to make daily two radiosonde observations of pressure, temperature and humidity, and four of wind, up to at least 50 mb. (about 78,000 ft.) and, if possible, to attain the 10-mb. level (103,000 ft.). As regards radiation, the Working Group recommends that observations of the total short-wave radiation (that is, direct solar beam and short-wave sky radiation) should be made at stations in all types of climate to establish for all parts of the world the empirical formulæ for determining global radiation from sunshine duration. Besides this, measurements are recommended of the ultra-violet radiation, of the spectral distribution of energy in solar radiation, and of the long-wave radiation at the surface. The vertical distribution of ozone, so important in studies of ultra-violet radiation, is to be measured, in particular in the sub-tropical anticyclone belt.

For the study of meridional exchanges it is important to be able to draw good meridional cross-sections. The Group proposes that meridional sections shall be drawn from pole to pole along meridians 180°, 140° E., 75° E., 10° E. and 75° W. The first is especially important as giving an oceanic section almost from pole to pole. Minor sections are to be made along other meridians—for example, along the tropical parts of 30° E. and 110° E. It is hoped that aerological stations will be set up in sufficient numbers along these meridians to enable good cross-sections to be drawn.

As regards publication of meteorological data for the year, the World Meteorological Organization has taken the bold step of deciding to use microcards. National meteorological services are to be asked to send a copy of the observational records of their stations to the secretariat, where they will be printed on microcards and sold. A trial of the method is to be held in January 1957.

THE PHYSICAL SOCIETY

ANNUAL REPORT FOR 1955

AT the annual general meeting of the Physical Society, held in London at the offices of the Society on May 24, the reports of the council and of the honorary treasurer and the accounts and balance sheet for 1955 were presented and adopted, and the officers and council for 1956–57 were elected. The council reported that the balance of income over expenditure for the year under review was £1,220. However, it should be noted that expenditure for 1955 was more than £9,000 greater than for 1954, £4,000 of this increase being due to the greater expense of housing the thirty-ninth annual exhibition of scientific instruments and apparatus in the New Hall of the Horticultural Society instead of in the Imperial College of Science and Technology, London, where former exhibitions were held. Interest in the exhibition was as great as ever, the attendance exceeding eighteen thousand, and the increased expenditure on the exhibition was more than balanced by a gain in receipts from exhibitors.

The activities of the Society during the year included five science meetings in London; three joint colloquia with the Institute of Physics on electron physics in London; a three-day meeting at the Atomic Energy Research Establishment, Harwell, during March 31–April 2; and two-day meetings at the Universities of Liverpool and Cambridge during July 5–6 and December 13–14, respectively. A highly successful innovation was a Fellow's luncheon, which was held in London on April 25, the opening day of the annual exhibition. The eighteenth Thomas Young Oration was delivered by Dr. W. S. Stiles, who spoke on the basic data of colour matching and some related aspects of visual theory, and the thirty-ninth Guthrie Lecture by Prof. E. C. Stoner on magnetism in retrospect and prospect; both these lectures have been published in the "Year Book of the Physical Society, 1955". Dr. N. Kurti was the recipient of the tenth Holweck Medal of the Société Française de Physique and the Holweck Prize of the Physical Society; the presentation took place in Paris on May 26, when Dr. Kurti delivered the Holweck Discourse entitled "Le domaine des températures où regnent les spins" (*J. Phys. et le Rad.*, 17, 85; Feb. 1956). The thirty-second Duddell Medal was presented to Dr. R. Kompfner, who gave an address on travelling-wave tubes, and the eleventh Charles Vernon Boys Prize to Dr. J. W. Mitchell, who spoke on some of his work on photographic emulsions.

The Society continues to be represented on various committees and institutions, details of which are listed in the annual report, together with brief accounts of the activities of the four Groups of the Society—the Colour, Optical, Low Temperature and Acoustics Groups. The summer meetings of the Colour and Optical Groups were held at the Paint Research Station, Teddington, and University College, London, respectively, while the Low Temperature Group for its summer meeting paid a visit to the British Oxygen Company's air separation plant at Brinsworth, to the United Coke and Chemicals Company's hydrocarbon separation plant at Handsworth and to the Low Temperature Physics Laboratory at the University of Leeds.

In the section of the report dealing with publications, it is stated that, after a three years trial, the reprints scheme, whereby members and subscribers of the Society were able to purchase reprints of the papers published in the Society's *Proceedings*, has had to be discontinued. The general demand for the scheme was far too small to justify the large expense involved. Two conference reports, "Defects in Crystalline Solids", the report of a conference held in Bristol during 1954, and "The Physics of the Ionosphere", the report of a conference held in Cambridge during 1954, which were mentioned in the 1954 annual report, were published during 1955, and Volume 18 of "Reports on Progress in Physics", containing ten specialist articles, was issued in September. The flow of papers to the *Proceedings* increased during 1955. 265 papers and 115 research notes and letters to the editor were accepted for publication, as compared with 215 and 111 respectively in the previous year. Seventy-three manuscripts were either rejected or withdrawn. A new annual publication, commenced in the autumn of 1955, was "The Year Book of the Physical Society", containing the texts of the presidential address, the Guthrie Lecture and other special lectures to the Society, in addition to the annual report and accounts.

The officers and council of the Society for 1956–57 are as follows: *President*, Prof. N. F. Mott; *Vice-Presidents* (in addition to those who have filled the office of president), Dr. A. B. Wood, Prof. S. Devons, Prof. F. Llewellyn Jones and Prof. H. Jones; *Honorary Secretaries*, Dr. C. G. Wynne and Dr. H. H. Hopkins; *Honorary Foreign Secretary*, Prof. E. N. da C. Andrade; *Honorary Treasurer*, Mr. A. J. Philpot; *Honorary Librarian*, Dr. R. W. B. Pearse; *New Ordinary Members of Council*, Dr. V. E. Cosslett, Dr. D. Gabor and Mr. E. S. Shire.

THE DELI PALM

A RECENT issue of the *Journal of the West African Institute for Oil Palm Research* (No. 3, pp. 5–87; 1955) contains a number of articles of interest both to botanists and planters. It is an odd and sometimes disconcerting fact that a haze of obscurity overhangs the origin of so many of our major crops. This is particularly true of the Deli palm—a strain of *Elaeis guineensis* that has been cultivated with great success in the East—concerning which an important article is contributed by A. F. M. Broekmans and F. W. Toovey. Seed of the Deli palm was introduced into Nigeria at various times before the Second World War in the hope that it would afford a means both of increasing the yield of palm oil and of resisting some of the diseases to which the local West African oil palm is subject. It is reported that, over the first eight-year period, the local strains gave a much higher yield of fruit bunches than the Deli strains;

in fact, they outyielded them by about one-third. The superiority of the local strains seems to be increasing, as during the latter half of the period the difference in their favour was as much as two-thirds.

A comparison of the yields of the parent trees in Malaya with those of their progenies in the West African trial has shown an inverse relationship, the best trees in Malaya giving the poorest yielding progeny in Nigeria. Despite the generally poor showing of the Malayan Deli strains in the West African trial, one of them has done outstandingly well and is probably at least as good as, if not better than, the best Nigerian strain. The fruit and bunch composition of two leading strains is being studied in greater detail with the view of a breeding programme, and some of the preliminary data obtained are given. The authors conclude that the Deli palm is not well adapted to West African conditions, and, accordingly, the further introduction of Deli seed into West Africa for general planting is not recommended. There may, however, be certain already acclimatized strains as, for example, the Malayan Deli strain 19 × 65 in the aforementioned West African trial, which would repay exploitation for breeding purposes. Special characteristics of the Deli palm, such as disease resistance and dwarfness of growth habit, may also prove valuable.

AGE OF URANINITES FROM BLIND RIVER, ONTARIO

By R. K. WANLESS and R. J. TRAILL
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AS part of a continuing programme of the Geological Survey of Canada to date Canadian uranium deposits, two uraninite and three galena samples from the Blind River district of Ontario have been analysed chemically and by mass spectrometry. Ages of the uraninites have been determined using the lead : uranium, lead : thorium, and lead : lead ratios.

The Blind River region (Algoma district) in Ontario occupies a position of world importance as a uranium-producing area. In a period of two years following a prospecting rush in the area, six mines have been developed containing upwards of 150 million tons of ore at an average grade of between 2 and 2·5 lb. of U_3O_8 per ton[1].

Geological interest is widespread because of the similarities that exist between these deposits and the famous Witwatersrand deposits of South Africa. The mineralization, in each case, occurs in thin beds of quartz-pebble conglomerate which form part of a group of sediments overlying a complex assemblage of very old rocks. In both deposits, uraninite and gold have been reported in association with pyrite and minor amounts of other minerals, notably thucholite, monazite, zircon, rutile, galena, chalcopyrite and cobaltite. Brannerite is abundant locally in the Blind River deposits, but does not occur in the Witwatersrand conglomerates[2]. The origin of the Blind River mineralization is as controversial an issue as that of the Witwatersrand, and theories include the placer and hydrothermal concepts, and combinations of these.

Samples collected from the Pronto and Algom properties are described in Table 1. The galenas were concentrated from crushed drill-core samples using a Haultain superpanner. Microscopic examination revealed that the concentrates contained more than 95 per cent galena and less than 5 per cent pyrites and quartz. Radioactive assays indicated negligible radioactivity (less than 0·05 per cent U_3O_8 equivalent). Uraninite was concentrated from two high-grade hand specimens by superpanning and hand picking. The hand specimens were very similar macroscopically, and a mineragraphical study failed to reveal any differences in texture, grain size, and mode of occurrence of the uraninite. In both samples, the uraninite occurred as discrete angular grains, about 100 microns in diameter, in the pyritized matrix of quartz-pebble conglomerate. No other radioactive minerals were identified in the concentrates. Both concentrates contained about 10–15 per cent pyrites.

The isotopic abundances of the lead extracted from the uraninite and galena minerals were determined using a 90-degree Nier type mass spectrometer having a 10-in. radius of curvature. The sample was admitted to the instrument in the form of gaseous lead tetramethyl, and isotopic abundances were calculated from the tri-methyl ion currents in the 249–254 mass-range. The abundances quoted are the results of one or more mass spectrometric analyses, each consisting of at least ten repeat scans through the mass-range.

The lead isotope abundances are given in Table 1. Galena 1, from a non-radioactive zone, has a normal isotopic distribution whereas galenas 2 and 3, from

Table 1. ISOTOPIC ABUNDANCE OF LEAD FROM GALENA AND URANINITE

No.	Mineral	Location	^{204}Pb	^{206}Pb	^{207}Pb	^{208}Pb
1	Galena	Near Algom property, 1,500 ft. above ore zone in non-radioactive rocks	1·42 1·00	24·30 17·11	22·67 15·96	51·61* 36·35†
2	Galena	Algom property in quartz–pebble conglomerate in ore zone	1·06 1·00	36·04 34·00	15·99 15·08	46·92 44·26
3	Galena	Algom property in cross-fraction in ore conglomerate	0·76 1·00	45·21 59·49	14·14 18·61	39·89 52·49
4	Uraninite	Algom Quirke Lake, 4th level east face	0·10	86·15	8·19	5·56*
5	Uraninite	Pronto Uranium from underground drift	0·33	81·42	9·82	8·43

* Isotopic abundance in per cent. † Isotopic abundance relative to ^{204}Pb.

radioactive areas, have high radiogenic (lead-206, lead-207, and lead-208) lead abundances. Since a small lead-204 contribution was apparent in both uraninite samples a correction for common lead was required. Using the lead-204 abundance as an index of the amount of common lead present and the isotopic distribution of galena 1, a correction was applied to the uraninite abundances. This correction was based on the isotopic distribution of galena 1 for the following reasons: (1) galena 1 occurs in non-radioactive rocks adjacent to the Algom ore zone from which uraninite 4 was obtained; (2) the lead isotope abundances of galena 1 are of the same order of magnitude as those found for average ore lead of Precambrian age; (3) the best internal agreement between the ages determined from the lead : uranium, lead : thorium, and lead : lead ratios was obtained using galena 1 as a basis for correction.

The age determinations based on the lead-207 : lead-206, lead-207 : uranium-235, lead-206 : uranium-238, and lead-208 : thorium-232 ratios, listed in Table 3, indicate an average age of 1,300 million years for the Algom specimen and 600 million years for the Pronto uraninite. Since mineragraphical studies revealed no differences in the two hand specimens, and since both deposits occur in a pyritized formation which has been traced along strike for more than eighty miles, the determination of two distinct ages of uraninite mineralization is somewhat surprising. From the chemical values listed in Table 2 it is apparent that the lower age of the Pronto specimen results from the lower lead content, and that the uranium : thorium ratio for the two specimens is approximately the same. Loss of lead from pitchblendes (unpublished studies of the Geological Survey of Canada) has been held responsible for age variations in other deposits, and certainly the lead isotope abundances for galenas 2 and 3 (Table 1) illustrate the fact that radiogenic lead has been added to the original lead in these galenas. However, loss of lead from a radioactive sample produces a characteristic lead-207 : lead-206 > lead-207 : uranium-235 > lead-206 : uranium-238 > lead-208 : thorium-232 age distribution between the ages calculated from the various ratios. Such a distribution is not found for the Blind River uraninites reported here. This study indicates that the uranium and thorium contents of the two uraninites are similar, and that the Algom uraninite is much older than the Pronto uraninite. Further study may, however, reveal more than one age of mineralization in both deposits.

Table 2. Partial Chemical Composition of Uraninite Concentrates

No.	Uranium (per cent)	Thorium (per cent)	Lead (per cent)
4 (Algom)	43·8	3·6	10·7
5 (Pronto)	48·3	4·5	5·2

Table 3. Age of Uraninites

No.	Common lead correction	Age in millions of years			
		$^{207}Pb/^{206}Pb$	$^{207}Pb/^{235}U$	$^{206}Pb/^{238}U$	$^{208}Pb/^{232}Th$
4 (Algom)	Galena No. 1	1,170	1,300	1,400	1,265
5 (Pronto)	Galena No. 1	630	600	590	—

Preliminary mineralogical and isotopic studies indicate a complex history of mineralization in this region, and continuing studies based on selected, representative samples from all known radioactive occurrences are in progress. Considerable difficulty was experienced in obtaining sufficient material for analyses, and modifications to the experimental techniques are being carried out to permit isotopic determination on smaller samples.

We are indebted to the staffs of Algom and Pronto Uranium Mines, Ltd., for making the samples available for study. This communication is published by permission of the Acting Deputy Minister, Department of Mines and Technical Surveys, Ottawa.

[1] Joubin, Franc. R., *Amer. Inst. Chem. Eng.*, Preprint 286 (1955).

[2] Traill, R. J., *Can. Mining. J.*, 75, 63 (1954).

VIVIPAROUS CAECILIANS AND AMPHIBIAN PHYLOGENY

By Dr. H. W. PARKER

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THE classical investigations of the Sarasins and of Marcus and his pupils into the embryology and development of the oviparous caecilians *Ichthyophis* and *Hypogeophis* have diverted attention from the fact that many of these little-known amphibians bear living young. This was first established as long ago as 1874, when Peters[1] recorded the occurrence of fœtuses in the oviducts of the species now known as *Typhlonectes compressicauda*. Since then, fœtuses have been reported in five other genera; but no one has determined whether the animals are merely ovoviviparous, retaining the eggs in the oviduct until ready to hatch, or whether nutritional material (embryotrophe) additional to the yolk of the egg is supplied by the mother.

Pregnant females of several species of four genera have been examined, and it is clear that the included yolk of each egg suffices for only a small part of the pre-natal growth and development. Several stages of pregnancy and the neonatal condition of *Geotrypetes* have been seen, and the sequence of events they reveal is as follows. The eggs are large, yolky and enclosed in a tough vitelline sphere just like the eggs of oviparous species. They are about 4 mm. in diameter and initially they are passed to the hinder end of the oviducts, where they lie in single file in contact with one another. Development proceeds inside the vitelline membrane until the fœtus is about 25 mm. long (mother 265 mm.), when hatching occurs. Until now the fœtus has been coiled, figure-of-eight fashion, over its yolk sac and has possessed long plumose external gills, three on each side with a short common stem. At the hatching stage the yolk mass has almost disappeared and the gills are in process of resorption. After rupturing the vitelline sphere, the embryos migrate in the oviduct and space themselves out equidistantly from one another throughout its length. They now lie fully extended, and by the time they have reached a length of 38 mm. the external gills have completely disappeared. Growth *in utero* continues and neo-natal specimens average 75 mm. in length. There is thus

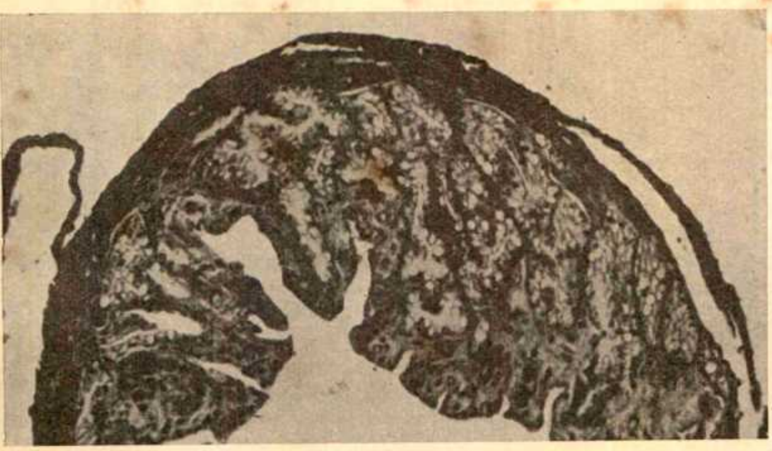

Fig. 1. *Schistometopum thomense.* Transverse section of anterior portion of pregnant oviduct, showing racemose glands and oil vacuoles. (× 90)

a 27-fold increase in mass after the initial yolk material is approaching exhaustion, and there must be some additional supply of nutritive material.

This general pattern may prove to be common to all the viviparous species. In the allied genus *Schistometopum*, fœtuses of 32–36 mm. have hatched and migrated and have no visible signs of yolk; their gills are small and asymmetrical and are presumably being resorbed. Fœtuses of 88–90 mm. (mother 257 mm.) are gill-less. Among the South American genera, gills (which are single and plate-like) are present in fœtuses of 59 and 62 mm. (*Chthonerpeton*) but wanting at a length of 110–120 mm. (*Gymnopis*: mother 405 mm.).

The mode of nutrition of the later fœtal stages is, as in many other anamniotes (cf. Matthews[2]), by means of 'uterine milk' ingested through the mouth. Many of the fœtuses examined had full stomachs, the material being mostly an amorphous non-cellular mass, but often containing a considerable amount of cellular debris and sometimes some recognizable erythrocytes. In the only fresh material seen (*Schistometopum*) the stomachs of the 88–90 mm. fœtuses contained a thick white creamy material consisting mainly of an emulsion of fat droplets, together with disorganized cellular material. This was clearly derived from the walls of the oviduct, which are richly provided with compound racemose glands lined by deep columnar epithelial cells the cytoplasm of which contains large oil globules (Fig. 1). It was also observed that the gall bladder in these fœtuses was relatively large and the contents of the hind gut were deeply coloured with bile.

The epithelium lining the lumen of the oviduct is highly vascular, with numerous capillaries lying within a few microns of the surface and thus fulfilling requirements for gaseous exchange. Correspondingly, the fœtal epidermis is nowhere more than two cells thick and is equally richly supplied with capillary blood vessels. The needs of the fœtus after loss of the gills are thus met by cutaneous respiration, but this must introduce a new problem for the animal. Such a delicate and highly vascular epidermis would be quite unsuitable for a burrowing life after birth. This difficulty appears to be overcome by sloughing the fœtal corneal layer immediately after parturition, coupled with a resting phase during which a new, thicker and tougher stratum corneum is proliferated. Newly born specimens of *Geotrypetes* have, in fact, been collected with their stomachs packed with their own sloughed cuticle one cell thick[3].

The caecilians thus exhibit no very novel departures from the method of viviparity occurring elsewhere among the anamniotes, but they do possess a feature that appears to be unique. There is a deciduous fœtal dentition. In all the fœtuses examined, the teeth are unlike those of the adult, both structurally and in arrangement. The teeth consist of two parts: a tubular pedicel and a crown with a hinged joint connecting the two (Figs. 2 and 4). The crown varies in shape from species to species and genus to genus; it may be spoon-shaped, with or without a single terminal cusp, spatulate and multicuspid or simple and recurved.

The teeth are arranged in multiple rows arranged quincuncially to produce a rasp-like structure, the number of rows varying on the different dentigerous elements of the skull and from species to species. (It is expected that a joint paper by the author and the late Prof. E. R. Dunn describing the various conditions in detail will be published soon.) The highest number of rows observed occurs on the nasopremaxillæ of *Chthonerpeton petersi*, where there are at least twelve; more usually, however, there are three or four rows (Fig. 2). The pedicels of the anterior rows are fused (Fig. 3) and the resulting plate is attached to the underlying dermal bone. This type of dentition has been found in fœtuses of every viviparous species examined. Nothing resembling it has been found in any free-living larva or in

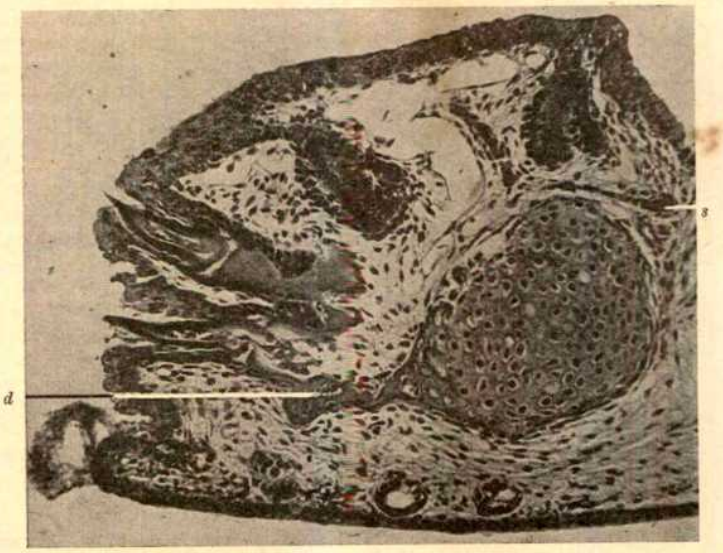

Fig. 2. *Chthonerpeton viviparum.* Paramedian section of fœtal lower jaw showing rows of hinged, pedicellate teeth associated with the dentary (*d*) and splenial (*s*) bones. (× 125)

the intra-capsular embryos of any species in six genera of oviparous caecilians; in these the teeth are like those of the adult.

The fœtal teeth are replaced by bicuspid, adult-type, teeth just before or just after parturition. In a very late (145 mm.) fœtus of *Gymnopis mexicanus mexicanus*, teeth are of the adult type, although younger fœtuses of the same subspecies have a typical rasp; on the other hand, newly born examples of *Geotrypetes seraphini* still have the fœtal rasp, although adult bicuspid teeth are also present but not attached to the bones.

Although there is a clear association between a special fœtal mode of nutrition and a special fœtal dentition, the latter can scarcely be an adaptation for the former. Apart from the apparent unsuitability of such a formidable rasp-like armament for ingesting milk, it is incredible that such an adaptation would have been developed more than once. So, all the species possessing it would represent a close phylogenetic assemblage. Yet any such taxonomic grouping cuts right across the systematic arrangements based on all other characters. For example, in American genera the gills are single and plate-like, but in the African forms they are triaxial and plumose; some genera are markedly zygokrotaphic, others slightly so, and one is completely stegokrotaphic. The only alternative explanation is that the fœtal dentition is an ancestral character that can persist only under conditions where teeth are not required and that has been suppressed as ineffective wherever a raptorial dentition is needed.

If this is indeed the explanation, it is not unreasonable to expect to find some traces of the ancestral condition elsewhere among the Amphibia, and this expectation is fulfilled. The amphibian tooth, both Urodele and Salientian, has two parts, pedicel and crown, separated, especially when young, by a washer of uncalcified tissue; these two parts, though not connected by a hinge, are clearly homologous with the two parts of the caecilian fœtal tooth. Further, the pedicels of Urodele and Salientian teeth fuse when they are in contact. Again, there are many instances, especially among the Urodela, of the teeth being arranged in multiple rows, and this occurs most frequently among the permanently neotenic "Perennibranchiates". Examples are *Siren* with several rows on the vomers, palatines and splenials, and the axolotl, which manifests "The ichthyic character of rasp-like teeth, aggregated in numerous series . . . upon the palatal region of the mouth and upon the splenial or opercular element of the lower jaw" (Owen[4]). The Urodela also show a tendency towards multiplicity of teeth in the larval stage and a reduction at metamorphosis. Throughout the Salamandridae, for example, larvæ have a splenial with several rows of teeth that are all lost in the adult, and multiple rows on the vomer are reduced to one in *Salamandra* and *Amblystoma*. Newly born larvæ of *Salamandra salamandra* and uterine larvæ of *S. atra* have four rows of teeth on the dentary and, although it has been claimed that these represent merely a single 'functional' row with successional replacements, they are arranged quincuncially and the two outermost are 'functional' in the sense that both are fused to the bone.

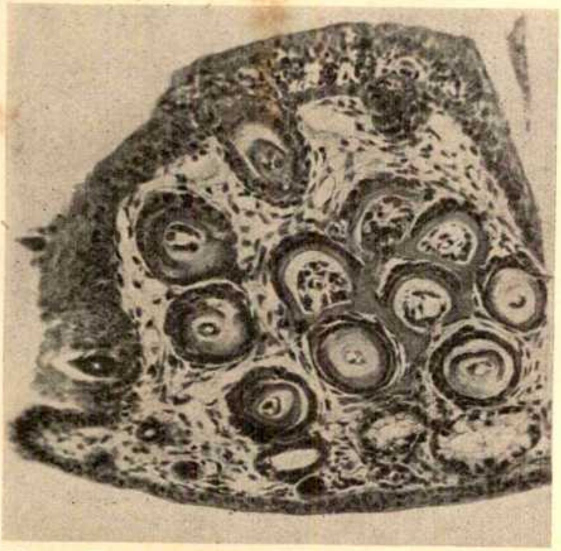

Fig. 3. *Chthonerpeton viviparum*. Transverse section of fœtal lower jaw, anterior to the symphysis, showing dental pedicels, some fused. (× 125)

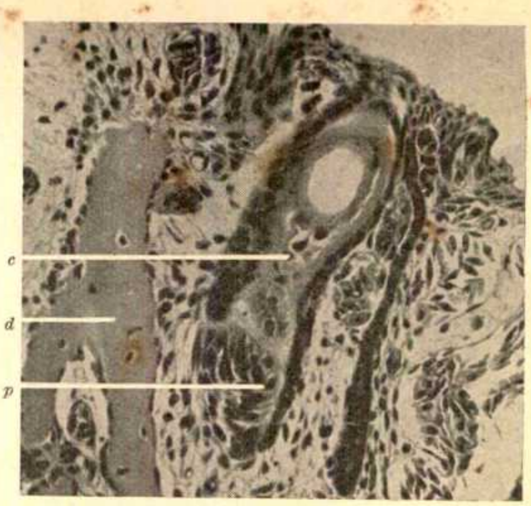

Fig. 4. *Schistometopum thomense*. Vertical section through a developing spoon-shaped fœtal tooth of the dentary series. The pedicel (*p*) is developing in association with the crown (*c*) and not as an outgrowth of the dentary (*d*). (× 200)

It seems, therefore, that the ancestor of the recent Amphibia possessed numerous rows of hinged teeth on all dentigerous bones. Owen characterizes a rasp-like dentition as "ichthyic"; but however that may be, there can be little doubt that this ancestral dentition was associated with a different method of feeding, and probably a different, perhaps vegetarian, diet. The ancestral dentition persists to the greatest extent in the most primitive group, the Gymnophiona, when circumstances permit, and to a lesser extent in some of the Urodela. In this latter group, however, as in those caecilians with a free larval life, their predaceous, carnivorous habits have required complete, or almost complete, suppression of the multiple, hinged, teeth and their substitution by single rows of rigid teeth modified from the original pattern by elimination of the hinge and simplification of the crown. The horny dentition of the Anuran tadpole must be accounted a secondary feature developed in association with a further change in larval feeding habits.

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[2] Matthews, L. H., "The Comparative Endocrinology of Vertebrates", 1, "Comparative Physiology of Reproduction", 133 (1955).

[3] Parker, H. W., *Proc. Zool. Soc. London*, 1, 160 (1936).

[4] Owen, R., *Odontography*, 1, 189 (1840–45).

DIMORPHISM IN THE PORTUGUESE MAN-OF-WAR

By A. H. WOODCOCK

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THE interesting problems of the sailing of *Physalia* have been revived by Totton and Mackie[1] and Fontaine[2]. Since the publication of my observations on the predominance of the left-sailing *Physalia* in the North Atlantic[3], I have had numerous opportunities to observe them in various parts of the world. These observations continue to show that North Atlantic animals are predominantly right-handed. Observations of *Physalia* in the North Pacific show similar results. Unfortunately, the southern hemisphere data are not yet extensive enough to test fairly my original suggestion that most of the animals on the southern seas may be mirror images of those in the northern hemisphere.

The purpose of this communication is to present and discuss these additional observations (see Table 1) and to discuss further the suggestions of Wilson[4] and of Totton and Mackie[1] concerning the role of wind direction in altering the 'landfall' possibilities of the two differently-sailing *Physalia*.

First, it should be pointed out that the original observations showing the dominance of the right-handed (left-sailing) *Physalia* in the northern hemisphere were made on the open sea. These data are not subject to the local wind-direction errors of beach observations, a fact which Totton and Mackie seem to have overlooked. Beached animals do, however, show a clear and similar dominance of right-handedness in the northern hemisphere when the local winds are nearly directly on shore. For example, compare observations 1, 2 and 3 in Table 1.

The greater number of the right-handed animals on the open sea does not necessarily indicate that this condition existed at the time the animals changed from the larval form. However, the numerical dominance of the right-handed animals, which was evident among the smallest of the *Physalia* found on a Florida beach (see Fig. 1 and Table 1), suggests that this dominance is present at the start.

These Florida observations, and many of those in Hawaii as well, indicate that the selective processes favouring the left-sailing animals begin very early in the life of the animal, if one supposes, with Totton and Mackie, "that in each brood of *Physalia* the two forms are produced in rough equality . . .".

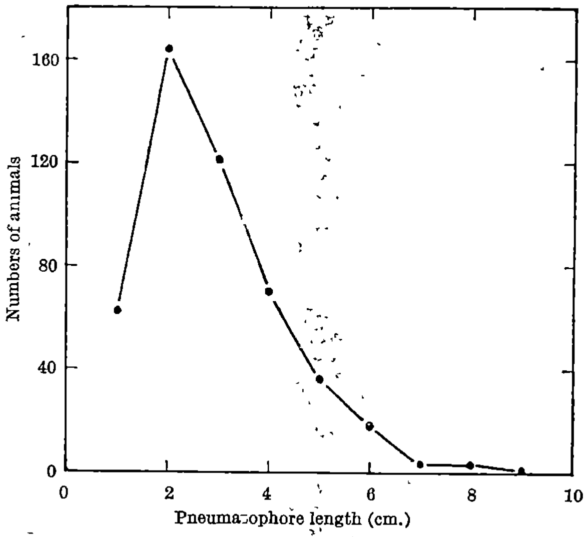

Fig. 1. A representative distribution of pneumatophore length among the *Physalia* seen during March, April and May 1944 on Ft. Pierce Beach, Florida. See Table 1 for total numbers

I have also measured roughly the sailing speed of a left-sailing North Atlantic *Physalia*, its angle of motion relative to the wind, and the approximate rate of down-wind drift of the upper 0·5 cm. of surface water. My results are about the same as those of Totton and Mackie, and are illustrated in Fig. 2.

Note in this figure that the number of animals which can land in unit time and on a unit length of beach (H) depends upon the angular relationship between their sailing-course line (for example, line BC) and the beach line (H). These lines control the angle α, and the length of line A. Thus the sine of the angle equals the ratio of the total possible landings on a section of beach (H) to the observed landings. This relationship is expressed in the following equation, and may be applied to all *Physalia* where α is known.

$$N_c = \frac{1}{\sin\alpha} N \qquad (1)$$

Table 1. OBSERVATIONS OF THE NUMBER OF RIGHT-HANDED (LEFT-SAILING) AND LEFT-HANDED (RIGHT-SAILING) *Physalia* SEEN ON THE SURFACE OF THE OPEN SEA AND ON VARIOUS SHORES. THE 'AT SEA' DATA INCLUDE THE ORIGINAL OBSERVATIONS FROM REF. 3

Data No.	Name	No. observed		Date	Location	Ratio of right-sailers to left-sailers	Average on-shore wind angle*	Position		Place name
		Right-handed	Left-handed					Lat.	Long.	
1	*Physalia physalis* L.	159	3	1939–45	at sea	0·02	—	25°–40° N.	46°–80° W.	North Atlantic
2	*Physalia physalis* L.	344	9	1942	at sea	0·03	—	26°–28° N.	84°–89° W.	Gulf of Mexico
3	*Physalia utriculus*, Esch.†	824	29	11/51–7/52	on beach	0·04	80–100	21° 23·5′ N.	157° 43′ W.	Hawaii
4	*Physalia physalis* L.	1,625	66	3/44–5/44	on beach	0·04	60–80	27° 13′ N.	80° 13′ W.	Ft. Pierce, Florida
5	*Physalia utriculus*, Esch	694	0	18/12/51	on beach	0·00	90	21° 23·5′ N.	157° 43′ W.	Hawaii
6	?	314	306	8/52	on beach	0·98	45	33° 45·2′ S.	151° 17·9′ E.	Deewhy Beach, Sydney, Australia

* The 'average on-shore wind angle' is measured in a counter-clockwise direction from a line parallel to the beach.
† From ref. 5.

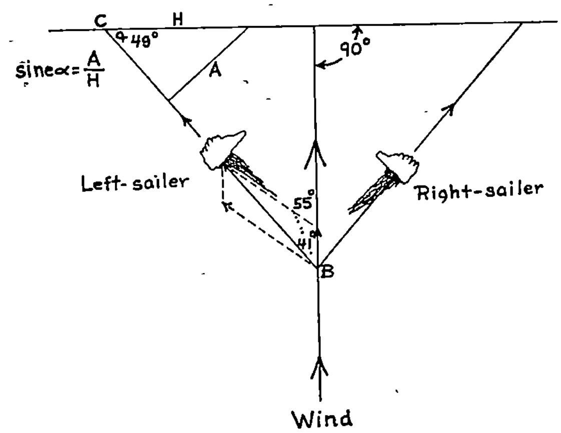

Fig. 2. Average sailing performance of a right-handed, left-sailing *Physalia physalis*, and further suggestions about effects of wind direction upon the number which will sail on to a shore (see text). A right-sailer is also shown in order to emphasize its markedly different sailing course in response to the same wind. Average speed of topmost 0·5 cm. of water = 9 cm. sec.$^{-1}$; average speed of wind = 680 cm. sec.$^{-1}$; average speed of *Physalia* = 26 cm. sec.$^{-1}$; pneumatophore length 17 cm., height 7 cm.

where N_c is the maximum possible number of arrivals in unit time and length of beach, and N is observed number of arrivals.

From Fig. 2 and the above equation it can be seen that the number of arrivals of the two forms of *Physalia* on a beach will represent the relative distribution on the sea only when the wind angle is 90° and the sailing angles α are equal.

The very small *Physalia*, such as most of those observed in Florida (see Table 1 and Fig. 1), sail much more slowly than the large *Physalia*. Their sailing course, assuming the same angular relationship to the wind as the large animal, would tend, therefore, to approach the shore at an angle which more nearly equalled that of the wind. For example, an animal sailing at one-fourth speed would follow a course from B, Fig. 2, shown by the dotted line. This may explain why the ratio of the right to the left-sailers on the Florida beach (see Table 1, observation 4) was so similar to this ratio among those observed on the open sea, despite the occasional obliquity of the wind.

On Lanikai Beach, Oahu, Hawaii, the north-east trade wind was almost always blowing from the sea and nearly normal to the beach. Hence the relative number of the two types of animals observed on this beach, as given in Table 1, observation 3, should represent their relative distribution on the open sea. During one exceptional period of several days, however, southerly or 'Kona' winds occurred, producing off-shore winds on the lee side of Oahu which carried the normal *Physalia* population far out to sea. Thus the lee side of the island became a 'shadow zone' for right-sailers (Fig. 3). For a period of about a day after the shift from southerly winds to the normal 'trades' occurred, only left-sailing *Physalia* were seen on the beach (see observation 5, Table 1). This result is explicable as illustrated in Fig. 3, the Kaiwi Channel producing a local separation of the two forms. (For convenience, equal numbers of lines are shown representing the differing sailing courses of the two forms during south-south-west winds. It is not intended to imply that an equality of number of the two forms exists at sea.) The first left-sailing *Physalia* to reach Lanikai beach after the wind shift to the north-east would presumably come from point A, while the first right-sailer would sail a greater distance from point B. Assuming the same sailing speed and sailing direction relative to the wind as that of the Atlantic *Physalia* (Fig. 2), the difference in the arrival time of *Physalia* from these two points would be about thirteen hours and may account for the observed complete dominance of the left-sailers among the first arrivals on the beach after the wind shift.

Observation 6, in Table 1, was made on the southern end of Deewhy Beach, Sydney, and seems to support the idea that most of the southern hemisphere animals sail to the right of the wind. On the only day when I was free to walk on the beach and to observe the stranded *Physalia*, the average wind angle was about 45° to the general trend of the irregular coast line of this region. According to equation (1), very few right-sailers should have been found on Deewhy Beach, since the angle α for the right-sailers would in this case become 4°, and the sine about 0·07. Actually, about one-half of the animals seen were right-sailers. These Deewhy Beach observations, when 'corrected' for the effects of the average sailing angle on the number of the right-sailers arriving on the beach, suggest a dominance of this form on the open sea of about ten to one of the left-sailers. This ratio agrees roughly with that among the southern hemisphere museum specimens discussed in the previous paper[3].

The above 'correction' is open to the serious objection that it is made using the sailing characteristics of the somewhat larger North Atlantic *Physalia*, which are given on Fig. 2. Also, in common with all beach observations of stranded animals, there are the added questions about the effects of coastal currents, and of changes in wind direction which may have occurred after they sailed ashore and before I arrived at the beach to observe them. It is hoped that someone will soon test these rather unsatisfactory southern hemisphere data by direct observation on the open sea in the Sydney region or elsewhere.

If further work proves the existence of a world-wide difference of *Physalia* form and sailing performance in the two hemispheres, we shall wish to know to what extent various physical factors may have produced this difference. Will such dominance of one form in each hemisphere be due to ecological factors acting selectively on each generation, to established genetic differences, or perhaps to 'tack' changes

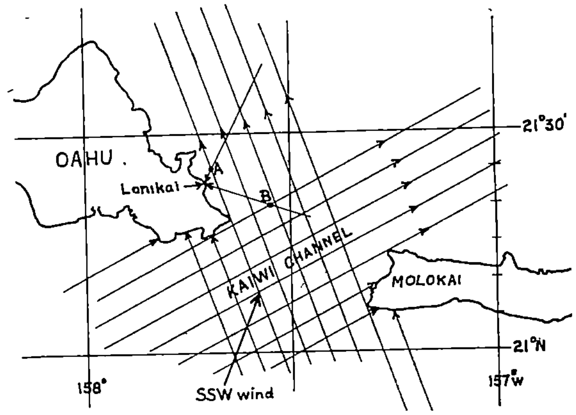

Fig. 3. Assumed separation of left-sailing and right-sailing *Physalia* in passing through Kaiwi Channel before a south-south-west wind. Note that the lee side of the islands is, in varying degree, a 'shadow zone' for either one or both forms. Following a wind shift to the normal east-north-east trades, the first animals of the two forms arriving on Lanikai Beach would sail different distances, along the new course lines shown, from points approximating intersections A and B

caused by migration of the tentacles on the pneumatophore? The answers to these questions will be interesting and perhaps useful in further studies.

My earlier proposal concerning a possible selective influence of small-scale wind-induced eddy motions in the surface waters[3] still seems reasonable to me. Larger-scale wind and water motions may be important, however. It is worth noting here that left-sailing *Physalia* in the average anti-cyclonic wind systems of the North Atlantic and the North Pacific[6] will move away from the centres of the systems, and often in the direction of coastal waters. The average wind systems of the oceans of the southern hemisphere tend to be cyclonic[6]. In cyclonic wind systems a right-sailer will also tend to sail away from the centres of the systems and in some cases toward coastal areas.

I am convinced that there is much that oceanographers can learn about the surface waters of the seas from detailed studies of the sailing of *Physalia*.

I am indebted to my young son, John B. Woodcock, for his enthusiastic help in collecting observations in Hawaii.

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STIMULATION OF COLEOPTILE- AND ROOT-GROWTH BY EXTRACTS OF MAIZE

By S. HOUSLEY*, A. BOOTH and I. D. J. PHILLIPS

Botany Department, University of Manchester

PAPER chromatography of the acidic ether-soluble material in plant extracts has revealed the presence of several growth-promoting and -inhibiting substances in a range of plant material[1] including roots and shoots[2,3]. One promoter, termed accelerator-α, has been shown[3,4] to enhance the growth of both roots and coleoptiles above that of a control at certain concentrations, yielding in the case of roots a characteristically shaped activity curve (similar to Fig. 3). Accelerator-α, an ether-soluble substance[5], possibly does not normally occur in plants[6]; but is thought to be formed during the preparation of plant extracts for chromatography from other compounds which occur in the aqueous ether-insoluble portion of extracts[5]. With tomato roots[6] this aqueous material, after chromatography on paper with ammoniacal n-butanol and bioassay with coleoptile sections, gives three zones of growth promotion. At least two of these zones, if eluted from the paper individually and then rechromatographed in the same solvent system on a new paper, result in chromatograms with the same pattern of growth promotion, showing that some of the active substances on the chromatograms may be converted readily from one to another. The present work reports the occurrence of similar compounds in maize and describes their effect upon the growth of cress roots.

Coleoptiles (703 gm.) and roots of four-day old maize seedlings (a dent-type derivative from Rhodesian 'White Salisbury' commercially termed 'African Giant Horse Tooth Hybrid') grown in the dark at 25° C. were quickly frozen, coarsely comminuted, and extracted separately in 1·5 l. ether at −5° C. and natural pH (approximately 5·5) for 4 hr. Protein was precipitated from the aqueous ether-insoluble fraction with ethanol (2 vol. absolute : 1 vol. aqueous fraction) and centrifuged off, and the alcoholic remainder distilled under reduced pressure to an aqueous syrup (34·7 gm. coleoptile extract) at a bath temperature of 40° C. The extracts were stored at −15° C. Paper chromatography was carried out in n-butanol saturated with $1 \cdot 5\,N$ ammonia; details of the chromatographic technique and of chromogenic spray reagents are described elsewhere[5], except for the Salkowski reagent (1 ml. 0·5 M ferric chloride + 50 ml. 35 per cent perchloric acid). The methods of bioassay with coleoptile sections of oats (Victory)[7] and roots of cress[5,8] have been reported previously. In the cress test, test solutions were pipetted on to filter paper in Petri dishes and were not incorporated into agar as previously described[5]. All means are derived from ten replicates, except in Figs. 3 and 4, where the number is shown above the standard error or mean.

Chromatography of the coleoptile aqueous syrup (0·33 gm., equivalent to 7·2 gm. fresh weight, on an 18 cm. starting line) in n-butanol/ammonia usually results in a histogram with four peaks (Fig. 1); but there may be less (Fig. 2, 0·74 gm. syrup on a 19 cm. line); similar results are obtained with corresponding extracts of roots. Although activity in the roots and coleoptiles is rather low compared with tomato roots[6], it is consistently present. Unpublished work by Mr. G. Britton in these laboratories has shown that these zones of growth promotion behave in a manner similar to those of tomato roots[6] when they are rechromatographed.

Results obtained with chromogenic sprays on chromatograms of coleoptile extracts are shown in Fig. 1. With roots, the chromogenic pattern with the same sprays was very similar except that the R_F values were smaller, and p-dimethylaminobenzaldehyde gave a more intense purple reaction (R_F 0·13–0·21) and ferric chloride/perchloric acid a yellow reaction in the same zone: in this respect it is of interest that R_F values may be influenced considerably by the viscosity of the aqueous syrup and the quantity loaded on a chromatogram. No evidence was obtained of the presence of 3-indolylacetic acid on any chromatogram. Ether-soluble material of the coleoptile and root extracts was also chromatographed, bioassayed and examined with chromogenic sprays; again, no evidence of the presence of 3-indolylacetic acid was obtained.

To examine the effect of growth promoters in the aqueous ether-insoluble fraction on the growth of roots, chromatograms were prepared in a manner similar to that used for Fig. 1 and a longitudinal strip bioassayed with coleoptile sections. The remainder was stored dry in the dark at −15° C. for 24–48 hr. until the R_F values of the active zones were known; these, between the limits of R_F 0 and 0·5, were then cut out of the stored portion, eluted with water and tested on cress roots. In some tests activity curves similar to *A* and *B* (Fig. 3) were obtained, whereas in others curves similar to *C* (Fig. 4) were given. Other data of interest were obtained when certain zones of a maize coleoptile chromatogram (Fig. 2) were tested on cress roots before the result of the corresponding oat assay was known. It is seen that in addition to the active zone *B*, the inactive zone *A* has stimulated root growth above a water control (Fig. 3, *B* and *A* respectively). Two other zones of the chromatogram were also tested (R_F 0·6–0·7 and 0·8–0·9); both gave curves similar to *C* in Fig. 4.

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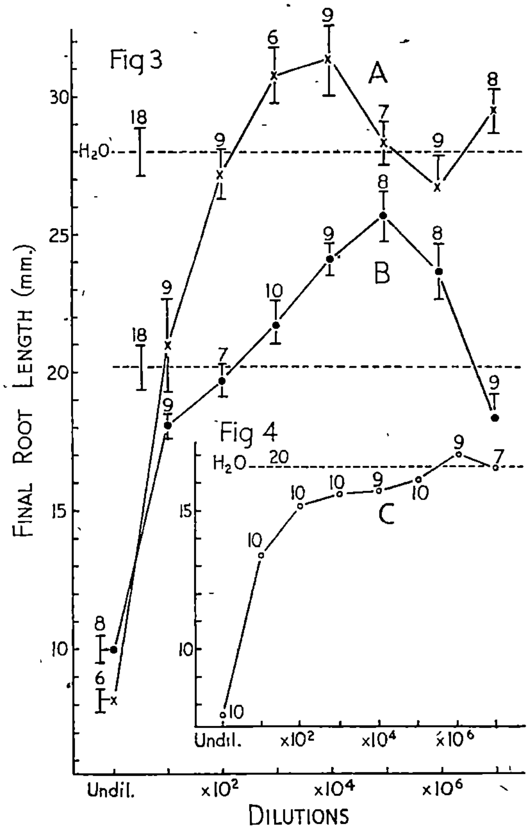
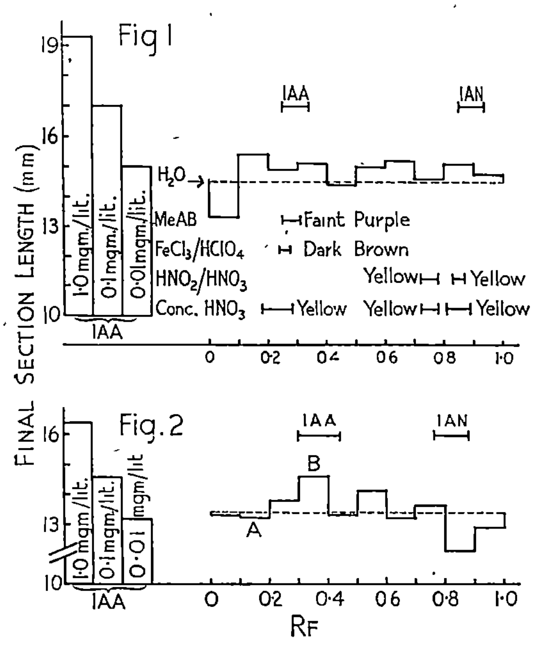
To account for these results, in which enhanced coleoptile- and root-growth may occur in the same zone or in different zones of chromatograms, it may be suggested that there were two chemically distinct types of growth-inducing substances present in the extracts, one auxin-like[9] inducing coleoptile-growth and the other, possibly hormonal[9] but not auxin-like, inducing root-growth. On the other hand, there may be a closer chemical relationship between these substances, and conversion from one to the other has to occur before enhanced root-growth can be obtained. The present data, including those of zone *A* in Fig. 2 in which conversion could have occurred before chromatography was carried out, may be interpreted equally well by either hypothesis and further work is required before a firmer opinion can be expressed.



Figs 3 and 4 Activity curves of cress roots (initial length 5 mm.). Curves *A* and *B* were obtained from eluates taken from zones *A* and *B* of the chromatogram of Fig. 2. Curve *C* was obtained from the eluate of a zone of a maize root chromatogram (not shown) corresponding to R_F 0 1–0 2 in Fig 1

The inability to detect free 3-indolylacetic acid in coleoptiles and roots of maize seedlings confirms other unpublished work carried out at Manchester on maize in which no indolylacetic acid has been found in the plant except in the fruit. This absence of indolylacetic acid is of particular interest in growth studies, for it has been long held that it is the sole or principal auxin in plants and that in roots it is present at supra-optimal concentrations. However, from the present studies and others in progress at Manchester, we have been led to question these views. On chromatograms of aqueous ether-insoluble extracts and on many chromatograms of ether-soluble materials, active zones of coleoptile elongation cannot be systematically associated with the chromogenic reactions given by those reagents generally used for indole detection. This and other evidence available at the present time suggests that in the plant there are other hormonal substances besides 3-indolylacetic acid controlling growth, the chemical nature of which may be non-indole.



Figs 1 and 2. Chromatography in *n*-butanol/ammonia of the aqueous ether-insoluble fraction of extracts of maize coleoptiles. The R_F of marker spots of 3-indolylacetic acid (IAA) and 3-indolylacetonitrile (IAN), and the response of oat coleoptile sections (initial length 10 mm.) in solutions of IAA are shown. MeAB = *p*-dimethylaminobenzaldehyde

We thank Prof. S. C. Harland for generous facilities in the Department of Botany, and Drs. P. F. Wareing and R. Pecket and Mr. J. Hannay for constructive criticism and valuable discussion. The work was supported by grants to two of us (A. B. and I. D. J. P.) by the Department of Scientific and Industrial Research.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Drift Experiments with Radioactive Pebbles

An experiment on the detection of movement of pebbles on the sea bed was carried out off Scolt Head Island in Norfolk during April and May 1956. Pebbles marked radioactively were used for this purpose. It is believed that it is the first time that such a method has been used in Britain to trace pebbles.

In each pebble, a hole ½ in. deep and ⅛ in. diameter was made. It was found that local flint from the beach was very difficult to drill, and a compromise had to be made by using pebbles of Permian Sandstone, with a few flints only, and also a number of pebbles made of cement. The pebbles averaged about 2 in. in major diameter and were all rounded. The specific gravity of the pebbles averaged 2·4, which is about 0·2 less than that of flint. In all, some twelve hundred were used.

The radioactive tracer used was barium-140, an isotope with a half-life of 12 days, which decays by beta-emission and low-energy gamma-radiation into lanthanum-140 (half-life 40 hr.). The lanthanum emits a series of gamma-rays of which the principal has an energy of 1·6 MeV., and it was these gamma-rays which were used for detection under water.

For loading the pebbles, pure barium-140 was used to avoid health hazard from the gamma-rays. The lanthanum-140 activity, which was negligible during loading, then built up to a maximum in about five days, after which it was almost in equilibrium with the barium-140 and decayed with an effective half-life of 12 days. About 15 microcuries of barium-140 was adsorbed to each of twelve hundred resin particles, and one of these was placed in each pebble and sealed with a resin-based adhesive.

In this experiment, three Geiger counter tubes with a sensitive length of 60 cm. were enclosed in a brass cylinder of 1 metre in length. The cylinder was mounted on a heavy metal sledge. The sledge was towed along the sea bed over an area of several hundred yards around the dumping position on each search. In the boat was a rate-meter, connected to the tubes in the cylinder by a multicore cable. The detector was capable of 'finding' a pebble at a distance of about twelve inches under water.

On April 5 the pebbles were all dumped at the same moment from a boat at a point some 500 yd. seaward from normal high-water mark off Scolt Head, in water varying in depth between 12 ft. and 25 ft., depending on the state of the tide. Throughout most of the time of the experiment the depth of water over the main dump of the pebbles was of the order of 16–20 ft. The shallowest depth of 12 ft. was only recorded at low-water springs and the greatest depth at high-water springs. The floor on which the pebbles were to be dumped was hard and consisted of shingle and sand. The place had been marked with a buoy which was placed 20 yd. farther seawards of the dump so that when detecting operations were carried out the buoy ropes should not foul the detecting apparatus. The position of the buoy was fixed by intersection from angles measured by theodolite and sextant from three fixed points on the island. The position of the stones was fixed by sextant angles from the boat to those points on the land. The weather at the time the pebbles were dumped was squally, and the following night there was a wind reaching force 5–6. It was impossible to make any further observations until April 8. On that day, clear records were found of some of the pebbles having moved southwards and a little west up to a distance of 200 ft. Further searches were made on April 9, 12, 20 and 23 and on May 5 and 15. The results obtained on all these dates were generally consistent and showed clearly that a number of pebbles had moved and continued to move very slowly in a direction slightly west of south, that is, inshore. The maximum movement was of the order of 260 ft. In addition, observations made on May 15 showed that some pebbles had also moved north and west, one definite record being found about 450 ft. north-west of the original dump. It may have been that this north-westerly movement had occurred previously, and was only found on May 15 ; but this seems unlikely since the area had been swept over on each search. It should be appreciated that the detecting apparatus sweeps a band only one metre wide, and therefore a considerable time is needed to sweep even a small area of sea bed, and it is impossible to guarantee that every square yard of a given area has been searched.

Nevertheless, the results show that in ordinary weather, with a few squalls but no true storms, pebbles can be moved along the sea floor. Waves during this period are not likely to have exceeded 3 ft. in height. The flood current in this part of Norfolk flows west, and the ebb to the east. The maximum speed of the flood at springs is about 2½ ft./sec. It seems unlikely that the current itself can move pebbles of this sort; but it might certainly work in with wave action and help to do so.

This experiment was designed to work out a technique for the use of radioactive tracers in determining underwater movement of coarser beach material. If the method can be perfected, it will give a very important aid to coastal physiographical study.

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Radiation-induced Changes in Reactivity of Bovine Fibrinogen

The acute effects of total body irradiation on mammalian hæmostasis are now well established[1]. Information concerning direct effects on individual clotting components is meagre, and in the case of fibrinogen is confined to observations following the application of doses of X-rays of such high magnitude as to have no practical significance in the field of mammalian radiation damage[2,3]. The present study of fibrinogen is therefore concerned with the direct influence of low doses of irradiation.

Purified bovine fibrinogen (lot No. 55199) was generously supplied by Dr. E. C. Loomis, of Parke, Davis and Co., and was shown to contain 90–93 per cent clottable protein. Solutions of this fibrinogen (3 mgm./ml.) in 0·15 *M* sodium chloride buffered

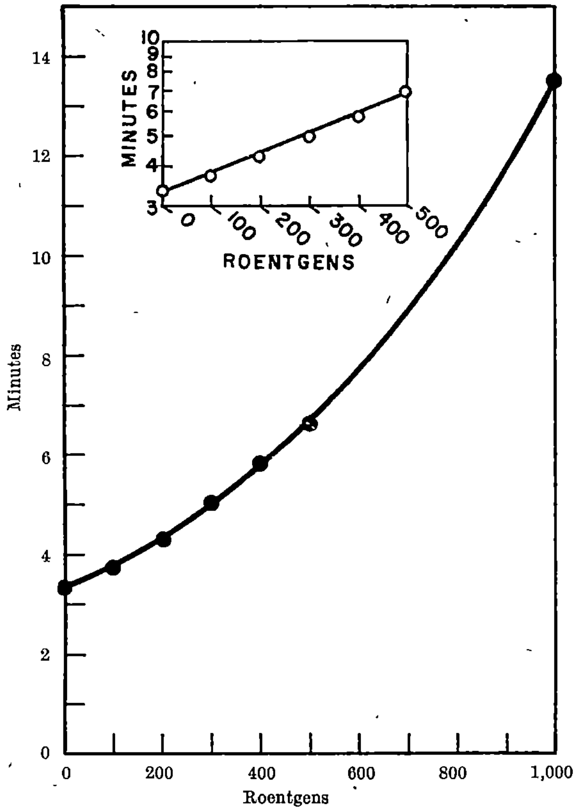

Fig. 1. Firm-gel clotting-time of irradiated bovine fibrinogen. (Inset: semi-logarithmic plot of data)

with imidazole at pH 7·4 were exposed to single X-ray doses, and the firm-gel time of a 0·3-ml. sample upon the addition of 0·05 ml. containing 1/16 unit of purified bovine thrombin was determined at 37·5° C. As Fig. 1 shows, the clotting time was increased with increasing X-ray dosage in the range of 100–500 r. and above. A similar relationship was obtained in the range of 25–100 r. The clotting delay was found to be independent of the fibrinogen concentration from 1 mgm./ml. to 5 mgm./ml., but was proportional to the thrombin concentration in the range of 0·063–0·5 units, at which point the clotting delay was abolished.

The clotting delay was accompanied by an alteration of the firm-gel characteristics. The rate of solution in 5 *M* urea of fibrin clots obtained from irradiated fibrinogen was accelerated. Apparently, irradiation alters some of the links which bind together the units of fibrin so that they become more readily accessible to the action of urea.

In view of the above influence of X-rays on final gel structure it appeared desirable to test the effect of sulphydryl compounds, since sulphydryl groups may play a part in firm-gel production[4]. Addition to fibrinogen, prior to irradiation, of solutions of 10^{-3} *M* cysteine or glutathione failed to alter the radiation-induced clotting defect but prolonged the clotting time in both the irradiated and unirradiated solutions. Thioglycollic acid (10^{-3} *M*), as well as higher concentrations of cysteine (10^{-2} *M*), completely inhibited the clotting process in both the irradiated and control solutions. These findings do not exclude the possibility that the polymerization phases of the clotting process are dependent on sulphydryl, since Scheraga and Nims[2], using very high doses, found that cysteine protects radiation-sensitive sites in the fibrinogen molecule.

The foregoing changes are also accompanied by a significant reduction in the release of fibrinopeptide during the clotting of irradiated fibrinogen (500 r.). Using the method of Lorand[4], a value of 3–4 per cent peptide split was obtained from unirradiated samples; in contrast, 30 per cent less peptide was liberated after irradiation. Despite this reduction in the thrombin-induced release of fibrinopeptide, the amount of clottable protein or the ratio of clottable/total protein in the fibrin clot remained unchanged.

From the above it follows that the radiation-induced defect in clotting does not simply lead to an inactivation of the fibrinogen molecule but to a specific alteration. If it is assumed that the exposure of charged sites as a consequence of the release of peptides results in the formation of linear polymers, then the reduction in peptide liberation provides an adequate explanation of the decreased rate of clotting. The observation, however, that the characteristics of the firm gel are also altered may reflect a dependence of the terminal processes on the extent of peptide release.

The specific modification(s) in the fibrinogen molecule induced by low doses of radiation may represent a mechanism of interaction between radiation and biologically active proteins. This may be of importance with regard to generalized radiation damage.

We wish to thank Messrs. J. L. Weatherwax and L. Stanton, of the American Oncologic Hospital, for the use of the X-ray apparatus. This work was carried out while one of us (P. R.) was working under U.S. Atomic Energy Commission contract *AT*(30-1)-1554.

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Paper Electrophoresis of Rat Pancreatic Juice and Water-Soluble Proteins of the Pancreas

ELECTROPHORETIC fractionation of pancreatic juice components in a dog has been described in the literature[1-4]. Some of the authors[2,3] isolated part of the fractions and studied their enzymatic activities. All authors used the free electrophoresis method with the exception of Delcourt and Delcourt[4], who employed paper electrophoresis for the separation of the different fractions.

As part of a general study of the synthesis of proteins of rat pancreas, pancreatic juice was analysed by means of paper electrophoresis. It was collected for three hours after a secretin–carbamoylcholine stimulus, as described by Junqueira, Hirsch and Rothschild[5], at 0° C. The electrophoresis of 10-μl. samples of pancreatic juice (average protein content; 6 per cent) was performed on Whatman No. 1 filter

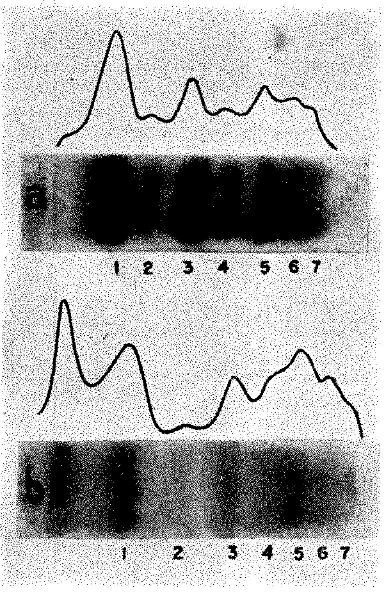

Fig. 1. *a*, Electrophoretic pattern of the rat pancreatic juice. 1—amylase; 2—ribonuclease; 3—proteolytic activity (trypsin) plus esterase and lipase activity; 5—proteolytic activity (chymotrypsin). *b*, Electrophoretic pattern of the water-soluble proteins of the rat pancreas. 1—amylase; 2—ribonuclease; 3—proteolytic activity plus esterase and lipase activity; 5, 6, 7—proteolytic activity

paper strips during 20 hr. at room temperature. Veronal-acetate buffer of pH 8·6, ionic strength 0·1, was used with a current of 110 V. 0·5 mA. per cm. in electrophoresis apparatus (No. 3276, L.K.B., Stockholm). Six or seven fractions could be separated in these conditions (Fig. 1*a*). A part of the paper was stained for proteins with amido black 10 *B* [6] and the other part cut into corresponding fractions, eluted with a suitable buffer and tested for their enzymatic activity. No lipoproteins or periodic acid–Schiff reagent-positive substances could be detected in the ionographs.

Amylolytic activity, as assayed by the method of Smith and Roe[7], was found to be associated only with fraction 1. The maximum of ribonuclease activity, determined by Rabinovitch's modification of the method described by Kunitz[8], was present in fraction 2. Residual activity could be detected in fractions 1 and 3. Lipase and esterase activity, measured by the method of Seligman and Nachlas[9], using β-naphthyllaurate as substrate, with and without taurocholate, was found to be associated with fraction 3, with little residual activity in the adjacent fractions. Esterase activity was also demonstrated directly on the paper, applying the histochemical method of Nachlas and Seligman, as modified by Gomori[10], using α-naphthylacetate as substrate. Proteolytic activity, as assayed by the Kunitz casein method[11], was found in fractions 3 and 5. Since trypsin, as well as chymotrypsin, are measured by this method, trypsin inhibitors such as ovomucoid and the soy-bean inhibitor were used, in order to distinguish the two enzymes. About 80 per cent inhibition was obtained with ovomucoid in fraction 3 and 40–50 per cent in fraction 5. The soy-bean inhibitor had a more marked effect. The results suggest that trypsin is probably associated with fraction 3 and chymotrypsin with fraction 5.

An interesting fact is that proteolytic activity appears without the addition of an activator, whereas this does not occur in fresh pancreatic juice. There is probably an autoactivation during the time of the electrophoretic run. This activation is, however, partial. On adding an activator, such as trypsin, to the different fractions, proteolytic activity appears in addition to bands 3 and 5, and also in the fast-moving bands 6 and 7. This suggests that the precursors of the proteolytic enzymes, namely, trypsinogen and chymotrypsinogen, may be located there.

Water-soluble proteins of rat pancreas, obtained from a centrifuged (40 min. at 15,000 *g*) 20 per cent aqueous homogenate of the pancreatic tissue, were subjected to paper electrophoresis as described above, using 30-μl. samples of the solution. A similar number of fractions as for the pancreatic juice was obtained (Fig. 1*b*), with an additional fraction that remained at the origin under the experimental conditions used. Amylase activity is associated with fraction 1; ribonuclease activity with fraction 2; esterase and lipase activities with fraction 3. Autoactivation of the proteolytic enzymes was only exceptionally observed. When activated with trypsin, proteolytic activity appeared in the fast-moving bands and also in fraction 2, instead of fraction 3, as in the case of the pancreatic juice.

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Comparison of the Metabolic Stimulating Action of Aspirin and Thyroid

SALICYLATE is a powerful metabolic stimulant in animals (Reid, J., personal communication, 1952), in man[1] and in tissue slices[2]. In hypothyroid patients it is possible to restore the basal metabolic rate to normal levels with dosage of the order of 8 gm. aspirin daily in divided doses.

Comparison of the effects of aspirin and thyroid (given seriatim) in two cases of myxœdema shows that they possess several actions in common: both cause increased oxygen consumption, decrease in the serum cholesterol, and hæmodilution. Since many features of myxœdema which have been attributed to the low metabolic rate (for example, slow cerebration) are unaffected by aspirin, the question arises as to whether the type of metabolic stimulation produced by aspirin and that by thyroid can be similar.

Fig. 1 shows a dose-response curve for thyroid extract in myxœdematous patients, constructed from data of Means and Lerman[3]. At each dose-level the drug was given for a prolonged period, until a constant effect was obtained. This constant basal metabolic rate is taken as the effect of the given dose.

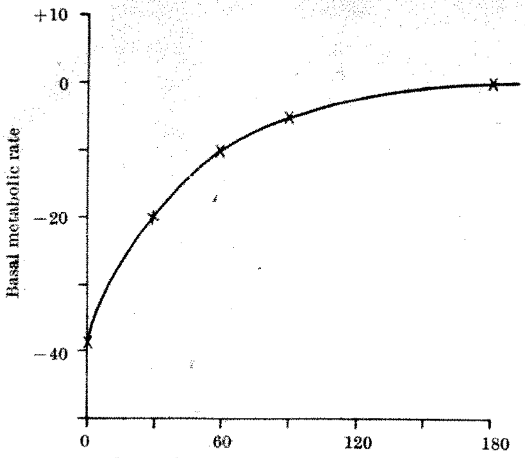
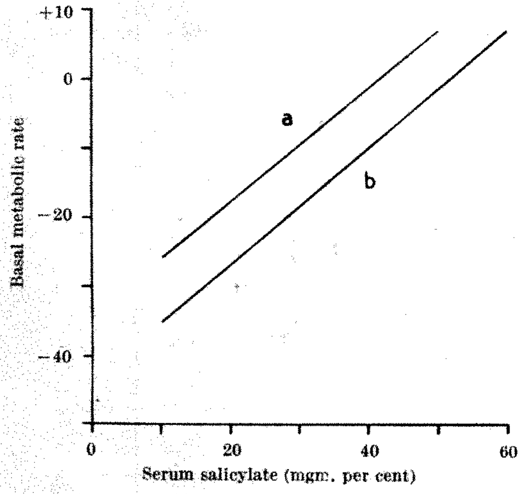


Fig. 1

Fig. 2 shows the serum salicylate-level plotted against basal metabolic rate in two female patients (*a*, age 65 years; *b*, age 43 years) with classical primary myxœdema. A similar linear relationship is obtained when dose of salicylate is used instead of serum-level.



	a	*b*
Number of observations	15	13
Correlation coefficient	0·931	0·944
Value of *P*	<0·001	<0·001

Fig. 2

The dissimilarity in the dose-response curves obtained with thyroid and with aspirin suggests that though they both produce metabolic stimulation, it is not of the same kind.

Details of this work will be published later.

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Synthesis and Biological Activity of a New Potent Analogue of Oxytocin

USING the recently described method for the synthesis of oxytocin[1], it was possible to prepare structural analogues of oxytocin by replacing the isoleucyl group by valyl, leucyl or phenylalanyl groups. Of the series obtained, the valyl analogue of oxytocin ('valyl-oxytocin') was the most active and interesting substance. A description of its synthesis and some biological properties follow:

N-CBO-S-benzyl-L-cysteinyl-L-tyrosine was coupled in tetrahydrofurane by the mixed anhydride procedure with L-valine methylester to give the tripeptide ester, melting point 132°, $[\alpha]_D^{18}$ − 36° (*c*. 2·9 in methanol). This was transformed, through the hydrazide, melting point 241°, into the azide, melting point 110°, which, by reaction with the hexapeptide (N-CBO-L-glutaminyl-L-asparaginyl-S-benzyl-L-cysteinyl-L-prolyl-L-leucyl-glycinamide) gave the nonapeptide (N-CBO-S-benzyl-L-cysteinyl-L-tyrosyl-L-valyl-L-glutaminyl-L-asparaginyl-S-benzyl-L-cysteinyl-L-prolyl-L-leucyl-glycinamide), melting point 232°. 20 mgm. of the nonapeptide was dissolved in 5 ml. liquid ammonia and reduced with sodium[2]. 5 mgm. of ammonium chloride was added; the ammonia was evaporated and the residue added to 100 ml. of water, the *p*H adjusted to 6·8, carbon-dioxide-free air bubbled through the solution for 2 hr., and the *p*H adjusted to 4·5. By this procedure the cyclic octapeptide was obtained.

This solution of 'valyl-oxytocin' was assayed by several methods, the international post-pituitary standard powder being used for comparison throughout. The tests used included the blood pressure in the chicken (sodium phenobarbitone anæsthesia)[3], the isolated rat uterus[4], the isolated cat uterus, the milk ejection pressure of the rabbit mammary gland (urethane anæsthesia)[5], the rat uterus *in situ* (urethane anæsthesia), the cat uterus *in situ* (chloralose urethane anæsthesia)[6], the anti-diuresis in non-anæsthetized rats[7] and the blood pressure in spinal cats.

The effect on the blood pressure in the chicken and on the isolated rat uterus was equivalent to that of 3 I.U./ml. These two methods usually recommended for the assay of oxytocic preparations therefore produced identical results. However, by measuring the milk ejection pressure of the rabbit mammary gland, which has been claimed to be the most sensitive test for oxytocin[5], the effect was equivalent to that of 15 I.U./ml. This figure was surprising, since synthetic oxytocin exerted identical effects in all three tests.

The remarkable difference between the effect on the isolated rat uterus and blood pressure in the chicken, on one hand, and on the milk ejection pressure of the rabbit mammary gland on the other, necessitated further investigation. On the cat uterus *in situ*[6] the effect was equivalent to that of 16 I.U./ml., whereas on the cat uterus *in vitro* it was equivalent to that of 6 I.U./ml. A similar difference was also found in experiments on rats; whereas the effect on the isolated uterus was equivalent to that of 3 I.U./ml., the effect on the uterus *in vivo* was approximately equivalent to that of 10 I.U./ml.

Finally, the anti-diuretic and pressor activity was investigated. In non-anæsthetized rats 'valyl-oxytocin' had an anti-diuretic effect equivalent to that of 0·03 I.U./ml. In spinal cats its pressor activity was approximately equivalent to that of 0·015 I.U./ml. Therefore, the relationship between the pressor activity and the uterine activity of 'valyl-oxytocin' is even more in favour of the uterine activity than is the case with natural and synthetic oxytocin[5,6].

These results show that for 'valyl-oxytocin': (1) there is good correlation between the effect on the blood pressure in the chicken and that on the isolated rat uterus; (2) the effect on the milk ejection pressure of the rabbit mammary gland bears no correlation to the effect on the blood pressure in the chicken and the effect on the isolated rat uterus; (3) there are great differences between the effect on the uterus *in vitro* and on the uterus *in situ* of the same species (rats and cats); (4) there are distinct species differences in sensitivity (rats and cats).

These findings suggest that synthetic compounds with oxytocin-like properties should be tested not only on the isolated rat uterus and on the blood pressure of the chicken but also on a much larger battery of tests to define their characteristics.

Extensive investigation into the chemistry, pharmacology and clinical activity of 'valyl-oxytocin' and related compounds is being pursued, and the results will be published in detail elsewhere.

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In vivo Inhibition of Oxidative Phosphorylation of Rat-liver Mitochondria by 2:4 Dinitrophenol

In a recent publication, Dianzani and Scuro[1] claimed that the oxidative phosphorylating capacity of mitochondria isolated from various rat tissues was greatly decreased 20 hr. after intraperitoneal injection of 2:4 dinitrophenol. The inhibition of P/O ratios from the mitochondria was 60 per cent; from kidney, 54 per cent; from heart, 51 per cent; and from skeletal muscle, 87 per cent.

Changes such as these are difficult to reconcile with the existing knowledge of the mode of action of 2:4 dinitrophenol. Like 3:5 dinitro-ortho-cresol[2], 2:4 dinitrophenol is an acute poison which, by intravenous or intraperitoneal injection, either kills an animal in 2–3 hr. or is followed by complete recovery in the next few hours. Further, this compound can be injected daily without any increase in susceptibility[3,4]. It has also been shown that *in vitro* inhibition of oxidative phosphorylation may be reversed by washing[5,6].

Table 1

No of animals	Treatment	Oxygen uptake (μmoles)	Inorganic phosphate uptake (μgm. atoms)	P/O ($\pm$ S.D)
5	None	3·39 ± 0·59	7·91 ± 2·0	2·36 ± 0·26
5	Dinitrophenol*	3·56 ± 0·60	8·23 ± 1·0	2·35 ± 0·26
3†	Dinitrophenol*	3·83 ± 0·92	8·92 ± 2·4	2·32 ± 0·20

* Intraperitoneal injection of aqueous solution of 2:4 dinitrophenol at 3 mgm./100 gm. body weight.

† Mitochondria isolated in sucrose.

Mitochondria prepared as in Aldridge and Cremer (ref. 7).

Each manometric flask contained: mitochondria equivalent to 250 mgm. fresh tissue; 0·02 *M* sodium phosphate buffer, *p*H 7·4; 0·001 *M* adenosine monophosphate; 0·0067 *M* magnesium sulphate; 0·025 *M* potassium chloride; 0·00001 *M* cytochrome *c*; 0·033 *M* glucose; 0·0167 *M* sodium fluoride and 300 units of yeast hexokinase ('step 3' purity, according to Berger *et al.* (ref. 8)), 0·5 ml. 30 per cent perchloric acid in side-arm. Total vol. 3·5 ml. Temperature 25° C. Gas phase, air. Potassium hydroxide in centre. Equilibrium for 7 min. followed by measurement of oxygen uptake for 10 min. Reaction stopped by tipping acid from side-arm. Phosphate on deproteinized fluid by Fiske and Subbarow (ref. 9).

In view of the importance ascribed to oxidative phosphorylation in energy metabolism and the relevance of these observations to the toxicology of 2:4 dinitrophenol and related compounds confirmation of Dianzani and Scuro's experiment was sought. Table 1 shows that there was no significant difference between the oxidative phosphorylative capacity of mitochondria isolated from the livers of normal rats and that of mitochondria from rats previously injected with 2:4 dinitrophenol. As during the preparation of these mitochondria they were washed with potassium chloride, a further experiment was made in which the mitochondria were isolated entirely in 0·25 *M* sucrose. Again no difference could be detected. Finally, six rats were each injected with 3 mgm. 2:4 dinitrophenol/100 gm. body weight on each of five successive days. These animals survived the experiment.

The discrepancy between these results and those of Dianzani and Scuro awaits elucidation.

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An Estimation of the Nature of Nucleoproteins by an Analytical Method

In previous publications[1,2] we have shown that a very constant relationship exists between the amount of deoxyribonucleic acid and the amount of arginine in the nucleus of an erythrocyte; we found the ratio 5·0 in the erythrocytes of all the species we studied (trout, pike, carp, tench, perch, barbel, roach). In the case of spermatozoa of some of these species, we found that this ratio is not the same as in erythrocytes. When the sperm contains a typical protamine (trout, pike), the ratio deoxyribonucleic acid/arginine is 1·6; in other cases (carp, tench) this ratio approximates to 5·0, just as in somatic nuclei.

A similar analytical study was performed with bovine species—on isolated calf thymus nuclei and on bull sperms; it was shown that the ratio 5·0 was found in the case of the somatic nucleus (thymus) and the ratio 1·48 in the case of sperm. This result led us to think that the bull sperm probably contains a protein rich in arginine; that is, a protein of the protamine type. The nature of the protein linked to the deoxyribonucleic acid in bull sperm, and that in the sperm of other mammals, is not known for certain, for the routine methods for the extraction of nucleoproteins cannot be applied to such material. We thought that an indication of the nature of the spermatogenetic modifications of the protein linked to deoxyribonucleic acid might be given (at least in many cases) by a simple determination of the deoxyribonucleic acid/arginine ratio. This method would need but minute quantities of biological material, and could be applied to small animals, for example, insects. In order to test the validity of this hypothesis, we applied our analytical procedure to a case recently studied by Daly *et al.*[3]. These authors isolated a nucleoprotamine from rooster sperm, and a histone from the nuclei of erythrocytes. Using our analytical method, we were able to confirm these data. Expressing our results per nucleus, we found for the rooster's erythrocyte, $2 \cdot 2 \times 10^{-6}\gamma$ of deoxyribonucleic acid and $0 \cdot 45 \times 10^{-6}\gamma$ of arginine. The ratio deoxyribonucleic acid/arginine is thus 4·88. In sperms, on the contrary, we found $1 \cdot 10 \times 10^{-6}\gamma$ of deoxyribonucleic acid and $0 \cdot 78 \times 10^{-6}\gamma$ of arginine per sperm, the ratio being 1·41. This result indicates the possibility of the presence in rooster sperm of a protamine rich in arginine, which is in a good agreement with the data of Daly *et al.*

Summarizing, the study of the ratio deoxyribonucleic acid/arginine could afford a rapid procedure for an extensive study in living species of the nature of the nuclear protein linked to the deoxyribonucleic acid in the nuclei, in order to determine whether a general process exists in the biochemistry of the formation of male gametes.

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Serotonin and Connective Tissue

Serotonin (= 5-hydroxytryptamine = enteramine) has been demonstrated in carcinoids of the small intestine as well as in the blood and urine of patients suffering from this disease[1]. The symptoms of these conditions are ascribed to the release of serotonin to the blood and tissues[2]. They consist primarily in cutaneous vasomotor signs (flushing), tachycardia, asthma-like dyspnœa and hyperperistalsis. Right-sided heart disease with tricuspid and pulmonal valvular lesions are noted in some but not in all cases. In prolonged cases pulmonary stenosis appears to be a fairly constant sign. Firm connective-tissue masses have been found to envelop the pelvic organs, as well as the iliac and hypogastric arteries. Considerable masses of connective tissue have also been observed deep to the cardiac valves, and microscopic examination has revealed connective tissue proliferation[3]. Articular swelling has been observed[2]. Hedinger and Gloor[3] mention the possibility that carcinoids and their metastases may secrete a substance stimulating connective-tissue formation.

It has been suggested that serotonin might act as a histamine-liberator substance, some of the clinical signs resembling a histamine effect[4]. Various histamine liberators are able to induce degranulation and disruption of tissue mast cells[5].

Since connective-tissue formation is invariably initiated by an accumulation of mast cells believed to produce important ground-substance components and to contain histamine, the effect of serotonin upon mast cells was studied.

Living connective tissue with intact circulation was studied in the cheek pouch of the hamster under nembutal anæsthesia by a method previously described[6]. Unstained living cells were studied in the phase-contrast microscope fitted with a water immersion lens and a warm stage. Mast cells stained with an aqueous solution of toluidine blue, 1 per mille, were studied in the bright-field microscope. By the last-mentioned method, the mast-cell granules stain metachromatically, indicating a content of mucopolysaccharides. Physiological saline was used as the immersion fluid.

Serotonin creatinine sulphate (National Biochemical Corp.), injected intraperitoneally in doses of 1 and 2 mgm., induced pronounced œdema of the connective tissue, and the animals showed signs of respiratory impairment as well as cyanosis of the muzzle and paws. A pronounced degranulation of the mast cells was observed within 10–20 min. When the metachromatic granular substance was no longer demonstrable in the mast-cell body, a basic structure resembling a sponge or a honeycomb was left in the cells, which were otherwise intact. Irreparable breakdown of the cells was observed only in exceptional cases.

The connective tissue formation caused by carcinoids and their metastases may be related to the degranulating effect of serotonin upon the mast cells. The tissue œdema induced by this agent is supposed to be primary to the release of water-binding mucopolysaccharides from the cells.

This work was aided by grants from Eli Lilly and Co., Indianapolis, Indiana, the Danish Anti-Cancer League, and the National Danish Association against Rheumatic Diseases.

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A Substance promoting Hatching and Liberation of Young in Cirripedes

DURING their passage through the oviducal tract, the eggs of barnacles appear to be mixed with a sticky secretion. Eggs removed directly from the ovaries remain separate; but those extruded from the oviducal openings cohere in strings, and eventually clump together, forming the paired egg masses. These are at first soft and gelatinous, but gradually become firmer, presumably because the secretion binding them together hardens. There is a clearly visible membrane surrounding each mass of eggs. Though when first formed each egg-mass is joined loosely to the oviducal opening, this connexion is transient and the egg masses lie freely in the mantle cavity for practically the whole of their development. Therefore, barnacles, unlike other Crustacea which retain eggs, need not lose them during the casting of the integument, nor is ecdysis a necessary part of the process by which embryos are discharged into the sea. Casting can and does occur regularly in many species while the eggs are still retained in the mantle space[1].

Egg masses are often retained for a considerable period after reaching their final stage in development[2], and throughout this period they will hatch only if removed from the parental mantle cavity and broken up in sea water. Although the mantle cavity is in direct communication with the sea and must exchange sea water freely when the barnacle feeds, hatching evidently takes place only when the individual eggs have access to sea water. They cannot hatch when in the centre of a mass of eggs, either because it is mechanically impossible or perhaps because the oxygen supply is too limited to allow the vigorous hatching movements to take place[3]. Natural hatching in all species studied is preceded by a breaking down of the egg masses into a soft pulp of separated eggs. These leave the mantle space in the jet of water forced out during the normal cirral beat between the last pair of cirri and the carina. Hatching usually occurs to some extent in the mantle space itself; but many unhatched eggs, some still clumped in small groups, are usually expelled with the freely swimming larvæ.

Aqueous extracts of tissues comprising mantle wall or body, but not of egg masses themselves, were found to stimulate liberation. If gravid barnacles were placed in such extracts liberation was sometimes induced within 10 min. The extracts clearly influenced the egg mass itself, not the parent barnacle, since equally rapid hatching and breakdown of isolated egg masses could be observed in watchglasses containing the extracts. Preliminary experiments showed the active principle to be heat-stable and non-specific.

It was noted that individuals of *Balanus balanoides* containing fully developed eggs which were kept in well-aerated sea water in the laboratory, but not fed, did not liberate their young at the normal time. The egg masses remained coherent and in some instances, particularly in those individuals maintained at temperatures exceeding 10° C., began to decompose in the mantle cavity. If the barnacles were fed, whether on animal or plant food, liberations took place normally within one or two days. This behaviour suggests the secretion of an active substance following the ingestion of food, perhaps the same substance that could be extracted from the tissues.

This response to food would normally delay the liberation of young until conditions were suitable for their nutrition. Thorson[4] has postulated a similar behaviour in other arctic forms, notably lamellibranchs. It might explain why the southern boundary of *B. balanoides* coincides with the March isotherm of sea temperature[5]. Too high a temperature in winter would accelerate development, and the eggs might be ready to hatch while there was scarcely any planktonic food available. If the temperature remained too high during this period the basal metabolism of the fully developed embryos might rise beyond the point at which sufficient oxygen could diffuse into the egg mass for its survival.

Liberation in response to feeding might also explain the limitation of this species to estuaries in Cornwall, Brittany and other places at the southern limit of its range[6]. The greater amount of detritus might provide sufficient food to stimulate barnacles growing in these estuaries to liberate their nauplii earlier and so avert the risk of embryonic suffocation.

In an environment where high temperature is limiting, this mechanism of liberation may render the species ill-adapted, so that a small difference in nutrition would have an important influence on distribution. In the arctic, where temperatures may be low all the year round, and where the season of plankton production is short, liberation of young in response to improved nutrition would be obviously advantageous.

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Production of Patulin in Apple Fruits by *Penicillium expansum*

IT has been thought unlikely that antibiotics are produced under natural conditions, (*a*) because the necessary nutrients would not usually be available and (*b*) because other micro-organisms might be expected to compete for nutrients and, in some cases, to destroy metabolically any antibiotic formed. Nevertheless, a plant parasite may have access to a relatively rich nutrient supply and may be, in early stages of an infection at least, isolated from the influence of other micro-organisms. *Penicillium expansum* is an unspecialized plant parasite, causing storage rots of apples; most freshly isolated strains produce the antibiotic patulin (synonyms: clavacin, expansine) in suitable culture media. We thought it of interest to see whether it produces patulin in apple tissues.

A strain of *P. expansum* known to produce patulin in culture was found to produce an antibiotic in apple tissues. The antibiotic had the same spectrum of antimicrobial activity as patulin, and its behaviour on paper chromatograms, using three different solvent systems, was the same as that of patulin. There seems no reason to doubt that it was, in fact, patulin. Its concentration in sap expressed from rotted tissues at times reached high levels; concentrations of the order of 600–1,000 mgm./l. (by bioassay) were found in rots of Bramley's Seedling apples. We have also found that sap from natural rots caused by *P. expansum* frequently contains an antibiotic with the antimicrobial spectrum of patulin. Thus the antibiotic patulin is produced under natural conditions, and, in view of the importance of *P. expansum* as an apple pathogen, probably in considerable quantities.

The known phytotoxic properties of patulin suggested that it might play a part in the production of rot symptoms. Strains of *P. expansum* which produce little or no patulin in culture media also produced no detectable quantities in apple fruits and yet caused equally vigorous rots. Thus it seems unlikely that patulin is concerned in pathogenesis. We hope to deal with this point more fully, in a later publication, and to consider at the same time the role of pectic enzymes. However, it is interesting to speculate whether the production of such substances as patulin, fusaric acid[1] and alternaric acid[2] in plant tissues by fungal parasites may not to some extent discourage secondary invaders, preserving territory, as it were, for the primary parasite.

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Response of Animal Fibres to Acid Attack

The stress–strain curves given by a wide range of animal fibres in air or water are practically alike, apart from differences in the low-strain region due to the presence of crimp. It has now been observed that even closely similar wools can exhibit substantial differences in the mechanical properties of their fibres, and corresponding differences in solubility in alkali, after exposure to chemical attack, such as boiling acid solution.

Such differences had been found to exist earlier among keratin fibres from different animal species[1]; but their occurrence between wools from the same type of sheep was unexpected.

The two wools used in these studies were closely similar in mean diameter (21·9 and 22·1μ, respectively), but differed in their crimp-level (14·8 and 8·9 crimps/in. in the staple). Samples of clean intact wool were treated under reflux with 100 vol. of boiling 0·04 *N* sulphuric acid for various times, following the procedure used earlier in this laboratory[1,2]; the alkali solubility was then determined, and the rate-constants for the acid-sensitizing reaction calculated, assuming two concurrent first-order reactions, by fitting the equation

$$\text{wool}_t = F_o e^{-k_o t} + F_p e^{-k_p t}$$

where wool_t is the fraction of wool found insoluble in the alkali-solubility test after *t* hours of exposure to acid. The '*o*' fraction presumably corresponds to the ortho portion of the fibre cortex, and the '*p*' to the para[1]; but this is not of primary importance to the present work. The results obtained are given in Table 1.

Table 1

Wool	F_o	k_o	F_p	k_p
High crimp	0·513	0·377	0·408	0·0440
Low crimp	0·521	0·458	0·408	0·0830
P		0·05		<0·001

Both rate constants are greater for the low-crimp wool, indicating that it is more susceptible to acid attack.

Force-extension tests to break were made on the Instron tensile tester at 70° F., in aqueous borate buffer, *p*H 9·2, at a constant rate of extension[3] of 50 per cent/min.; eighteen fibres were examined for each wool in the intact state and after two exposures to acid. The results for two mechanical properties of the fibres, together with the corresponding alkali-insolubility values, are reported in Table 2.

Table 2

Time in acid (hr.)	Alkali-insolubility			Elastic modulus (gm./cm.^{2}) $\times 10^{-6}$			Breaking energy (gm.-cm./cm.^{3}) $\times 10^{-4}$		
	High cr.	Low cr.	*P**	High cr.	Low cr.	*P**	High cr.	Low cr.	*P**
0	93·4	94·1	—	13·6	14·5	0·2	34·1	36·7	0·2
4	47·0	39·1	0·001	8·4	6·7	0·01	14·3	10·2	0·0
16	24·7	16·6	0·001	4·0	3·6	—	3·4	2·7	—

* Values greater than 0·2 not listed

All the parameters derived from the stress–strain curve show, like the alkali-insolubility values, that the low-crimp wool has suffered greater degradation as a result of acid treatment. The properties derived from the yield portion of the curve (stress at 20 per cent extension, energy for 20 per cent extension) exhibit less change after acid attack, and differentiate less clearly between the two wools than either the low-strain properties (uncrimping stress, elastic modulus, stress at 5 per cent extension) or the properties at break (particularly breaking stress and breaking energy).

The difference between the two wools in their susceptibility to chemical degradation is sufficiently large to be detectable in the properties of fibres from fabric dyed with metallized acid dyestuffs; furthermore, this difference is reflected in the resistance of the fabric to flex-abrasion, wet, determined on the Stoll tester[4].

Preliminary results on other wools do not suggest that the difference in response to acid attack between the two specimens studied is related directly to their crimp configuration.

This work forms part of the Wool Research Project of the Textile Research Institute, supported by the International Wool Secretariat and a group of industrial sponsors.

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Measurement of Mean Red-Cell Thickness by the Use of a Probability Function

WHEN attempting to find the mean thickness of any kind of circular and biconcave red cell, one has either to be content with the mean corpuscular thickness, obtained by treating the cell as a cylinder and dividing the mean cell volume by πr^2, or one has to measure the dimensions of red cells on edge[1], thus obtaining the greatest thickness, the least thickness, and so on. The former method does not take the shape of the cell into consideration, and the latter method is laborious. This communication describes a new method, intermediate in accuracy but sufficiently reliable for many purposes. It depends on the fact that the number of red cells seen on edge, in a preparation in which the cells are randomly oriented, depends on the mean dimensions of the cells, including the diameter. Virtually no cell will be seen exactly on edge ; but a number will present themselves in the direction of observation in such a way that their observed thickness will be less than a selected value w—where w is a little larger than t, the true mean thickness. The probability f of such cells being seen in the preparation is

$$f = \frac{w - t}{d - t} \qquad (1)$$

an expression for which we are indebted to Dr. R. T. Cox (the proof of this expression is a little too long to be included here ; but we shall be glad to communicate it to anyone who is interested), and which treats the cross-section of the red cell as a rectangle with a semicircle at each end.

A preparation of red cells in plasma is made between slide and coverslip, and is examined under conditions of reasonable high resolution (× 20 objective, N.A. 0·5, × 5 eyepiece, and Kohler illumination). The preparation is stirred up by pressing on the coverslip so that the red cells move in the currents thus produced, and several fields are photographed (Leica 111 *f* camera with Adox *KB*-17 film) at an exposure of 0·001 sec., provided by a Strobonar IV electronic flash. After development, the fields are projected at a magnification of about × 800, and a cell is considered to be on edge if its image falls within two lines separated by a distance w and drawn on a glass plate ; it is convenient to choose two values for w, one about 1·5 times and the other about twice the estimated cell thickness. The values chosen for w are not particularly important, although they must be known exactly in μ. The number of red cells on edge and the total number of cells in the fields examined give f, from which t, the mean cell thickness, can be calculated for each of the two values of w. Virtually the same value of t is usually obtained from the two values of w.

This method has given excellent results. For the red cells of man $t = 2{\cdot}07 \pm 0{\cdot}1\mu$, which is in good agreement with the value found by photography of human red cells on edge[1]. For rabbit red cells, $t = 2{\cdot}1 \pm 0{\cdot}1\mu$, which again agrees with direct observations if one allows for the limitations which the latter suffer because of diffraction phenomena at the cell edge. For the mouse red cell, $t = 2{\cdot}05 \pm 0{\cdot}05\mu$.

A corollary to expression (1) is that if no red cell or ghost presents itself on edge, the cells or ghosts are necessarily spherical. Their volume is then $4\pi r^3/3$, where r is their radius, and their surface area is $4\pi r^2$.

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Electrical Properties of the Plasma Membrane of Erythrocytes at Low Frequencies

EARLIER investigations of the dielectric properties of biological interfaces dealt with the plasma membrane of erythrocytes and obtained from its capacitance a value of its thickness near $10\varepsilon_M$A., where ε_M is dielectric constant of membrane[1]. Other contributions considered the possibility of a frequency dependence of cellular membrane impedance which can be expressed by a power law[2]. Both frequency dependence of membrane and complexity arising from variability in cell size and shape may affect similarly dielectric properties of cellular suspensions in the R_F-range.

Thus, measurements of biological interfaces at lower frequencies than previously investigated are indicated to differentiate power law behaviour of interface from form and size variation effects.

This study was undertaken to obtain data of resistivity and capacitance of erythrocytes at low frequencies. Accurate impedance measurements on red cell suspensions were obtained in a frequency-range of 10–200,000 c./s. Heparinized fresh beef blood was washed with Ringer tyrode, *p*H 7·6, and centrifuged to 80–90 per cent volume concentration of erythrocytes. The packing was done to reduce artefacts due to electrode polarization[3]. This concentrated suspension was placed in a cylindrical electrolytic cell, the impedance of which was measured in a precision bridge[4]. Temperature was stabilized to 25° C. ± 0·01° C. Effects of distributed capacitances and leakage conductances were eliminated by a substitution technique. The measurements of impedance as function of frequency (f) were made with high accuracy, resistance to ± 0·0005 per cent except at 10 c./s. and capacity to $(0{\cdot}5/f_{\text{kc.}} \pm 0{\cdot}5)$ per cent. Changes due to small temperature variations and sedimentation were eliminated by alternating experimental measurements with control readings at 1 kc./s. The small drift of the control readings with time was found independent of frequency and used for determining corrections for the experimental data at other frequencies.

Electrode polarization impedance, which appears in series with the sample impedance, was nearly independent of sample volume. Hence, the difference between measurements at two electrode spacings could be taken to be proportional to the impedance of the differential blood volume[3,5]. Accuracy of these difference measurements was kept high by minimizing

Table 1

kc./s.	$\frac{\varepsilon}{\varepsilon(1\text{ kc./s.})}$	kc./s.	$\frac{\varepsilon}{\varepsilon(1\text{ kc./s.})}$
0·05	1·0	5	0·991
0·1	1·0	10	0·987
0·2	1·00	20	0·983
0·5	1·00	50	0·978
1	1·00	100	0·973
2	0·996	200	0·961

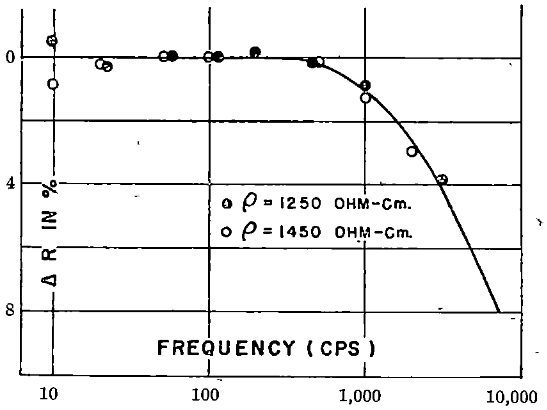

Fig 1

polarization with electrodes heavily covered with platinum black and using large electrode spacing (up to 15 cm.). Fig. 1 represents specific resistance ρ of two samples. Results are typical of all samples investigated. Table 1 gives dielectric constant values, averaging eight samples. The drop in resistance above 1 kc./s. and in dielectric constant above 10 kc./s. is the result of the known dispersion caused by the cell interior. Measurements have also been carried out with rabbit blood with the same results. The frequency dependence reported previously by others for rabbit erythrocytes[5] between 500 and 5,000 c./s. cannot be confirmed.

The results in both resistance and capacitance support the frequency independent nature of the erythrocyte membrane. If a power law $C=C'f^{-m}$ would characterize membrane capacitance, then accuracy of capacitance data corresponds to m deviating from zero by less than 0·004, that is, the phase-angle of the interface must be equal to 90° within 0·4°. From the frequency independence of resistance, and from measured capacitance of suspensions and known capacitance of plasma membrane[1], it follows that the conductance of the plasma membrane per cm.^{2} of its surface is constant between 20 and 500 c./s. within 0·1m.mho. Electrical relaxation effects due to structure occur if different molecular layers are arranged in series[6]. Presuming such a structure, our results mean that dielectric losses of these layers are extremely small, placing the relaxation effect outside our range of observation. A more likely possibility to explain our results is a mosaic structure of the lipid–protein complexes[7]. Such a mosaic arrangement cannot show a frequency dependence, at least as long as its components are independent of frequency.

This investigation was supported by a research grant *H*-1253(*C*2) from the National Institutes of Health, Public Health Service.

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Energy Relations of Mitotic Activity in Mouse Hair Bulbs

It is now recognized, especially from studies on the physiology of adult epidermis, that the energy requirements of mitotic activity are high[1]. There is a marked diurnal rhythm in epidermal mitotic activity, and this appears to be determined by variations in the rate of uptake of glucose from the blood. Hair bulbs contain cells which are epidermal derivatives; but their mitotic activity follows a remarkably individual pattern, which is not influenced by the diurnal rhythm. Waves of hair-growth pass slowly across the body of a mouse, and, according to the position of these waves, the hair bulbs are either completely quiescent or are engaged in the most violent mitotic activity.

It has been shown *in vitro* that epidermal mitotic activity is dependent on an adequate supply of glucose and oxygen so that, in the absence of one or other of these substances, mitosis is severely depressed or even eliminated. Efficient energy-production through respiration is essential to epidermal mitotic activity, and such activity cannot be supported by anaerobic means, although in embryonic tissues this is evidently possible[2]. The question now arises whether the peculiarly violent and short-lived mitotic activity of the hair bulbs in the growth zone is also dependent on respiration, or whether it is supported by some alternative or ancillary mechanism. The following experiments were designed to provide an answer.

Adult male mice of Kreyberg's *WLL* strain had their body hair removed by electric clippers, and within a few days the regions of active hair growth became obvious. When the leading edge of the advancing growth-wave had reached the flank regions, the mice were killed and a strip of skin containing active hair bulbs was removed from both sides of the body and cut into small pieces (size approximately 50 mm. × 100 mm.). The skin fragments, arranged so that each group consisted of three pieces of skin each taken from a different animal, were immersed in a phosphate-buffered saline medium maintained at 38° C. in a Warburg flask. They were incubated for 1 hr. in order to eliminate those mitoses which were present in the hair bulbs when the skin was taken from the mouse. Colchicine was then added and the incubation continued for a further 4 hr. During this period, all the developing mitoses were arrested in the metaphase by the colchicine. Full details of this technique have been given elsewhere[3].

In addition to determining the effects of the presence or absence of glucose and oxygen, a study was also made of the effects of cyanide (which inhibits the cytochrome system), of fluoride (which inhibits glucolysis) and of 2 : 4-dinitrophenol (which is said to inhibit energy transfer). The results, taken from sections cut 7μ thick, are given in Table 1.

Accurate mitosis counts, similar to those previously obtained for epidermis, were difficult to make; but it was found that the results were so uniform and so obvious that this was unimportant. There was high mitotic activity in the group given both glucose and oxygen, low mitotic activity in the group deprived of glucose, and no mitotic activity at all in the groups treated with nitrogen and with optimum concentrations of cyanide, fluoride and 2 : 4-dinitrophenol.

It is evident from these results that the energy relations of mitosis in hair bulbs are similar to those

Table 1. MITOTIC ACTIVITY IN MOUSE HAIR BULBS INCUBATED *in vitro* FOR 4 HR. AT 38° C.

Phosphate-buffered saline	Gas phase	Inhibitors	Mitotic activity
+ 0·02 *M* Glucose	Oxygen	None	++
Saline alone	Oxygen	None	+
+ 0·02 *M* Glucose	Nitrogen	None	0
+ 0·02 *M* Glucose	Oxygen	0·0005 *M* Cyanide	0
+ 0·02 *M* Glucose	Oxygen	0·001 *M* Cyanide	0
+ 0·02 *M* Glucose	Oxygen	0·005 *M* Cyanide	0
+ 0·02 *M* Glucose	Oxygen	0·0005 *M* Fluoride	+
+ 0·02 *M* Glucose	Oxygen	0·001 *M* Fluoride	0
+ 0·02 *M* Glucose	Oxygen	0·005 *M* Fluoride	0
+ 0·02 *M* Glucose	Oxygen	0·0001 *M* Dinitrophenol	0

Note: ++ indicates high mitotic activity.
+ indicates low mitotic activity.
0 indicates full inhibition of mitotic activity.

already described for epidermis. In the first place, it appears that sufficient energy is stored during the antephase to ensure that, when glucolysis and respiration are inhibited, any mitoses already in progress are capable of passing to completion. In the second place, it is clear that few, if any, new mitoses can develop in cells in which the antephase storage of energy is prevented by the absence of glucose or oxygen. Normally, in the rapidly dividing cells of the hair bulbs this storage of energy must occur very quickly. It evidently depends on active respiration, and it cannot be accomplished by glucolysis alone.

It has been suggested that the normal ability of an epidermal cell to undergo mitosis is limited by the degree of activity of the cell surface in absorbing glucose. If the same is true in the case of mouse hair bulbs, then it appears that, according to the stage of the hair cycle, these cells must alternate between an exceedingly low and an exceedingly high rate of glucose uptake, or, in other words, between a state of very low and very high cell-surface activity.

We thank Miss Anne Rogers for her assistance in this investigation, which was supported by a grant from the British Empire Cancer Campaign.

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Assay of Spider Venom and Antivenene in *Drosophila*

DURING studies on the toxicity of the venom of the Australian red back spider (*L. hasseltii*) it was found that the venom injected into *Drosophila* causes paralysis of the insect. This effect has been utilized for assaying antivenene.

Venom was obtained from the dissected venom glands of *L. hasseltii* as described elsewhere[1]. About 0·2 c.mm. of varying concentrations of venom was injected with a capillary pipette into the thorax of *Drosophila* under carbon dioxide anæsthesia. The results are shown in Table 1, where the amount of venom which was injected is expressed in fractions of the venom of one spider. With the higher concentrations of venom, the insects became paralysed within 5–20 min. after the injection. With concentrations of venom near the minimum lethal dose the insects showed progressive difficulty in turning over when they were made to fall on their backs and became paralysed without recovery during the next 24 hr. Results were recorded 24 hr. after the injections. It can be seen from Table 1 that 5 × 10⁻⁶ of the amount of venom contained in one spider constituted the minimum lethal dose for *Drosophila*. It has been found previously that on the average one spider contains about 0·1 mgm. of venom. Thus 5 × 10⁻⁷ mgm. of spider venom was sufficient to kill one *Drosophila* weighing about 1 mgm. A mouse of 20 gm. is usually killed by 0·2 of the amount of venom of one spider. On the basis of body-weight the venom of *L. hasseltii* is therefore approximately eight times more toxic in *Drosophila* than in the mouse. Millot[2] suggested that spider venom is most toxic to those animals on which the spider normally feeds.

Table 1. TOXICITY OF SPIDER VENOM IN *Drosophila*

Amount of venom in fractions of one spider ($\times 10^{-3}$)	No. of insects	No. paralysed
0·2	6	6
0·1	3	3
0·05	3	3
0·02	3	3
0·01	3	3
0·005	3	3
0·002	3	0
0·001	3	0
0·0005	3	0

Antivenene was prepared in a rabbit using venom adsorbed on aluminium phosphate[1]. The antivenene (*F*7) used here was obtained seven days after the second dose of venom. Using mice, it was found that one millilitre of serum neutralized the venom of four spiders.

For assaying antivenene in *Drosophila*, equal volumes of fixed quantities of venom were mixed with varying dilutions of serum. Each dose of 0·2 c.mm. contained the venom of 0·0001 spider which corresponded to twenty lethal doses. Table 2 shows the amounts of serum injected with each dose and the results which were obtained. It can be seen that 0·3 × 10⁻⁴ ml. of serum neutralized 1 × 10⁻⁴ of the amount of venom contained in one spider. One millilitre of serum, therefore, neutralizes the venom of about 3·3 spiders. This result agreed reasonably well with that obtained when the same serum was assayed in mice.

The use of *Drosophila* as an index of antigen–antibody reaction for the titration of spider-antivenene enables a larger number of lethal doses of venom to be injected and neutralized than is practicable in the case of mice. A more reliable estimate of the potency of the serum is therefore possible[3]. At the same time, there is a considerable saving in the amount of venom required for assaying antivenene, and results are available within 24 hr.

The method here described is simple and might prove useful for assaying antisera of medical import-

Table 2. ASSAY OF SPIDER ANTIVENENE IN *Drosophila*

Amount of venom in fractions of one spider ($\times 10^{-3}$)	Amount of serum (F_7) in millilitres ($\times 10^{-3}$)	No. of insects	No. paralysed
0·1	0·01	5	5
0·1	0·012	5	5
0·1	0·02	5	5
0·1	0·025	5	3
0·1	0·03	4	0
0·1	0·05	4	0
0·1	0·1	4	0
—	0·1	4	0

ance prepared against other venoms and toxins which also happen to be toxic to insects.

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Histamine and Histidine in Excreta of the Blood-sucking Bug *Rhodnius prolixus*

Paper chromatographic studies of the dry excreta of *Rhodnius* fed in the laboratory on the rabbit have shown the presence of the following amino-acids or related compounds: leucine, histidine, histamine, taurine, glycine, valine, phenylalanine and alanine—the first three giving particularly intense spots with ninhydrin.

The presence of histidine and its amine in substantial concentration was confirmed by tests with the diazo reagent of Pauly as applied to chromatograms by Dent[1]. Histidine was further checked by parallel runs with pure substance. The histamine spot corresponds to the position allotted to it in the literature[1] and when eluted with 0·9 per cent sodium chloride solution, and scratched into the skin, it gave a marked reaction compared to a negative response with distilled water. A value of 0·041 mgm. histamine/100 mgm. dry excreta was obtained by an assay kindly performed by Dr. W. E. Ormerod on guinea-pig ileum by comparing the contractions produced with those produced by a standard dose of known histamine concentration.

A semi-quantitative study of the free amino-acids in *Rhodnius* hæmolymph by the method of Auclair and Dubreuil[2] has shown that histidine accounts for almost 35 per cent of the total free amino-acids detected (2,594 µgm./ml.). It is well in excess of all others in the amino-acid picture. It was not detected in excreta of bugs fed on horse serum through a rubber membrane, and histamine was present in low concentration. Sterile bugs, that is, bugs deprived of their intestinal micro-symbionts, *Actinomyces rhodnii*, gave excreta with a significant decrease of histidine but with an intense histamine spot.

The high concentration of histidine in both hæmolymph and excreta of *Rhodnius* is similar to that found in *Bombyx mori*, where it has been detected in hæmolymph of larvæ[3] in equally high concentration[7], of pupæ[4] and of adults[5]. In addition, it has been found in large amount in larval fæces[6] and adult urine[5]. There appear to be no previous records of the detection of histamine in insect excreta or tissues.

Histamine was not detected in *Rhodnius* hæmolymph at any time, so one can assume that decarboxylation of histidine has occurred in the gut prior to elimination of the amine. Since it appears in excreta of sterile insects, it must arise as a result of tissue decarboxylation of histidine and not by bacterial agency. Also, the absence of histidine (and most of the amine) in excreta of serum-fed bugs suggests that both may be derived predominantly from the substantial concentration of histidine in the dietary blood, where it forms 6–10 per cent of the globin derived from hæmoglobin[8]. In other words, the red blood cells in the diet account for the high concentration of histidine and its amine in the excreta. There is further confirmation for this, as histamine does not appear in the copious urine immediately after the blood meal but only in the excretory products of digestion which takes place weeks after ingestion of the blood. Ingested hæmoglobin may remain red for several weeks[9]. The lower concentration of histidine in excreta of sterile insects is difficult to explain as it does not correspond to any change in its amine, which is present in high concentration. It is possible that the intestinal symbionts are contributing histidine to the host.

The detection of histamine, a 'tissue poison', in high concentration in the gut is particularly interesting. It is curious to find an organism converting a harmless substance into a 'toxic' derivative before excreting it. The presence of both these substances could be further elucidated by studies on the excreta of other blood-sucking insects.

This research formed part of a study for the degree of Ph.D. of the University of London and was carried out under the late Prof. P. A. Buxton, whose fundamental criticisms and assistance were most valuable. It is a pleasure to thank the South African Council for Scientific and Industrial Research for generous financial support during the study.

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The Small Saphenous Vein as a Route for Intravenous Injection in the White Rat

A number of years ago, in searching for an accessible vessel from which blood could readily be obtained several times a week, we found that the small saphenous vein could easily be visualized and entered through the skin on the dorsum of the rat's foot. This vessel has since proved far more satisfactory than the commonly used tail vein for either bleeding or injection[1,2]. The technique of injection by this route has been briefly, but obscurely, described[2], and it thus remains not generally known.

The location of the small saphenous vein on the foot is shown in Fig. 1. The unanæsthetized rat is prepared for injection by wrapping in a towel or by insertion in a restraining cylinder. In either case, the one leg chosen for injection is left protruding. Shaving the area over the vein not only makes it easier to see through the skin, but also by provoking increased circulation causes the vein to distend prominently. The latter effect may be enhanced by washing the skin with 70 per cent alcohol and by snapping one's finger against the foot; application

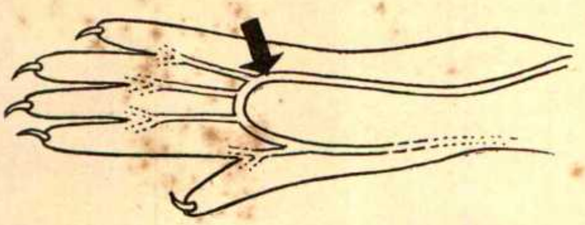

Fig. 1. Dorsal venous arch on the right hind foot of a rat. The small saphenous vein forms the lateral limb of the arch proximal to the arrow

of heat has never been necessary. The operator holds the foot by the toes during the procedure, and an assistant aids by holding the knee in such a manner that its sudden flexion and consequent withdrawal of the foot are prevented. A 1-in., 26-gauge hypodermic needle directed toward the ankle is inserted through the skin and into the vein at the approximate point indicated by the arrow in Fig. 1. With pressure of the operator's thumb over the point of insertion, the foot and needle are held firmly between thumb and index finger so that with any slight movement of the foot the needle and syringe move with it. Extreme variations from the venous pattern illustrated are rare and constitute no special hazard.

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A *p*H Gradient Agar Plate

IT is often advantageous for the microbiologist to know the *p*H limits within which a micro-organism will grow, and the influence of *p*H on the antimicrobial action of various drugs. Customarily, such studies are carried out in a series of separate vessels, each adjusted to a different *p*H-level. This note describes a modification of the Szybalski gradient plate technique[1] so as to provide a *p*H gradient across the surface of an agar plate, thus facilitating studies involving *p*H effects on the growth of micro-organisms.

The Szybalski technique involves solidification of a layer of agar (containing an antibiotic) while the Petri dish is held in an inclined position. An equal amount of agar is then added which is allowed to harden while the plate is level, thus forming two complementary slanted layers, and establishing a graded antibiotic concentration across the plate. The modification presented involves the introduction of K_2HPO_4 into the lower layer, and KH_2PO_4 into the upper layer (antibiotic omitted). In practice $1M$ buffer solutions are sterilized separately and added to the medium just prior to pouring (1 : 10 v/v). These plates develop a gradient ranging from about *p*H 5·6 to *p*H 7·8 and which is readily visualized by placing filter paper strips, each impregnated with a different *p*H indicator, on the agar surface. The colours formed provide a convenient guide to the *p*H at any position along the gradient. A photograph of such a plate with indicators transferred to the agar (after removal of the paper strips) is shown in Fig. 1.

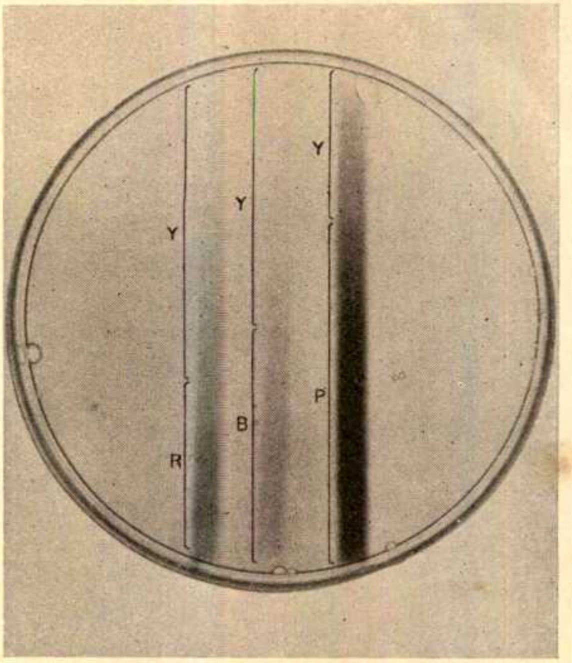

Fig. 1. *p*H gradient plate, showing *p*H indicators transferred to the agar by contacting the agar for about ten minutes with filter paper strips impregnated with the indicator. Indicators are (left to right) phenol red, brom thymol blue, brom cresol purple. Bottom is alkaline, top acidic

The influence of *p*H upon antibiotic action can be determined in several ways. The simplest is to incorporate the antibiotic in a thin surface layer (10 ml. per 150 mm. plate) of 2 per cent agar. The test

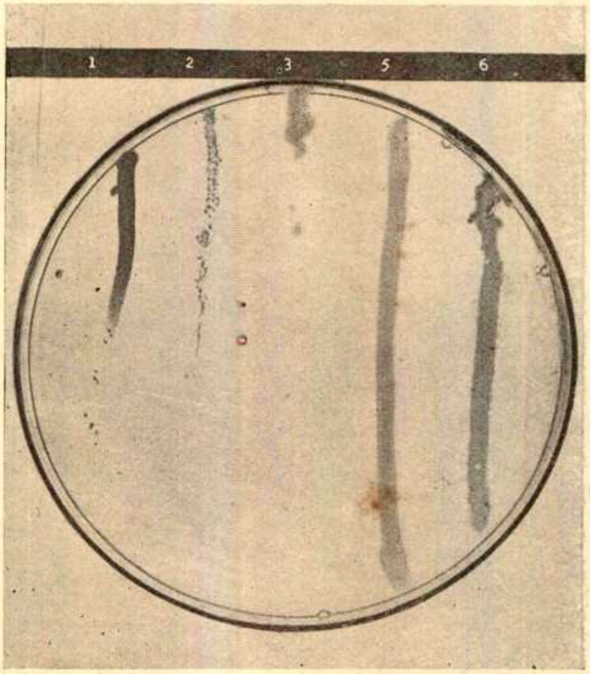

Fig. 2. Influence of *p*H on the antibacterial action of streptomycin. 1, *Staphylococcus aureus* (H). 2, *S. aureus* FDA 209. 3, *Bacillus megaterium* B-938. 5, *Escherichia coli* 456. 6, *Serratia marscesens*. Surface layer contains 20 p.p.m. Note absence of growth in alkaline regions for organisms 1, 2, 3

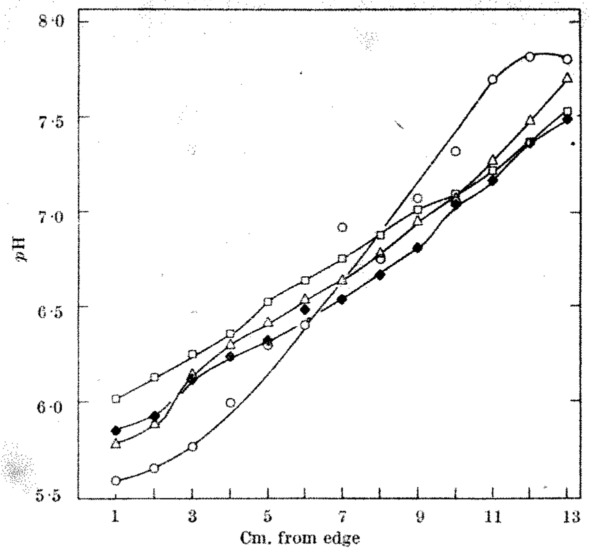

Fig. 3. Stability of pH gradient. ○———○, 1 hr. after pouring agar; △———△, 1 day; ■———■, 2 days; □———□, 8 days; pH determined with glass electrode; plates held at 25° C., 0 to 4 days; at 5° C., 4 to 8 days

organisms are then streaked along the gradient with swab sticks soaked in suspensions of 24-hr. cultures. Several plates, each with a different antibiotic concentration, are generally prepared, along with a control plate from which the antibiotic is omitted. Fig. 2 shows the increased effectiveness of streptomycin in the alkaline region[2]. An alternative method (cf. Streitfeld and Saslaw[3]) involves placing a filter-paper strip impregnated with the antibiotic on the plate and overlayering with a thin layer of 1 per cent agar containing the inoculum. Flaring of the inhibition zone indicates increased activity in that region of the gradient.

The pH limits within which an organism will grow may be readily determined by omitting the antibiotic from the surface layer, and streaking. By using H_3PO_4 instead of K_2HPO_4 a pH range of 2 to 5 may be obtained.

The pH gradient is quickly established, and changes but little in 48 hr. On the 150-mm. plates shown, the pH values shifted appreciably only at the extremes of the gradient where buffering capacity is poor (Fig. 3).

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Generic Status of *Glossopteris*, *Gangamopteris* and *Palæovittaria*

Though the *Glossopteris* flora has been known for more than a hundred years now, our knowledge of this flora does not extend beyond the gross features of the plants comprising it. As is well known, the fronds of the three important genera, *Glossopteris*, *Gangamopteris* and *Palæovittaria* are more or less similar in external form and are usually distinguished by the presence or absence of midrib and anastomosing of the secondary veins. But many times the characters of one genus merge into another and then it becomes difficult to refer it definitely to any one of the three genera. Some good examples are, *Glossopteris mitchelli*, *Glossopteris intermittans*, *Glossopteris decipiens* and *Gangamopteris indica*. Owing to such inconsistency shown by these external characters, doubts were raised in the past about the generic status of *Gangamopteris* and *Palæovittaria*. It appears that between the three genera there are no sharply defined distinguishing features, and the criteria like the presence or absence of midrib and the anastomosing of secondary veins are too inconsistent to be relied upon as generic characters.

As Prof. B. Sahni[1] remarked, while describing the cuticle of *Glossopteris angustifolia*, in dealing with material of this nature any information that took us beyond the gross features would be welcome. Fortunately in India these plant remains are found as impressions, many of which are carbonized and therefore suitable for cuticular studies.

Such studies of the *Glossopteris* flora of India have now been taken up at this Institute. The late Dr. P. N. Srivastava made cuticular studies of the following:

Glossopteris browniana, *G.* cf. *divergens*, *G. communis*, *G. communis* var. *stenoneura*, *G. conspicua*, *G. formosa*, *G. retifera*, *G. damudica*, *G. intermittans*, *G. tænio-pterioides*, *G. sahnii*, *G. arberi*, *G. longicaulis*, *G. tænioides*, *Gangamopteris* cf. *cyclopteroides*, *G.* cf *hughesi*, *G. indica*, *G. flexuosa*, *G.* sp. *A.*, *G.* sp. *B. Palæovittaria kurzi*.

He compared all his specimens with the type specimens which were available, and it is provisionally presumed that the specific determinations are correct.

Srivastava's cuticular studies show that it is again not possible to delimit the three genera as defined at present on the basis of epidermal characters, because there are species in two genera which show very similar characters and some species of a single genus show such diversity as cannot be regarded only of specific importance. It is therefore evident that the three genera include diverse types, perhaps belonging to different genera, but possessing somewhat similar external features.

If only epidermal characters are taken into consideration, the various species of the three genera described by Srivastava fall into six groups which may provisionally be considered as of generic rank. For example, *Glossopteris angustifolia* and *G. retifera* might well be the species of a single group, whereas *G. formosa* and *G. communis* appear to be the species of another group. Similarly, *Gangamopteris* cf. *cyclopteroides* and *G.* cf. *hughesi* are the species of two distinct groups. Srivastava's studies are shortly to be published in full in the *Palaeobotanist*.

However, before the three genera are broken up into natural genera, one important fact has to be taken into consideration. Recently some fructifications have been described as borne on the leaves of certain *Glossopteris* species[2] and it can be hoped that similar discoveries may be made in the case of other related genera. When such organs are found in connexion it is natural to connect them together and define more exactly the taxonomic limits of the plant to which they belong. But before doing so in the case of *Glossopteris* and other related genera it would be desirable if the true identity of the leaves is first established on the basis of cuticular study (provided, of course, the cuticle is available). Otherwise, as Srivastava's studies have shown, the identification of a fructification-bearing leaf based only on external features may be wrong to start with and consequently lead to wrong conclusions regarding the definition of the plant represented by these organs.

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Polyploidy and Radiosensitivity

THE effect of polyploidy on the radiosensitivity of cells has been the object of some discussion in the past, and it may be of some practical importance in such cases as cancer therapy, for example, since tumours are often mixed diploid–polyploid populations[1,2]. For chromosomal aberration production by radiation, polyploid sensitivity equal to[3,4], greater than[3], and less than[5,6] the diploid have been reported. Each of the various experiments involved a comparison of different diploid and polyploid species, and the lack of agreement between the experiments may be due to intrinsic differences in species sensitivity, rather than to the effect of polyploidy itself.

The ideal situation—irradiation within a single tissue or organ of a single mixed population of normal cells and polyploid cells derived from them—was realized through a fortunate accident in a *Tradescantia* radiation experiment designed for another purpose. A single *Tradescantia paludosa* flower bud (made into a single acetocarmine slide) was found with a mixed population of haploid and diploid microspores. The bud had been irradiated four days previously (500 r. of 250-kVp. X-rays in 1 min., hvl., 1·45 mm. of copper) while the cells were in postmeiotic interphase, an extended period of uniform radiosensitivity; the bud was examined at the microspore mitotic division. About half (48 per cent) of the cells were diploids.

Chromosome aberrations were carefully counted at metaphase in 50 of the haploid (6-chromosome) and 25 of the diploid (12-chromosome) microspores, with the results given in Table 1.

Table 1. CHROMOSOME ABERRATION PRODUCTION BY 500 R. OF X-RAYS IN HAPLOID AND DIPLOID MICROSPORES WITHIN A SINGLE FLOWER BUD OF *Tradescantia*

Cell type	No. of cells	Aberrations per 100 cells					
		Exchanges			Deletions		
		Intrachange, interarm (centric rings)	Interchange* (dicentrics, etc.)	Total ± S. E.	Interstitial 'minutes'	Terminal	Total ± S. E.
Haploid (6 chromosomes)	50	22	160	182 ± 19	292	60	352 ± 26
Diploid (12 chomosomes)	25	16	344	360 ± 38	624	157	776 ± 56
Ratio of diploid to haploid							
aberrations per cell				2·0 : 1			2·2 : 1
aberrations per chromosome				0·99 : 1			1·1 : 1

* No. of interchanges = 1 (dicentrics) +2 (tricentrics) + 3 (quadricentrics) + . . . ; for haploid cells = 1 (82) + 2 (24) +3 (10) + 4 (0) = 160; for diploid cells = 1 (240) + 2 (32) + 3 (8) + 4 (4) = 344.

The aberrations observed in both haploid and diploid cells are the customary chromosome kinds resulting from irradiation of undivided chromosomes in interphase. Per cell, the diploid cells have almost exactly twice as many aberrations as the haploid. However, *per chromosome* (since there are twice as many chromosomes per cell in the diploid) the aberration frequency is the same in the diploid and haploid cells. Thus, in the ideal situation of mixed cells in the same tissue, we can say that chromosomal radiosensitivity, or sensitivity per unit length of chromosome, is identical in haploid and diploid cells.

This conclusion probably is not compromised by differences in stage and sensitivity of the haploid and diploid cells, which could result from a possible difference in the rate of development of the cells. Both kinds of cells displayed only the chromosome type of aberrations, which indicates that both were in the same stage, interphase, when irradiated. In addition, radiosensitivity in this interphase is known to be uniform for not less than one day before and one day after the time the radiation was delivered[5].

The observation that for the same dose diploid cells have only twice as many exchange aberrations per cell as the haploid cells affords geometric evidence of the limitation of space over which chromosome breaks can interact to produce an exchange. It is known that with X-rays, exchange aberrations, which result from the interaction of two independently produced breaks, increase as the square of the dose; it is believed with considerable reason that the breaks increase linearly with dose[7]. Now, per nucleus, a doubling of the number of breaks can be achieved by doubling either the dose (chromosome number constant) or the chromosome number (dose constant). In terms of concentration, doubling dose doubles the number of breaks per nucleus, and also breaks per unit volume; however, doubling chromosome number doubles only breaks per nucleus—breaks per unit volume remain the same if volume is also doubled. The ratio of diploid to haploid volumes, both cellular and nuclear, on this slide was roughly about 2·8 : 1, as estimated from the ratio of measurements made on pairs of cells in the same stage and lying side by side; total chromosome length, from metaphase measurements, was in the ratio 2 : 1. The finding that, for the same dose, a diploid cell has twice, not four times, as many aberrations as a haploid cell shows that breaks do not exchange freely over the entire volume of the nucleus but only over a very limited volume. Two breaks, to exchange, must be very close together.

This work was performed under Contract No. W-7405-eng-26 for the U.S. Atomic Energy Commission.

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Allium neapolitanum: a Mixed Species

In two samples of *Allium neapolitanum* bulbs, received from Van Tubergen, Holland, Levan[1] reported 14 and 28 chromosomes. Feinbrun[2] also reported the tetraploid form ($2n = 28$) of this species growing wild in Palestine. In a sample I have received from de Jager's, Holland, I have found only the diploid. In a second sample, however, there were again tetraploids; in addition there were two new types, triploids ($2n = 21$) and pentaploids ($2n = 35$).

No great differences were observed in chromosome form between the four strains. All of them had chromosomes, ranging in size from 8μ to 12μ, with median or submedian centromeres. However, an interesting feature was observed in one small chromosome of the triploid and occasionally of the tetraploid form. There was a pronounced attenuation of the centromere, which had the appearance of a long thread joining the two arms. An analogous situation has been described in several species. It has been attributed to two possibilities: (1) to unspiralized heterochromatin at one side of the centromere, as in *Fritillaria lusitanica*[3] and *Fritillaria pyrenaica*[4]; (2) to a close proximity of the nucleolar organizer, which seems to be the case in *Poa alpina*[5] and in *Campanula persicifolia*[6]. There are also other examples where for reasons unknown the centric constrictions appear accentuated, as in *Aconitum*[7] and in *Crocus*[8].

The presence of an extended polyploid series in *Allium neapolitanum* reminds one of the situation described by Levan[9] in *Allium nutans*, where the whole range from $2x$ to $12x$ was found. The fact that three different forms can occur in the same commercial sample of bulbs seems, however, unprecedented. It suggests that this species has a form of versatile reproduction in which either fertilization or meiosis, or both, may be omitted from the normal sexual process.

This investigation was made possible by a scholarship from the State Scholarships Foundation of Greece, to which grateful acknowledgment is made.

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A Gene for Eyelids Open at Birth in the House Mouse

In a stock of mice kept by one of us (J. H. B.) there has arisen a mutant gene which in the homozygous condition causes the eyelids to be open at birth. A similar character has been observed in mice by others[1,2]; but this seems to be the first occasion on which it has been found to have a simple genetical basis.

In a normal mouse the eyelids fuse about five days before birth and reopen about nineteen days later. In the abnormal mice described here, there is no pre-natal fusion of the eyelids. One day after birth an inflammatory exudate covers the eye opening; about four days later this falls away and a whitish excrescence may be seen in the superior fornix conjunctivæ. This excrescence gradually decreases in size and has usually disappeared by the eighteenth day after birth. The eye is then smaller than normal. Corneal opacity results but tends to diminish with advancing age.

Table 1. Data from Backcrosses in Coupling for *wa*-1 and *eo*

Sex of heterozygous parent	Offspring				
	wa-1 *eo*	*Wa*-1 *Eo*	*wa*-1 *Eo*	*Wa*-1 *eo*	Total
Female	39, 40	49, 48	4, 1	1, 4	93, 93
Male	54, 47	43, 43	6, 7	4, 2	107, 99

The first figures refer to females, the second to males

The recessive gene wavy-1 (*wa*-1) for wavy coat and vibrissæ was segregating in this stock, and at first the eye abnormality was observed only in *wa*-1 homozygotes. All offspring from matings between *wa*-1 homozygotes with abnormal eyes but none of the offspring from outcrosses of such abnormal *wa*-1 homozygotes had the eye abnormality. Some progeny from these outcrosses were mated together and others were backcrossed to the wavy parent with abnormal eyes. A few wavy mice with normal eyes and some non-wavy mice with abnormal eyes appeared in the next generation. The backcross data (Table 1) which have accumulated from this and later genera-

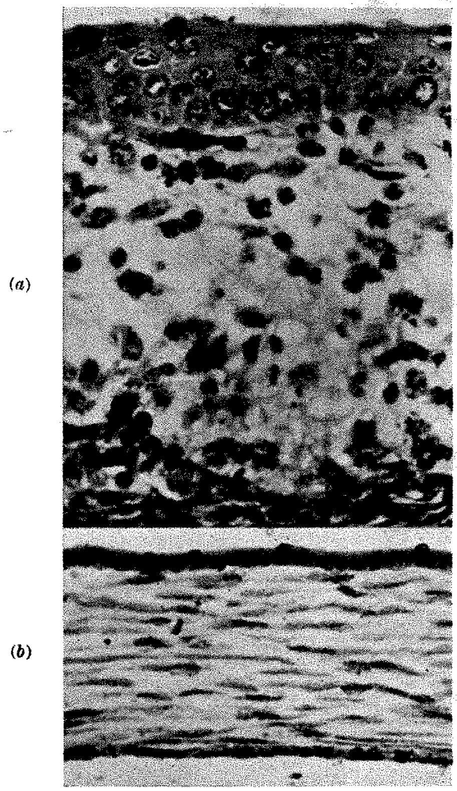
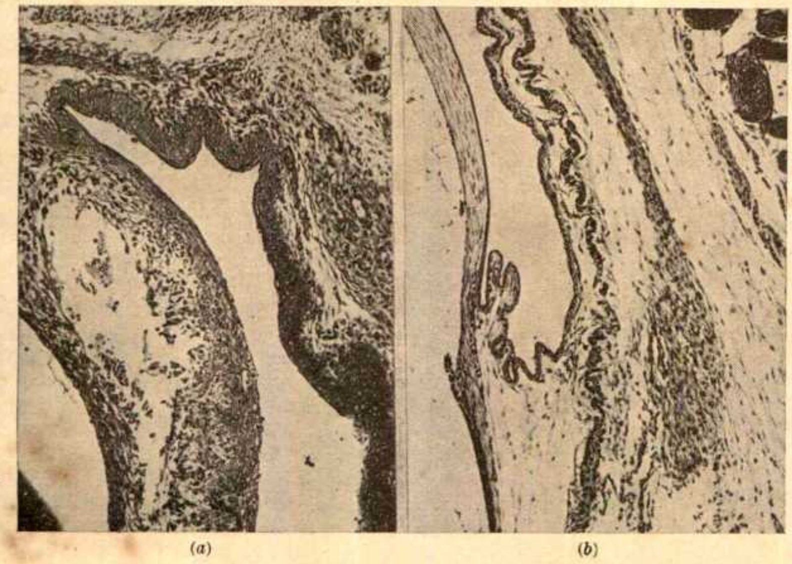


Fig. 1. Section through epithelium overlying the cornea, (*a*) in a four-day old mouse with eyes open at birth, showing œdema and polymorphonuclear infiltration of the substantia propria corneæ with hyperplasia of the external epithelium, and (*b*) in a normal four-day old mouse. (× *c*. 387)



(*a*) (*b*)

Fig. 2. Section through the cornea, (*a*) in a four-day old mouse with eyes open at birth, showing swelling and vesiculation of substantia propria corneæ, and (*b*) in a normal four-day old mouse. (× *c*. 83)

tions seem to indicate that 'eyelids open at birth' is due to a single recessive gene (*eo*) linked with *wa*-1, the recombination frequency being 5·376 ± 1·654 per cent in females and 9·223 ± 2·016 per cent in males. All these data have come from coupling backcrosses. Repulsion backcrosses, which have been set up, have not yet had time to produce offspring. Our estimates of the recombination frequency consequently may be biased because of differential viability. There was no noticeable difference in viability between the normal and affected mice under laboratory conditions; but the mutant homozygote presumably would be at a selective disadvantage in the wild.

More than three hundred mice with eyelids open at birth have now been reared and in all but ten (four females and six males) both eyes were affected. One of these ten mice had an abnormal right eye and the others had abnormal left eyes. In five other mice, the eyelids were open at birth but the conditions described above failed to develop.

Eyes of seventeen- or eighteen-day old embryos from an abnormal-eyed female crossed with a male heterozygous for the eye character were examined histologically. The thirteen embryos were sorted into two groups—those with opaque and those with clear eyes. Coronal sections of their eyes confirmed that the eyelids were open in embryos of the second, but not in those of the first, group. Six abnormal four-day old mice were also examined. The separated eyelids were swollen and purplish-red, and the cornea was visible. The eyes and lids of these mice and of six normal ones were excised and serially sectioned. The corneæ of the affected mice were thickened, the nuclei of the substantia propria were enlarged, and there was an infiltrate of a few polymorphonuclear leucocytes. The overlying epithelium, instead of being a single layer of cuboidal cells (Fig. 1), consisted of three or four layers with a few mitotic figures. The connective tissues of the eyelids were œdematous; but cellular infiltration was not conspicuous (Fig. 2). There was no indication of a conjunctival slough such as has sometimes been said to be associated with this condition[1].

The histological appearances suggest that infection may account for the abnormal post-natal eye conditions. The eyes and lids of several abnormal four-day old mice were therefore excised under sterile conditions, ground, and an extract prepared with a suspension of a sterilized rabbit serum in saline solution. This extract was centrifuged and the supernatant liquid, after it had been mixed with sufficient penicillin and streptomycin to destroy bacteria, was inoculated intraperitoneally into one group of three-day old mice and intracerebrally into another. None of these mice showed signs of disease during the ten days in which they were afterwards observed. The extract was also injected into eleven-day old chick embryos, by the chorioallantoic route in one group, and into the yolk sac in the other, but no growth of virus was detected. Cultures were prepared aerobically and anaerobically from the centrifuged material before the addition of penicillin and streptomycin; but no bacteria were detected.

Sections from the eyes of abnormal ten-day old mice showed œdema of the cornea, especially in its outer part. Polymorphonuclear leucocytes were scanty; and the overlying epithelium had fewer mitotic figures than did that from four-day old mice. In abnormal adult mice the cornea was found to consist of two distinct zones, an outer œdematous zone and an inner compact zone of fibrous tissue.

The histology indicates a mild inflammatory reaction with the subsequent development of corneal fibrosis leading to opacity. The hypothesis that the inflammatory reaction is due to trauma, probably associated with the eyes being open at birth, is supported by the presence of sterile cultures and by the absence of an inflammatory reaction in the corneæ of open-eyed mice *in utero*.

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An Adhesive for labelling Animals exposed to Sea-Water over Long Periods

THE adhesive, 3*M EC*-1341, has been found to be successful in attaching paper labels to the valves of experimental oysters which were living in a natural salt pond for eight months.

The method of labelling was as follows.

A small (2 cm. × 2 cm.) smooth area of the oyster's valve was scrubbed clean with a brush, washed with fresh water, then with 80 per cent alcohol, and finally wiped with a dry cloth. Next the oyster was placed either in the sunlight or under a gooseneck lamp for 5–10 min. until the treated area became completely dry. Then the adhesive was applied to the clean, dry surface with a brush. A small (7 mm. × 7 mm.) paper label was placed on this spot and covered with a second application of the adhesive. Again the oyster was set aside to dry, this time for 30 min. or until the sticky fluid became completely dry and hard. The oyster was then placed, with others in the series, in a wire cage which was submerged in the water of a natural salt-pond. When the oysters were examined at the end of an eight-months period all the labels (fifty oysters) were firmly attached and easily readable.

The labels were cut to the desired size from regular filing cards and the appropriate data were marked upon them with a sharp but soft lead pencil.

This method is by far the most successful of any of the various means of labelling which have been tried in the past. First, the labels remain attached for the longest period of time. Secondly, the numbers can be marked on the paper labels with a fine-pointed pencil before the labels are stuck on to the valve. This is a great advantage over using a wax crayon, small paint-brush or pen upon either the surface of the valve itself or upon adhesive tape already adhering to the relatively rough surface of the valve. Furthermore, the second coat of adhesive protects the identification numbers so that they are as easily read after eight months as the day they were written. Their appearance suggested that they would remain in this condition for many more months.

The adhesive 3*M* *EC*-1341 is a liquid which, if it becomes too thick for easy application, can be diluted with acetone. However, the container should be kept closed whenever the adhesive is not being used. The adhesive was kindly given by the Minnesota Mining and Manufacturing Co., 700 Grand Avenue, Ridgefield, New Jersey.

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An Interfacial Barrier observed during Liquid–Liquid Extraction of Uranyl Nitrate

Earlier investigations on the transfer of solutes across liquid–liquid interfaces in a stirred cell[1,2] have been extended to a study of the transfer of uranyl nitrate, in both directions, between water and three solvents, dibutyl carbitol, methyl *iso*butylketone (hexone) and tributyl phosphate; the last-named was used as 20 per cent solutions in the inert diluents, 'odourless kerosene', benzene, and carbon tetrachloride. The same apparatus was used as previously described, the two phases, contained in the upper and lower compartments of the transfer cell, being stirred independently. An annular gap between the two compartments enabled the interface to be constrained to a fixed plane of known area. A rigorous study of the hydrodynamics of this transfer cell had already been made[1], so that it was possible to compute the diffusional resistances on each side of the interface for any stirring conditions. The stirring-rates used were sufficiently high for transfer to and from the interface to take place by eddy diffusion, molecular diffusion being negligible.

With the dibutyl carbitol–water and hexone–water systems the observed 'overall' mass-transfer coefficients for transfer in either direction were initially generally either in good agreement with the values calculated assuming the diffusional resistances to be the rate-controlling processes or else somewhat higher. As in the earlier work the higher rates were found to occur in those systems where interfacial turbulence arose[2,3]. These results appear to indicate that initially there is no significant interfacial barrier present. It was found, however, that the rate of transfer fell off markedly during each experiment, eventually reaching values of about a fifth of the initial value. The final slow rate, which in any particular system was substantially independent of concentration, corresponded to an apparent interfacial barrier several times larger than the eddy diffusional resistances. In the case of the dibutyl carbitol–water system experiments were carried out at 50°, as well as 20°; but the final slow rate was independent of temperature. The transfer of uranyl nitrate from water to the tributyl phosphate solutions was also initially controlled by eddy diffusion and the rate fell off as before to a slow final value independent of concentration. With transfer in the reverse direction, however, slow rates corresponding to an interfacial barrier were always obtained.

The reciprocal of the transfer-rate is equivalent to a transfer resistance so that the difference between the reciprocals of the observed and calculated rates gives the value of the additional interfacial resistance. This, of course, is equal to the reciprocal of an interfacial transfer-rate. Typical variations of the resistance with time are shown in Fig. 1.

The transfer of uranyl nitrate between the dibutyl carbitol–water and hexone–water phases has been previously studied by Murdoch and Pratt[4], in a

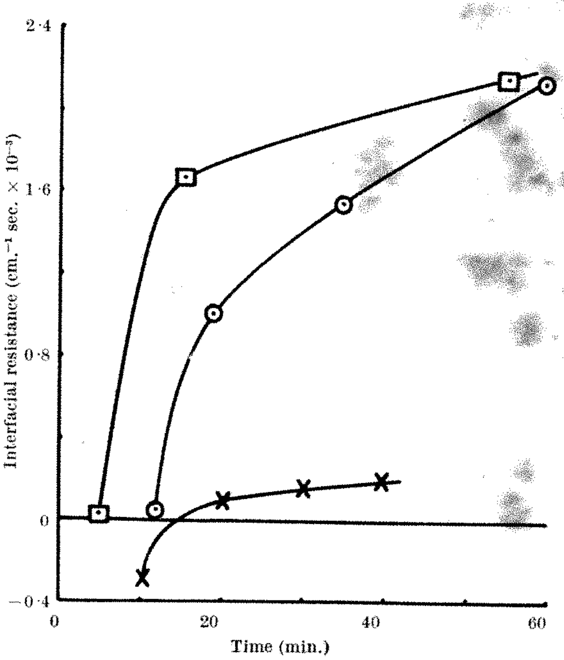

Fig. 1. Increase of interfacial resistance with time: ⊡—⊡—, water → tributyl phosphate/kerosene; ⊙—⊙—, dibutyl carbitol → water; ×—×—, hexone → water (interfacial turbulence)

'wetted wall' column in which the interface was continuously being renewed. An interfacial resistance was shown to be present; but the interfacial transfer coefficients reported were greater than those obtained in this work, for example, about 0·015 cm./sec. as compared with final values of about 0·001 cm./sec. This difference might conceivably be due to the rapid renewal of the interface in the wetted wall column, each element of which is replaced in a few seconds, as compared with the increasing age of the interface in the transfer cell.

A study of the extraction of uranyl nitrate from water into a hydrocarbon solution of tributyl phosphate has recently been carried out by Hahn[5]. Neither phase was stirred, so that transfer to the interface was by molecular diffusion. No interfacial barrier could be detected; but as molecular diffusion is considerably slower than eddy diffusion, a barrier sufficiently large to affect the rate of transfer in stirred systems might be undetectable in Hahn's experiments.

All attempts to provide a theoretical explanation for the fall-off in rate have so far been unsuccessful; however, it has been shown that the effect is real and not due to surface contamination.

I wish to thank Mr. A. S. White for his continued interest in this work and Dr. H. R. C. Pratt for much useful discussion.

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Relation between the Volume of a Liquid and its Internal Energy

IN a recent paper[1], Benninga and Scott have pointed out that an adequate theory of liquids must account for the approximate identity, EV = constant. E is defined as being equal to the difference between the internal energy of the substance in the perfect gas state and in the liquid state at a given temperature, and will be identified with the potential energy between the molecules: V is the molar volume of the liquid. We wish to point out that this relationship can be made a direct consequence of the simplest form of 'hole' theory. Although only the case of spherical molecules of a single species will be considered here, it is intended that a treatment generalized to include the case of mixtures of non-spherical molecules will be published elsewhere in the near future.

Although the molecules in the liquid state do not in general display long-range order, 'short-range' order is known to exist: thus there is a fairly clearly defined distance l between the centres of molecules which are nearest neighbours. The expansion of such a liquid with change of temperature or pressure can be considered from two extreme points of view: either the distance between all the molecules may alter, resulting in a uniform stretching of the whole liquid structure, or the distance l may remain constant and vacant sites may appear in the ring of nearest neighbours surrounding each molecule. The former theory—uniform stretching—leads, on the basis of a Lennard-Jones 6–12 intermolecular potential, to the law[2] EV^2 = constant. In order to investigate the implications of the second theory, two simplifying assumptions will be made: (*a*) that the vacant sites are randomly distributed throughout the body of the liquid; (*b*) that the vacant sites (or 'holes') are equal in size to a molecule.

Let there be h such sites and N molecules, and let e be the interaction energy due to each pair of molecules which are nearest neighbours. Longer-range interactions will be neglected. Then

$E = \frac{1}{2}NZe \times$ (proportion of nearest neighbour sites which are occupied by molecules)

$$= \tfrac{1}{2}NZeN/(N + h)$$
$$= \tfrac{1}{2}NZeV'/V$$

where V' is the molar volume of the hole-free lattice, and V is the molar volume of the liquid.

Thus this method of expansion leads to the required relationship $EV = \frac{1}{2}NZeV'$ = constant.

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Production of Carrier-free Cobalt-58 by Pile Irradiation of Nickel

IN the course of a study of neutron–proton reactions in the Harwell pile, we have irradiated nickel metal both in the ordinary irradiation facilities and in a hollow uranium bar. In this bar the energies of the fast neutrons available approximate to the spectrum of fission-neutron energies.

The yields of cobalt-58 obtained are shown in Table 1; the fast-neutron fluxes were measured by counting phosphorus-32 formed in sulphur monitors irradiated at the same time as the nickel, assuming a cross-section of 0·03 barn, as given by Hughes[1], for the reaction sulphur-32 (n,p) phosphorus-32.

We have separated cobalt-58 from irradiated nickel in a carrier-free state, obtaining about 80 per cent yield. The nickel was dissolved in nitric acid, the solution evaporated to dryness, and the residue taken up in 9 N hydrochloric acid. This solution was added to a column of 'De Acidite FF' anion-exchange resin, when the nickel passed through and the cobalt was adsorbed. When all the nickel had been removed

Table 1

Irradiation	Fission neutron flux (neutrons/cm.^{2}/sec.) ($S(n,p)$ ^{32}P monitors)	Saturation activity (mc./gm. Ni)	Cross-section (Ni-58) (millibarns)	Cross-section (Ni metal) (millibarns)
Hollow slug, 9 days	4·9 × 10^{11}	4·4	47	31·5
Thermal flux, 1·4 × 10^{12} (n/cm.^{2}/sec.), 6·4 days	2·7 × 10^{11}	2·3	45	31
Thermal flux, 1·2 × 10^{12} (n/cm.^{2}/sec.), 6·4 days	2·3 × 10^{11}	1·9	44	30
Thermal flux, 1·0 × 10^{12} (n/cm.^{2}/sec.), 6·4 days	2·0 × 10^{11}	1·7	44	30

with more 9 *N* hydrochloric acid, the cobalt was eluted with water and dilute ammonia[2].

From 5 gm. of spectroscopically pure nickel irradiated for eighteen months a solution of cobalt-58 was obtained with the following characteristics, extrapolated back to the end of irradiation (assuming a half-life for cobalt-58 of 70 days).

Activity = 33·6 millicuries
Volume = 50 ml.
Nickel concentration = $<0·2$ p.p.m. of solution
Cobalt concentration = $<0·4$ p.p.m. of solution
Specific activity = $\geqslant 1,680$ curies/gm. cobalt

The cobalt concentration was below the lower limit of the spectrographic and spectrophotometric methods used for its determination. In this specimen of cobalt-58 there was present 0·06 per cent cobalt-60 at the end of irradiation; as the maximum estimated cobalt in the solution would produce only 0·03 per cent cobalt-60 by (n,γ) reaction, 0·03 per cent at least must be due to the reaction nickel-60 (n,p) cobalt-60. This gives a cross-section for this reaction of between 3 and 7 millibarns.

No other radiochemical impurities have been found in the cobalt-58, either by $\beta +$ absorption in aluminium, rate of decay, or by examination with a γ-scintillation spectrometer.

The cross-section for fission neutrons of 47 m.barns for the reaction nickel-58 (n,p) cobalt-58 is the highest recorded for a reaction of this type, the next highest being that of sulphur-32 (n,p) phosphorus-32 at 30 mb. It is about four times the cross-section calculated from consideration of mass differences and proton penetrability in the way described by Hughes[3].

An absolute determination of the radioactivity of one cobalt-58 solution was obtained by coincidence measurements and by counting positrons in a 4π Geiger counter, the source being covered with 260 μgm./cm.^{2} of aluminium to cut out Auger electrons. A branching ratio of 15 per cent for positrons was assumed, and an accuracy claimed of ± 5 per cent. Other cobalt-58 solutions were referred to this one by comparing peak heights obtained for the 0·81 MeV. γ-ray on a γ-scintillation spectrometer.

We should like to thank Dr. R. A. Allen, of the Physics Group of the Isotope Division, for providing a standard phosphorus-32 solution, and for standardizing a cobalt-58 solution, and Mr. F. Birks for spectrographic analysis of our cobalt-58 solution.

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Ca II Emission Lines in the Twilight Spectrum

Spectra obtained at Saskatoon during the summer of 1955 showed sharp emission lines of wave-lengths 3933·8 A. and 3968·4 A. ± 0·2 A. to be present at times in the twilight. The spectra were obtained with two Schmidt spectrographs of dispersion 20 A./mm. and 10 A./mm. A microphotometer tracing of a twilight plate obtained on July 14 is shown in Fig. 1.

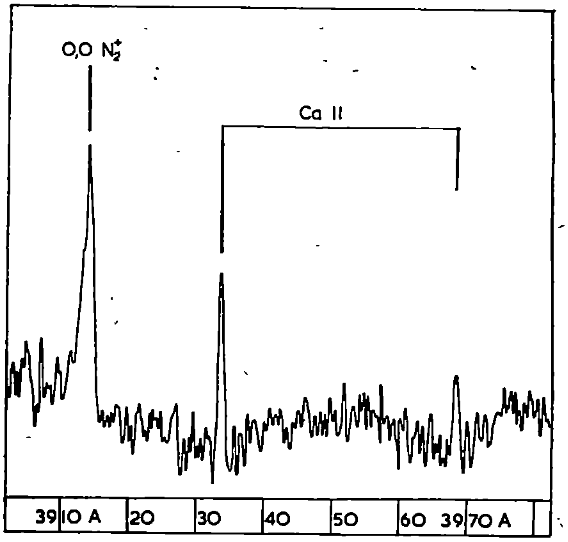

Fig. 1. Microphotometer tracing of twilight spectrum obtained July 14, 1955

The wave-lengths of the *H* and *K* lines of ionized calcium are 3933·7 A. and 3968·5 A. Comparison of the measured wave-lengths with the "M.I.T. Wave-length Tables"[1] showed that no other element besides Ca II could give rise to both emission lines. A measured intensity ratio of 2·1 ± 0·5 is consistent with the identification with Ca II. The theoretical intensity ratio in the absence of self-absorption for a non-selective excitation process is 2. For a resonance excitation process due to sunlight, as is suggested below, the ratio will be reduced slightly since there will be less energy available in the solar continuum at the wave-length of the stronger line than at that of the weaker. The variation in the intensity of the solar continuum is, of course, due to the *H* and *K* Fraunhofer absorption lines.

The twilight spectra were obtained by directing the 'line of sight' of the spectrograph so that it intersected the boundary between the illuminated and dark regions of the atmosphere at a constant height of 100 km. (neglecting atmospheric refraction). Exposures of three hours or more in one night are possible at Saskatoon in midsummer. The altitude and azimuth of the line of sight must, of course, be varied continuously according to a precalculated programme. The zenith angle varied from 30° to 85°.

It was found that the emission was not present with constant intensity. A continuous programme of observation was therefore carried out from early July until December. The results of this series of spectra

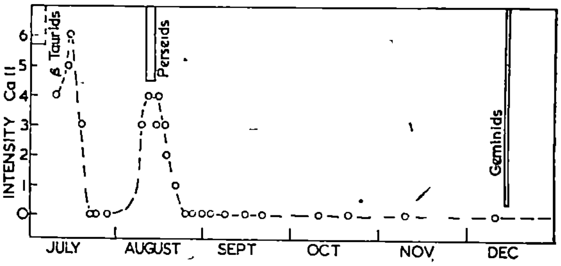

Fig. 2. Eye estimates of the intensity of Ca II lines in the twilight spectrum obtained during months of July–December, 1955. The times of the principal meteor showers occurring during this period are indicated in the upper part of the graph

are shown graphically in Fig. 2. Each point represents a satisfactorily exposed plate. Most of the later plates were exposed for two or more days; the median date is indicated. It will be noticed that the emission lines disappeared by the end of July but reappeared strongly about August 9–10. The intensity then decayed steadily over a period of about ten days; no further reappearance of the line was detected.

While the lines were observable, two exposures were programmed for a height of 80 km. and two for a height of 120 km. No emission was detected for the 80 km. spectra whereas the plates for 120 km. showed the lines with measurable intensity. There is thus some evidence for supposing that the emission may be concentrated in the region 100–120 km.

The question as to whether or not the emission is primarily a twilight phenomenon was investigated by exposing five plates to the morning and evening twilight for one half of the slit and to the night sky (and aurora) for the other half of the slit. Two of these plates obtained over the period August 11–12 showed the Ca II emission lines to be present also in the night sky and aurora; indeed, the emission was stronger in the latter section of the plate. In the case of these two plates it is not possible to be sure whether the emission was really associated with the night sky or aurora. The spectrograph which was directed towards the lower part of the northern sky may have received some residual twilight radiation from higher atmospheric levels or may even have recorded the Ca II lines emitted directly from meteor trails. However, in the three other plates obtained during the period of declining activity in August, the lines were observed only in the twilight and were absent in the night sky and aurora.

The most reasonable interpretation of the above results is that the observed emission is due to a resonant excitation of the calcium ions by sunlight analogous to the well-known twilight spectrum of sodium. The intermittent appearance of the emission would possibly suggest that the calcium was of meteoric origin. In Fig. 2, the dates of the principal meteor showers are indicated[2]. There is a striking correlation between the August reappearance of the calcium emission and the Perseid meteor shower. The earlier appearance of the emission may have been connected with the day-time meteor activity occurring in June and early July. Further observations planned for the coming summer should enable a definite decision to be reached on this point. The failure to observe any twilight emission in December at the time of the Geminid meteor shower is not very significant since no exposures were obtained between December 7 and December 18, whereas the meteor shower has its maximum intensity about December 13–14.

The heights quoted above are derived from calculations of the position of the shadow of the surface of the Earth neglecting the effect of the atmosphere. Two corrections must be made to these results. The first is that due to atmospheric refraction which tends to lower the shadow boundary by 20–30 km. The second correction is that due to the high extinction coefficient of the lower regions of the atmosphere for radiation of wave-length 4000 A.; as a consequence of this effect some higher level of the atmosphere rather than the surface becomes effective in casting the shadow. The latter effect consequently tends to raise the effective shadow height. It is quite likely that in this case these two corrections may cancel one another.

The maximum absolute surface brightness, B, of the stronger line referred to the zenith was estimated provisionally to lie between $0 \cdot 4$ and $2 \cdot 4 \times 10^6$ photons cm.$^{-2}$ sec.$^{-1}$ steradian^{-1}. In terms of the recently proposed new unit, the rayleigh[3], this brightness corresponds to a value of $4\pi B$ between 5 and 30 rayleighs. An extinction coefficient of $0 \cdot 10$ km.$^{-1}$ was taken for the atmosphere at 4000 A., following the results of Baum and Dunkelman[5].

I am indebted to Dr. D. M. Hunten for valuable discussions on the subject of twilight spectra.

The investigation reported here has been sponsored by the Geophysics Research Directorate of the U.S. Air Force Cambridge Research Center, Air Research and Development Command, under Contract *AF* 19(122)-152.

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Sudden Absorption of Atmospherics due to Increase in Cosmic Ray Intensity

An effect of the solar flare and cosmic ray increase of February 23 reported by several observers[1–4] was recorded on the atmospheric noise study apparatus located at the U.S. Air Force Cambridge Research Center site at Fourth Cliff, in Scituate, Mass.

The sudden absorption of energy that occurred is of interest because it was recorded during the night. The night-time absorption appears to be directly related to the cosmic ray increase.

The apparatus consisted of a whip antenna feeding a receiver, set at a frequency of 49 kc./s. The output of the intermediate-frequency amplifier was fed into a probability computer designed and built by the University of Florida. A milliammeter recorded the percentage of time that the electric field intensity exceeded the threshold voltage set on the computer. The level on the accompanying illustration is such that an input of 2 µV. exceeds the threshold voltage 50 per cent of the time when the chart time reads at the middle of the scale. The time constant of the unit was 16 sec.

Fig. 1 illustrates the absorption of signal taking place at approximately the time of observation of the

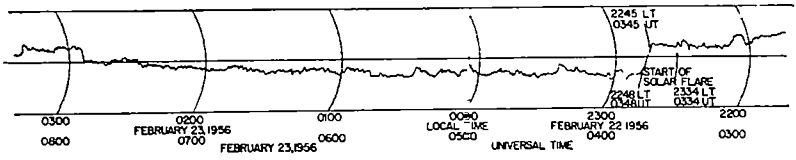

Fig. 1

flare. The exact sequence of time was as follows: The flare was observed in Tokyo at 0334 U.T. February 23. At 0340 U.T. an S.I.D. was reported. The drop in signal-level of the 49 kc./s. atmospherics started at 0344, a few minutes earlier than the beginning of the cosmic ray increase noted at 0348 at Cheltenham, 0350·3 at Chicago, and 0353 at Godhavn, Greenland. At 0343 Pierce and Moritz[4] observed at Cambridge, Mass., an increase in the rate of change of phase of 16 kc./s. signals from Rugby, England.

The time lapse involved between the S.I.D. and the sudden absorption of atmospherics (4 min.) and the fact that the event occurred at 2244 local time seems to indicate that the disturbance observed was produced by the cosmic ray increase rather than being connected with the S.I.D. produced by the ultra-violet. Considering the geometry of the situation it seems unlikely that the decrease in signal-level was due to the increase in absorption of atmospherics in the sunlit portion of the globe, because observations were made around the period of local midnight.

The signal intensity decreased to its daylight value within the period of 5 minutes. It returned to its pre-absorption level at 0830 U.T. or 0330 L.T. At this time the Cheltenham and Godhavn cosmic ray increases were down to about the same level as their pre-flare value, while the Chicago amplitude had declined to approximately 200 per cent of its pre-flare level (it had increased by a factor of eighteen times). The time of onset of the sudden absorption and the rise to pre-flare value of the 49 kc./s. signal-level both indicate a close correlation with the sudden increase in cosmic ray intensity on the dark side of the Earth.

Considering the path taken by the cosmic ray particles and the ionization produced, it might be of interest to consider the role of the steady-state particles in producing the night-time ionosphere.

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Representation of the Inelastic Deformation of Concrete by means of a Mechanical Model

THE non-linearity of the relation between the stress and the strain of concrete at high loads was observed by many of the early workers in the field of reinforced concrete research at the turn of the century. It is, however, doubtful whether the difference between non-linear elasticity and inelastic behaviour was fully recognized at that time. Glanville's experiments[1] established the existence of partially reversible inelastic strains, occurring at the lowest loads, which are for all practical purposes directly proportional to the concrete stress. These inelastic strains, usually referred to as creep, are consequently a viscous phenomenon, and rheological models have been constructed[2-4] to describe the visco-elastic deformation of concrete. Models of this type have satisfactorily explained the deformation of concrete subject to moderate loads over long periods of time; however, they fail to account for the observed relation between stress and strain in concrete tested to destruction at a constant rate of strain. Since 1938 stress–strain diagrams obtained from individual test pieces have been reported from time to time, which show a descending portion terminating at a relatively high ultimate strain. Both phenomena have now been confirmed by a systematic investigation[5].

Freudenthal[6] has suggested that the departure of the concrete stress–strain diagram from visco-elastic behaviour is due to breakdown of the adhesion between the cement and the aggregate. This is confirmed by the observation of minute cracks at about 60 per cent of the ultimate load by Berg[7] using an optical method, and by Jones[8] using an ultrasonic method; the presence of micro-cracks has also been inferred from tensile tests by Blakey and Beresford[9]. These considerations lead to the statistical concept of a concrete specimen made up of a number of elements with strengths distributed over a specific range. Williams and Kloot[10], working on the behaviour of timber specimens in tension, have produced a mathematical theory for a model of this type.

The mechanical model shown in Fig. 1 has been devised to reproduce the various features of the elastic and inelastic deformation of concrete referred to. It consists of two series of viscous dashpots and elastic springs in parallel, the dashpot of one of the units being blocked by non-return valves; and a series of brittle springs in parallel which behave elastically up to failure, the failing loads of these springs being distributed over a range. When this model is deformed by a moderate load, so that the brittle springs are not damaged, it exhibits an immediate elastic deformation proportional to the applied load, and a progressive inelastic deformation at a decreasing rate, the total inelastic deformation over an infinite period being proportional to the applied load. When the model is unloaded the procedure is reversed; but due to the blocking of the second dashpot some of the inelastic deformation is not recovered. When the model is loaded sufficiently rapidly to produce negligible deformation of the dashpots, it deforms elastically until the fracturing load of the weakest brittle spring is reached, and the subsequent inelastic deformation is irreversible. A typical load-deformation diagram of a model under these conditions is shown in Fig. 2, and this is very similar to the experimental stress–strain diagrams for concrete tested rapidly at a constant rate of strain which have been referred to. When the model is deformed sufficiently slowly to allow for appreciable deformation of the dashpots, and the load is carried

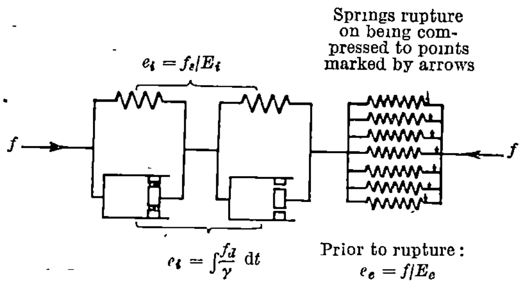
Springs rupture on being compressed to points marked by arrows
$e_i = f_s/E_i$
f
f
$e_i = \int \frac{f_d}{\gamma}\, dt$
Prior to rupture:
$e_e = f/E_e$

Fig. 1. Comprehensive mechanical model for the elastic and inelastic deformation of concrete

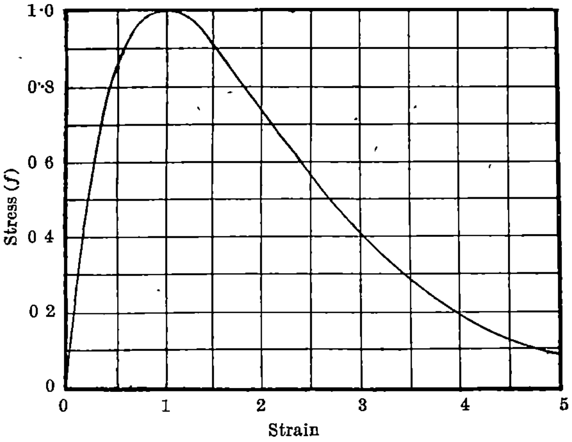

Fig. 2. Load-deformation curve produced by the mechanical model in Fig. 1 when it is deformed sufficiently rapidly to produce negligible viscous deformation (Expressed in terms of the maximum stress and strain)

at the same time above the fracturing load of the weaker brittle springs, then both types of inelastic deformation are reproduced.

Apart from the quantitative determination of the inelastic deformation of concrete, the model may assist the qualitative examination of the long-term behaviour of concrete under load. The recent successful application of the theory of plasticity to structural steel design has focused attention on the development of a similar theory for reinforced concrete structures. The plastic deformation of steel, like the viscous deformation of concrete, does not constitute structural damage although it results in permanent and frequently serious distortion of the structure. The deformation of concrete at high loads due to the formation of micro-cracks, on the other hand, results in structural damage which can be repaired only by chemical action over long periods. It has been established that stress relation due to creep over long periods increases the capacity of redundant structures to carry sustained working loads. Furthermore, the high inelastic strains due to micro-crack formation increase the load-bearing capacity in a continuous test to destruction. It cannot, however, be assumed that inelastic deformation increases the load-bearing capacity of a reinforced concrete structure for all combinations and sequences of loading.

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Creep in Coal at Room Temperature

THE deflexion of a cantilever of a bituminous coal (Barnsley Hards) has been found to increase steadily with time under a constant load well below the rupture value. This movement is taken to be evidence of the phenomenon known as creep.

A typical graph showing the relationship between the deflexion of a cantilever of Barnsley Hards and the duration of loading is shown in Fig. 1. The deflexion d satisfies an equation of the form:

$$d = A + B \log t + Ct$$

where t is the duration of loading. This is similar in form to the equation used by Griggs[1] to represent the deformation of a cube of rock subjected to uniaxial compression.

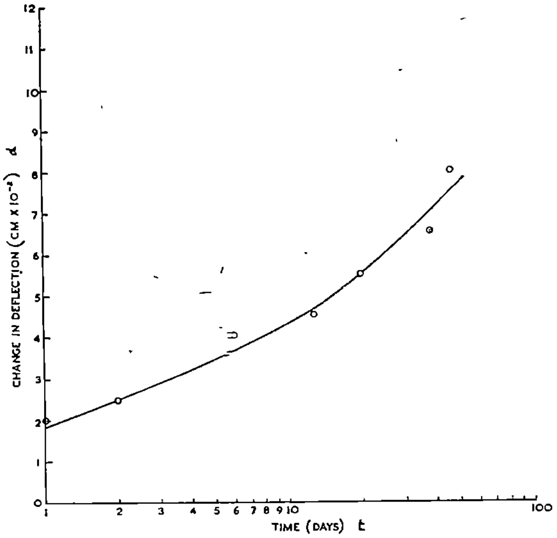

Fig. 1. Change of deflexion with time of a loaded cantilever of Barnsley Hards. Curve gives $d = 1{\cdot}95 + 1{\cdot}82 \log t + 0{\cdot}051\, t$. Specimen dimensions (cm.): width, 1·62; thickness, 0·24; unsupported length of cantilever, 8·5. Applied load, 31·4 gm. $\eta_c = 1{\cdot}81 \times 10^{16}$ poises

In like manner, the recovery of the cantilever when unloaded satisfies the equation:

$$d = A + B_1 \log t$$

used by Griggs for the recovery of cubes. The logarithmic term can be interpreted as a pseudo-elastic or recoverable creep and the linear term Ct as a pseudo-viscous creep. Using this subdivision, the creep viscosity η_c of Barnsley Hards coal at room temperature has been estimated to be of the order of 10^{16}–10^{17} poises, compared with 10^{20}–10^{22} poises obtained by Griggs for limestone. This comparison may not be strictly valid, since Griggs obtained his results from compression tests.

In similar experiments at the same sensitivity of observation, no creep of anthracite was observed.

Although Barnsley Hards and anthracite have closely similar compressive strengths across the bedding planes (about 8,000 lb./in.^{2} for 1-in. cubes), they are easily distinguishable by the manner in which they break. Anthracite breaks into conchoidal fragments which frequently have razor-sharp edges, whereas the Barnsley coal breaks into more regularly shaped pieces with less acute edges. In general, cubes of both coals break explosively when they are compressed between flat platens; but it has been found possible to induce non-explosive breakage in the Barnsley coal provided extremely low rates of straining are used. No matter how slowly the anthracite cubes have been loaded, explosive breakage has always occurred. These differences are probably related to the rheological properties of the coals, and in particular to the presence or absence of creep.

Somewhat analogous to the explosive breakage of cubes are the violent outbursts of coal from the seam which occasionally occur. These outbursts have occurred in many areas, but there is strong evidence that in the United Kingdom they are most prevalent in the anthracite areas. Outbursts have been attributed to many factors, but high in importance among these would seem to be the nature of the coal itself. If the coal can creep, the roof load will be more easily accommodated as the workings advance, so that the stresses in the coal remain below the breaking strength. If the coal cannot creep, there is a greater risk that the breaking strength of the coal will be exceeded, resulting in an explosive outburst. This may offer an explanation of the prevalence of outbursts in anthracite; but it would be unwise to generalize further since other considerations, such as the nature of the floor, the thickness of the seam and the rate of build-up of the overburden stresses all affect the problem.

This communication describes work forming part of the research programme of the Mining Research Establishment of the National Coal Board and is published by permission of Dr. W. Idris Jones, director-general of research. The views expressed are my own and not necessarily those of the Board.

C. D. Pomeroy

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Mining Research Establishment,
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[1] Griggs, D. T., *J. Geol.*, 47. 225 (1939).

Photographic Sensitizers in Gelatin

Thirty years ago, Sheppard[1] isolated allyl *iso*thiocyanate from extracts of photographically active gelatins. It has since been made evident that this sulphur sensitizer is not usually present in gelatins produced by existing methods. Steigmann[2] has demonstrated by chemical tests the presence in lime-treated hide gelatins of thiosulphate and trithionate ions, and has indicated a mode of formation of these sensitizing substances by alkaline degradation of cystine. Wood[3,4] has applied paper chromatography and paper electrophoresis to extracts from gelatins, and has detected thiosulphate and polythionates. He has suggested alternative mechanisms of sensitizer formation, including oxidation of sulphides used for depilatory purposes in gelatin precursor treatment, and also oxidation or autoxidation of sulphur dioxide. The purpose of the present communication is to indicate that a quantitative method has been devised for determining sensitizers in gelatin extracts.

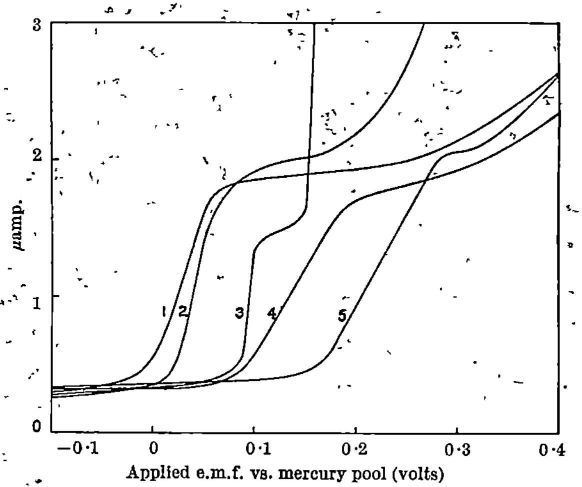

Fig. 1. Anodic polarograms of various sulphur sensitizers in 0·2 *M* potassium nitrate: (1) 0·4 m*M* Thiosulphate. (2) Gelatin extract. (3) 4 m*M* Allyl *iso*thiocyanate. (4) 0·5 m*M* Thiourea. (5) 0·5 m*M* Thiosinamine

The method of extraction was similar to that used by Wood[3], but on a smaller scale; 25 gm. of the gelatin were extracted at 0° C. with a total of about 200 ml. of water, and the extracts were concentrated *in vacuo* to 10 ml. These concentrated extracts have been examined polarographically. Fig. 1 shows the results of anodic polarography in 0·2 *M* potassium nitrate on the extract from a particular gelatin and on some known sensitizers. In making such comparisons, it is essential to compare at roughly the same wave-height, as the substances shown all have a half-wave potential which varies with concentration.

It will be seen that the sensitizer present closely resembles thiosulphate in its behaviour. Cathodically, in 1 *M* ammonium dihydrogen phosphate[5], tetrathionate has been detected in the extract. Apart from their polarographic characteristics, the identification of these constituents is confirmed by the behaviour of the extracts towards anion-exchange resins, and to such reagents as iodine (for the thiosulphate) and sulphite (for the tetrathionate).

This technique is readily applicable to the routine examination of gelatins. In this Laboratory, fifty-two gelatins have been examined in this way, and the conclusions indicated above have been found to be generally valid. Neglecting for the moment the tetrathionate content as of secondary importance[4], the thiosulphate contents of the gelatins tested range from 34 p.p.m. for a very active hide gelatin to 0 for inert gelatins. In general, the thiosulphate contents correlate well with the photographic activities of the gelatins.

This work will be reported in full elsewhere. Thanks are due to the directors of Ilford Limited for permission to publish this communication.

G. Russell

Chemical Research Laboratory,
Ilford Limited,
Brentwood, Essex.

Feb. 13.

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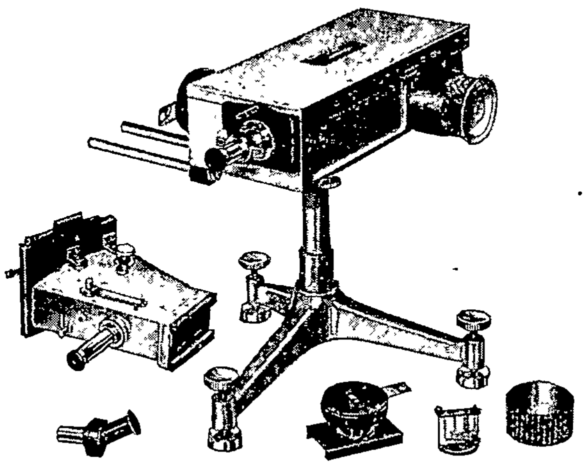

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SCIENTIFIC AND ENGINEERING MAN-POWER IN THE UNITED STATES

AT a Sigma Xi meeting of the American Association for the Advancement of Science in December 1955, Dr. James R. Killian, jun., president of the Massachusetts Institute of Technology, outlined the strategy for augmenting the scientific and engineering man-power resources of the United States (*Amer. Sci.*, April 1956).

The nature of the present dearth of scientists and engineers, he said, is not simply a shortage of men. First and basically, it is a shortage of intellectual talent adequately educated and in the right place. Second, it is more a shortage of specific talents and skills adaptable to specific areas than a general shortage of numbers.

The shortage of high talent is aggravated by the fact that too many young people of exceptional intellectual ability drop out of the educational system before they have achieved an education which fully exploits their abilities. Of the ablest 50 per cent of high-school graduates, only about a third take degrees at college. Too many of the ablest youth of America fail to get the kind of education their abilities deserve. Without dropping standards, only a limited increase in college population can be achieved by stepping up the percentage of high-school graduates who go to college. These conclusions stress the importance of motivating and using more of the exceptional talent and directing attention to its conservation and cultivation.

The American nation would be better served, in Dr. Killian's opinion, by augmenting the total pool of exceptional talent so that all professions benefit, rather than by giving exclusive attention to science and engineering, even though the need for man-power in these fields is at the present time the most urgent. If an attempt is made to build up science and engineering through methods which apparently deprive other professions of talent, it may generate undesirable reactions and side-effects inimical to the welfare of science in the long run. It may also attract into science too many whose talents and predilections are more compatible with other kinds of careers and who would therefore become indifferent scientists and engineers.

Any grand strategy for augmenting scientific man-power must be related to a concerted effort to identify, encourage and more fully educate the top talent among youth.

Considerations of quality show that employers are not looking merely for university degrees; they are looking with a critical eye for very special qualifications—for a sound education in fundamentals, for analytical power, for a grasp of the new and advanced fields of technology. They are looking less for specialized competence at the first-degree level and more for men who have the versatility to follow successfully any one of several specialties.

These special demands indicate a great shortage of young engineers with a mastery of engineering science and thus a competence to handle new, advancing technologies, such as data processing, internal and external aerodynamics, energy conversion, communications, servo-mechanisms, 'molecular engineering' and solid-state physics for the design of materials, and similar functional components of technology.

Thus industry and government are pressing the colleges for engineers of more advanced education and analytical powers. They are looking for men with a fundamental, integrated education in science, engineering and the humanities, rather than for men specialized in some field of technology at the expense of fundamentals.

In the basic sciences the most pressing needs are for those scientists who have the imagination and trained creative power to make the discoveries and generate the new concepts which advance science.

Despite the critical shortage in the rank and file of good competent scientists and engineers, the really acute shortage is now in the 'flag-officer' group.

In the secondary schools the first requirement is to fill in the depleted ranks of science teachers and to do this, not with culls from other fields, but with teachers possessing a grasp of science and the perception to identify and stimulate young people with the bent and capacity for science.

There is the need for earlier identification of scientific talent and for more rigour, more emphasis on excellence in the secondary school. Much of the flight from science at the secondary school-level has resulted from the fear of science as a difficult subject of study.

Blame for this aversion to rigorous thinking rests with parents even more than it does with the schools. "The United States has hitherto displayed an attitude of condescension toward hard intellectual labour in our schools." The survival of the United States requires that the American people attach a higher value to the hard labour of rigorous thought.

The high-school programme should also be flexible, so that an early election of programme does not commit a boy or girl irrevocably to some prematurely selected career or educational programme.

Although the education of the future scientists and engineers has been neglected with effects endangering the nation, the education of other kinds of people is also important. No group of young people should be neglected in order to strengthen another. Secondary schools play a major part in maintaining the fluid, classless society of the United States. Methods for strengthening science teaching and increasing the numbers of scientists will not result in unfortunate distortion of this broader function of the secondary school programme. The highest priorities should be given to better provision for intellectually gifted young people, greater stress on the more rigorous teaching of intellectual skills, and on higher standards of excellence for both teachers and pupils.

At the college-level there are many opportunities available for strengthening scientific and engineering education. The liberal arts colleges are the principal sources of candidates for graduate schools of science. The Wesleyan study and others have shown how remarkable has been the success of a number of small liberal arts colleges in preparing men and women to become distinguished specialists in science.

The needs of the colleges for science teachers is as serious as in the schools, and particularly in those institutions where little research is done; industry and other agencies have drawn the promising young material away by providing opportunities to do research and development and by higher compensation. More grants and fellowships should be given to enable professors of science in liberal arts colleges to have time off from teaching to do research or to have first-hand contacts with creative work in science in the universities or in industrial or government laboratories.

The professional schools of science and engineering have suffered in the competition for top-flight men. The engineering schools are especially vulnerable because their young and imaginative graduates and teachers—especially those in the advancing, growing fields of technology—are more in demand for non-educational employment than any other group in the educational institutions in the United States.

If engineering education is to meet this challenge it must find a way to make engineering schools a more attractive environment for top-flight engineers and thus for top-flight teaching of future engineers.

The teaching loads in engineering schools are very high, with the result that their staffs have too little opportunity for the creative work that leads to further professional development both as teachers and engineers.

The engineering profession or society can no longer be adequately served by a professional engineering education that is predominantly undergraduate. While qualified recipients of the bachelor's degree in engineering frequently go on for graduate study in other fields such as the physical sciences and management, the amount of advanced study in engineering still seems small compared with the advanced study required by the professions of law and medicine. The number of advanced degrees in the United States in engineering, both master's and doctor's, in 1953–54 totalled about 4,800, while the totals of M.D.'s and LL.B.'s were 6,757 and 9,898, respectively.

Many educators are also advocating changes in undergraduate engineering courses, and engineering education seems to show signs of the bold experimentation and innovation that marked it in its early days when it was struggling to throw off the unsympathetic sanctions of classical education. There is a spreading conviction that the engineering curriculum must include a larger content of basic science, less of its traditional compartmentalization, more emphasis on such fundamental functional aspects o engineering as materials, thermodynamics, fluid flow and energy conversion. It bodes well for the future quality of technology that some of the new ideas are originating in the engineering schools. A superb opportunity exists to provide a new type of libera education polarized about science, unified by professional requirements, and relevant to the needs o our technological society. In the American institutes and schools of technology there is a vision of a new kind of university, a modern university built around science and social technology rather than classica studies, but embracing the arts, the social sciences and the humanities as essential and equal partners in its corporate aims and culture.

The goal should not be set as an academic numbers race with the Russians. The Russian educationa system serves the State, the American the individual The Russians are highly specialized in their scientific and engineering education and the United States is developing towards more fundamental generalized education, especially at the undergraduate-level.

One of the great difficulties is the surprising amount of fear of science and of a misreading of what science really is. Some of this adverse reaction arises from anti-intellectualism, from the disdain and distrust toward the learned man and the realm of reason. This drawing away from science is related to an attitude of antagonism and fear with respect to scientists. There is the common attitude that because a man is a scientist, he is disqualified for public and private administrative responsibility even though he may have all the qualifications.

This attitude reflects something wrong in the relationship of the scientist to society and in society's current estimate of the scientist. The scientist and engineer are themselves partly to blame for the manner in which their function in public affairs has been derogated. They have tended too much to professional parochialism.

The humanist, too, has a responsibility for this hurtful condition. There is still too much of the separatist spirit among the lower reaches of the humanists, too much facile criticism of science as materialistic, too much envy of the scientist for his intellectual achievements, too much protesting that only in the liberal arts can the true gospel of man be found.

It is the great humanistic responsibility of colleges and universities to stress the kinship, indeed the unity, of all knowledge, and to ease the vested interests and snobberies which sometimes appear among learned men. Objectivity, for example, is not the exclusive monopoly of science, nor humanism the tight monopoly of the liberal arts.

If science is to continue to prosper it must combat the notions that science and engineering are incompatible with the disciplines of the great humanities, and that they are narrowly materialistic and destructive of human values. Scientists have an obligation to make this true character of science better understood by the balanced and tolerant presentation of science as one of the powerful means by which man can increase his knowledge and understanding, and still remain humble and ennobled before the wonder and the majesty of what he does not understand.

As Dr. Caryl Haskins, president of the Carnegie Institution of Washington, recently remarked, it seems that the United States and Great Britain have problems in common with regard to the training of scientists and engineers and to the supply of the man-power of the right calibre. Dr. Killian's opinions as expressed in his address at the American Association proves this. All men of science and those concerned with scientific man-power problems would do well to read this address with the object of producing not only more, but also better educated, scientists and engineers in the future.

PRINCIPLES OF THE DYNAMO

Electromagnetic Principles of the Dynamo

By Prof. E. B. Moullin. (Oxford Engineering Science Series.) Pp. xi+367. (Oxford: Clarendon Press; London: Oxford University Press, 1955.) 50*s.* net.

It happens not altogether infrequently that a book which has been projected and upon which a substantial amount of work may have been done fails for one reason or another to achieve completion and publication. Most of those who, twenty-three years ago, read in the preface to Prof. E. B. Moullin's book, "Principles of Electromagnetism", that he hoped to publish shortly a book entitled the "Principles of the Direct Current Dynamo", must long ago have assumed that the volume would never now appear. On the contrary, this book, under the slightly altered title of the "Electromagnetic Principles of the Dynamo", has now taken its place in the literature of electrical machines.

Prof. Moullin explains in the preface that the manuscript, almost complete, lay aside from 1933 until 1950 and was then on the point of being discarded. At that time, Mr. G. E. Middleton, who had for many years been engaged on the design of electrical machines, joined the staff of the University of Cambridge, and he was invited to read the manuscript and express an opinion as to whether it would still be worth while to complete the book. Happily, Mr. Middleton recommended the completion of the task, and the author records his appreciation of the invaluable help rendered by him in the completion and revision of the manuscript.

The book conforms closely to the terms of its title and deals almost exclusively with the electromagnetic principles of direct-current machines. After an initial chapter on basic principles come five chapters dealing individually with the estimation of the ampere turns on the poles, the magnetic effects of the armature current, characteristic curves, efficiency and energy losses and commutation. These are followed by two chapters, one of which deals with a group of special machines, and the other, the last chapter, is entitled "Supplementary Matter". This treats in considerable detail certain topics which have been dealt with less fully earlier in the book and with a number of problems which link alternating-current with direct-current machines.

Perhaps the essential quality of this book can best be described by saying that, in it, the author has asked himself and has answered to his own satisfaction most of the searching and often awkward questions which an acute and critical mind would ask when presented with the conventional treatments of the theory of electromagnetic machines. Many of the paradoxes and conundrums which tantalized electrical engineers of an earlier generation receive serious study and elucidation. The induction of the electromotive force in the homopolar machine, the magnetic force on conductors embedded in slots and the e.m.f. in such conductors are examples of these problems. The treatments which are given of such topics as commutation and of the load characteristics of machines are exceptionally thorough and penetrating. There is a particularly interesting analysis of the Rosenberg dynamo, a machine which has nowadays a greatly increased interest as it is, in principle, the prototype of an important class of control machine.

At the end of the book is a collection of examples, eighty in number, taken for the most part from Cambridge examination papers, which illustrate the topics discussed in the text, each example being accompanied by an outline of its solution.

Mathematical analysis is used in varying degree in relation to nearly all the subjects with which the book deals, but no advanced methods are involved. The standard required is well within the competence of a second- or third-year university student. The real interest lies, however, in the critical questioning of the assumptions underlying many accepted pieces of theory and in their justification often by more than one method. This searching examination of the physics of machine problems, with the consequent quantitative assessment of the validity of assumptions, not only illuminates the problems themselves but also illustrates that spirit of inquiry which is an essential characteristic of the scientific mind.

This is a stimulating book which will interest and satisfy the teacher concerned with the subject of electromagnetic machines, and it will do the like for the student whose intellectual curiosity and insight have crossed the 'pons asinorum' of his subject. While it is clearly for the student that this book has been written, it is not too much to say that the experienced designer of electrical machines may find in its pages a new approach to some fundamental matter which may elucidate an intractable practical problem.

J. Greig

OPTICS OF CHARGED PARTICLES

Handbuch der Physik

Herausgegeben von S. Flügge. Band 33: Korpuskularoptik. Pp. vi+702. (Berlin: Springer-Verlag, 1956.) 122.50 D. marks.

The first volumes of the new "Handbuch der Physik" are out and give every promise of its being a worthy successor to the original edition of Geiger and Scheel, which appeared between 1926 and 1930. The intervening quarter of a century has seen some notable advances in international co-operation as well as great progress in physics itself, and both developments are reflected in the new edition. The contributors are drawn from many countries, and the articles may be in English, French or German. The progress of physics is reflected in the complete recasting of the treatment and its extension to fifty-four volumes. The change is exemplified in the subject-matter of Vol. 33, "Korpuskularoptik", one of the first of the new series to appear. Vol. 22 of the old series, the second edition of 1933, included mention of beta-ray and mass spectrometers and of electron diffraction; but there was little on sources of electrons and ions, and nothing on their optics. We now have a volume of more than seven hundred pages dealing with these subjects and with the electron microscope. The concern with instrumentation is new to the "Handbuch". The emphasis previously was very much on the fundamentals of physics; although technical physics in the wider sense was given some space, it has now been excluded in order to keep the number of volumes within reasonable limits.

The individual articles in Vol. 33 vary considerably in length and treatment. The first, on electron and ion sources, by D. Kamke, is perhaps too much a collection of types of ion guns (in eighty-five pages), and, even so, sources for accelerators are left to Vol. 44, where they will be treated in conjunction with injector systems. Electron guns are given only thirty-three pages, and a number of important aspects are comparatively neglected or omitted, such as the work of Haine and Einstein on medium-high-voltage guns and the more recent work of Klemperer on waist formation in electron beams. In general, very few pieces of work later than 1953 are cited. The section on electron and ion optics by W. Glaser, on the other hand, gives a balanced and thorough treatment of its subject. It is essentially an abbreviated version, in 270 pp. instead of 700 pp., of his monumental "Grundlagen der Elektronenoptik". Every topic of any importance is handled with rigour and economy, including deflecting fields and systems with curved axes. A supplementary bibliography includes references well into 1955.

Similarly, S. Leisegang's treatment of the electron microscope is a *zusammenfassende Bericht* in the best German manner. It runs to 150 pages with 137 figures and is almost a "Handbuch" in itself. In addition to the design and performance of the instrument, fundamental problems of image formation are dealt with, such as phase effects and energy losses in the specimen. The bibliography is up to date.

The final two articles, on mass spectrometers by H. Ewald and on beta-ray spectrometers by T. R. Gerholm, have much in common in mode of presentation. Each describes, in sixty-odd pages, the various types of instrument which have been devised for the respective methods of analysis: principles, practical details of construction, and efficiency of operation in terms of gathering aperture and resolving power. The treatment of beta-ray spectrometers is rather more critical, perhaps, in its comparison of different types. It ends with a conversion table, to six figures, from electron momentum (in gauss-cm.) to equivalent energy from just below 1 keV. up to nearly 30 MeV. The bibliography in each article runs into 1955. It is perhaps due to the geographical position of the author (Sweden) that, in addition to being the only one in this volume to write in English, he is also alone in making any appreciable reference to Russian work.

On the other hand, Gerholm's article is by no means the only one in which misprints occur with a greater frequency than is to be expected in a work of this kind, and in the German even more than in the English text. It is perhaps a reflexion of haste in publication, in an endeavour to keep to the announced intention of issuing the whole work within three years. Layout, printing and illustration are up t the standard of the earlier series, but the bindin may not stand up so well to the hard use which th "Handbuch" must expect. One other point need mention: the absence, not only from this volum but also from the list of contributors to others, o many of the leading exponents of the respectiv subjects. Looking back into Vol. 22 of Geiger an Scheel, one finds that most of the articles were b physicists who had been major contributors to thei subject: Bothe, Frisch, Gerlach, Hahn, Meitner Paneth, Ramsauer, Stern. Furthermore, it is no a question of 'hind-sight', as most were already o established international reputation and almost al held a chair at a German university. It is probabl another sign of the growth of physics, in speed an complexity of research as well as in its technica importance, that its leading men are now too bus to write reviews of their subject. In the present volume only one author bears the title of professor and he is now in an industrial laboratory in th United States.

V. E. Cosslett

RESEARCH ON BREWING

European Brewery Convention

Proceedings of the Congress, Baden-Baden, 1955. Pp. xi+358. (Amsterdam: Elsevier Publishing Company; London: Cleaver-Hume Press, Ltd., 1955.) 55s.

THE idea of science infiltrating into brewing still frequently produces a reaction from the layman on the grounds that, first, beer has been brewed for more than six thousand years, so there can be little still to learn; second, the less the scientist has to do with it the better because it used to be better than it is (in fact, it is even hinted that nowadays "beer is made from chemicals"); third (triumphantly), brewing is an art and not a science. The first two points are born of ignorance of the real position, and the truth of the third depends on the sense of the word 'art': in so far as it refers to experience and skill in 'know how' it may be correct. Convincing arguments could be presented to explain why research in brewing is necessary, but perhaps it is adequate here to say that more research is being done in this field than ever before.

In Britain there is the Brewing Industry Research Foundation, financed entirely by the brewing trade, and organizations of a similar, albeit less comprehensive and fundamental, character exist on the Continent of Europe and in North America. In Europe there was formed after the Second World War a Brewery Convention which embraces those countries with organizations competent to be members. Congresses are held biennially at different centres, and scientific and technical papers on brewing and malting are presented. The attendance has risen to several hundreds of brewers and brewing scientists, and so far the temptation has been resisted of splitting the meetings into two sections, one for the brewers and the other for the scientists. Should that happen, one of the chief objects of the founders will have failed.

The present volume contains the papers and discussions presented at the 1955 congress at Baden-Baden. A glance at the papers shows the high standard of most of the three dozen papers, including the reports of the Convention's two standing committees, on barley and analysis. The papers are grouped under headings covering raw materials: that is, barley and malt and hops; carbohydrates, proteins and yeasts (surely wide enough); and 'miscellaneous', covering topics from the influence of alcohols and esters on beer foam to the survival of pathogenic bacteria in beer.

Some of the papers on hops show the recent progress in hop resin chemistry, which has been quite significant. The eventual practical result will be the more economical use of hops by the brewer. Investigations on barley and malt range from dormancy to cytolytic activity during malting. An important activity of the barley committee is the arrangement of simultaneous trials in many countries on new varieties of brewing barley. A topic touched upon, and which may well attract more future attention, is that of the barley gums and polysaccharides other than starch of barley and malt.

Two other fields of perennial interest have papers devoted to them in this volume—yeasts and barley proteins. The mechanism of yeast flocculation in fermentation is still imperfectly understood, and the proteins in beer must always rank high in research because they are associated with the curse of haze and the blessing of 'head'.

The Convention has in preparation a six-language dictionary of brewing and malting terms.

H. J. BUNKER

A DICTIONARY FOR THE NEW WORLD

Webster's New World Dictionary

Pp. xiv+1702. (London: Macmillan and Co., Ltd., 1956.) 70*s*. net.

THIS "New World Dictionary" contains more than 142,000 vocabulary entries. It is an up-to-date record of words and phrases, giving full etymologies and a discriminative choice of synonyms. The entire work comprises a single alphabetical listing of words and their meanings, abbreviations, and personal, place and Christian names, etc. This has the distinct advantage of rendering it almost impossible to miss an insertion if it is there at all.

Both British and American forms of spelling are given, either in their alphabetical sequence or with cross-references. For example, there are about forty main entries with the prefix "sulf-", and one entry "sulph-", followed by a cross-reference to the others.

The insertion of the names of distinguished men and women in a general dictionary of this sort is open to question. For example, Sir Alexander Fleming is described as "one of the discoverers of penicillin"; there is no indication who the others were, and Sir Howard Florey is not included. Lord Rutherford is described as a "British physicist, born in New Zealand; received the Nobel prize in chemistry, 1908"—not a very informative description of the great atomic physicist for a general reader. James Watt is described as a "Scottish inventor", but what he invented or discovered is not given. Yet, in other cases the compilers show considerable ingenuity in their brief descriptions; for example, Charles Darwin is described as the "English naturalist, originated theory of evolution by natural selection".

It is difficult to conceive of the qualifications needed by any living or dead person to justify his inclusion in such a compilation as this. Browsing at random, one comes across the names of Bohr, the two Braggs (William and Lawrence), Conant, Julian Huxley and Urey. Appleton appears not under his own name but under "Appleton layer". Conversely, thinking at random, one looks for Bronk, Chadwick, Dale, Hale, Meitner and Spencer Jones; but these are not there. Again, among the abbreviations, UNESCO is explained, but not WHO. There are only three insertions under the abbreviated form of "Fellows" of learned societies, namely, F.R.S. (Fellow of the Royal Society—though the Society itself is not inserted), F.R.S.L. (Fellow of the Royal Society of Literature) and F.R.S.S. (Fellow of the Royal Statistical Society). In order to avoid the sins of omission and commission in a compendium such as this, it might have been wiser to omit proper names, abbreviations and very technical terms and to stick to general words and their meanings; for the resulting tendency is to become a not very comprehensive encyclopædia which might give only enough information to enable the reader to satisfy the question-master in a parlour or quiz game.

Again, where certain common names have connotations different in the New World from the Old, then the definitions should be more explicit. For example, "cowslip" is described as "1, the marsh marigold, a swamp plant with yellow flowers. 2, a wild plant of the primrose family with yellow flowers; English primrose". This description would have been more informative and less misleading if it had ended at the semicolon, and if '(Amer.)' had been inserted at the end of 1, and '(Brit.)' at the end of 2. "Bluebell" is described as "any of the various plants with blue-bell-shaped flowers, as the wild hyacinth, harebell, etc.". This vague approach will cause many local arguments. The "snowdrop", besides receiving the correct British identity, is also defined as the "common anemone"; whereas "hazel" is described as a group of trees or shrubs of the birch family. British botanists will lift their eyebrows at these loose and, in some cases, erroneous definitions. The term "Alsatian" from the canine point of view is described only as "a variety of police dog"; but this breed did not originate from Alsace, though the reason for the name is well known. Cross-reference to "German shepherd dog" should have been given. Among the examples of "black-birds" is "the common English thrush"; the "robin" is described as "1, a large North American thrush with a dull-red breast and belly. 2, a small European thrush with a yellowish-red breast". Generally speaking, this may be accepted by the ornithologist; but it is just terse enough to confuse a layman.

The examples given indicate the difficulties of compiling a dictionary which will satisfy both the British and the American English-speaking peoples. Perhaps the compilers have aimed at too many insertions at the expense of clarity and sometimes even accuracy. Indeed, it seems that the time has come when we must admit that British and Americans, though speaking the same language basically, have rather different vocabularies. This New World Dictionary will certainly satisfy the general inhabitants of the New World, for it is biased in that direction. Nevertheless, many of the technical terms which are common to both worlds are quite cleverly defined and are certainly up to date; so it might well be worth considering an Old World version of this New World Dictionary.

Handbuch der Physik

Herausgegeben von S. Flügge. Band 2: Mathematische Methoden, 2. Pp. vii+520. (Berlin: Springer-Verlag, 1955.) 88 D. marks.

This is a valuable compendium of methods of mathematical physics which, while in no way threatening the pre-eminence of "Courant–Hilbert" and "Jeffreys and Jeffreys", makes its own selection of material and thus contains some valuable techniques which are absent from those standard works. It is stronger, particularly, on algebraical and geometrical methods. A fairly substantial account of the theory of groups (including group representation), rings, fields, ideals and linear algebras, with indications of fields of their application, is given first. It is followed by an account of analytical geometry, differential geometry and field theory, Riemann geometry, tensors, spinors, and canonical transformations. Next follows the longest section—functional analysis, by Prof. I. N. Sneddon; this section is in English, whereas the rest of the book is in German. He begins with a synopsis of Banach space theory and then goes on to a rather full account of integral transforms, including the Laplace, Fourier, Mellin and Hankel transforms, and various finite transforms such as the Legendre transform and other transforms arising from equations of Sturm–Liouville type. This section concludes with an account of operators in Hilbert space and Schwartz's theory of distributions.

The following, and second longest, section of the book is a fairly full account of numerical and graphical methods, which though on conventional lines contains many useful tips about practical procedure. Half this section is devoted to initial-value, boundary-value and eigen-value problems for ordinary and partial differential equations and to integral equations and functional equations. The book concludes with a rather brief account of modern computing machines of both the analogue and digital types. There are subject indexes, both in English and in German.

Like "Courant–Hilbert", the book will perform its most useful service by introducing to applied mathematicians a number of techniques which they are apt sometimes to regard (erroneously) as proper only to investigations in pure mathematics. A copy could usefully be purchased for any mathematics or physics library.

M. J. Lighthill

Thermodynamics and Statistical Mechanics

By Arnold Sommerfeld. (Lectures on Theoretical Physics, Vol. 5.) Translated by J. Kestin. Edited by F. Bopp and J. Meixner. Pp. xviii+401. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1956.) 7 dollars.

Sommerfeld died before completing this present volume of his theories on theoretical physics, but he had done a good deal of the work and the plan of the rest was clear enough for Profs. Bopp and Meixner to complete it, following as closely as possible the author's intention.

The book, which is now available in translation, shows no sign of these difficulties, and the treatment has preserved throughout Sommerfeld's characteristic clarity of approach and his emphasis on physical principles. He follows Boltzmann rather than Gibbs, even to the point of having to resort to the Darwin–Fowler contour integration method in the derivation of Fermi–Dirac and Bose–Einstein statistics in order to cope with the combinatorial difficulties. To the reviewer, who was introduced in Sommerfeld's lectures to the beauty and simplicity of the method of the grand canonical ensemble, this is a source for regret. It is clear from the author's preface as well as from the note by the editors that Sommerfeld himself was not satisfied with this section and might have intended to change it if he had had the opportunity to do so.

The treatment starts with thermodynamics as a logically independent subject and only later reaches statistical mechanics by way of the elementary kinetic theory of gases, an order which is not only the historical but also the simplest one logically if perhaps not deductively.

Chapter 4, which deals with the general principles of statistical mechanics, is perhaps the least satisfactory for the reasons already stated.

Chapter 5 gives an outline of an exact kinetic theory of gases and covers, in particular, transport phenomena and deviations from statistical equilibrium. This chapter, which is almost entirely due to the editors following what seemed to be Sommerfeld's intentions, is a useful addition in bringing out a very practical approach to many problems not usually covered in such books.

The book is a welcome addition to the text-books on this subject. Like the others in the series, it displays Sommerfeld's attitude of putting practical problems and their solution above abstract principles, an attitude by its nature closer to Boltzmann than to that of Gibbs.

R. E. Peierls

The Chemical Constitution of Natural Fats

By Prof. T. P. Hilditch. Third edition, revised and enlarged. Pp. xix+664. (London: Chapman and Hall, Ltd., 1956.) 95s. net.

Since the second edition of this book in 1947, there has been a broadening of interest in the natural fats, which, through their number and variety, provide almost endless opportunity for systematic study. This has occurred, first, because shortages due to war and later economic factors have stimulated research for alternative fats for food and other purposes; at the same time, the development of new and more delicate methods has brought rewarding results in a field in which their introduction had become essential if further important advances in knowledge were to be made. Prof. T. P. Hilditch has thus been faced with an arduous task in incorporating the mass of new material available in the third edition of this book, and he has overcome the difficulties with much success.

The new edition naturally contains extensive additional data on the fatty-acid composition of many fats. More important, however, are the three rewritten chapters which discuss recent material advance in knowledge concerning the component glycerides, the nature of which plays a part in determining the industrial uses to which fats are put. Two other largely rewritten chapters also call for comment. The first is that which is concerned with the chemical constitution and synthesis of fatty acids, particularly of the naturally occurring unsaturated acids, and of some acids which occur rarely and in small amount. Many uncertainties are now cleared up, and some of the findings may prove of considerable importance in the biochemical understanding of fats. The second is important because in it are presented the methods of research on fats, with particular emphasis on such newer approaches as low-temperature crystallization from solvents and spectrophotometry, which are yielding valuable results.

This book, which includes findings published as recently as the end of 1954, thus remains a comprehensive reference book of great value in the field of natural fats and reflects throughout the experienced judgment of its author, who has carried out so much pioneering work on this subject for so many years.

Comprehensive Inorganic Chemistry

Vol. 4. Edited by Prof. M. Cannon Sneed and Prof. Robert C. Brasted. Zinc, Cadmium, and Mercury; by Howard M. Cyr and the Editors. Scandium, Yttrium, and the Lanthanide Series; by Thomas D. O'Brien and the Editors. Pp. xii+193. (Princeton, N.J.: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd., 1955.) 37*s.* 6*d.* net.

In judging a book like this, one naturally takes a few test samples, preferably on familiar topics; so I started by looking up the separation of the rare earths. I found that solvent extraction was dismissed as being no better than fractional crystallization; the authors have evidently overlooked the not inconsiderable literature on the use of tributyl phosphate. Ion exchange was somewhat better assessed; but the account was marred by a quite inadequate description of ion exchangers in general, going right back to peat, greensand and clay, which no sensible person would attempt to use for the separation of the rare earths. Moreover, the facts about the ion exchange methods actually used for the rare earths seemed scrappily chosen. A minor point was the use, without explanation, of the name "Manhattan Project". Does everyone nowadays know the name?

Next I tried looking up the calomel electrode, on which I found two sentences, giving its potential and its reproducibility, but no word at all of what it is or how it works. There were indeed similar inadequacies at every sampling point, although some attempt seems to have been made to repair the deficiencies of earlier volumes by means of a liberal sprinkling of thermodynamic and crystallographic data.

The root of the trouble probably lies in the basic conception of the series, with its uneasy combination of encyclopædic treatment with efforts to inculcate basic principles. The two can be integrated, as Sidgwick has shown. But inorganic chemistry is now so vast and complex that we shall probably be better served in future by books falling definitely into one category or the other.

H. A. C. McKay

Physical Properties of Chemical Compounds

Compiled by R. R. Dreisbach. Edited by the Staff of *Industrial and Engineering Chemistry*. Pp. iv+536. (Washington, D.C.: American Chemical Society, 1955.) n.p.

This book tabulates, for 504 cyclic organic compounds, properties such as boiling point, density, viscosity, latent heat and a number of derived values (for example, constants for the Antoine equation). Some properties have been checked or derived by the use of well-known equations or of others devised by the compiler.

The compounds may be put into two classes; the first comprises hydrocarbons (328) and sulphur compounds (51). For these, the primary data are drawn from the work of the American Petroleum Institute Research Projects. It is known that properties have been determined by these for a large number of highly purified compounds; but, to the outsider, it would appear that, for some items recorded by Project 44, for example, tritriacontyl*cyclo*pentane, values have been derived by mathematical relationships such as were devised by Smittenberg for density and refractive index in some homologous series of hydrocarbons. If this is so, it is perhaps questionable how far one is justified in applying further equations to values so obtained.

The other class is a miscellaneous group: phenols (52), halogenated benzenes (27), amines, etc., for which the basic data have been taken from the general literature or have been specially determined in the Dow laboratories.

Among minor comments, the title of phenol 25 has been mistyped, the tertiary amyl group is consistently formulated as $—CH_2{\cdot}C(CH_3)_3$, and the calculated surface tension of *n*-tetratriacontylbenzene is quite out of step with that of its several neighbours. There is, however, one serious blemish; phenols 37 and 51 are the same compound recorded under different names and, except for molecular weight and PV/RT, every figure differs, that of the boiling point by 11°. The seriousness lies in the fact that the data for forty-six other phenols have been taken from the same source as those for 37, so that, short of drawing invidious distinctions, at least a shadow of doubt falls on about a hundred items.

B. A. Ellis

Minerals in World Industry

By Prof. Walter H. Voskuil. Pp. vii+324. (London: McGraw-Hill Publishing Company, Ltd., 1955.) 43*s.*

This is an authoritative study of the part played by commercially important deposits of mineral substances in peace-time economy, and also in international politics. It has taken two World Wars to bring home to both politicians and the public the prime importance to great nations that lies in the possession or control of deposits of what have often been termed 'strategic' minerals; and, conversely, the consequences that can ensue, particularly under conditions of modern warfare, when such supplies are cut off. There are, too, other aspects of the question. It should, for example, be a matter of much greater concern than it seems to be in Britain that, having extensive coal reserves, the nation seemingly prefers to import coal from abroad rather than make full use of them. Certain aspects of mineral economy have indeed received much publicity lately in Britain, notably the search for sources of the minerals used in the development of atomic energy, and the question of political control in the major oilfields.

Apart from coal, oil and the ores of such well-known metals as iron, copper and aluminium, there are many other minerals, metallic and non-metallic, which are essential for the highly developed chemical, engineering and metallurgical industries, and also for agriculture and food production. There are, too, a number of little-known metals, such as titanium, zirconium, germanium and rhenium, which already play an important part in industry, or are likely to do so in the near future. The author discusses the mineral resources of the world, both geographically and statistically, and the economic, social and political consequences that arise from their uneven distribution.

This is a thoughtful book, which should appeal to all whose interests extend beyond the borders of pure science.

V. A. Eyles

WILLIAM BUCKLAND (1784–1856)

By J. M. EDMONDS

Department of Geology and Mineralogy, University of Oxford

AUGUST 14 of this year marks the centenary of the death of Prof. William Buckland, D.D., F.R.S., sometime reader in mineralogy and in geology in the University of Oxford and also Dean of Westminster Abbey. As the sponsor of the 'glacial theory' in Britain, he opened up a completely new field to physiographical investigation; he was among the first to recognize the comparatively late geological date of the great upward movement of the Alps; he described the fossil reptile, *Megalosaurus*, from Stonesfield, Oxon, and he illuminated a large variety of geological and palæontological problems by his researches.

It was after taking his B.A. degree at Oxford in 1804 that Buckland began to attend the lectures of Prof. John Kidd on mineralogy and chemistry, and those of Sir Christopher Pegge on anatomy, while, during the vacations, he searched out the field-evidence which was then being gradually brought together in order to establish the geological succession of strata, scarcely known at that time even in outline. In 1813, Buckland followed Kidd as reader in mineralogy in Oxford, and the success of his courses was such that, on the intervention of the Prince Regent, a readership in geology was endowed in 1818, and to this Buckland was also elected.

When Buckland delivered his inaugural lecture, "Vindiciæ Geologicæ", in 1819[1], the chief challenge to him as a theologian was to reconcile the evidence revealed by the young science with the accepted teachings of the Scriptures. He set out the facts as he saw them, which supported his belief in the 'Mosaic records', but introduced the hypothesis that there was an undefined period of time before the last great change that affected the surface of the Earth and before the creation of its present animal and vegetable inhabitants, a period during which a long series of operations and revolutions were going on "wholly unconnected with the history of the human race". Four years later, he adopted the same point of view in his first major work, "Reliquiæ Diluvianæ"[2], which was essentially a record of his own exploration and excavation of caves with a description of the animal remains found in them. To this was added an account of the 'diluvial' deposits (surface gravels, sands and loams). These he linked in date to the cave deposits by means of the fossil content of elephant, rhinoceros, hippopotamus, bear, tiger and hyæna, which are no longer present in Britain but which were shown by him to have inhabited the country with more familiar animals in 'antediluvian' times.

There is no continuous record of the modifications which came to Buckland in his interpretation of this problem, which so limited the horizon of contemporary thought. There seems to have been no fundamental change in his views in regard to the origin of the surface deposits by 1836 when he published "Geology and Mineralogy considered with Reference to Natural Theology"[3], although he now ascribed them to causes distinct from "the comparatively tranquil inundation described in the Inspired Narrative".

The accounts of grooving and scratching of surfaces of solid rock by the movement of boulders (believed to have been carried along by water) had long been known to Buckland, and he had himself observed that these markings showed some alignment in particular localities. In 1838, he was shown polished, striated and furrowed surfaces and transported granite boulders by Louis Agassiz in Switzerland, where they were attributed by the latter to the agency of ancient glaciers. When he had confirmed the explanation by means of an independent examination of existing glaciers in the Alps, Buckland began to relate it to similar phenomena in Scotland and northern England. At the Glasgow meeting of the British Association in 1840, Agassiz described the action of glaciers and the deposits associated with them, and then he accompanied Buckland to examine the evidence for former glaciation in Scotland. Soon they returned to London to present their findings to the Geological Society, of which Buckland was then president. Their exposition, together with a paper by Lyell (whom Buckland converted after the Glasgow meeting), was the introduction of a new theory regarding the origin of much of the surface deposits covering Britain, and Buckland went so far as to assert[4]: "The subject appears to me the most important that has been put forth since the propounding of the Huttonian Theory: and the surface of the whole Globe must be examined afresh with the view of ascertaining how far the effect of Glaciers and Ice-bergs and of Floods produced by melting ice and snow can be found and identified with the actual effects of ice and snow in our present polar and Alpine regions".

It is probable that Buckland's most important contribution to geology was his ability to present palæontology and the past history of the Earth in such vivid terms. In the "Bridgewater Treatise" and in his lectures, fossils were no longer treated as markings on stones or even as the dead remains of unknown animals; they became the key to the understanding of the sequence of past inhabitants of the Earth. An impression of a footprint on a slab of rock could disclose the size, attitude and even the shape of an animal; a tooth show how a creature lived; coprolites reveal the shape of the intestines and the undigested fragments of the food.

At first in Oxford and later among wider audiences, his lectures aroused remarkable enthusiasm:

> "In Ashmole's ample dome, with look sedate,
> 'Midst heads of mammoths, heads of Houses sate;
> And tutors, close with undergraduates jammed,
> Released from cramming, waiting to be crammed."

The registers show that in 1819, immediately after his inaugural lecture, the Vice-Chancellor and the Junior Proctor paid the statutory fee for the course on the elements of geology. Among the young men were Charles Lyell and John Henry Newman (later Cardinal). In 1823, Buckland wrote to a correspondent: "I have this day been occupied in lecturing to an overflowing class amongst whom I reckon the Bishop of Oxford & 4 other Heads of

Colleges, and 3 Canons of Chch [Christ Church] on the newly discovered Caves. . . .".

In 1845, Buckland was appointed Dean of Westminster, and although he still travelled to Oxford to give his lectures, the popularity of the subject had declined in the University and the numbers attending his courses had fallen to an average of ten persons. The efforts of the scientific professors had for some time been bent towards the inclusion of the natural sciences among the subjects in which undergraduates might be examined for a degree, and Buckland had earlier been prominent in support. The recognition was won in 1850, but in its final stages it came without Buckland's backing, for in 1847 he refused to add his signature to a memorial, prepared by some of his scientific colleagues, asking for a building to house the natural science teaching collections and to contain lecture rooms for the professors. His reasons for his refusal to sign were rather an expression of despair than of lack of regard: "Some years ago I was sanguine, as you are now, as to the possibility of Natural History making some progress in Oxford, but I have long come to the conclusion that it is utterly hopeless".

Whatever were his disappointments in his own University, Buckland attained a high position in the scientific world outside. The Royal Society, the British Association, the Geological Society all provided him with a forum, and he was prominent in support of agricultural, civil engineering and archæological societies. He lectured, entertained and travelled widely, and his friendship with Sir Robert Peel gave him access to a wide and influential circle. With Prof. Adam Sedgwick and Charles Lyell, he prepared the report which resulted in the formation of the Geological Survey of Great Britain, and he later helped towards the establishment of the School of Mines and the Mining Records Office.

As Dean of Westminster, Buckland found his abilities diverted into an entirely different channel of service in the maintenance of the functions and the fabric of a great religious house. He made many improvements in the precincts of both Abbey and School just before the cholera epidemic of 1849, and on the day of thanksgiving for its ending he preached a sermon which was a remarkable plea for sanitary reform in London. He contrasted the cholera-ridden city with the towns of Nottingham and Newcastle upon Tyne, to which water had just been brought; and with Birmingham, "standing on a salubrious rock of clean and filtering porous sandstone". He included a demand for "one grand comprehensive system for a general supply of fresh water near to every house", and "a simultaneous removal of all impurities at the moment of their production, by means of a combined and systematic arrangement of sewage".

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[1] "Vindiciæ Geologicæ; or the Connexion of Geology with Religion Explained" (Oxford, 1820).

[2] "Reliquiæ Diluvianæ; or, Observations on the Organic Remains contained in Caves, Fissures, and Diluvial Gravel, and on other Geological Phenomena, attesting the action of an Universal Deluge" (London, 1823).

[3] No. 6 of the Bridgewater Treatises: "On the power, wisdom and goodness of God, as manifested in the Creation".

[4] Manuscript notes quoted by W. J Sollas in his inaugural lecture, "The Influence of Oxford on the History of Geology" (Oxford, 1897).

THE BIOLOGY OF OLD AGE*

By Dr. ALEX COMFORT

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CONTROL over the rate of human ageing and the transmutation of elements are long-standing and closely associated human ambitions. They have at various times been considered by scientists as a leisure occupation, pursued by magicians and charlatans, or regarded as fundamentally impossible. The second has now been achieved by physicists, though in circumstances far from its traditional context; the first may well be the next major problem to be attacked by medical biology.

Much of the work necessary to increase our knowledge and control of age processes is descriptive and clinical, but the whole problem poses many extremely important questions in general biology, and involves the collection of data in very diverse fields, both descriptive and experimental. A detailed bibliography of the work summarized in this article has been published[1].

The general theories devised in the past were commonly based on the assumption that senescence must involve a single 'fundamental' cellular or chemical process common to all multicellular organisms, and contrasting with the unfortunately named 'potential immortality' of protozoa. None of these assumptions can now remain unquestioned—it seems very probable that there are many multicellular animals which are capable of indefinite cell replacement without loss of vitality, while in some unicellular organisms such as suctorians, where mother and daughter cells are clearly identifiable at fission, the age status of the fission products is not identical, and individuals have a fixed life-span which can be modified experimentally[2]. It is probably wise to assume that, in those animals where vigour does decline with age, the responsible processes are multiple, and to treat senescence as the sum of all those factors—from mechanical wear of teeth or chitin to more complex endogenous changes—which progressively impair homœostasis. A general definition of this kind, as well as being convenient, is theoretically justified by the place which senescence seems to occupy in evolution[3,4]. In a population subject to the high mortality which is common to many animals in the wild, the evolutionary relevance of individuals, and hence the selection-pressure towards vigour and homœostasis, probably decline very rapidly with increasing age: the common feature of all ageing processes in animals may be that they represent a 'running out of programme', and an escape from the selection pressures which maintain fitness at the ages when contribution to the next generation is greatest. One manifestation of this may be the failure to eliminate late-acting lethal genes, for where individuals very rarely reach even mid-adult life unless protected, the postponement of an adverse effect is as effective an adaptation as its removal. If this is so, we might expect the processes which limit the lives of different animals to be diverse. At the same time, in view of the general similarity of animal cells throughout phylogeny, the likelihood that some deteriorative processes at the cellular level are shared by all animals whose powers of regeneration are incomplete is sufficient to justify wide comparative study.

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* Substance of a Friday Evening Discourse delivered at the Royal Institution, London, on June 1.

Animal Life Tables

By far the best measure of senescence in a population of organisms is their liability to die at different ages. If we had a full account of the relation between growth, age and mortality in a sufficient range of representative animals, the truth of many existing general theories of senescence could probably be tested by inspection. Those actuarial studies which we have suggest an inverse relationship in phylogeny between degree of cell-replacement and liability to senile change. Thus death from old age in rotifers and nematodes, where the cell number is fixed, is sudden and unanimous, with obvious cellular change, whereas in sea anemones the cell turnover is probably continual, and they appear to remain indefinitely vigorous.

It is particularly important now to obtain accurate actuarial figures for the main types of vertebrates. Although typical senescence, with a sequence of changes similar to that in man, almost certainly occurs in all mammals and birds, the longevity of birds is strikingly greater than that of mammals of comparable size and activity (29 years in a chaffinch, compared with 3–4 in a mouse), and there are large differences between closely related species. It is also by no means certain that all poikilothermal vertebrates do in fact undergo any marked change in mortality with age, beyond that resulting from the accumulation of evident injuries. It has been suggested that the particular type of ageing found in mammals is in some way connected either with homoiothermy, or with the evolution of a fixed specific size. Bidder[5], from work on the continued growth of plaice at high ages, put forward the theory that senescence in its mammalian form is the direct result of growth-inhibitory mechanisms evolved during the transition to life on land to limit adult size, and that it does not occur in fish or reptiles which grow continuously, or remain capable of doing so.

In view of hypotheses like these, one of the main preoccupations of comparative research on ageing is the collection of animal, and particularly vertebrate, life tables, based on animals living under conditions of captivity sufficiently good for a fair proportion of them to reach old age. So far as can be ascertained, no life table based on a captive population has ever been published for any fish, reptile or amphibian. The longevity of many small species (14 years in frogs and 25–30 in newts) makes it almost impossible to seek experimental data directly. One incomplete life table exists for domestic poultry[6], and this is constructed on an assumed equation. Apart from these, we have satisfactory actuarial data only for man, laboratory rats and mice, and a few other rodents (*Microtus*[7,8], *Mastomys*[9]), with partial figures for a few agriculturally important animals (for example, merino ewes[10]). No general view of mammalian age processes can yet be obtained, and in view of the time necessary to follow experimental populations, the deficiency can be remedied only by the unearthing of already existing data. The possible value of such information in comparing the life-spans of similar animals, in correlating patterns of growth and of age-mortality, and in the criticisms of general theories of ageing is still not sufficiently widely appreciated. Actuarial figures for all the main breeds of dog, for example, would be of great interest. Workers who normally keep large animal populations, or who have suitable records, could help greatly in this work by bearing these needs in mind. The same applies to accurate data on maximum life-spans: the quality of the information available was greatly improved by the work of Flower, but many, if not most, of the commonly quoted figures are still based on legend.

Studies on specially kept populations of small aquarium fish have demonstrated a pattern of senescence which, in the guppy (*Lebistes*), is very similar in its time-scale to that of laboratory rats (median $\simeq$ 500 days, limit $\simeq$ 1,200 days), and which occurs at a rather similar rate in both sexes, although the adult size of the males is fixed by growth cessation early in life, while the females may continue to grow at any age. This fish is particularly suitable for experimental work on poikilothermal growth and ageing, since it readily survives handling, and its growth can be precisely controlled by altering its food intake and living space. We are taking advantage of these properties in a number of experiments to study the effect of age and of various growth regimes on the force of mortality in a poikilotherm.

Cytology

There are a number of cytological problems, quite apart from descriptive pathology of senile changes, which should be susceptible to investigation. One of these, in view of the correlation which appears to exist between senescence and cessation of cell division, is the sequence of changes which limits the life of non-dividing cells. Some of these changes, like those in rotifers, occur visibly and should be accessible to microchemical and enzyme studies.

It is probably true that the life-span of all fixed postmitotic cells is limited in terms of molecule turnover. Spoilage of enzyme systems in such cells probably accounts for the senescence of animals the cell number of which, as in rotifers, is strictly determinate. A similar process in cells such as neurones might play a part in the senescence of vertebrates; but very little is known of the life-span and replaceability of any tissue cells *in situ*, and it is quite possible that in higher animals which senesce there is a change in the quality and responses of successive cell generations.

The question whether changes due to faulty copying are inherent in clones, and if so whether metazoan bodies are analogous to other clones in this respect, was asked long ago by Maupas, and cannot yet be answered with certainty, except to the extent that there are apparent instances among plants and protozoa of both stable and unstable clones. Recent work by Sonneborn and his school has shown that the degeneration of clones of *Paramecium* is probably due to uneven distribution of the chromosomes of a highly polyploid macronucleus between daughter cells. This process is presumably peculiar to ciliates; it might be that something similar occurs in somatic cells, or in some of them, through distribution of cytoplasmic structures, or through aneuploidy, but there is so far no evidence that this is a factor in metazoan ageing.

Another relevant question is the effect of cell division on the age-status of the fission products. The fact that suctorians have a demonstrable life-span has already been mentioned. It would be interesting to know whether in cases where one fission product receives a newly formed and the other a pre-existing organelle, this difference confers any difference of viability. The assumption that in any fission without differentiation the daughter product is a pair of cells equal in age status may require re-examination, both in acellular organisms and possibly, by photographic means, in tissue cultures. The construction of life tables for various mammalian somatic cells, by labelling techniques such as are now used *in situ* for red blood cells, is also probably not out of the question, and would be well worth the attempt.

Experimental Physiology and Genetics

In 1935 McCay[11] and his co-workers showed that rats which were kept in a juvenile condition by calorie restriction could be restarted in growth at ages up to and even a little beyond a thousand days, and that the period of retardation represented a true postponement of the senile increase in mortality, the life-span being increased by that amount. This is perhaps the most important piece of information so far; but although it is twenty years old, little more has been done to determine which components of development must be retarded in order to slow down ageing. Dietary restriction after puberty lengthens the life of rats, but only by a much smaller amount: intermittent fasting (one day in three) and restriction of diet (short of preventing growth)[13] have both been found to lengthen the life of rats; but in these cases the increase was less striking, and more closely related to the avoidance of surfeit diseases than to developmental slowing.

An incidental implication of McCay's work is that the optimal dietary intake for human growth in childhood might not be that which produces the longest total life-span. McCance and Widdowson[14] and Sinclair[15] have suggested that by pursuing rapid growth in childhood dietitians might be shortening the plateau which normally occurs in the human prepubertal growth curve, and possibly reducing the life-span, either by that amount or even by more. The age of puberty in Western countries is said to have shown a substantial advance over the past century. Maturity, judged both by the date of the menarche in girls[16] and the age of maximum stature in boys[17], has advanced in that time by as much as seven years. This may possibly represent a reversion to an older pattern which had been disturbed in the 1800's, and its cause is unknown, although diet, better economic and social conditions, and heterosis due to a reduced degree of inbreeding have all been invoked. Life statistics cannot be used to determine whether earlier development has altered the rate of ageing, since the gain in expectation of life from medical science is much larger than the loss which might be expected. Where rapid development is genetic in origin it is usually a character of vigour, and in human congenital precocious puberty, where menstruation may begin at the age of two or three years, the expectation of menstrual life is greater, and that of total life no less, than in normally timed individuals[18]. This might not be true of dietary acceleration: the optimal rate of human development is difficult to establish, but it seems that we may still need to establish it.

The only experimental procedures which can at present produce increases in mammalian life-spans equal to those due to dietary restriction are genetic. There is a correlation between human parent and child longevities, but it is only a quarter of that for stature[19]. The life-span of laboratory animals can be increased by eliminating specific heritable disease, but the tendency of inbred stocks is to reach a stable life-span shorter than that of random-bred animals[20,21]. This can be increased, and sometimes doubled[22], by hybridization, though probably not beyond the figure for fully heterozygous 'wild' individuals of the same species (direct comparison with wild-caught stock is greatly complicated by other factors). The mechanisms responsible for the vigour of hybrids may prove significant in studies of ageing: the differences between hybrid and inbred animals are in some ways similar to those between young and old, especially the low variance of many characters in hybrids and their greater resistance to outside disturbance[23,24]. Both old and inbred animals appear to have a diminished repertoire of responses to biological stresses. It should be instructive to analyse this similarity in specific cases.

Apart from these questions, there is a rapidly growing range of methods which can now be used to study ageing along the lines of classical experimental physiology. The improvement of grafting techniques and the knowledge of their limitations make it possible to create age chimeras, the use of these being to study the mutual interaction of host and graft of different ages, rather than in the first instance the endocrine effects of young grafts on ageing animals, as in the past. It is also possible through the use of storage techniques to re-implant tissue taken from infant animals in the same animals when they are old. The obstacles to larger experimental procedures of this kind are chiefly problems of tissue compatibility—the surgical techniques available already permit work such as the complete transplantation of heart–lung preparations in dogs, and their exchange between animals, carried out routinely by Demichov at the Vishnevsky Institute; the survival of these large-scale transplants is limited only by the homograft reaction. Ingenious ways of overcoming this in specific cases, such as the intra-embryonic injection of cell antigens recently described by workers at University College, London[25], might eventually make possible the creation of very extensive age chimeras. Organ culture, which has been relatively little pursued since the early work of Carrell, offers yet other possibilities in this direction.

Classical methods can also be applied to the endocrinology of ageing, with the powerful reinforcement of paper chromatography. Much previous work in this field may have been based on false assumptions, and it now seems decreasingly probable that mammalian age changes will prove controllable by hormones alone, even when more of them are available: the most promising in this field may prove to be those controlling protein anabolism. The endocrinology of timing mechanisms—in particular, those affecting puberty and the menopause—is of great importance, and is already under examination. The second of these is complicated by the lack of laboratory animals which follow the human pattern; the first offers some promise of finding a developmental timekeeper in the central nervous system, which might open very wide fields of investigation.

To those engaged in any of these studies, however, the main requirement of progress is a wide awareness among biologists in general of the nature and scope of the problems which age studies raise, since only through this will the additional information we need be forthcoming.

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OBITUARIES

Dr. John Wishart

Dr. John Wishart, reader in statistics in the University of Cambridge, was born in Perth on November 28, 1898, and was educated at Perth Academy and the University of Edinburgh, where he was one of the many able mathematicians taught by Sir Edmund Whittaker. After leaving Edinburgh he spent two years teaching at Leeds, and then went in 1924 to the Galton Laboratory at University College, London, as research assistant to Prof. Karl Pearson. He stayed there three years, and after a brief period at the Imperial College of Science and Technology, joined the staff of the Rothamsted Experimental Station in the statistical department just at the beginning of its great period of expansion under Sir Ronald Fisher's inspiring leadership. He made his mark there, and left to become reader in statistics at Cambridge in 1931. During the Second World War he served as a captain in the Intelligence Corps during 1940–42 and was a temporary assistant secretary at the Admiralty during 1942–46. He was a Fellow of the Royal Statistical Society, of the Institute of Mathematical Statistics and of the American Statistical Association, a member of the International Institute of Statistics, and an associate editor of *Biometrika*.

To one who was associated with him from the earliest days and in all three places where his life-work was done, the tragedy of his early death at the age of fifty-seven is only too apparent. He was drowned in a bathing accident in Mexico on July 14, during a visit to Central America on behalf of the United Nations Food and Agriculture Organization, to organize a research centre for the teaching of statistics in agricultural research.

Wishart was the author of three books on field experimentation and many research papers on mathematical statistics in scientific journals. His scientific work was characterized by exceptional accuracy and attention to detail, with which he combined more than usual organizing ability. The first of these characteristics was shown in his earliest papers on the numerical computation of certain integrals; the second became manifest at Rothamsted, where he helped with the organization of field experimental programmes and for several years carried out most of the statistical analysis. His best-known paper, produced at Rothamsted, was concerned with what came to be known as the 'Wishart distribution'. This is the generalized product moment distribution in samples from a multivariate normal population. Another of his main theoretical interests was the development of explicit formulæ for the cumulants of 'k statistics' using Fisher's combinatorial methods. This subject formed an important part of the lectures which he gave at Cambridge, and he returned to it as late as 1952.

Wishart was at his best in the years 1931–39, when as a result of his teaching at Cambridge, the modern statistical outlook was adopted by a number of Cambridge mathematicians who took up statistics as a career. They spread the knowledge of statistics as a scientific subject and did much to set up a chain-reaction which still continues. Their training made them aware of the almost unlimited potentialities of statistical methods in many diverse fields, and there is still no sign of diminishing *tempo* in their application.

J. O. Irwin

Prof. E. A. Braude

By the sudden and untimely death on July 23 of Prof. E. A. Braude we have lost one of the most brilliant and most active of our younger organic chemists.

Ernest Braude was born in Germany in 1922, came to Britain as a boy of fifteen, and was naturalized at the age of twenty-four. His British education started in private schools and at Farnham Grammar School. He spent one year at Birkbeck College before going to the Imperial College of Science and Technology, where he spent virtually the rest of his academic life. He graduated with first-class honours in chemistry in 1942, receiving the Acland and Frank Hatton Prizes. He spent the next three years as research assistant to Sir Ian Heilbron, became an assistant lecturer in organic chemistry in 1946, lecturer in 1947 and reader in 1952. He succeeded to the chair of organic chemistry in 1955. In 1950 he received the Meldola Medal of the Royal Institute of Chemistry and the D.Sc. of the University of London.

Braude published his first original papers at the age of twenty-two, and in the next twelve years, up to the time of his death, a flow of research memoirs followed, remarkable both in quantity and in the very high standard maintained. In his earlier years he worked in collaboration particularly with Dr. (now Prof.) E. R. H. Jones, and more recently, in studies of hydrogen transfer, with me. He had a number of enthusiastic junior collaborators, including many from overseas. The names of Stern, Timmons, Waight, Jackman and Forbes come to mind. To all his work he brought deep knowledge, sound judgment and enthusiasm, and he was particularly generous in giving helpful advice on other research going forward at the Imperial College.

He was remarkable for the range of his interests. He did valuable work on the synthesis of hydroaromatic and condensed benzenoid systems, particularly in the direction of vitamin D. He was responsible for a new synthesis of thioctic acid. He made important studies of molecular rearrangements, particularly of anionotropy. But he will probably be best remembered for his great knowledge of, and contribution to, the methods of organic chemistry. He discovered the lithium alkenyls and illustrated their synthetic value; he made most significant contributions to the methods of hydrogen transfer processes and their interpretations; and above all he was a master in the application of methods of light absorption to the elucidation of structure and reactions. It was his expert knowledge in this and allied fields which made the book "The Determination of Organic Structures by Physical Methods", which he edited with Nachod, of such great value.

Braude was an extremely clear and conscientious teacher and was in great demand at scientific meetings. He had travelled and lectured in many countries. He was happily married, a most valued colleague and a kind friend. His sudden death at the height of his creative powers, so soon after obtaining a leading academic position, is a matter for profound regret and leaves a great sense of loss.

R. P. LINSTEAD

NEWS and VIEWS

Presidency of the Canadian Association of Physicists : Dr. G. Herzberg, F.R.S.

DR. GERHARD HERZBERG, director of the Division of Pure Physics of the National Research Council of Canada, has been elected president of the Canadian Association of Physicists. Dr. Herzberg was born in Hamburg in 1904 and studied physics at the Darmstadt Institute of Technology. During 1928–30 he did postdoctorate work at the University of Göttingen and at the University of Bristol, and then for five years was an assistant in the Department of Physics at the Darmstadt Institute of Technology. He joined the staff of the University of Saskatchewan as research professor of physics in 1935 and became professor of spectroscopy at the Yerkes Observatory of the University of Chicago in 1945. He returned to Canada three years later as principal research officer with the National Research Council at Ottawa, becoming director of the Council's Division of Physics in 1949 and director of the Division of Pure Physics in 1955. Dr. Herzberg has contributed to the knowledge of the structure of a number of important molecules, including molecular oxygen, molecular nitrogen, carbon dioxide, acetylene and hydrogen cyanide; and he has discovered several new molecules, such as phosphorus nitride and phosphorus carbide. By comparison with his laboratory spectra, it has been possible to establish the presence of certain molecules in planets, stars and in the interstellar space; for example, molecular hydrogen has been detected in the atmosphere of Uranus, and the presence of a diatomic molecular ion consisting of carbon and hydrogen in interstellar space has been demonstrated. Recently Dr. Herzberg and his collaborators have carried out work on the spectra of free radicals. In 1953, he was awarded the Henry Marshall Tory Medal of the Royal Society of Canada "for his achievements in the field of atomic and molecular spectra".

Mechanical Engineering at Sheffield : Prof. J. P. Duncan

MR. J. P. DUNCAN, who has been appointed to the new chair of mechanical engineering in the University of Sheffield, was educated at Scotch College, South Australia, and then at the University of Adelaide, graduating in engineering in 1941. During 1940–46 Mr. Duncan was a student apprentice with Richards Industries, Ltd., a company closely associated with the Chrysler Corporation of the United States. After training in all phases of the company's activities and a period spent in the United States, he afterwards held the executive posts of assistant superintendent of aircraft production and assistant development engineer; in the latter capacity he was for a time solely responsible for the design of post-war motor bodies built in Australia under contract to British and American firms. During 1947–54, Mr. Duncan was on the staff of the University of Adelaide with a primary responsibility for the design and layout of equipment in a new school of mechanical engineering, and in 1954 acted as head of this department. In 1952 he spent one year of study leave in the steam turbine and mechanical research departments of Metropolitan-Vickers Electrical Co., Ltd., and conducted researches into several problems associated with steam power plant, on which he has since published several papers. He returned to England in 1955 as a Turner and Newall Research Fellow for the purpose of extending these researches, and is at present lecturer in mechanical engineering design in the University of Manchester. Mr. Duncan's general interests are in experimental stress analysis, machine design and engineering economy. A special interest is the mechanical design of heat exchangers, in which he is developing optical interference as a method of studying the bending of multiply connected elastic tube-plates.

Acoustics at Newcastle upon Tyne : Prof. E. G. Richardson

DR. E. G. RICHARDSON, who has been appointed professor of acoustics at King's College, Newcastle upon Tyne (University of Durham), has been on its staff for many years. He joined as lecturer in physics in 1931 and became a reader in 1943. During the Second World War, he did important research in acoustics for the Admiralty and in aerodynamics for the Royal Aircraft Establishment. Always interested in the literary side of science, he has written a standard text-book on sound which is now in its fifth edition, together with others on architectural and musical acoustics, ultrasonics and on science for the layman. He is British editor of the international journal *Acustica* and general editor of a large work on technical acoustics, the contributors of which include authorities from most countries of the scientific world. His researches cover a wide field in acoustics, ultrasonics, aerodynamics and rheology, and his published work amounts to about one hundred papers. Prof. Richardson, who has lectured in France, Belgium, Italy and Egypt, has recently returned from the United States and Canada, where he has been attending conferences and visiting acoustic laboratories as a consultant. In his new chair, he is commencing an ambitious programme of research, and at the moment, as holder of a Leverhulme fellowship, is particularly interested in meteorological and marine acoustics.

Department of Scientific and Industrial Research Bill

In presenting in the House of Lords on July 23 the House of Commons amendments to the Department of Scientific and Industrial Research Bill, the Lord President of the Council, Lord Salisbury, said that they are all clarifying amendments relating to Sub-section (3) of Clause 1. The first secures specific mention of technical colleges as places in which the Advisory Council may encourage and support scientific research, and Lord Salisbury said that it has always been the intention of the Government that they should be so covered. The second relates to what may be called, in general terms, development work; and this likewise is intended by the Government to be within the orbit of the new Council, as it is indeed within that of the Department of Scientific and Industrial Research to-day. The third amendment is designed to make it clear that the Council can take account of what is being done elsewhere; although it is not intended or desired that the new Council should attempt to organize and co-ordinate all the scientific and industrial research in Britain, it is intended that, in planning the Department's research programme, the Council should have regard to the total picture of the country's research effort. In commending this amendment, Lord Salisbury also added that, while the amendment should help to ensure that unnecessary overlapping would be avoided, it is left open for the Council to engage in some particular line of research already being pursued elsewhere, if for some special reason it is desirable to do so. The amendments were agreed.

Agricultural Improvement Council for England and Wales

The Agricultural Improvement Council, which recently reached the end of a further three-year period of office, has been reconstituted by the Minister of Agriculture, Fisheries and Food. The Council, which was set up in 1941, keeps under review the progress of research and improvements in technical methods so as to ensure that promising results are applied as rapidly as possible to agriculture and horticulture and to commercial practice in these fields, generally, and advises the Minister from time to time on agricultural and horticultural problems which appear to require scientific investigation and on general policy whereby production may be increased. The reconstituted Council is as follows: Sir Alan Hitchman (*chairman*), permanent secretary, Ministry of Agriculture, Fisheries and Food; Sir Frank Engledow (*vice-chairman*), Drapers' professor of agriculture, Cambridge; Captain J. F. Bomford, farmer and market gardener; Harold Collison, general secretary, National Union of Agricultural Workers; H. R. Finn, farmer, Canterbury; E. Gibby, farmer, Pembroke Dock; Prof. K. Mather, professor of genetics, Birmingham; J. W. S. Mount, horticulturist and farmer, Canterbury; the Duke of Northumberland, landowner and farmer; H. J. Rathbone, chartered land agent, Mold; F. Rayns, director of the Norfolk Agricultural Station, Sprowston; Prof. Ellis J. Roberts, professor of agriculture, Bangor; Sir James Scott Watson, formerly chief scientific and agricultural adviser to the Minister of Agriculture and Fisheries; Sir William Slater, secretary, Agricultural Research Council; H. Cole Tinsley, farmer, Peterborough; Sir James Turner, president, National Farmers' Union; Prof. T. Wallace, director, Long Ashton Fruit and Cider Research Station; and Prof. E. G. White, professor of veterinary preventive medicine, Liverpool. The secretary of the Council is W. Morley Davies, senior education and advisory officer, Ministry of Agriculture, Fisheries and Food, Great Westminster House, Horseferry Road, London, S.W.1.

Tobacco Manufacturers' Standing Committee

The formation is announced of the Tobacco Manufacturers' Standing Committee, composed of representatives of the Federation of Home and Export Tobacco Manufacturers, British–American Tobacco Co., Ltd., and the Imperial Tobacco Co. (of Great Britain and Ireland), Ltd. This development gives formal status to the co-operation in research of the group of manufacturers which in 1954 made a donation of £250,000 to the Medical Research Council for investigation into the causes of lung cancer. Sir Alexander Maxwell will be chairman of the Committee and Sir Alfred Egerton and Sir Ronald Fisher have consented to act as scientific consultants to the Committee in the fields of physical chemistry and statistics, respectively. It is intended in due course to invite authorities on other subjects to serve in a consultative capacity. The offices of the Committee will be at 6–10 Bruton Street, London, W.1.

Technical Education Courses in Britain

In a written statement given in the House of Commons on July 24 about arrangements for regional co-ordination of technical courses and inter-authority payments, the Minister of Education said that he had met representatives of the London County Council and of the Associations of Local Authorities and Education Committees on July 17 and that they had agreed to make certain recommendations to their constituents. In the light of the White Paper on Technical Education and Circular 305 of the Ministry, the local education authorities should invite regional advisory councils to examine urgently the existing provision of vocational courses and to consider how far industry and employers generally are aware of the provision already made for technical education, and how industry and the technical colleges can be better informed of any decisions resulting from a regional advisory council's advice which may affect the pattern of future development and particularly the planning of new advanced vocational courses. A working party of officers of the Ministry, H.M. inspectors, representatives of local authorities and education committees (including representatives of technical colleges), representatives of industry and officers of regional advisory councils should be set up to consider procedure for examining and approving, in the first instance, technical education courses. Authorities should give automatic consent to the attendance of students at any advanced courses at a designated college of advanced technology outside the area in which they reside and also in respect of attendance at any other course in a designated college or elsewhere, except where an authority finds it desirable to require prior consent. The Minister and the regional advisory council concerned should be informed of the exceptions. Automatic consent may be withdrawn if, in the authority's opinion, the student's attendance or progress is unsatisfactory. Local education authorities should review the composition of governing bodies of technical colleges to ensure that they include appropriate representation of authorities from whose areas substantial numbers of out-county students are drawn.

International Radio Consultative Committee

THE eighth plenary assembly of the International Radio Consultative Committee (C.C.I.R.) was formally opened in Warsaw on August 9, to study various technical problems encountered in the practice and development of radio communication, with the view of making recommendations to be submitted to the International Telecommunications Union (I.T.U.). The work of the Committee is organized under fourteen study groups, which are meeting during the period August 10–31, after which the full assembly will discuss the various recommendations and study programmes with the view of their adoption as a guide to future progress in the radio field. The United Kingdom delegation is led by Captain C. F. Booth, assistant engineer-in-chief, General Post Office, accompanied by seven other delegates of the Post Office staff, and one each from the Department of Scientific and Industrial Research and the Ministry of Supply. The delegation also includes technical advisers of the Radio Industry Council and representatives of the organizations operating radio services in Britain. Two members of the delegation are the international chairmen of study groups, namely, Dr. R. L. Smith-Rose (Study Group V), on tropospheric wave propagation, and Mr. H. Stansby (Study Group IX), which deals with general technical questions.

Among the subjects of particular scientific interest under discussion are those of radio wave propagation over the ground and through the troposphere and ionosphere, atmospheric noise in various parts of the world, radio time signals and standard frequencies and various aspects of broadcasting and television. Adequate liaison arrangements have been established between the International Radio Consultative Committee and the International Scientific Radio Union (U.R.S.I.) for the study of subjects of mutual interest, with the general objective of improving the efficient and economical use of the radio-frequency spectrum for all practical and scientific purposes.

World Resources in the Immediate Future

THE spring issue of *Progress*, the magazine of Unilever, Ltd., includes the last of a series of articles surveying world resources which Sir Solly Zuckerman has edited during the past five issues. The series was introduced by Sir Solly himself in the spring issue of 1955 with an article in which he outlined broadly the problem presented by the rapid growth of world population and the consequent growing demand for capital and consumer goods and higher standards of living. In following articles M. John considered, first, world supplies of power and water and then those of land and food, and finally of raw materials, setting out in broad terms the main material considerations that are likely to determine the development of industry over the next two or three decades. In this final article on the social and political aspects, Sir Solly Zuckerman agrees that no shortage is likely to develop capable of defeating human ingenuity; but he believes that the unequal division of resources between 'have' and 'have-not' countries is the core of a social challenge steadily growing more urgent with the rapid increase in the populations of the under-developed countries of the Eastern world. The price of peace may well be the sharing of resources, and if the British are not to lose by the sharing they must remain constantly alert to the challenge of new industrial technologies and to the possibilities of creating greater wealth.

The Imperial Forestry Institute, Oxford: Report for 1954–55

THE thirty-first annual report for 1954–55 of the Imperial Forestry Institute, Oxford, to which is attached the University School of Forestry (pp. 32; from the Institute, 1956), points out that in 1955 the School celebrated its fiftieth year, having been brought to Oxford by Dr. Schlich when the Royal Indian Engineering College, Coopers Hill, was closed in 1905. The Forest Herbarium, though still housed in the Botany Department, has now been transferred back to the School of Forestry. The number of students attending courses during the year was fifty-eight. Fourteen were successful in the examination for their forestry degrees; and of these, two were Colonial forest probationers who returned to their Colonies, two obtained posts in the Colonial Forest Service, one returned to Pakistan to join the Forest Service there, a South African obtained a post in the Northern Rhodesian Forest Department, and another two went to Canada before returning to South Africa. One government scholar from each of Kenya and Jamaica returned to join their respective forest departments. One graduate joined the Oxford University Expedition to Borneo as botanist, and four joined up for National Service. This enumeration furnishes ample evidence that the Institute has fully justified its inauguration, the more so since many parts of the British Colonies will in future be more or less dependent upon it for maintaining the requisite professional knowledge in the staffs of their departments. The forest officers' course at the Institute was attended by twelve officers of the forest services of various Colonies. The sections dealt with in the report are sylviculture, ecology, tree physiology, forest botany, forest pathology, forest entomology, mensuration, aerial surveys, statistics, forest economics, forest law, Colonial forest administration, forest protection, surveying and the library.

Agricultural Research in India

A BRIEF account of research and agriculture in India under the Second Five-Year Plan is given in the April number of *Science and Culture* by M. S. Randhawa. Out of Rs. 350 crores for the Central and State research and development schemes, Rs. 38 crores is for direct expenditure by the Central Government. The production and distribution of nitrogenous fertilizers is to be increased to three times the present level of 600,000 tons a year, and a scheme is proposed for the distribution of improved seeds through a network of seed farms, each serving a group of a hundred villages. Large-scale developments are proposed for cattle, sheep and poultry, including an additional three hundred artificial insemination centres and six hundred extension centres for which more than thirty thousand bulls will be required, including 4,200 of known pedigree and productive capacity. Rinderpest is to be eradicated by planned mass-scale vaccination of all cattle throughout the country, and by 1961 the National Extension Service for extending knowledge to the farmer will cover the entire country. In regard to research, Dr. Randhawa stresses the importance of radiobiology, particularly radiogenetics, and the exploitation of hybrid vigour, notably hybrid maize, sorghums and vegetables, and also hybrid poultry and pigs. Provision has also been made for the establishment of two horticultural plant introduction stations at Saharanpur and Hasarghatta; a Division of Horticulture is being established at the Indian Agricultural Research Institute at a cost of Rs. 11,29,000, and regional research is projected on mango, citrus, grapes, guava, apples and pineapples.

Farming Advisory Services in North America

IN 1955 a mission, sponsored by the Nuffield Foundation, visited the United States and Canada to study the farming and advisory services in order to gain ideas for increasing the efficiency of the agricultural advisory work in England and Wales. Its report, "Farming Advisory Services in North America", has now been published (pp. 53; from the Nuffield Lodge, Regent's Park, London, N.W.1; 1956; 4*s*. 6*d*.). While fully recognizing the different physical, economic and social factors that influence farming in North America and Great Britain, the report suggests certain changes in the organization of the National Agricultural Advisory Service based on American 'extension' experience. It recommends "that serious reconsideration should be given to the desirability of making it (as in Scotland) an extramural activity of university schools of agriculture. Removal from direct government control would help to give the service a better professional status and to increase the farmer's confidence and co-operation". More encouragement should also be given to developing local interest. To this end, county and rural district councils might contribute to the cost of the service and more use made of the district office, now in danger of being closed. Programme planning with later assessment of results, carried out at the local level, could be a further means of promoting co-operation between the advisory officer and the farming community. The issue of supervised loans at low interest-rates to low-income farmers, similar to those provided under the Farmers Home Administration in the United States, is another suggestion put forward; but it is made clear that the responsibility of any such scheme should not be with the Advisory Service. In conclusion, much of the success of the American 'extension' was felt to be due to the prevailing spirit of confidence, both in itself and between the service and the farmer.

Datura Research Material

THE Smith College Genetics Experiment Station was discontinued at the end of 1955, a year after the death of Dr. Albert F. Blakeslee, its founder and director since 1942. For many years the investigations of Dr. Blakeslee and his colleagues at Smith College, and earlier at the Department of Genetics of the Carnegie Institution of Washington, had been concerned with the genetics of *Datura*. As a result of this work, tetraploid, as well as diploid, lines of most species as well as chromosomally different races are available. The National Science Foundation has recently made a grant to Smith College to finance the assembling of the data on the genetics of *Datura* and related problems, and its publication in a monograph on *Datura*. This will be in charge of Amos G. Avery, and the principal contributors will be Dr. Sophie Satin and Dr. J. Rietsema. Seed of all the species and of most of the races and types have been grown and placed in controlled cold storage. These are available to any investigator who desires to continue some aspect of research on *Datura*. Application should be made to Dr. H. H. Plough, Amherst College, Amherst, Mass., indicating the seeds desired and the general nature of the investigation planned.

Cell Mounts for Biological Materials

IN an article in the *Museums Journal* (November 1955), Mr. C. V. Adams, of the City Museum, Plymouth, discusses the use of cell mounts as an alternative to embedding biological specimens in transparent plastic. It is maintained that the use of plastic entails several stages in the work and that specialized skill and a fair amount of time are necessary. In cell mounts the material may be mounted in formalin, alcohol or in the dry state. The last is especially useful as it enables many of the Lepidoptera to retain their colour, which is often lost in an embedding process. The mount consists of a transparent polystyrene lid which fits on to the flange of a polystyrene base-plate. The base-plate can be obtained in black, white or completely transparent, and the entire mount measures 2¾ in. × 1½ in. × ½ in. When used with a liquid mount, the cell is capable of holding 40 c.c. of preservative. The lid is welded to the base by 'Cristalite'. The cell mounts can be obtained from P. K. Dutt and Co., Ltd., of Alfred Place, London, W.C.1.

Production and Transport of Liquid Methane

AT a recent meeting of the Institution of Gas Engineers, J. Burns and L. J. Clark considered the economics of liquid methane derived either from methane itself or natural gas in association with oilfields (Publication No. 484 of the Institution; pp. 22; 1956). It is argued that, in the Middle East alone, more natural gas is being burnt to waste than would be needed to meet the total requirements of the British gas industry. Regarding sources of supply to Great Britain, the Middle East, Mexico and Venezuela are potential areas since reserves are vast and comparatively unexplored, reasonably near seaports and, at present, subject to limited local demand. The chief problem is trans-ocean transport of the liquefied gas which, incidentally, only occupies 1/600 of its volume in the gaseous state. It would require the construction of liquid methane tankers capable of carrying this fluid at sub-zero (Fahrenheit) temperatures; such tankers would have to be of at least 35,000 tons and would be at least double the cost of conventional oil tankers. Storage conditions and costs would also be considerably higher than for oil; further, distribution would be restricted to industrial areas where deep-water facilities are available.

Scottish Soil Survey

THE fourth memoir to be published of the Soil Survey of Great Britain, and the second concerning Scotland, has appeared under the title "The Soils of the Country round Jedburgh and Morebattle" (pp.

178. Edinburgh: H.M.S.O. 30*s*.). The area surveyed embraces Sheets 17 and 18 of the 1 inch/1 mile Geological Survey of Scotland. Sheet 18 comprises only a small corner of Scotland, the rest being left blank, presumably to be completed in due course by the Soil Survey of England and Wales. It would have been more convenient for the user and more economical in the printing of the map if the two constituent parts of the Soil Survey of Great Britain had collaborated to produce two complete sheets of this border country instead of each separately producing two incomplete sheets. The memoir caters for the needs not only of the soil specialist, but also of the land user, the country planner, and students of ancillary sciences such as geology and ecology. The work of combining these many points of view has been well executed, and has produced a very readable account of the physical environment of the district. The main soil associations and series are adequately and concisely described and their relationships to local types of agriculture are indicated. Data of mechanical and chemical composition are given in an appendix. The soil maps are excellent, and many beautiful photographs, not all of which are illustrative of the soils, are included. In some respects the memoir has been produced with unnecessary extravagance, which is reflected in the price.

International Conference in Munich of University Teachers

The ninth conference of university teachers, organized by the International Association of University Professors and Lecturers, will be held in Munich during September 3–8, under the chairmanship of Prof. Francesco Vito. The aim of the conference is to discuss problems fundamental to universities throughout the world. In particular, the following topics will be considered: the scientific and social responsibilities of the university teacher in relation to his academic independence, and the effect of these responsibilities and of the pressure of non-teaching and outside work on a proper fulfilment of his task; the maintenance of a university tradition and the training of future university teachers; the conditions of employment and the contractual obligations of university teachers working in countries other than their own; scientific research in the universities and its relations with industrial research; the status and careers of research workers and those engaged in the social sciences; the place of classical studies and the humanities in a general education. The conference is open to all university teachers, whether members or not of the Association. Further information can be obtained from the Secretary, International Association of University Professors and Lecturers, 21 Dawson Place, London, W.2.

Oversea Service Division, Colonial Office

The following appointments have recently been made in the Oversea Service Division, Colonial Office: C. Yates (inspector of works, Public Works Department, Nigeria), chief supervisor of forest works, Forestry Department, Sierra Leone; W. A. Dos Santos (pathologist, Trinidad), pathologist, Federation of Nigeria; D. J. Bargman (meteorologist, East African Meteorological Department, East Africa High Commission), regional representative (Uganda), East African Meteorological Department, East Africa High Commission; C. J. Cartledge (meteorological assistant, Nyasaland), meteorological assistant, East African Meteorological Department, East Africa High Commission; J. P. Henderson (assistant director, East African Meteorological Department, East Africa High Commission), deputy director, East African Meteorological Department, East Africa High Commission; D. McCullum (meteorologist, East African Meteorological Department, East Africa High Commission), regional representative (Tanganyika), East African Meteorological Department, East Africa High Commission; B. W. Thompson (meteorologist, East African Meteorological Department, East Africa High Commission), regional representative (Kenya), East African Meteorological Department, East Africa High Commission; Dr. I. E. M. Watts (assistant director of Malayan meteorological services, Singapore), director of the Royal Observatory, Hong Kong; D. O. Mill (senior statistician, Jamaica), deputy director of statistics, Jamaica; Dr. D. E. L. Rollinson (chief veterinary research officer, Uganda), assistant director of veterinary services (research), Uganda; T. G. C. Vaughan-Jones (director of game and tsetse control, Northern Rhodesia), commissioner for rural development, Northern Rhodesia; D. I. Allen, agricultural engineer, British Guiana; R. M. Veevers-Carter, assistant fisheries officer, Aden; R. W. Bartholomew, geologist, Fiji; E. B. Wolfenden, geologist, Sarawak; M. J. Glover, scientific officer (West African Stored Products Research Unit), Federation of Nigeria; L. E. Stephen, senior scientific officer, West African Institute for Trypanosomiasis Research, Nigeria; P. F. Byrne, veterinary officer, British Guiana; H. Steding-Jessen, veterinary officer, Gold Coast; K. S. Thomson, veterinary officer, Tanganyika.

Announcements

Dr. D. G. O. Morris, senior lecturer at the University College of North Wales, Bangor, has been appointed to the University of London readership in electrical engineering tenable at the Imperial College of Science and Technology.

The culture collection of bacterial plant pathogens built up by Dr. W. J. Dowson (who retired in 1952 from the staff of the Botany School, Cambridge) has now been transferred to the Plant Pathology Laboratory of the Ministry of Agriculture, Fisheries and Food, 28 Milton Road, Harpenden, Herts, where it will be in the care of Mr. R. A. Lelliott. Dr. Dowson is continuing his researches on various aspects of plant bacteriology at the Botany School, Cambridge.

Two fellowships have recently been awarded by the Mental Health Research Fund, the first of which, a Leverhulme fellowship of a total value of £3,600, tenable at the Department of Anatomy, University College, London, is to Dr. Brian G. Cragg, to continue his research on the function of the hippocampus. The other award is a Mental Health Research Fund fellowship, of £900 a year for two years, to S. Folkard, who is working at the Netherne Hospital, Coulsdon, Surrey, on an assessment of the contribution which social science techniques can make to the diagnosis and treatment of patients in a mental hospital. The Mental Health Research Fund will be offering further fellowships for competition during the coming year.

Erratum. In the article entitled "Growth and Sexual Maturity in Aquatic Mammals", by Dr. R. M. Laws, in *Nature* of July 28, p. 193, the lengths quoted in Table 1 should be "in feet" for the Cetacea and "in inches" for the Pinnipedia.

ROYAL GREENWICH OBSERVATORY

ANNUAL REPORT FOR 1955–56

THE annual report of the Astronomer Royal for the period April 1, 1955–March 31, 1956*, deals with the Royal Greenwich Observatory under three headings: Greenwich and Abinger; Herstmonceux; and Hartland.

As no major overhaul of the Yapp 36-in. reflector had taken place since its erection, it was decided to dismount it earlier than the progress of its dome at Herstmonceux would otherwise have justified, and to use the poor observing months in reconditioning it, repainting the structure and re-wiring where necessary. The repainting was largely completed by the end of the year under report, but the re-wiring remains to be done. Defects of the figure in the main mirror were referred to in the 1954–55 report, and it was decided to dispatch the mirror to the firm of Sir Howard Grubb, Parsons and Co., Ltd., for the removal of these defects.

Observations of the four bright minor planets for position have been continued with the astrographic refractor, and reductions of the plates are well advanced. Investigations on the systematic errors of deduced place due to photographing well away from the meridian were carried out by exposures in three-star fields at widely different declinations, and most of the thirty-nine hour-angle plates taken during the year have been measured and reduced. The magnitude and sign of the effect vary with the declination of the test field in such a way that the small displacements found cannot easily be attributed to such effect as flexure. It is impossible to interpolate to other declinations so long as a physical explanation is lacking, but it is not considered likely that the effect can appreciably influence astrometric work except in the few cases where large ranges in hour-angle are deliberately employed, for example, in single-station parallax work on minor planets. Some test plates taken by Dr. D. W. Dewhirst with the new 17/24-in. Schmidt camera of the Cambridge Observatories have been examined to find whether the optically similar instrument planned for Herstmonceux will be suitable for astrometry.

In accordance with the recommendations of the International Union of Pure and Applied Physics, recording of the general ionizing flux under 10 cm. of lead has been done without any significant interruption, and the diurnal and other variations have been investigated. The cosmic-ray flare of February 23 last was recorded, showing more than 100 per cent increase; observatories throughout the world are supplying information on this remarkable flare (see *Nature*, July 21, p. 125).

Routine observations with the Lyot birefringent $H\alpha$ filter on the $6\frac{1}{4}$-in. Newbegin refractor started on June 13, 1955, and on 175 days out of the 293 days up to March 31 daily photographs were taken of the Sun's disk and of the prominences visible at the Sun's limb. Also, special series of photographs were taken on about twenty-five occasions during periods of flare-activity on the Sun. The photographs were taken on red-sensitive 35-mm. film specially provided by Kodak, Ltd.; the film, which is of fine grain, requires an exposure of about $\frac{1}{5}$ sec. under favourable sky conditions. The image-size is approximately 21 mm. to the solar diameter, and the photographs normally reveal details down to a size of 5″ of arc. The firm of Kodak, Ltd., has taken considerable trouble to produce a suitable film, and various difficulties experienced with the film have been overcome.

Among the numerous matters dealt with in the report is a short account of the Electronics Laboratory in which experimental work on operating a quartz-crystal oscillator with the resonator at the temperature of liquid hydrogen has been carried out at Oxford with the help of the Clarendon Laboratory. The experience derived has suggested modifications in both the low-temperature and the electronic-measuring equipment, and results obtained are so promising that it is intended to continue these experiments. Acting on the request of Study Group 7 of the International Radio Consultative Committee to investigate the possibility of high-accuracy frequency comparison by means of the 16- and 60-kc./s. controlled transmissions from Rugby, experimental equipment for continuous recording of the phase of these transmissions has been built, and an accuracy of a few parts in 10^{10} has been achieved. This method of frequency-checking possesses such accuracy and simplicity that it has been chosen for the next series of tests at Oxford.

At Abinger the routine work has continued, and it is intended that this Station will continue to provide data throughout the International Geophysical Year. The building of the new magnetic observatory at Hartland was commenced in the early summer of 1955, and it is expected that it will be operating by the late summer of this year.

The routine calculations and proof-reading in the preparation and printing of the publications for which the Nautical Almanac Office is responsible have been continued as usual. It has been agreed that the "Abridged Nautical Almanac" and the "American Ephemeris and Nautical Almanac" shall become identical, beginning with the 1958 editions. The unification of the two publications has required a number of changes in both, but as complete agreement has been reached on the numerous details of presentation, most of the copy is now ready for photographic reproduction. Among the ramifications of the work of the Nautical Almanac Office may be mentioned the prediction of occultations of radio sources by the Moon. The predictions are at present restricted to the twenty-six radio sources of the second Cambridge survey with a flux density not less than 50 units within the zodiacal band, the unit being 10^{-26} W. m.^{2} (c./s.)$^{-1}$. The predictions are sent in manuscript form direct to the radio stations: those for July–December 1955 were sent to eight stations, and those for January–July 1956 to fourteen stations.

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* Report of the Astronomer Royal to the Board of Visitors of the Royal Greenwich Observatory. Pp. 25. (Herstmonceux: Royal Greenwich Observatory, 1956.)

It has been decided that the duplex design for the Isaac Newton telescope be abandoned and that attention be concentrated on the construction of a conventional paraboloid telescope. A committee is working out a detailed design on this basis, and substantial progress is reported.

ONTARIO RESEARCH FOUNDATION

REPORT FOR 1955

THE annual report of the Director of Research of the Ontario Research Foundation for 1955* refers to additions to the duties and responsibilities of the Foundation in consequence of the termination of the Research Council of Ontario. The Foundation is now authorized to spend 50,000 dollars a year on scholarships and fellowships for postgraduate students in science, and for the year 1955–56 forty-one scholarships were awarded. The estimates also provide for grants of 145,000 dollars to universities and colleges in Ontario for postgraduate research in the natural sciences and engineering, and sixty-four such grants were made for 1955–56. The advisory committees for research in fisheries and wild-life and in forestry and forest products and for industrial research have been reconstituted, and their membership is given in an appendix. The Director again notes the growing difficulty in recruiting an adequate number of Canadian graduates with the requisite scientific background and character and also the need for further space and equipment, particularly for pilot-plant operatives in the Metallurgy and Chemistry Departments in view of the growth of the Foundation's activities over the past ten years, during which its income has increased from 364,385 dollars in 1945 to 1,014,086 dollars in 1955.

The Biochemistry Department has achieved further success in modifying chemically a lignin sulphonic acid phenol condensate and applying it in tanning heavy leather, and it is hoped that the Department will be able to re-examine potential sources of vegetable tannins in Canada. Workers under the Rice Mills Fellowship have met with continued success in the production of humidifier plates from rice hull ash, and they are now engaged in a study of experimental lots of acoustic tile. Besides co-operative work with other Departments, the infra-red laboratory has been used by eight companies in their own investigations. A close correlation has been noted in the oils and fats laboratory between the tendency of an oil to deteriorate and its ability to react with 2-thiobarbituric acid, and fodder yeast has been produced from cheese whey by a simple process.

The Department of Chemistry, using improved methods of paper chromatography, has determined quantitatively the nine lower members of the phosphoric acid series and occasionally up to the twelfth member, and has continued its work on phosphate glasses. It is proposed to concentrate the work of the air pollution laboratory on careful analysis of the atmosphere in relation to climatic conditions, and on a determination of the organic constituents and the ozone concentration. A commercial model has been constructed which is able to check accurately sixty piezo-electric quartz crystal units per hour. A study of the viscosities of grafted copolymer solutions showed that the viscosity increases rapidly as the shear-rate decreases for branched copolymers, but is unaffected for linear copolymers. The electroplating laboratory has found that large inclusions in commercial steel could be an important source of failure for nickel deposits of the order of 0·0001 in. thickness from a low-pH Watts bath. Work on the utilization of waste sulphite liquor continued.

The volume of work in the Engineering Section of the Department of Engineering and Metallurgy is two and a half times that in 1954. Pilot-plant work in the research on controlled-density steel has yielded important results on the economics of the process, furnace design and the production of the reducing gas; work in the ferrous metallurgy laboratory included the chemical production of pure magnetite, the decrepitation of ores at various temperatures to improve concentrates, the design and construction of improved magnetic separators, particularly for handling extremely fine particles, and the design and construction of a machine for pelletizing iron ore concentrates. Fundamental work in the physics of metals is aimed at acquiring new knowledge about the fatigue process and applying this knowledge to discover new materials of high fatigue strength, as well as developing tests to measure fatigue damage. In the X-ray laboratory a helium bath has been obtained and the range of the X-ray spectrographic analysis has been extended to elements of lower atomic numbers.

In the Department of Parasitology, work continued on the blood protozoa in birds; and tests on the antimalarial drugs 'Daraprim', 'Camoquin' and 'Aralen' against *L. simondi* in ducks showed that 'Daraprim' prevented parasitæmia, but neither of the others had any prophylactic or therapeutic value. The investigation of the life-history of two species of flukes that occur in foxes and other carnivores was completed; 30 per cent of almost a thousand nests of forty-five species of birds examined were infested with thirteen different species of *Protocalliphora*. In the Department of Physiography laboratory work was completed on minerals in the colloidal fraction of glacial tills and water-laid clays in southern Ontario, and a study was made of climate for peaches in Ontario. The Textile Department is concentrating its resources on short-term work in the immediate future, and undertaking only one or two fundamental problems, including the physical properties of viscose yarn and the resistance of nylon to immersion in water and exposure to light.

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* Ontario Research Foundation. Annual Report, 1955. Pp. 35. (Toronto: Ontario Research Foundation, 1956.)

RESEARCH ON ANIMAL PRODUCTION

THE British Society of Animal Production was established towards the end of the Second World War for the purpose of bringing together those interested in both the science and practice of the breeding, feeding and management of farm animals, and the recently published volume of its Proceedings for 1955* contains many interesting and important papers on current research in animal production. The following examples indicate the wide range of the problems under investigation by many different workers throughout Great Britain.

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* Proceedings of the British Society of Animal Production, 1955. Pp. 122. Edited by I. L. Mason and G. Wiener. (Edinburgh and London: Oliver and Boyd, Ltd., 1956.) 15*s*.

Work at the University College of North Wales, Bangor, shows that the weight of the lamb in hill sheep in September is probably the best single guide to adaptation and production, for this shows the best correlation with adult weight and has a heritability of 0·68 ± 0·06. From the rumen contents of hill sheep in Scotland the selective grazing on heaths and heathers in different months has been assessed. In fast-growing suckling lambs implantation of œstrogen caused but little increase in live weight, but reduced carcass fat and caused some cases of vaginal prolapse. By comparing worm-free lambs with those artificially infected, the depression of live weight and wool growth was measured and a method of grazing management to prevent infection is described. Under similar management, for each additional pound at birth a difference of 2–4 lb. may be expected in lambs at weaning.

A pasture-sampling method for the estimation of daily dry-matter intake of grazing animals is described, and this was used for measuring the intake of cows in different circumstances. The management necessary to prevent pregnancy toxæmia in sheep is described. In field trials flock fertility was increased by treatment of the ewes with pregnant-mare serum hormone. The time onset of bloat in cattle and its severity are affected by pasture conditions, rate of grazing and previous feeding. Free-range grazing of pigs allows them to select young leafy leguminous growth, while close folding restricts selection, so that in summer free-range grazing effects a saving of 32 per cent of a medium protein meal whereas close-folding saved only 8 per cent.

From an analysis made of the progeny tests of bulls in different herds, it is concluded that within a breed only a small fraction of the difference between herds in milk yield is genetic, but that for fat percentage the fraction is rather higher. In medium- and high-producing herds the first lactation record is superior to the second as an indication of the cow's inherent capacity for yield. By applying magnesium sulphate to grass intended for silage, the magnesium content of the blood of the cattle consuming it was raised, but dropped again when they were turned out to young grass, showing that no body reserves of magnesium are built up.

If the present standard of this publication is maintained, it will prove to be an important contribution to the literature on animal production by presenting in a concise manner an up-to-date account of research work in progress.

MULTIPLE FIRING AT CENTRAL SYNAPSES

By Prof. A. K. McINTYRE, R. F. MARK and J. STEINER

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ELECTROPHYSIOLOGICAL investigations in which penetrating microelectrodes have been used for recording action in the central nervous system have led to a number of reports of single neurones discharging repetitively in response to brief peripheral stimulation[1–5]. In most of these and other similar reports little attention has been paid to this synaptic peculiarity, despite the fact that little or no such repetitive postsynaptic firing occurs in the most intensively studied central synaptic system, the spinal stretch-reflex arc[6,7]. Exceptions are the papers of Bishop, Jeremy and McLeod[8] and of Rose and Mountcastle[9], in which the phenomenon of multiple firing was singled out for study, in the lateral geniculate and thalamic afferent relay systems respectively.

In our own microelectrode studies during the past three years, neurones firing repetitively in response to single-shock presynaptic stimulation have been frequently encountered. These stand in striking contrast with motoneurones, which scarcely if ever discharge more than once to similar stimulation of the monosynaptically-connected afferent fibres of the stretch-reflex arc. The contrast is illustrated in Fig. 1, which displays responses of single units in various parts of the nervous system, each recorded by way of a Ling–Gerard type glass micropipette[10]. The typically single monosynaptic discharge of a motoneurone is shown in *A* ; multiple responses of other neurones are illustrated by records *B–F*, the details of which are explained in the legend. Examples such as these suggest that the behaviour of motoneurones, upon which so much of our present knowledge of synaptic mechanisms is based, so far from typifying synaptic action generally, actually represents an exceptional case.

The synaptic system which in our hands has proved most favourable for experimental analysis of the multiple firing phenomenon is the relay from lumbosacral primary afferent fibres to second-order neurones the axons of which course headwards in the dorsolateral tract. In earlier studies of the whole tract response, prolonged, irregular firing after the initial nearly synchronous tract discharge was noted[11,12], but it was not certain until unit responses were obtained, such as those of Fig. 1 *B*, whether individual tract fibres actually fired more than once. Our experiments have now revealed that many of the fibres do behave in this fashion, and the form of the whole tract after-discharge is adequately explained by summation of the responses of many repetitively-firing fibres.

The experimental advantages of the dorso-lateral tract synaptic relay can be summarized as follows. The tract fibres are large, and, lying superficially during most of their course in the spinal cord, are well suited both for recording and direct stimulation. Thus their responses to presynaptic action can be studied with the recording electrode remote from the actual synaptic region, which we have found to be extremely vulnerable to injury even by the finest electrodes. Furthermore, antidromic volleys can be readily set up in the tract fibres, a matter of considerable technical difficulty in many of the other central synaptic systems of like behaviour. Because of these favourable features, it has been possible to obtain new evidence bearing on the mechanisms responsible for repetitive firing. Our results will now be considered in relation

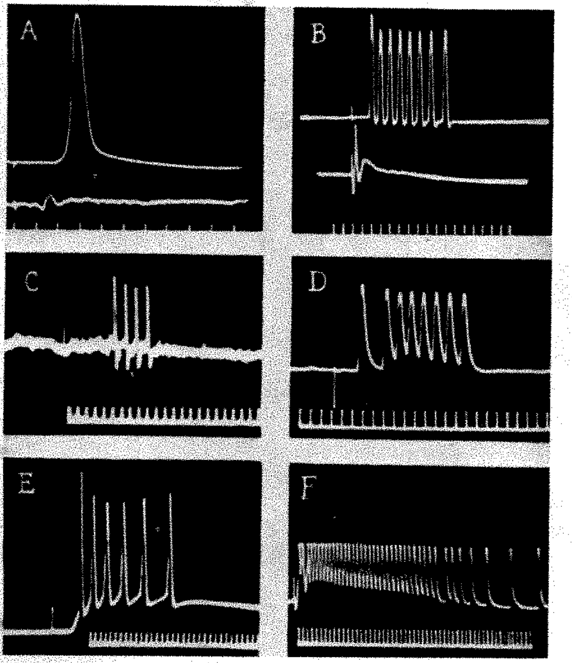

Fig 1. Discharges recorded from units in different parts of the central nervous system by means of Ling–Gerard micropipettes. The top record in *A* is the monosynaptic discharge, recorded intracellularly, of a hamstring motoneurone in response to a volley in the combined biceps and semitendinosus nerves. The upper trace in *B* is the response of a single dorso-lateral tract fibre to a stimulus applied to the ipsilateral seventh lumbar dorsal root. The lower beams in each case display the afferent volley at its entry into the spinal cord. *C* shows the response of a cell in the cuneate nucleus to a single volley in the superficial radial nerve. *D* that of a spinal cord internuncial to single-shock stimulation of a lumbar dorsal root. *E* illustrates the firing of a neurone in the cerebral cortex (somatic sensory area) elicited by a single stimulus to the medial lemniscus in the medulla. *F* shows the discharge of a Renshaw cell in the ventral horn of the seventh lumbar segment in response to a single volley in the corresponding ventral root. All records from cats under barbiturate anæsthesia. Time marks show millisecond intervals

to various possible explanations which might be advanced to account for the phenomenon.

Injury discharge. In most of the earlier reports, the potentials were recorded from postsynaptic cell bodies, and it is possible that slight electrode damage to a cell, normally responding singly, might create a tendency to repetitive discharge, a common effect of injury. Records such as the one shown in Fig. 1 *B* effectively dispose of the notion that electrode damage to cell bodies is a necessary requirement for such synaptic behaviour, since the discharge was recorded from a tract fibre, the actual synaptic region being quite undisturbed. The possibility of the fibre itself being in a similar abnormal state through electrode damage is precluded by the observation that direct tract stimulation gives but a single (antidromic) response.

Temporal dispersion of primary afferent volley. Simple temporal dispersion of impulses ascending primary afferent fibres in the dorsal funiculus undoubtedly occurs, especially in fibres of small and intermediate size-range. Since convergence of such fibres (especially from skin receptors) on to dorso-lateral tract units has been demonstrated[13], such dispersion could lead to the impingement upon individual second-order neurones of a prolonged shower of presynaptic impulses. Were this the sole explanation, latency of the first discharge would be expected to remain relatively independent of volley size, being largely determined by conduction time in the largest, lowest-threshold afferent fibres making synaptic contact. This, however, is not the case, latency being much longer with small than with large presynaptic volleys. Furthermore, reduction of temporal dispersion by stimulating the afferent fibres in the dorsal column near the site of synaptic relay does not substantially reduce the repetitive firing. Though such dispersion may contribute to the after-discharge mechanism, we do not think it can account fully for the phenomenon.

Repetitive action of presynaptic fibres. The 'dorsal column relay' of Hursh[14] could prolong presynaptic action by causing repetitive firing of individual primary afferent fibres. However, the phenomenon is sensitive to temperature, and since we have not detected any clear-cut change in tract discharge patterns at different cord temperatures, it does not seem likely to be an important factor.

Internuncial activity. The most popular hypothesis at the present time postulates the operation of internuncial delay-paths[15] to account for the prolongation of action. In one specific form of this hypothesis, collaterals from the principal postsynaptic neurones constitute the first link in the recurrent chain[8]. Our observations have definitely excluded this particular scheme, at least for the dorso-lateral tract relay, for should it be operative, antidromic conduction of impulses by tract fibres would also lead to their firing repetitively, and this, as stated already, does not occur. It is difficult to obtain unequivocal evidence of the possible role of purely presynaptic delay-circuits. Nevertheless, it may be doubted whether internuncial activity could bring about discharges of such striking regularity and rapidity. In the case of the classical flexor reflex, in which internuncial chain activity certainly figures prominently, the successive bursts of polysynaptic bombardment impinge on flexor motoneurones with less regularity and at a slower rate[16] than, for example, the discharge shown in Fig. 1 *B*. Furthermore, in preliminary experiments it has not been found possible to abolish the repetitive firing with the powerful internuncial depressant, myanesin. The repetitive discharge of Renshaw interneurones[3,5] may be cited as a further indication that prolonged postsynaptic activity may occur in the absence of repetitive presynaptic action. There is no evidence that internuncial chains are involved in the activation of these cells by recurrent axon collaterals, yet a synchronous ventral root volley coursing antidromically for a few centimetres at most can bring about remarkably rapid and prolonged firing (Fig. 1 *F*).

At present, therefore, we incline to the view that explanations based on repeated bombardment of second-order neurones by presynaptic impulses cannot account fully for the phenomenon of multiple firing. Prolonged transmitter action exerted by individual impulses in the presynaptic terminal ramification appears to us a more likely hypothesis.

Whatever the exact presynaptic mechanism may be, the ability of the postsynaptic cells to fire so rapidly in response to sustained excitation calls for comment, in view of the failure of motoneurones to discharge repetitively at a fast rate even with repeated presynaptic excitation. Powerful depolarizing pulses applied directly to the motoneurone membrane can evoke several impulses in rapid succession[17], but excitability soon fails, and sustained firing at rates such as those seen in Fig. 1, *B–F*, does not occur. One suggestion which can be advanced to account for this difference is that neurones capable of sustained rapid firing are so organized that impulses do not invade regions of slow recovery such as the dendrites[18]. According to this view, the transmitter agent brings about in postsynaptic dendrites a long-lasting depolarization which acts as a generator potential evoking repeated discharges in the cell body and axon, much as described by Kuffler and Eyzaguirre in crustacean stretch receptor neurones[19].

As to the significance of the multiple firing phenomenon, its prominence in afferent nuclear relays suggests that it might play an important part in the neural processes underlying sensation. It is conceivable that temporal expansion of afferent signals could act as a matching device between receptors and higher centres. However, the extensive convergence of primary afferent fibres on second-order neurones suggests other possibilities. Since recruitment of additional converging afferent fibres to the presynaptic volley commonly leads, not to occlusion, but to an increase in the number of postsynaptic impulses discharged, the multiple firing mechanism provides a means of converting a spatial pattern in primary afferent fibres into temporal patterns of impulses in individual second-order neurones.

The studies on which this report is based were supported by a grant from the Medical Research Council of New Zealand.

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WATER ECONOMY OF TROPICAL MERINO SHEEP

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NEARLY eight million sheep live on unshaded plains in tropical Australia. Since May 1954, we have studied the thermal adaptation of merinos at Julia Creek, Queensland, 21° S. lat. and 142° E. long. Summer ambient temperatures reach 46° C. (115° F.), and for six months the mean monthly maximum temperature is above 35° C. (95° F.). For the three winter months, temperatures range from 0° to 25° C.

The water intake, output and distribution of sixty young merinos have been followed through two winters and two summers. The sheep have proved physiologically hardy and well adjusted to extremes of heat, water supply and nutrition. They normally lived on the native pasture; but they were trained to feed on native grass hay and maize in yards. In the yards mean winter water intake over 120 sheep-days was 7·3 ml./kgm./24 hr.; and in midsummer it reached a mean of 88·8 ml./kgm./24 hr. Corresponding 2 p.m. respiratory-rates were 38 ± 11/min. in winter and 154 ± 43/min. in summer. Urine output (8 sheep) in winter was 1·34 ± 0·65 l./24 hr. and in summer 0·73 ± 0·30 l./24 hr. The mean output, in ml./kgm./24 hr., was 35 and 46 in successive winters, and 24 and 15 in successive summers. We have found that a standard heat stimulus of 40° C. releases antidiuretic substances in summer, but not in winter. Water for evaporative cooling by panting is provided in summer by drinking twelve times the winter water intake; and by reduction of urine to half the winter volume. Young sheep, also, stored 28 per cent more extracellular water in summer than in winter.

Sheep standing in the open, between noon and 2 p.m. in summer, were exposed to air temperatures between 36° and 42° C., and radiant insolation of 700 k.cal./m.^{2}/hr. Wool tip temperatures rose to 87° C. (190° F.) and the corresponding skin temperature was 42° C., with rectal temperatures of 40·0–40·5° C. Tip wool heats rapidly in the sun and is cooled by air movement. When the terminal 1 cm. was clipped away reflectance doubled (to 0·36 cal./cm.^{2}/min.) and the clean tip temperature fell by 17–20 deg. C. The dark weathered tip accepts more heat than freshly cut wool; but the skin is insulated effectively, for 4 cm. of wool sustained a gradient of 45° C. between tip and skin. An inverse relation was observed between length of wool and respiratory-rate of sheep in the sun. Two pairs of similar merino wethers, for example, were compared while insolated. Two shorn sheep with 1 cm. of wool had skin temperatures 3 deg. C. hotter than the unshorn carrying 3·5 cm. of wool. Shorn sheep panted at 230 ± 26/min., while unshorn sheep panted at 108 ± 23/min. in an ambient air temperature of 38° C.

The interactions of these heat loads and water reserves were studied by depriving five wethers of water for four days, and three for five days. The 50 kgm. animals were 27 months old. They stood in the summer sun and were allowed full rations of *Astrebla* (Mitchell grass) hay supplemented with grain.

Table 1

	Initial	120 hr. without water	Per cent change
Body weight (kgm.)	50·3	38·5	− 23
SCN space (l.)	13·3	7·3	− 45
Plasma vol. (l.)	3·16	1·74	− 45
Plasma sodium (m.eq./l.)	144·1	157·0	+ 9
Plasma chloride (m.eq./l.)	111·0	142·0	+ 28
Plasma osmotic pressure (Δ° C.)	0·585	0·782	+ 34
Max. urine osmotic pressure (Δ° C.)	4·180	5·940	+ 42

Mean values for body fluid volumes and concentrations induced in three merino wethers by five days without drinking water. Food was supplied. The sheep were exposed to sun in air temperatures reaching 40° C. (104° F.) with relative humidity between 10 and 50 per cent

Rectal temperature reached 41° C., extracellular fluids (Table 1) were reduced by 45 per cent and the plasma osmotic pressure increased by 34 per cent. Plasma protein concentration rose 60 per cent and the hæmatocrit 39 per cent. Plasma sodium rose only 9 per cent, though urinary sodium/potassium fell, so sodium probably entered cells. Each plasma constituent seemed separately adjusted to dehydration.

Urinary water-loss averaged 1,680 ml. in 120 hr. (0·23 ml./min.) and in that time 702 m.equiv. sodium and 486 m.equiv. potassium were excreted. Urine volume fell from 585 ml. to 130 ml./24 hr. by the fifth day. Two sheep had less power of renal concentration after the third day, although urine volume continued to fall. Osmotic pressure of the urine rose to a maximum of 3,190 m.osmols and specific gravity reached 1·069. Less than half the osmolarity of the urine could be accounted for by sodium and potassium salts. As dehydration continued the urine sodium/potassium ratio fell from 1·8 to 1·2. When offered water after five days the sheep drank 7–9 l. at once. The following 24-hr. urine volume did not exceed 250 ml., but the sodium/potassium ratio fell to 0·2. Sodium was thus retained to hold the water ingested. The sheep were apparently unharmed by five days without water. The Schmidt-Nielsens[1] found that kangaroo rats concentrate urine to 5·5 osmols. The rock wallaby *Setonyx*[2] achieves 2·1 osmols. Merinos approach the camel in power of water conservation[3].

In contrast with the day to night change of rectal temperature over 4–7 deg. C. found in the camel, the merino in summer has a fluctuation of only 1·5–2·0 deg. C. The relative stability is achieved by panting. Sheep, accordingly, lose water somewhat faster than the camel. But the merino tolerates a similar water loss to the camel, and survives more extracellular volume reduction than is possible for man. From a mean weight-loss of 11·8 kgm. it was found in the dehydrated merino that 5·2 kgm. could be assigned to tissue wastage and intracellular water loss. These losses approach those survived by camels. Attempts to measure directly intracellular water of merinos by antipyrine failed because of the rapid rate of removal of antipyrine in sheep and the unpredictable occurrence of impossible dilution curves.

Adaptation to high heat loads and dehydration by merinos involves insulation by wool against radiation, production of antidiuretic substances in summer to help concentrate urine to 3 osmols, toleration of reduction of plasma volume to half, and increase of plasma osmotic pressure to 440 m.osmols/l.

We are grateful to the Commonwealth Scientific and Industrial Research Organization Wool Fund for a grant. Mr. G. R. Moule, Mr. R. B. Young and their associates at Toorak gave invaluable help in the field.

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EFFECT OF TEMPERATURE UPON THE CROSS-LINKING OF POLYETHYLENE BY HIGH-ENERGY RADIATION

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RECENT work upon the degradation of polymethyl methacrylate by gamma-radiation[1] has shown that the radiation appears to have a greater effect at a higher temperature and that less energy is therefore required to degrade the polymer at 74° than at 18° C. With poly*iso*butylene, the effect has been studied in greater detail[2] and the experiments carried out leave no doubt as to its validity. From the initial experiments the dependence on temperature would seem to be rather unusual in character; the number of main-chain fractures for a given energy deposition increases approximately proportionally to the absolute temperature.

In view of the possible implications of this phenomenon for the mechanism by which radiation-induced changes are brought about in polymers, the behaviour of a system which exhibits cross-linking rather than degradation has been investigated. Polyethylene is particularly suitable for this purpose as, not only has its behaviour under irradiation been studied in considerable detail by Charlesby and his colleagues[3], but also the irradiated polymer exhibits rubber-like elasticity at temperatures above 120° C. which can readily be measured and is directly related to the degree of cross-linking[4].

A series of polyethylene specimens ('Alkathene' grade 7), cut to the shape of standard 3-in. dumb-bells, were irradiated in a 400-curie cobalt source over a temperature range − 196° to 75° C. The energy deposited in the specimen was estimated by ferrous sulphate dosimetry, taking the value of $G(\text{Fe}^{3+}) = 20$.

Elastic moduli of the irradiated specimens were measured by suspending the specimen in a constant temperature oven at 140° C. and applying weights at regular intervals by means of a cantilever device through the roof of the oven.

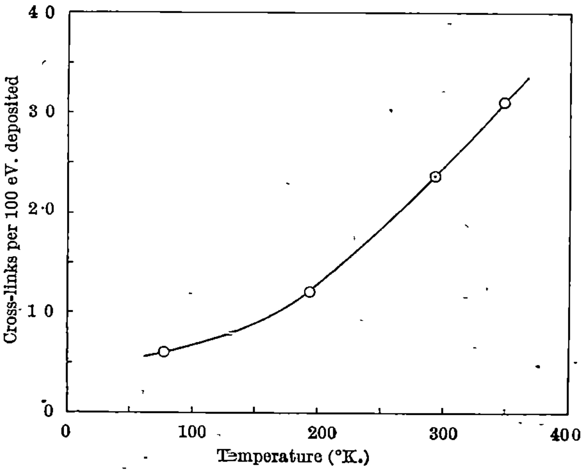

Fig. 1. Effect of temperature upon the cross-linking of polyethylene by gamma radiation

For rubber-like elasticity, the elastic modulus is inversely proportional to the molecular weight between cross-links (M_c), and can be expressed by the relationship :

$$E = \frac{3\rho R_g T}{M_c} \qquad (1)$$

where E is the elastic modulus in dynes/cm.², ρ the density of the polymer ($\sim 0{\cdot}92$), R_g is the gas constant ($8{\cdot}3156 \times 10^7$ in c.g.s. units), and T the absolute temperature at which the measurement is made (413° K). Now, M_c is defined by the expression :

$$M_c = \frac{M_0}{\gamma} \qquad (2)$$

where M_0 is the initial number-average molecular weight of the polymer and γ the cross-linking index or average number of cross-links per molecule produced by unit radiation dose. If q is the fraction of monomers cross-linked by such a dose and the number of cross-links is proportional to the radiation dose, R, received, then in a polymer of initial molecular weight M_0 there will be $M_0/14$ carbon atoms capable of being cross-linked and the molecular weight between cross-links after a radiation dose R will be given by :

$$M_c = \frac{14}{qR} \qquad (3)$$

Substituting this value for M_c in equation (1) gives :

$$E = \frac{3\rho R_g T q R}{14} \qquad (4)$$

It is desirable to express the amount of cross-linking produced by a given radiation dose in terms of the number of cross-links produced by an energy deposition of 100 eV., in agreement with present-day radiation chemistry procedure (G values), whence the G value for cross-linking (G_c) will be given by :

$$G_c = \frac{\text{fraction of carbons cross-linked in 1 gm. polymer}}{\text{energy deposited in 1 gm.}} \times 100$$

$$G_c = \frac{(N/14)q.R \times 100}{R} \quad (N \text{ is Avogadro's number, } 6{\cdot}023 \times 10^{23})$$

If R is initially expressed in eV. per gm. this becomes :

$$G_c = \frac{100Nq}{14} \qquad (5)$$

Substituting this value of q in equation (4) will give the G value in terms of elastic modulus and radiation dose only, whence it can be shown that

$$G_c = 6{\cdot}35 \times 10^{14} E/R \qquad (6)$$

Fig. 1 shows the values calculated in this manner over the range 77°–348° K. It is uncertain whether the curve should pass through the absolute zero.

As with polymers in which degradation processes predominate after exposure to high-energy radiation, the measured values leave no doubt that less energy is required to produce a cross-link as the irradiation temperature is increased. Moreover, the temperature relationship appears to be very similar, as can be seen from the curves of Fig. 2.

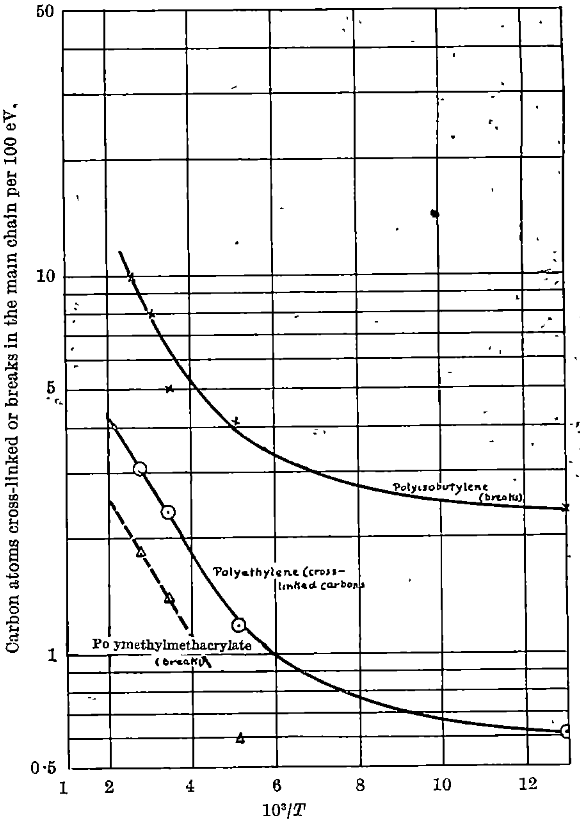

Fig. 2. Effect of irradiation temperature upon cross-linking and chain fracture in vinyl polymers

The mechanism by which cross-linking or degradation takes place must involve at least three stages : excitation or energy absorption, dissociation with ion or radical formation, and interaction of the excited radicals or ions to give stable products, whether carbon–carbon double bonds, cross-links or by disproportionation chain fracture. The amount of energy initially absorbed by the molecules which results in chemical change is very small, as bond-energies in general are of the order of 3–4 eV. and a larger proportion of the energy is either degraded into heat or re-emitted in the form of fluorescence radiation, which may afterwards be re-absorbed to bring about photo-dissociation[5]. This absorption process is generally held to be independent of temperature and it can therefore be concluded that the temperature effect is to be found in either the dissociation or interaction stages of the process. At first sight it might appear that the interaction stage is the critical one, as a plot of log G_c against I/T is approximately linear down to − 80° C. ; but, in view of the similar dependence on temperature of both cross-linking and chain-fracturing reactions, there is a possibility that the dissociation stage may also be involved.

My thanks are due to Dr. L. G. Brazier, director of research and education, British Insulated Callender's Cables, Ltd., for permission to publish this communication, and to Dr. P. Alexander and Dr. A. Charlesby for helpful discussion.

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LETTERS TO THE EDITORS

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Effects of Ionizing Radiations on Serum Complement and Enzymes

ANIMALS exposed to ionizing radiations almost invariably have a lowered resistance to bacterial infection. The serum complement system which aids lysis of invading bacteria is known to be readily inactivated by radiomimetic substances such as nitrogen mustard[1], and it was considered of interest to examine the effects of X-rays and electrons on this system *in vitro*. It was hoped that an investigation of the effect of various types of radiations on the relatively labile complement system might yield useful information about the biological effects of these radiations. The 15-MeV. linear accelerator at St. Bartholomew's Hospital has been used as the source of X-rays and electrons in all our experiments, and guinea pig serum has been used as a source of complement.

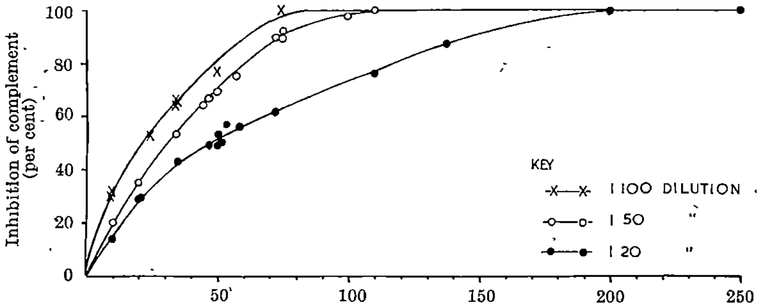

Fig 1

It has been found that doses of X-rays and electrons up to 200,000 rads have little or no detectable effect, if undiluted serum or strong solutions are irradiated; but when dilute solutions are irradiated, the specific hæmolytic activity of serum complement is destroyed. Fig. 1 shows the inhibition produced by irradiation with electrons as a function of dose and concentration of serum. With a very dilute serum (1 : 100 dilution) some inhibition was observed with as little as 500 rads, and it is considered probable that the enhanced destruction of complement in dilute solutions may be a result of the reduction of concentration of protective substances in the serum.

When using electron irradiation, the mean dose-rate was about 12 million rads per min.; but practically the same results were obtained with X-rays at a dose-rate of about 1,000 rads per min., indicating that the effect is independent of dose-rate.

The percentage inhibition is approximately an exponential function of the dose, but there does not appear to be a simple relationship between the amount of destruction and the degree of serum dilution.

In most of these experiments the diluted serum was irradiated in the presence of air; but irradiation of the serum in a Thunberg tube from which the air had been removed and replaced by nitrogen containing 5 per cent carbon dioxide did not produce a significant change in destruction of the complement in 1 : 20 or 1 : 50 dilution of serum, by an X-ray dose of 50,000 rads.

The destructive effect of X-rays on complement can be partially prevented by the addition of cysteine or cysteamine to the diluted serum before irradiation. For example, a dose of 50,000 rads completely destroyed the complement activity of diluted (1 : 50) serum, but the inhibition was reduced to 48 per cent in the presence of $M/500$ cysteine and to 32 per cent in the presence of $M/500$ cysteamine.

The possibility that complement inactivation by radiation was due to the production of anti-complementary substances in the serum during the irradiation has been examined. Irradiated dilute serum was added to normal serum, and subsequent determination of the total complement titre showed that no long-lived inhibitory substance was present in the irradiated serum.

An examination of the enzymic activity of samples of the irradiated and non-irradiated 1 : 20 and 1 : 50 diluted serum used for the complement tests showed that X-ray doses of 20 and 50 kilorads caused no reduction in the activity of the cholinesterase, lipase or alkaline phosphatase present in the serum. The fact that these enzymes are unaffected by the same conditions in which complement is powerfully inactivated emphasizes the marked selectivity in the biological effects of X-rays. This work is being continued by studying the serum complement and enzyme activity-levels in irradiated guinea pigs and other experimental animals.

Since hæmolytic complement is readily inactivated by nitrogen mustard[1], the results presented here provide a further instance of the similarity in biological effects produced by X-rays and the so-called radiomimetic substances (such as the nitrogen mustards).

These investigations form part of a programme of research carried out with the aid of grants provided by the Treasurer and the Board of Governors from the Discretionary Fund of St. Bartholomew's Hospital. One of us (P. J. H.) is also indebted to the Medical Research Council for a studentship.

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Absolute Amount of Ribonucleic Acid in Viruses

ON the basis of work with plant virus strains, Knight[1] expressed the view that all strains of virus contain the same quantity of nucleic acid. Recent experiments have shown that there exist a number of animal viruses which contain only ribonucleic acid. If one plots the percentage of ribonucleic acid against the particle weight of viruses containing ribonucleic

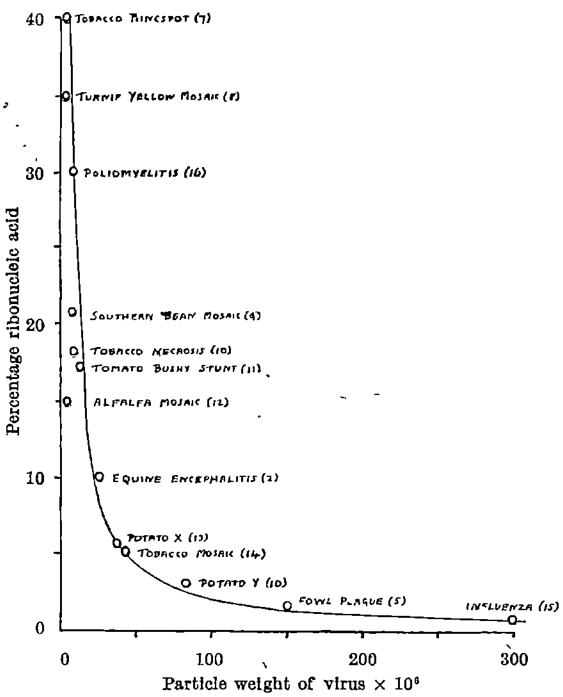

Fig 1. Percentage of ribonucleic acid in relation to particle weight of viruses containing ribonucleic acid

acid, a hyperbola results. Thus in animal viruses also the absolute amount of ribonucleic acid seems to be the same, and coincides with the quantity found in most plant viruses. As the actual equation of the hyperbola is percentage ribonucleic acid × molecular weight of the virus = 2×10^8, the average weight of the ribonucleic acid in a single virus particle amounts roughly to two million times that of a hydrogen atom.

This amount of ribonucleic acid consists of about 6,000 nucleotides. However, this should not be interpreted to be a single macromolecule comparable to some sort of gene. It has been shown in some strains of plant and animal viruses that there are smaller sub-units containing the total ribonucleic acid in smaller portions. Tobacco mosaic virus can be degraded to about 108 sub-units, still containing 5·5 per cent ribonucleic acid. This sub-unit has a particle weight of 360,000 [2]. If this unit contains only one molecule of ribonucleic acid, the molecular weight of the nucleic acid would be 20,000 and it would contain 60 nucleotides. The sub-unit of the influenza virus containing ribonucleic acid is the soluble antigen with a particle weight of 600,000 and a ribonucleic acid content of 5·3 per cent. About 70 such sub-units were found in an elementary body of the virus[3]. In this case the ribonucleic acid would contain 100 nucleotides. There are about 13 sub-units containing ribonucleic acid in fowl plague virus. These have a particle weight of about 1,300,000 and a ribonucleic acid content of 15 per cent[4,5]. The ribonucleic acid contains about 600 nucleotides.

It is probable that one single virus particle is sufficient to infect the host cell[6]. In spite of the different sizes of the elementary bodies and the different numbers of sub-units containing ribonucleic acid, it seems that it is the absolute amount of ribonucleic acid which is concerned with turning the normal metabolism of the host cell into virus production. This amount seems to be the same for viruses ranging from a particle weight of some millions to some hundreds of millions and acting upon a great variety of hosts—plants as well as animals.

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Isotopes incorporated in the Nucleic Acids of *Trypanosoma mega*

THE trypanosomes can be cultured in media containing nucleic acids or purines. *Crithidia fasciculata* grows in a synthetic medium with folic acid, guanine or guanosine[1,2]. *Trypanosoma cruzi* has been cultured by Citri and Grossowicz[3] in a defined medium enriched with ribonucleic acid, and its growth is stimulated by guanosine. *T. rhodesiense* seems to need adenine and adenosine as growth factors[4].

In view of these facts, we thought it interesting to try to discover whether trypanosomes could synthesize nucleic purines from simpler precursors such as labelled glycine and formate.

Experiments were made with a trypanosome isolated from the African toad, *Bufo regularis*. This trypanosome is morphologically identical with *Trypanosoma mega*, described by Dutton and Todd, Broden and Rodhain[5]. It has been cultured for more than a year in the medium used successfully by one of us (G. J. B.) for *T. cruzi*. This medium has the following composition: NaCl, 4 gm.; $\text{Na}_3\text{PO}_4 12\text{H}_2\text{O}$, 5 gm.; KCl, 0·4 gm.; glucose, 2 gm.; 'Bacto-tryptose Difco', 15 gm.; 'Oxoid' liver infusion, 1 gm.; hæmin, 20 mgm.; twice-distilled water, 1,000 ml.; *p*H adjusted to 7·8. The solution was sterilized by autoclaving for 10 min. at 10 lb. This medium contains large quantities of free purine bases, mainly hypoxanthine.

The trypanosomes were cultured at 24° C. either in roller tubes or in flat-bottomed flasks. After seven days, the culture was centrifuged, the trypanosomes were washed with buffered saline and suspended in culture medium containing a known quantity of labelled precursor (0·25–0·50 μc./ml.). After a period of incubation of 10–50 min. at 24° C., the trypanosomes were killed by ice-cold 1 per cent trichloracetic acid; they were washed several times with a 1 per cent trichloracetic acid solution of a carrier (adenine, formate or glycine, according to the experiments). The ribonucleic acids and deoxyribonucleic acids were hydrolysed and their components analysed by paper chromatography according to the method previously described by one of us (M. S.)[6]. The specific incorporation of the isotopes was determined in the adenine and in the guanine of both nucleic acids.

Adenine-8^{14}C was rapidly incorporated by *T. mega* for the synthesis of its nucleic acids. Adenine isolated from ribonucleic acid had a specific activity 3–10 times higher than adenine isolated from deoxyribonucleic acid. Adenine was incorporated 4–5 times more rapidly in the adenine-ribotides than in the guanine-ribotides, and about twice as rapidly in the adenine-deoxyribotides as in the guanine-deoxyribotides.

Simpler precursors such as glycine-2^{14}C and formate-^{14}C, even when samples of higher specific activity were used, were not incorporated in the purine bases of trypanosomes, although actively incorporated in their proteins. It seems, therefore, that *Trypanosoma mega* is unable to synthesize the purine nucleus.

The rapid incorporation of free adenine by *T. mega* suggests that the ribonucleic acid contained in the medium of Citri and Grossowicz could be, at least partially, replaced by free bases.

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Metabolism of Isolated Liver Cells

Longmuir and ap Rees[1] have recently described a new method for preparing suspensions of isolated rat liver cells. We have been interested for some time in the metabolic properties of such isolated cells, and wish to direct attention to some of their peculiarities not mentioned by these authors.

Four methods are now available for preparing such material: (*a*) simple squeezing or crushing of the liver tissue; (*b*) the method of Anderson[2], in which the cells are loosened by a preliminary perfusion of the organ with a calcium-free solution containing citrate or versene, with subsequent squeezing of the tissue as in (*a*); (*c*) the method of Kaltenbach[3], in which the tissue without previous treatment is pushed through sieves of increasingly fine mesh; and (*d*) the method of Longmuir and ap Rees[1], in which the minced tissue is incubated in a slightly acid medium (*p*H 5–6) and then disrupted by violent agitation. In all four methods a large proportion of the cells is broken, and the remaining whole cells are obtained free from cytoplasm, cytoplasmic particles, nuclei, debris and red blood cells by differential centrifugation. The yield of isolated cells obtained by the different methods varies very widely, that of Anderson giving in our hands a yield incomparably better than any of the others (Table 1); moreover, this method invariably yields suspensions consisting almost exclusively of single cells, whereas those obtained by the other methods we have found to be frequently contaminated with cell clumps.

Table 1. Total Dry Weight of Isolated Rat Liver Cells obtained by Four Different Methods

Method of preparation	No. of exps.	Average yield of cells (mgm. dry wt./rat liver)
1. Simple washing	2	20
2. Method of Anderson (ref. 2)	13	190
3. Method of Kaltenbach (ref. 3)	3	18
4. Method of Longmuir and ap Rees (ref. 1)	3	12

The outstanding characteristic of these isolated cells, by whichever method prepared, is a complete absence of respiration, and no addition to the medium so far tested will restore this capacity (glucose, pyruvate, citrate, cytochrome *c*, adenosine triphosphate, blood serum and a liver extract freed from mitochondria have been added; 2 : 4-dinitrophenol also does not elicit any respiratory activity). Kaltenbach[3] has stated that cells prepared by his method show a respiration not dependent on the addition of succinate but does not indicate its magnitude; this we have not been able to confirm.

Further, the isolated cells have lost their capacity to convert intracellular glycogen to lactic acid. The only metabolic processes associated with catabolism which remain are those of succinoxidase and fumarase. The succinoxidase activity is of similar magnitude in cells prepared by all four methods (Table 2) and is greatly augmented compared with the values found in the original tissue; it is not affected by the addition of cytochrome *c*. In several batches of cells Q_{O_2} values in the range − 140 to − 160 have been observed, and these are higher than can be accounted for by the activity of the isolated mitochondria[4]. It appears, therefore, that the mitochondria *in situ* are more active in this respect than when isolated in hypertonic sucrose solution.

Table 2. Endogenous Respiration and Succinoxidase Activity of Liver Cells, in Slices and in Suspension

Condition of cells	Method of preparation	No of exps.	Q_{O_2} (endogenous)	Q_{O_2} (succ.)
Slices	—	8	−11·1	−26·2
Isolated cells	Crushing	2	−0·3	−68
,,	Anderson (ref. 2)	11	−0·2	−113
,,	Kaltenbach (ref. 3)	2	0	−73
,,	Longmuir and ap Rees (ref. 1)	2	0	−88

Longmuir and ap Rees[1] give a figure of − 18 for the Q_{O_2} of their cells in the presence of succinate. This is about one-sixth of the figure we have obtained, and the discrepancy may perhaps be explained by the following facts. The Q_{O_2}(succ.) of the cells is maximal only at high succinate concentrations (0·025 *M*), and only if the cell concentration in the test mixture exceeds a critical value which is of the order of 1·5 mgm. dry weight/ml. (Table 3). The

Table 3. Relationship between Cell Concentration and Q_{O_2}

Concentration of cells (mgm. dry wt./ml.)	Q_{O_2} (succ.)
0·52	−2
1·03	−70
1·55	−90
2·5	−96
3·6	−107
5·2	−96

succinoxidase activity which is lost on dilution of the cells may be restored by the addition of an extract of liver cells, but not by cytochrome *c*.

We believe the most interesting part of these observations is the complete loss of endogenous metabolism in isolated liver cells, by whatever method they are prepared, and are anxious to discover the nature of the change in the cells which leads to this result. By contrast, it is well known that isolated tumour cells of various ascites tumours are still capable of catabolizing, and at an increased rate compared with the same tumour grown in the solid form.

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Salicylate and Carbohydrate Metabolism

WE have observed that when rat diaphragms are incubated aerobically in the medium of Sacks and Sinex[1] with $5 \times 10^{-3}\,M$ salicylate the amounts of creatine phosphate and adenosine triphosphate in the tissue are significantly reduced and the inorganic phosphorus increased (Table 1).

A possible explanation of these results is that salicylate interferes with oxidative phosphorylation processes and inhibits the synthesis of high-energy phosphate bonds. Support for this view is provided by the similarity between the effects of salicylate and 2:4-dinitrophenol, which is known to interfere with oxidative phosphorylation reactions[2]. Both salicylate and dinitrophenol increase the oxygen consumption of whole animals and isolated tissues[3,4] and dinitrophenol also reduces the creatine phosphate and adenosine triphosphate in the rat diaphragm[1,5].

$5 \times 10^{-3}\,M$ salicylate has been observed[6] to decrease the glycogen and increase the lactic acid production and the respiratory quotient of the rat diaphragm, and these changes may be evidence of substrate being broken down to provide energy for increasingly inefficient phosphorylation processes. The decreased glucose uptake also found in the diaphragms in the presence of salicylate is explicable on the same basis if the first step in glucose utilization involves phosphorylation.

The concept that salicylate may prevent the normal synthesis of high-energy phosphate bonds and hence impair the general efficiency of synthetic processes may also provide an explanation of some of the effects of the substance on carbohydrate metabolism in animals. The subcutaneous injection of salicylate, producing plasma salicylate concentrations of the order of $5 \times 10^{-3}\,M$, causes a marked depletion of the blood glucose concentration of the fasted alloxan-diabetic rat[7]. In this animal preparation the blood glucose-level is maintained by synthetic reactions, the increased liver glucose-6-phosphatase activity present[8] producing hyperglycæmia rather than deposition of liver glycogen. The hypoglycæmic effect of salicylate may therefore be due to an impairment of synthetic ability caused by an interference with the formation of high-energy phosphate bonds. Similar considerations may apply to the effect of salicylate in causing a depletion of the liver glycogen in the normal rat[9] although adrenaline release may also be an important factor[10].

Full details of the experiments described above will be published elsewhere.

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Elastomucoproteinase and Collagenmucoproteinase, the Mucolytic Enzymes of the Pancreas

THE elastolytic enzyme of human and animal pancreas which we have named elastase[1–4] seemed to be specific for elastic fibre[5], but apparently had no effect on native collagen fibre. Hall, Reed and Tunbridge[6] have shown that elastase preparations have some effect on the mucopolysaccharide of elastin also, and during digestion sulphate and polysaccharide components are split off from elastin. Hall[7] suggests the existence of two enzymes acting on elastin, having evidence that one of these must be regarded as a mucolytic one. Partridge and Davis[8] determined the release of N-terminal residues from elastin by elastase

Table 1. EFFECT OF $5 \times 10^{-3}\,M$ SALICYLATE ON THE INORGANIC PHOSPHORUS, CREATINE PHOSPHATE AND ADENOSINE TRIPHOSPHATE OF THE RAT DIAPHRAGM INCUBATED AEROBICALLY

Mean values ± *S.D.* and ranges are given for the results, which are expressed as mgm. inorganic phosphorus/100 gm. wet weight. The figures in brackets represent the number of experiments

	Inorganic phosphorus			Creatine phosphate			Adenosine triphosphate		
Time (min.)	15 (8)	30 (12)	60 (11)	15 (8)	30 (12)	60 (11)	15 (8)	30 (6)	60 (8)
Control	23·2±3·7 18·1–29·3	25·5±3·7 20·2–31·3	25·7±4·0 19·8–32·1	22·6±3·4 18·4–29·3	19·1±3·6 13·0–24·1	18·4±4·8 10·6–24·1	27·9±4·4 21·7–34·4	20·9±3·8 16·6–27·0	24·3±3·4 18·4–27·5
Salicylate	51·6±3·6 46·9–55·5	41·8±4·2 35·4–47·7	36·4±4·6 30·0–41·4	1·5±2·5 0–7·5	3·5±2·9 0–7·0	3·8±2·0 1·0–6·7	14·3±6·0 3·8–25·2	3·9±2·9 0–7·7	7·6±2·7 5·2–12·2

Statistical comparison between the results of the control and salicylate groups showed that $P < 0{\cdot}001$ at each point and concluded that elastase preparation contains a proteolytic component also.

Our recent experiments have proved that elastase preparation purified to a high degree is still not homogeneous but consists of several protein components. We wish to retain the name 'elastase' for the enzyme which has a proteolytic effect on elastin. So, according to this nomenclature, the elastase is a proteinase. Banga[9] has shown that besides elastase the pancreatic extract contains an enzyme which acts on the mucoprotein of human sera and is different from the mucolytic enzyme acting on elastin. Here we wish to report some new findings which show that pancreatic extracts do contain enzymes acting on the mucoproteins of connective tissues. Two enzymes will be described, which seem to be distinct from each other. One acts on elastomucin and the other splits the mucoprotein from native collagen fibre. The first may be called elastomucoproteinase and the other collagenmucoproteinase.

The polysaccharide of both the mucoproteins of elastin and collagen was determined by the quantitative method of the Molisch reaction worked out by Szára[10] and used by Bagdy and Szára[11] for the examination of the polysaccharide of fibrinogen. With this method 10–100 μgm. sugar can be determined in an exact manner. The reagent 1-naphthol-2-sulphuric acid is soluble in water, and with glucose, galactose and mannose gives the same mauve colour with uniform intensity. Mucoproteins, enzymatically split from elastin and collagen, react with the reagent but give different colours. The polysaccharide of elastomucin turns from mauve to red with increasing concentration, but the mucoprotein which is split off enzymatically from native collagen fibres reacts with orange-yellow colour. These two different colours prove the difference of the polysaccharide components building up elastomucin and the mucoprotein of collagen respectively. The deviation in colour from the known hexoses indicates that the composition of the mucopolysaccharides of elastin and collagen is not homogeneous and contains unknown components also.

The quantity of the mucoproteins of collagen and elastin which split off enzymatically were determined using concentration curves obtained empirically against a blank. Since these curves are straight lines for concentrations between 10 and 100 μgm. and conform to the monosaccharide of adequate quantity, we inferred that we could calculate the plausible value of these mucopolysaccharides.

The substrate for measuring the elastomucase activity was the preparation of lig. nuchae also used by Hall[7] which was freed from collagen by boiling with acetic acid. The elastomucoproteinase splits off the elastomucin from this preparation. 20–25 per cent of this polysaccharide was dialysed against water, from which we concluded that at least a part of the polysaccharide is present as a component of low molecular weight. The *p*H optimum for elastomucase is 7·3–7·4. The *p*H curve could not be determined in an exact manner in alkaline *p*H because the elastomucin is hydrolysed from the elastin at this *p*H without enzyme too. On the other hand, at alkaline *p*H the elastase which is present in small quantity displays its proteolytic activity also.

For studying the activity of collagenmucoproteinase, collagen fibres of rat-tail tendon and of bovine Achilles tendon were used.

The collagenmucoproteinase dissolves a mucoprotein from the native collagen fibres as well as from the collagen fibres treated with alcohol. The quantity of the dissolved mucoid is 5–8 per cent of the native protein. The polysaccharide content of the mucoprotein is between 8 and 12 per cent, from which 20 per cent can be dialysed against water. The *p*H optimum of the enzyme is 7·4. If the enzyme acts on native collagen fibre the dissolved mucoprotein with 1-naphthol-2-sulphuric acid gives an orange-yellow colour but the mucoprotein dissolved from the alcohol-treated collagen reacts with a red colour. The collagenmucoproteinase has no proteolytic action on collagen and does not dissolve it. The collagen treated with collagenmucoproteinase and afterwards heat-contracted can be dissolved entirely with elastase[12], and the collagenolysate obtained in this way contains 0·20–0·25 per cent polysaccharide, which gives with the above reagent a mauve colour. This observation proves our former suggestion[13] that two kinds of mucopolysaccharide exist in the collagen fibre: that which can be dissolved from the native collagen without dissolving the protein, whereas the other is bound firmly to the protein and can be released only when the collagen is digested.

It seems that the system of the elastase complex contains a whole series of enzymes acting on connective tissue fibres and mucoproteins. These enzymes could not be demonstrated in raw pancreatic extract because of the inhibiting effects of the specific enzyme inhibitors. After purifying the extract these enzymes, which chemically resemble one another closely, can be demonstrated by their specific activity.

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Alkaline Phosphatase in the Rabbit Mammary Gland

STRONG positive reactions for alkaline phosphatase have been reported in the basket or 'myo-epithelial' cells of the mammary gland of some pregnant and lactating mammals[1,2]. Progressive transfer of this activity from the basket cells to the adjacent capillary endothelium later in pregnancy has also been described[1].

Mammary tissue from pregnant and lactating rabbits, taken 14, 20, 23 and 24 days after mating and 9 and 14 days after parturition, was fixed for 14 hr. in acetone at 4° C., vacuum-embedded in paraffin (m.p. 45° C.) and sectioned at 5 or 15μ. Alkaline phosphatase activity was demonstrated by Gomori's technique[3] or by a modified coupling azo-dye method[4], using the stable diazotates of *o*-dianisidine or

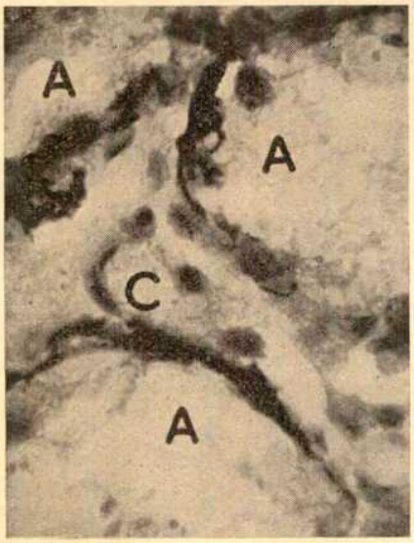

Fig. 1. Mammary tissue from a pregnant rabbit 24 days after mating, incubated with *o*-dianisidine, nuclei coloured by the Feulgen reaction. Parts of three alveoli (*A*) are seen, with the alkaline phosphatase reaction limited to the basket cells. Between them lies a capillary (*C*) the walls of which show a negative reaction. (× 900)

4-chloro-*o*-anisidine, with sodium α-naphthyl phosphate as the substrate. Following incubation some of the sections were treated by the *PAS* technique[4] and in others the nuclei were demonstrated by the Feulgen reaction. These procedures facilitated the accurate localization of the phosphatase reaction without causing any apparent loss of intensity or diffusion of the precipitate compared with untreated sections.

All the samples of tissue except that taken 14 days after mating gave a strong positive reaction after 5 min. incubation with the diazotate; in the latter sample alveolar development was still slight, and the reaction faint. The coloration obtained was sharply limited to the basket cells in all cases, and absent from all nuclei, true alveolar cells, capillary walls and stroma (Fig. 1). Increasing periods of incubation up to 15 min. increased the intensity of coloration but did not affect its location.

The Gomori preparations showed in addition to intense darkening of the basket cells some slight and variable darkening of nuclei, capillary walls and stroma, which became more marked as the incubation time was increased up to 3 hr.; control sections showed no reaction.

It is considered that in the rabbit the alkaline phosphatase of the mammary gland is confined to the basket cells throughout pregnancy and lactation, and that there is no transfer of activity from these cells to the adjacent capillary endothelium in the later part of pregnancy. Rapid embedding in low melting-point paraffin enables alkaline phosphatase activity to be demonstrated with short incubation times, and minimizes diffusion artefacts.

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Properties and Composition of the Bile Pigment giving a Direct Diazo Reaction

THE bile pigment, giving the van den Bergh reaction with the diazo reagent in the absence of organic solvents, displays highly polar properties. Conjugated deoxycholic acid has been erroneously supposed to be a component which imparts to this pigment these properties (water-solubility, chloroform-insolubility, electrophoretic mobility, etc.)[1]. This statement was made on the basis of experiments with a preparation from bile containing a large excess of bile salts.

Further experiments[2] concerning the action of enzymes on the directly reacting bile pigment showed the splitting of the bilirubin from the 'direct' pigment under the influence of spleen or bacterial β-glucuronidase and of liver and pancreatic esterases. These enzymic reactions suggest the presence of glucuronic acid in this pigment. The extreme lability toward alkalis is in favour of the ester glucosidic linkage.

In order to prove the presence of glucuronic acid in the direct pigment, the crude preparation from bile (obtained by fractionated precipitation with acetone and rich in this pigment) was purified by reprecipitation with acetone and hydrolysed with ammonia at room temperature. Ammonia was removed *in vacuo* over sulphuric acid and the glucuronic acid was demonstrated by paper chromatography and colour reactions. The bile acids and the ninhydrin-positive material present in the preparation obtained from bile, with the aid of acetone, can be essentially removed. The pigment was precipitated from the solution of this preparation from dog bile by lead acetate and the washed precipitate has the composition corresponding to lead bilirubinyl-*bis*-(β-glucoside uronate)[3].

Billing and Lathe simultaneously came to the same conclusion; but different methods were used in their experiments[4]. Thus, the composition of the directly reacting pigment from bile is now confirmed by independent experiments from both sides.

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An Unfavourable Effect of Shaking on Fungal Cellulases

SHAKING in some form or other is often resorted to during the incubation of enzymes with their substrates in order to obtain uniformity of results and a high rate of enzyme activity. In studies with insoluble cellulosic substrates this has been the usual practice among various workers. However, in an investigation of the cellulolytic activities of the culture filtrates of some fungi, preliminary experiments indicated that no advantage was to be gained by shaking, either in uniformity or in rate of enzyme activity, and that shaking might actually be harmful. Some of these experiments are summarized below; fuller details will be published elsewhere.

The culture filtrates were prepared by growing six cellulose-decomposing fungi on Czapek–Dox salt solution with filter paper as carbon source, at 30° C. for 6–9 days; the stale medium, after filtering through fritted glass, was used as the source of enzyme. The substrates were reactive cellulose, prepared by treating cotton linters with phosphoric acid as described by Walseth[1], and sodium carboxymethyl-cellulose, in the form of 'Cellofas *B*', which was dissolved in hot water before use.

Hydrolysis was carried out in 125-ml. duplicate 'Pyrex' conical flasks, each containing 200 mgm. substrate, 2 ml. enzyme and 10 ml. $M/10$ acetate buffer at *p*H 5·0 saturated with the antiseptic pentachlorophenol; the volume was made up to 20 ml. with distilled water. After incubation at 37° C. for 3 hr., 5 ml. of the hydrolysate was withdrawn and titrated for reducing sugar, according to Somogyi's micro-method[2]. The titres were corrected by subtracting the blank titres for substrate alone and enzyme alone.

One set of flasks was incubated in a water-jacketed electrical incubator and the other set clamped to a movable metal frame situated above a thermostatically controlled water-bath; the bottom parts of the flasks were submerged in water and the shaking frame moved with a to-and-fro motion parallel to the water surface across a distance of 0·9 in. with 130 strokes per minute in each direction. In both incubator and water-bath, variation in temperature was well within ± 0·5 deg.

It was found that shaking decreased the hydrolysis of both substrates by all the enzyme solutions (Table 1). Moreover, unshaken flasks gave equally concordant titres. These results were confirmed by repeated experiments in which the time and temperature factors were carefully equalized between incubator and water-bath.

Another experiment indicated that this effect might be partly due to the inactivation of the cellulase enzyme molecule itself by shaking. In this experiment, the six enzyme solutions were first incubated without substrate, with and without shaking, for 3 hr. at 37°; from these, 1 ml. quantities were then reincubated with reactive cellulose as usual. The results given in Table 2 show that enzyme solutions previously shaken were less active than the unshaken ones.

For the sake of comparison, the activities of three other enzymes in a fungal extract prepared from *Aspergillus oryzae* were studied in the shaken and unshaken states. These were invertase, amylase and proteinase, with sucrose, starch and gelatin as substrates. No effect of shaking was observed, except with amylase, which registered a 10 per cent fall in titre in the shaken flasks, after incubation for 3 hr. Equally concordant results were obtained with and without shaking in every case.

Table 1. ENZYME TITRES (ML., $N/200$ THIOSULPHATE) WITH AND WITHOUT SHAKING

Fungus	Sodium carboxymethylcellulose		Reactive cellulose	
	Without shaking	With shaking	Without shaking	With shaking
Curvularia lunata	4·25 4·15	1·55 1·60	1·70 1·70	0·80 0·90
Aspergillus fumigatus	10·15 10·25	8·35 8·50	1·95 2·00	1·90 1·95
Chaetomium indicum	8·80 —	2·15 2·40	0·80 0·75	0·70 0·65
Penicillium rubrum	11·50 11·40	7·35 7·25	1·95 2·05	1·70 1·80
Penicillium wortmanni	13·05 12·90	12·01 12·15	1·45 1·50	0·95 0·80
Myrothecium verrucaria	4·55 4·55	2·55 2·45	— —	— —

Table 2. EFFECT OF PREVIOUS SHAKING OF CELLULASE SOLUTIONS ON ENZYME TITRE

Fungus	Titre (ml., $N/200$ thiosulphate)	
	Not shaken	Previously shaken
Curvularia lunata	13·50 13·65	10·60 10·40
Aspergillus fumigatus	4·85 4·80	4·15 4·05
Chaetomium indicum	1·65 1·75	1·35 1·45
Penicillium rubrum	9·40 9·40	7·80 7·75
Penicillium wortmanni	1·60 1·80	0·95 0·90
Myrothecium verrucaria	0·65 0·60	0·55 0·60

Thanks are due to the Research Director, Indian Jute Mills Association Research Institute, for permission to publish these results.

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Enzymatic Formation of Hexosamine in Epiphyseal Cartilage Homogenate

CHONDROITIN sulphate, or its protein complex, may be an integral part of the process of calcification[1,2]. Sulphate-containing mucopolysaccharides appear whenever calcification takes place.

According to Neuman *et al.*[3] and Caglioti *et al.*[4] calcium should be bound to the molecule of chondroitin sulphuric acid by one valence of the sulphuric group.

Rubin and Howard[5] found an increase in metachromatic staining in regions where there is active calcification, and attributed this effect to an increase in the concentration of chondroitin sulphate or a change in its degree of polymerization; however, the chondroitin sulphate is modified by the cells during the first stage of calcification. For this reason we have decided to study chondroitin sulphate metabolism in epiphyseal cartilage, beginning with the formation of hexosamine which is a component of chondroitin sulphate.

A preliminary report of this work has already appeared[6].

Work by Leloir and Cardini[7] has shown that hexosamine may be derived from glutamine and hexose-6-phosphate. An enzyme system catalysing this synthesis has been found in *Neurospora crassa*. As significant amounts of hexose-6-phosphate and glutamate are present in the epiphyseal cartilage, a similar enzymatic mechanism was supposed by us to exist in cartilage homogenate.

Epiphyseal cartilage of growing rabbits was used. The tissue was excised at 0° C., and homogenized with a cold solution of 10^{-2} M glutamine and 10^{-2} M glucose-6-phosphate in 0·1 M citrate buffer (*p*H 6·4). Test-tubes were incubated at 30° C. for 3 hr. The enzymatic reaction was blocked by immersion in boiling water for 10 min. and the addition of hydrochloric acid. The final concentration of the acid was $0 \cdot 3\,N$. The hexosamine present in the supernatant liquids before and after incubation was estimated by Schloss's method[8].

These experiments have shown that epiphyseal cartilage homogenates can synthesize very large quantities of hexosamine (*c.* 900γ per gm. of fresh tissue during 3 hr.). This activity is destroyed by immersion of homogenates in boiling water.

Other tissues have been investigated with regard to their ability to synthesize hexosamine : rib cartilage, liver and lung homogenates showed synthesis of very small amounts of hexosamine. Heart, kidney, and spleen homogenates and blood were completely inactive.

We may therefore conclude that a thermolabile enzymatic system, catalysing the synthesis of hexosamine from glutamine and glucose-6-phosphate, is present in epiphyseal cartilage. The enzymatic activity is much greater in this tissue than in others (about ten-fold). For this reason we could consider this enzyme a part of the "local factor(s)" (Sobel[9]) connected with the mechanism of calcification.

Recently a report has been published by Boström *et al.*[10] concerning the influence of glutamine in chondroitin sulphate synthesis in slices of cartilage. Our findings, regarding the formation of hexosamine, and those of Boström *et al.*, regarding the catalytic action of glutamine in chondroitin sulphate synthesis, are essentially in agreement. In fact, hexosamine could constitute an intermediate point in the synthesis of chondroitin sulphate.

Work is being carried out to determine whether, in our experiments, there is an increase in the amount of chondroitin sulphate, utilizing the hexosamine formed by the aforementioned enzyme.

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A Rapid Method for estimating Total Protein in Milk

IN 1944, Fraenkel-Conrat and Cooper[1] determined the acid-binding capacities of several proteins by treating the protein with an excess of an anionic dye, orange *G*, at a *p*H of 2·2. The dye and protein react quantitatively to form an insoluble complex which can easily be separated either by centrifuging or filtering. (Ordinary filter paper binds a small amount of dye which must be accounted for to obtain accurate results.) From the concentration of unbound dye (measured colorimetrically), the binding capacity can be calculated. Using this method in principle in an investigation designed to determine the acid-binding capacities of several protein fractions derived from wheat flour, I[2] noted an unexpected uniformity in the binding capacity of mixtures of the two major fractions as obtained from each of several varieties of wheat. These two individual protein fractions have binding capacities differing by a factor of nearly two.

The foregoing observation prompted a study of the binding capacities in whole wheat and wheat flour which led to the conclusion that when the total proteins of either of these products are taken collectively, these proteins can be characterized by a single binding capacity value. Although starch and bran of wheat also bind some dye, the total protein in whole wheat and wheat flour can be conveniently measured by this technique. (A detailed account of this work has recently been published[3]. Application has been made for a public patent.)

An extension of this general technique to the determination of total protein in milk products has been made. The assumption that the total protein in milk also has a common binding capacity is substantiated by the results of tests on more than one hundred samples of milk.

Samples of fresh whole milk and spray-dried milk were obtained from the dairy herd at the State College of Washington through the courtesy of the Department of Dairy Science. Two series of measurements were made. In the first, 1·5 ml. aliquots of fresh milk were mixed with 25·0 ml. of buffered orange *G* dye. The concentration of added dye was 1 gm./l. After being shaken for 5 min., the mixture was centrifuged. The concentration of unbound dye in the clear supernatant was measured in a special absorption cell of short light-path (a note describing this cell has been submitted to *Analytical Chemistry* for publication) using a 470-mμ filter in an Evelyn photoelectric colorimeter. Galvanometer readings were estimated to the nearest 0·1 per cent transmission.

Results of tests on seventy-three samples of liquid whole milk from Holstein, Jersey and Guernsey breeds of dairy cows are presented in Fig. 1. The protein values (N × 6·38) were determined by a standard macro-Kjeldahl procedure in routine analyses by the Dairy Science Department.

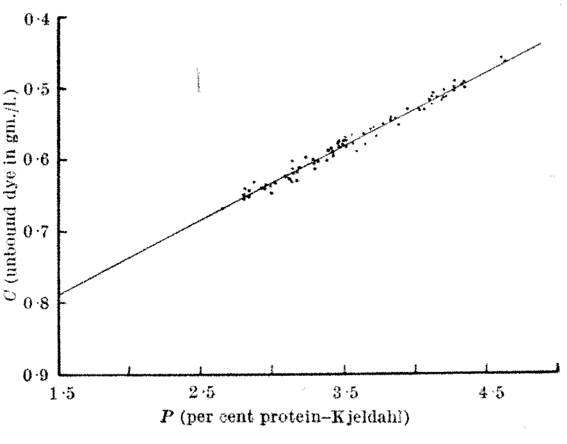

Fig. 1. Relationship between protein content of liquid whole milk and the concentration of unbound dye at equilibrium. Standard error of estimate is 0·07 per cent protein

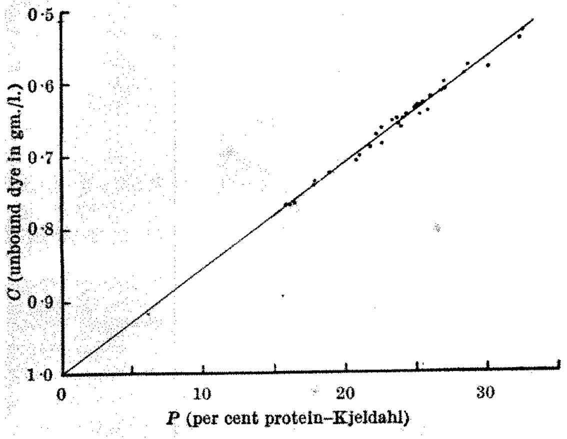

Fig. 2. Relationship between protein content of spray-dried milk and the concentration of unbound dye at equilibrium. Standard error of estimate is 0·42 per cent protein

A second series of measurements was made on thirty-four samples of spray-dried milk. The butter-fat content was altered in some of these samples before spray drying. Except for the size of sample (200 mgm.) and the time of shaking (30 min.), the procedure was unaltered. The ratio of protein to dye was adjusted in each series so that the concentration of unbound dye did not drop appreciably below 0·5 gm./l. Quantitative binding is not obtained if the concentration of dye becomes too dilute. The results are shown in Fig. 2.

Evidently the only constituents binding the dye are the milk proteins, since a line drawn through the experimental points passes very near the origin. In Fig. 1 the origin is different from that in Fig. 2 because of the diluting effect of the added liquid sample (see equation 3 below). A general equation expressing the protein content can be written as follows :

$$P = \frac{100\,[VC_0 - (V + v)\,C]}{kEvd} \qquad (1)$$

where P is the percentage protein, V is the ml. of stock dye solution added, v is the ml. of milk added, C_0 is the concentration of stock dye in gm./l., C is the concentration of unbound dye at equilibrium, k is the equivalent weight of the dye (226 gm.), E is the milliequivalents of dye bound per gram of milk protein, and d is the density of the milk sample.

In the case where the sample is solid, ($v \times d$) in the denominator is replaced by W (the weight of the sample in gm.) and the value of v in the numerator s zero. We then have the equation :

$$P = \frac{100\,V\,(C_0 - C)}{kEW} \qquad (2)$$

When equation (1) is solved for C, we get :

$$C = \frac{VC_0}{(V + v)} - \frac{kvdE}{100\,(V + v)}\,P \qquad (3)$$

This is the equation of a straight line, and as plotted n Figs. 1 and 2, C is the ordinate, P the abscissa, $VC_0/(V + v)$ the intercept, and the coefficient of P s the slope.

Treatment of the results by the method of least quares gave slope values of 0·1043 and 0·01455, espectively, for the data in Figs. 1 and 2. From these lopes, the respective values of E were computed. For liquid whole milk E is 0·792 and for spray-dried milk E has a value of 0·805. The small difference can probably be attributed to denaturation occurring during the processing of spray-dried milk. These values are close to those reported in the literature[4] for casein.

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Fractionation of Human Urinary Gonadotrophins

Follicle-stimulating and interstitial cell-stimulating hormones can be extracted from animal pituitary glands; but there is little evidence that two such substances can be separated from human urine. Walter[1] suggests that separation is possible, and recent evidence[2] is claimed to show that the levels of the two hormones in human urine vary independently. This evidence was obtained by using two assays simultaneously: one assay is believed to measure the combined effect of both hormones and the other to measure the follicle-stimulating hormone alone[3]. The two assays have now been used for investigating the fractionation of human urinary gonadotrophins.

Three crude extracts were made from pooled human urine by adsorption on kaolin. The urine was from normal and abnormal subjects belonging to the categories shown in Table 1. No subjects were pregnant, and pregnancy would not have been overlooked as they underwent detailed and prolonged observation. The crude extracts were fractionated by the method of Butt and Crooke[4] and fraction B was assayed in terms of fraction A by both methods.

The results (Table 1) show that comparison of the same fractions by the different assays gave significantly different estimates of relative potency in two cases. All assays were of at least four-point design and there was close parallelism between dose-response lines. The results therefore show that human urinary gonadotrophin can provide fractions with different biological activities.

The probable reason for this biological difference is a separation of the gonadotrophins, but the influence of other hormones must be excluded. It is unlikely that prolactin interferes in these assays; but œstrogen can do so[3]. Both fractions from the young adult women were therefore tested for œstrogen by the method of Butt and Kinnear[5]. The dose given

Table 1

Subjects	Fraction B as percentage of fraction A (95 per cent fiducial limits)	
	Total gonadotrophin assay	Follicle-stimulating hormone assay
Postmenopausal women	21 (11–35)	19 (9–50)
Young adult women	47 (29–66)	20 (15–29)
Men	102 (69–175)	44 (39–50)

to each spayed mouse represented ten times the greatest dose used in the gonadotrophin assays. No œstrogenic effect was detected. There was insufficient material from the men for this test, but in one case at least interference from œstrogen was shown to be unlikely.

The different biological activities of the fractions are therefore considered to demonstrate a partial separation of follicle-stimulating and interstitial cell-stimulating hormones.

This investigation was supported by grants from the Endowment Fund of the United Birmingham Hospitals Medical Research Committee.

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Restoration of Sodium-deficient Frog Nerve Fibres by an Isotonic Solution of Guanidinium Chloride

It has been known for some time that certain quaternary ammonium ions are able to restore the ability to conduct impulses to the small myelinated and unmyelinated fibres (*B* and *C* fibres) of frog nerve that has become inexcitable in a sodium-free medium. Quaternary ammonium ions do not restore the excitability of the large myelinated fibres (*A* fibres)[1].

It has been found that the guanidinium ion, which also has a tetracovalent nitrogen atom[2], restores to sodium-deficient *A* fibres the ability to conduct impulses, while it fails to restore the excitability of *B* and *C* fibres.

In order to avoid the question as to whether or not the epineurium is an effective diffusion barrier, the experiments have been performed with the spinal roots or with the sciatic nerve after removal of the epineurium. Large bull-frogs have been used throughout. All solutions were $0{\cdot}11\,N$ and were prepared by dissolving the hydrochloride of the substance in redistilled water in 'Pyrex glass' containers. (Years ago, several samples of a commercial preparation of 10 per cent aqueous solution of tetraethyl-ammonium hydroxide, which was marketed by a reputable firm in containers of soft glass, were found in this laboratory to contain sodium ions at the concentration $8\text{–}10 \times 10^{-3}\,N$.) A few drops of sodium-free $0{\cdot}006\,M$ diethanol-dimethyl-ammonium phosphates buffer were added, which usually brought the *p*H of the solution to 7·2–7·3. When not, the *p*H of the solution was adjusted to 7·2–7·4 with diethanol-dimethyl-ammonium hydroxide. Analyses with a flame photometer have shown that the concentration of sodium ions in the test solutions was below $10^{-5}\,N$. (Frog nerve fibres become inexcitable in a solution containing sodium ions at the concentration $3 \times 10^{-3}\,N$ practically as fast as in a sodium-free medium.)

The motor root becomes inexcitable in an inert sodium-free medium ($0{\cdot}11\,N$ diethanol-dimethyl-ammonium or choline chloride) in 16–25 min. Judging by the height of the restored spike, guanidinium chloride restores the ability to conduct impulses to approximately 80–90 per cent of the *A* fibres. The sensory root becomes inexcitable in 12–20 min. Guanidinium ions restore approximately 70–80 per cent of the *A* fibres. In both instances the restoring action begins instantaneously and becomes maximal in less than 3 min. The desheathed sciatic nerve becomes inexcitable in 2–4 min. and the guanidinium ions restore approximately 60–80 per cent of the *A* fibres. The restoring action begins instantaneously and becomes maximal in less than 5 min. In all cases the spike duration, the speed of conduction and the relatively refractory period of the restored fibres were found to be practically normal.

The effects of several substituted guanidines—methyl, N,N-dimethyl, *n*-amyl and N,N′,N″-triethyl—have been investigated. (Guanidine hydrochloride, methyl guanidine sulphate, N,N-dimethyl guanidine sulphate and arginine hydrochloride were purchased from Distillation Products Industries, Division of Eastman Kodak Company. *n*-Amyl guanidine sulphate was synthesized by the method used by H. King and I. M. Tonkin[3] for the synthesis of *n*-butyl guanidine sulphate. N,N′,N″-Triethyl guanidine was prepared according to A. W. Hoffmann[4].) Although all the N-substituted guanidines are as strong bases as guanidine itself[5], the substituted guanidines do not restore the excitability of any sodium-deficient nerve fibre. Even more, a $0{\cdot}11\,N$ solution of an N-substituted guanidine renders the nerve fibres inexcitable faster than an inert sodium-free solution, and markedly delays and reduces the restoring ability of guanidine and of sodium ions. To be more specific, after the $0{\cdot}11\,N$ solution of a substituted guanidine has been allowed to act upon the nerve for a few minutes, guanidine is able to restore the excitability of only a discrete number of *A* fibres and only after repeated renewal of the guanidine solution. After the action of $0{\cdot}11\,N$ *n*-amyl guanidine hydrochloride, even sodium ions can restore the excitability of only a fraction of the *A* fibres, and only after long, repeated washing of the nerve with Ringer's solution.

This effect of N-substituted guanidines develops without appreciable depolarization of the nerve fibres, which suggests that it is referable to competitive inhibition of chemical processes in the nerve membrane. As a matter of fact, *n*-amyl guanidine readily blocks conduction of impulses in the presence of sodium. Mixtures were made of a $0{\cdot}11\,N$ solution of *n*-amyl guanidine hydrochloride and of a $0{\cdot}11\,N$ solution of sodium chloride in the proportions 15–85, 25–75 and 40–60 parts. The first solution caused block of conduction in a small number of *A* fibres; the second blocked about half the *A* fibres after having caused a marked reduction in the speed of conduction of all, and the third blocked all the *A* fibres in 12–15 min. In all cases recovery after washing with Ringer's solution was prompt and complete.

Although arginine and *n*-amyl guanidine have the same number of carbon atoms, arginine hydrochloride yields a practically inert sodium-free medium. It causes total inexcitability of the nerve in the usual 2–4 min., and affects the restoring actions of guanidine and of sodium ions, if at all, only slightly.

The facts presented in this communication suggest the thought that in the nerve membrane the N-substituted guanidines do not compete directly with sodium ions, but rather with some guanidine-like nitrogen compound.

In regard to the specificity of the various nitrogen compounds that have restoring effects, the following facts should be mentioned. The excitability of sodium-deficient frog muscle is not restored by either quaternary ammonium ions[6] or by guanidinium ions[7]. The excitability of crustacean muscle is maintained in sodium-free solutions of quaternary ammonium ions that are inert for frog nerve[8]. The excitability of the plant cell *Nitella*, that has become inexcitable in distilled water, is restored by ammonia, ammonium ions, guanidinium ions and a number of other compounds[9]. Ammonium ions do not restore frog nerve fibres[10] or muscle fibres[11].

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Electrical Activity of the Intrafusal Muscle Fibres

The efferent regulation of sensory discharges in muscle proprioceptors is accomplished by activation of the intrafusal fibres through their motor nerve supply. Contraction of these fibres would produce stretch-deformation of the sensory nerve endings and thereby an increase in the frequency of afferent discharges. In the frog it is achieved mainly by activation of the large-diameter motor axons[1] while in the cat it is elicited only when the small nerve fibres are stimulated[2]. Although the bulk of experimental evidence is quite convincing, it still remains largely indirect because direct observations on intrafusal fibre activity are few.

Some developments in recent years have helped considerably in understanding how the muscular portion of a stretch receptor is capable of modulating the frequency of sensory discharges. Alexandrowicz[3] discovered some special organs in the abdomen of the lobster (*Homarus vulgaris*) which were identified as stretch receptors by Wiersma, Furshpan and Florey[4]. It is possible to study them in complete isolation and under direct microscopic observation. This unique advantage enabled Kuffler[5] and Eyzaguirre and Kuffler[6] to demonstrate that they possess motor nerve fibres which activate either a 'fast', twitch-like bundle or a 'slow' receptor muscle.

The present study was designed to obtain some direct evidence on the behaviour of intrafusal muscle fibres in amphibians. The preparation employed was the muscle extensor longus dig. IV of the Chilean toad (*Callyptocephalus gayi*). The muscle was dissected free and placed in a 'Lucite' dish. It was immersed in Ringer solution covered by a layer of mineral oil. The nerve was lifted into the oil for stimulation and recording with 50μ platinum–iridium electrodes. This thin muscle made a flat and transparent preparation in which details could be easily detected using a combination of dark-field illumination and polarized light. Usually the muscle or the nerve was cut down until a single sensory unit remained discharging. Once the preparation was properly set up, *d*-tubocurarine hydrochloride was added to the bath in concentrations of 1–2 μmol./l. This procedure was employed in order to block extrafusal contractions because it is known that the intrafusal junctions are more resistant to curare than the extrafusal ones[1]. After 30–50 min., complete neuromuscular block was achieved; but the spindles could be seen contracting apparently unimpaired. Thus the intrafusal fibres were impaled with microelectrodes filled with 3 *M* potassium chloride and having a d.c. resistance of 10–60 megohms. The external diameter of the tip was about 0·5μ measured with a water immersion objective and an over-all magnification of × 900.

Isolation of the spindle was attempted as the most direct approach; but this procedure inevitably caused destruction of the motor nerve supply to the intrafusal bundles. Therefore these bundles were identified in the following way: (1) Once a critical level of curarization was reached, one or two very tiny filaments remained contracting. Usually it was difficult to see them unless magnifications of × 40–63 were used. The contraction of these filaments was not strictly isometric even when the muscle tendons were firmly gripped by forceps. (2) An increase in the frequency of sensory discharges was observed if, and only if, this filament contracted. (3) Destruction of the muscle filament by a sharp needle, operated by a micromanipulator, always produced disappearance of the contractions and cessation of frequency changes in spite of strong shocks given to the nerve. (4) An excessive dose of curare produced a similar effect. (5) The zone where the contracting filament appeared was marked and histological sections were made. A spindle was invariably found in such a place (Fig. 1). It is concluded, therefore, that this particular muscle filament is a neuromuscular spindle and that the contracting fibres form part of an intrafusal bundle.

Impalement of the intrafusal fibres was usually very difficult due to their small size (around 10μ) and because in most preparations the spindles were deeply embedded in the muscle mass. Success was achieved when these structures were located near the surface. In one experiment several successful penetrations were possible and resting membrane potentials of 61·3–88·6 mV. measured. A single shock

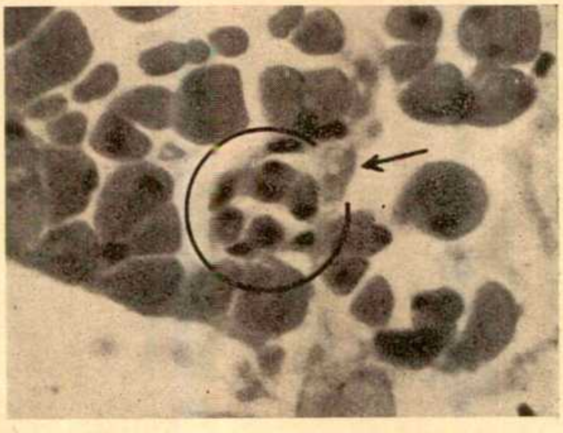

Fig. 1. Muscle strip dissected from extensor longus dig. IV of *Callyptocephalus gayi*. Cross-section made through region where potentials illustrated in Fig. 2 were recorded. This bundle had 70 fibres. Circle, spindle with four intrafusal fibres where intracellular recordings were made; arrow, cross-section of thick myelinated, presumably sensory, axon. (× 500)

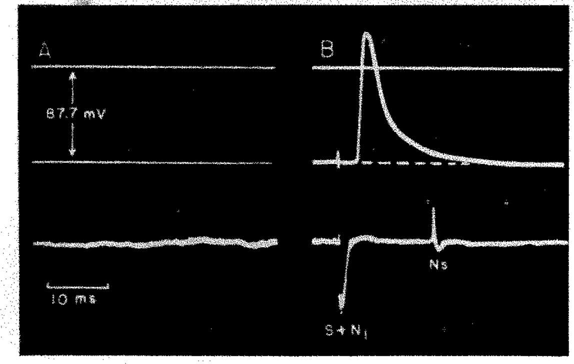

Fig. 2. Electrical activity of neuromuscular spindle. Extrafusal junctions blocked by curare. A single sensory unit was left intact. Upper records in *A* and *B*, intracellular lead from a single intrafusal muscle fibre. Lower records, extracellular electrodes from the nerve. Simultaneous intra- and extra-cellular records.

A, Preparation at rest and under light tension. Resting membrane potential 87·7 mV. Lower record shows no baseline discharge. *B*, After a single nerve shock an action potential of 119·3 mV. is recorded from an intrafusal fibre. Lower record shows artefact plus nerve action potential ($S + N_1$) followed by one sensory discharge (N_s) 15·6 m.sec. after the shock

to the nerve produced action potentials of 84–119·3 mV. and always presenting a positive overshoot of 12·5–31·6 mV. at 21° C. The presence of this spike was always concomitant with an increase in the frequency of sensory discharges (Fig. 2). The characteristics of the action potential indicate that the intrafusal bundles are formed by twitch fibres, innervated by large-diameter motor axons. Nevertheless, the presence of some slow muscle fibres, innervated by the small-nerve motor system, has not been excluded.

This work was financed in part by grants from the Rockefeller Foundation (New York) and the Fundación Gildemeister (Santiago).

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Occurrence of Leuco-anthocyanin in Pears

The anthocyanin pigments of plants may occur in two possible colourless forms, as the pseudo-base and as leuco-anthocyanins[1,2]. In both cases conversion to the corresponding anthocyanin occurs on acidification, but is slower in the latter case. Although leuco-anthocyanins have been isolated only from cacao beans[3] and Australian heartwood of *Acacia melanoxylon*[4] their occurrence is implied on the basis of the vanillin test and chromatographic identification of anthocyanins[2,5]. The occurrence of leuco-anthocyanins in pears (*Pyrus communis*) was suggested by Joslyn[6] to explain the reddening that occurs in tinned pears stacked before they are completely cooled, and by Bate-Smith[1] to explain the reddening of stewed pears. Kiesser *et al.*[7] reported the occurrence of leuco-anthocyanins in perry pears on the basis of chemical and chromatographic examination of the insoluble matter causing haze and turbidity and depositing as a sediment in perry. The red pigment obtained by treatment of the sediment with warm dilute acid was found to contain small quantities of phloroglucinol, protocatechuic acid, catechol and cyanidin but was composed chiefly of complex leuco-anthocyanins related to cyanidin. We have recently examined Bartlett pears for the occurrence of leuco-anthocyanins and found evidence for the presence of the leuco-anthocyanin related to cyanidin.

Halved ripe California Bartlett pears tested with vanillin reagent[5] gave a strong positive test for leuco-anthocyanin in the core tissue surrounding the seeds and particularly strong reaction in the seeds. The tissue surrounding the seed receptacle gave a less intense and more diffuse reaction. For this reason, the core tissue was separated, ground and extracted first with boiling water, then with absolute methanol. The residue was then extracted with methanol containing 1 per cent hydrochloric acid. This extract, strongly positive to the vanillin test, was brought to 5–10 per cent hydrochloric acid and heated for 5–10 min. The red pigment so obtained was identified by paper chromatography with several solvent systems. The R_F values obtained with butanol–acetic acid–water, butanol–2 *N* hydrochloric acid and acetic acid–hydrochloric acid–water respectively were: 0·24, 0·47; 0·69; 0·49; respectively. The R_F values reported for cyanidin in these solvents are: 0·24; 0·69; 0·50. Robinson's ferric chloride test was applied to extracts, in *iso*-amyl alcohol containing 1 per cent hydrochloric acid, of pear core tissue, after conversion to anthocyanidin by boiling with added acid. On addition of water, sodium acetate and a small amount of ferric chloride and shaking, the organic solvent layer turned blue just as cyanidin does. The anthocyanidin obtained from pear core and pear seed was stable to oxidation, as is cyanidin. The only anthocyanidin obtained from pear tissue thus is similar in R_F value and other properties to cyanidin.

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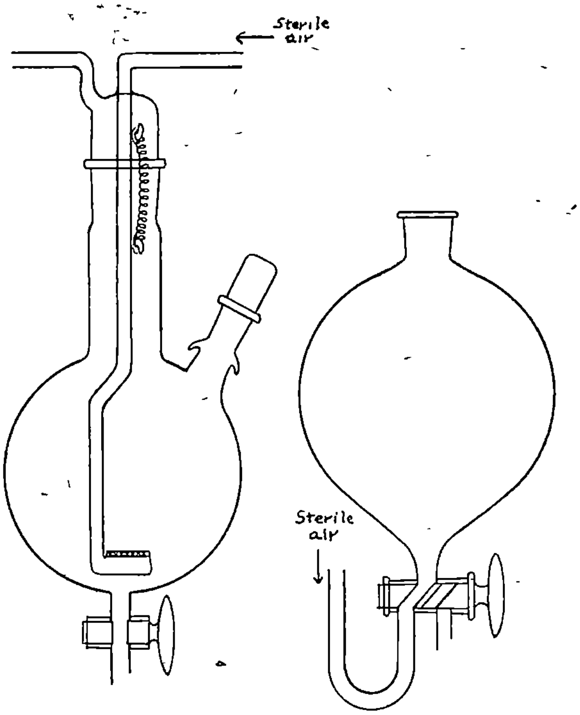
Apparatus for Aeration and Sampling of Bacteria during Growth and Metabolic Studies

The need frequently arises for the sampling of bacterial cultures during aerated growth, or of non-proliferating bacterial suspensions in the course of metabolic studies under aerated conditions. Methods requiring the use of a pipette for the withdrawal of samples are somewhat unsatisfactory because the aeration arrangements, usually capillary tubing or tubing carrying a sintered glass distributor disk, are



(A) (B)

Fig. 1

disturbed when the pipette is introduced into the neck of the flask or tube. The present apparatus were designed to permit aeration and sampling of cultures with the minimum of operations.

Type 1. This apparatus is illustrated in Fig. 1*A*. A 1-litre round-bottom flask with *B*40 neck carries a special glass head with inlet and outlet arms. The inlet tube, which extends almost to the bottom of the flask, bears a sintered glass distributor disk of 20 mm. diameter and porosity No. 1. The head is held in position by two spring clips. At the bottom of the flask is fitted a wide-bore drain stopcock with a stem $\frac{1}{2}$ in. long which permits samples to be withdrawn as required. The combined effect of short stem and wide-bore is to prevent liquid from being retained in the stem. Additionally, the flask has a *B*19 socket set at an angle to the neck ; this is used as an inoculation port or for the addition of substrates. The stopper may be replaced by a tube bent at an angle, so that it forms a side-arm similar to that of a Warburg manometer flask. Simply by rotating this tube in its socket the contents are discharged into the culture flask.

The apparatus is autoclaved in an assembled condition. A small folded strip of Kraft paper is inserted between the ground-glass joints to prevent possible seizure during the process. These joints are then covered over with Kraft paper. After sterilization, the strips of paper are removed with sterile forceps and the joints are then properly seated. The stopcock is lightly treated with silicone grease.

Type 2. With an organism that grows in clumps in liquid media, such as *Sarcina lutea*, even when using vigorous aeration in an apparatus of type 1, there was a tendency for cells to sediment and collect in the stopcock outlet below the glass disk distributor when growth extended over periods of 18–24 hr. To eliminate this difficulty the apparatus shown in Fig. 1*B* was devised. It consists of a 1-litre capacity pear-shaped dropping funnel with *B*24 neck. At the base is fitted a three-way double oblique bore stopcock with one vertical outlet $\frac{1}{2}$ in. long and the other U-shaped. The latter tube is used as the inlet for the sterile air stream which, entering from the base of the funnel, ensures thorough agitation of the medium. By turning the stopcock the air supply is momentarily cut off, a sample withdrawn through the vertical outlet, and aeration then resumed. The mouth of the funnel is closed by a cotton-wool plug. Where a compressed-air supply is not available, the requirements of this apparatus may be met by a small aquarium air pump.

If the air supply is replaced by nitrogen, both pieces of apparatus may be used for anaerobic studies where sedimentation is to be avoided. We have found type 1 to be very useful for organisms such as *Escherichia coli* and *Aerobacter aerogenes* while, as mentioned, type 2 was designed for use in our studies with *Sarcina lutea*.

The pieces of apparatus were made for us by Messrs. Quickfit and Quartz, Ltd., Stone, Staffordshire.

We are indebted to Mr. D. R. S. Cameron for his help and to the Medical Research Council for a grant-in-aid.

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Relation between the Optical and Thermodynamic Properties of Saturated Paraffinic Hydrocarbons

The optical properties of hydrocarbons, such as the refractive index and the magneto-optical rotating power, are controlled by absorption frequencies in the far ultra-violet region of the spectrum. These frequencies are due to electronic excitation of the molecules, and since the electrons involved are the outer, that is, the valency, electrons it is reasonable to anticipate a correlation between these electronic transitions and the strength of the valency bonds, that is, the thermodynamic properties of the compounds.

The ratio p/γ, where p is the number of dispersion electrons per molecule effective in optical refraction and γ is the magnetic anomaly, may be calculated from a knowledge of the refractive index (n), the magneto-optical rotating power (V) and the density (d) by the equation[1]

$$\frac{p}{\gamma} = \frac{\pi}{2\lambda^2 eA} \cdot \frac{M}{d} \cdot \frac{(n^2-1)^2}{nV}$$

where λ is the wave-length of the light used, e is the electronic charge and A is the Avogadro number. This equation is valid provided the frequency of the light concerned is far from the frequency of the absorption band, and provided the optical dispersion can be regarded as being controlled by a single absorption frequency. Thus the expression is applicable to most saturated hydrocarbons when sodium D light is used. Darwin and Watson[2] have shown that for most hydrocarbons, γ is approximately 0·60 for the sodium D line. On this basis, values of p have been calculated for forty-two liquid paraffin hydrocarbons in the range C_5 to C_{20}, using values for $n_D{}^{20}$, $V_D{}^{20}$ and d^{20} from the literature[3,4].

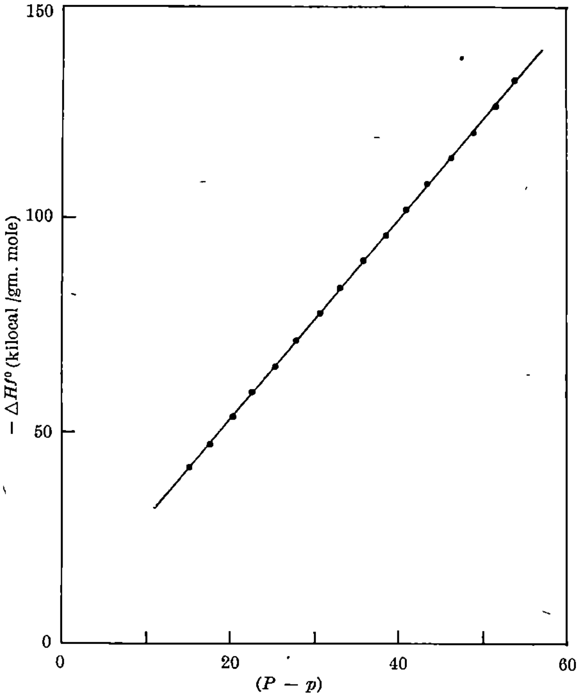

Fig. 1. Relation between standard heat of formation (ΔH_f^0) and number of inactive valency electrons ($P - p$) for *n*-paraffins

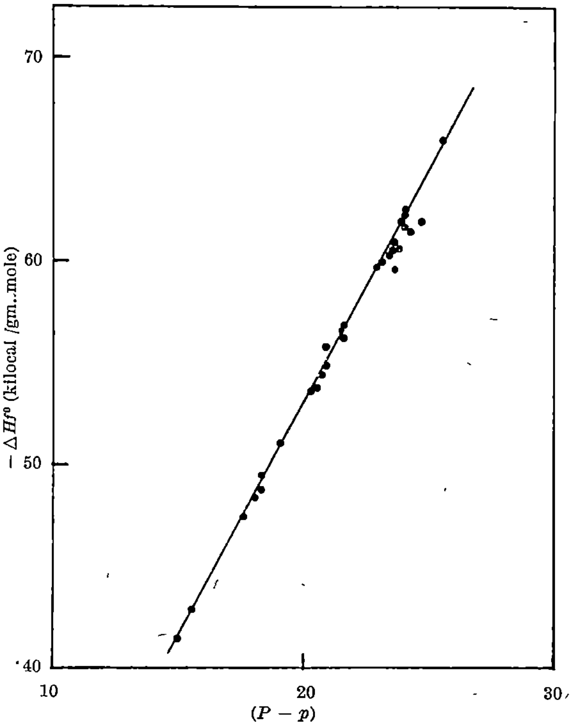

Fig. 2 Relation between standard heat of formation (ΔH_f^0) and number of inactive valency electrons ($P - p$) for pentane, hexane, heptane and octane isomers, and *n*-nonane

Figs. 1 and 2 show that the value of $(P - p)$, where P is the number of valency electrons per molecule, is a linear function of the standard heat of formation of the liquid (ΔH_f^0). The values of ΔH_f^0 used are those listed at 25° C.[5], since it is considered that the small error introduced through the use of the two different temperatures is relative only and does not seriously change the correlation. Deviations from the linear relationships are within the estimated experimental error of the measurements except for three octane isomers. While the linear relation for the *n*-paraffins (Fig. 1) could result from a combination of separate linear relations of ΔH_f^0 and $(P - p)$ with molecular weight, the correlation for the isomers (Fig. 2) suggests that the relation is of a more fundamental character.

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Examination of Honey in Australian Honey-ants

The honey-ant (*Melophorus inflatus*) is found in many parts of central Australia, where it is highly regarded by the aborigines as an article of food[1,2]. The honey-bearing ants seem to be modified workers which are fed with nectar or honey by ordinary workers until their distended abdomens approach ⅜ in. in diameter[1]. "In eating them the native seizes each with the fingers by the forepart of the body and, after blowing off the dust, places the distended abdomen of the insect in the mouth and bites it off, letting the slightly acid honey flow over the tongue with evident satisfaction. The abdomen is swallowed while the remainder of the body is discarded"[3]. Colonies of these ants are generally found in rather arid country often near mulga trees. Little seems to be known of their habits, or of the origin of the honey, which is apparently stored against a barren season[4]. As a contribution to this problem, we have now examined the carbohydrate constituents of this honey.

Using a 5 per cent solution of the honey and 1 per cent solutions of glucose and fructose as controls, paper chromatographs were run in pyridine/water/ethyl acetate. and acetic acid/water/ethyl acetate. The application of aniline picrate to the chromatograms developed by both solvent systems gave a prominent spot corresponding to glucose and a less prominent spot corresponding to fructose. The presence of the latter was also confirmed by spraying the paper with urea oxalate. A very faint spot probably corresponding to a disaccharide (but not sucrose) was observed when a 25 per cent solution of the honey was spotted on the paper, which was then developed for fifty-five hours.

An estimation of the reducing sugars by the Lane and Eynon method gave 59 per cent. This result, together with the optical rotation, was used (Mathews formula) for determining the fructose : glucose ratio[5]. This was found to be 0·67. In bee-honey, fructose generally predominates, and this ratio averages 1·20; but wide variations are found, depending on the source of the honey. According to Wetherill[6], the Mexican honey-ant produces honey consisting of an almost pure solution of fructose, but the evidence presented is inconclusive.

We wish to thank Mr. M. J. Barrett, of the Department of Dentistry, who kindly collected some of these honey-ants at the Yuendumu Native Settlement, about 190 miles north-west of Alice Springs.

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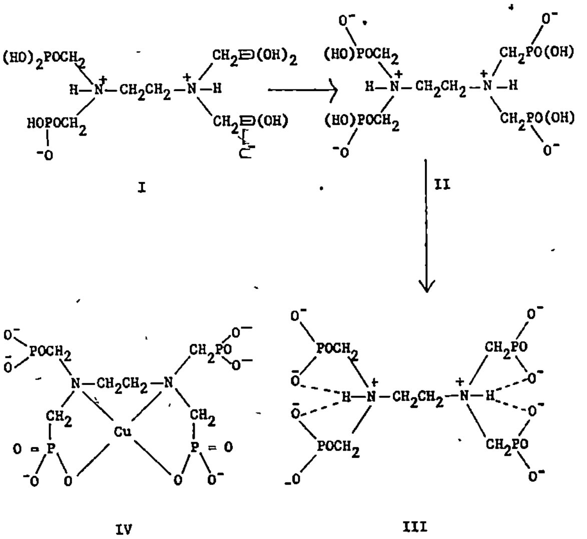
Ethylene-diamine-tetra(methylene-phosphonic) Acid

SINCE the publication by Schwarzenbach *et al.*[1] of the relatively high degree of calcium binding by N-methylene-phosphonic-imino-diacetic acid, it seems that the phosphonate group may be quite as effective as the carboxylate group in chelating agents. An attempt to prepare ethylene-diamine-tetra-methylene-phosphonic acid (EDPA) was therefore indicated because of its similarity to ethylene-diamine-tetra-acetic acid (EDTA). Although the preparation of this and similar compounds has been reported by Bersworth[2], the present communication gives quantitative information of the affinity of the ethylene-diamine-tetra-methylene-phosphonic acid anion for hydrogen ions and metal ions.

The procedure employed in the synthesis of ethylene-diamine-tetra-methylene-phosphonic acid was similar to the methods used by Schwarzenbach *et al.*[1] and Bersworth[2]. Ethylene-diamine was treated with sodium chloro-methylene-phosphonate in alkaline solution at reflux for three days. It was converted first to the lead salt with lead acetate and then to the free acid with hydrogen sulphide. The product was a colourless hygroscopic syrup which was very soluble in water, slightly soluble in alcohol and insoluble in ether. It was obtained as a glassy solid by dehydration under reduced pressure.

Potentiometric investigations of acid-base and metal-binding equilibria were carried out at 25° C. and 0·1 ionic strength with a Beckman Model *G* pH meter. The eight acid dissociation constants of the ligand were found to be 1·46, 2·72, 5·05, 6·18, 6·63, 7·43, 9·22 and 10·95. The equilibrium constants corresponding to the overlapping dissociation steps in each of the three buffer regions were determined by a graphical method. Because of the presence of two basic nitrogen atoms alpha to the acidic groups, the most acid form of the ligand is believed to be a double dipolar ion (I). If formula I is accepted, the presence of only two strongly acidic groups, corresponding to dissociation of hydrogen ions from neutral $—CH_2PO(OH)_2$ groups, becomes understandable. After the removal of two protons, there remain (formula II) four equivalent phosphonate hydroxyl groups which give rise to a long sloping buffer region involving four overlapping dissociation steps to form compound III. It is somewhat surprising that charge repulsion in III gives rise to a difference of only 1·7 pK units between the seventh and eighth dissociation constants. This may be due in part to the high negative charge of the anion, and to partial electrostatic binding of the ammonium hydrogens to the negative phosphonate oxygens.



The titration curves of the ligand in the presence of equimolar concentrations of metal ions given in Fig. 1 all indicate the formation of metal chelates containing as much as two hydrogen ions in addition to the metal. At higher pH all the acidic chelates go over to the 'normal' chelates from which all the dissociable hydrogens have been displaced. The copper (II) titration curve shows the sharpest break at eight moles of base per mole of ligand or metal, and indicates the formation of a metal chelate compound corresponding to formula IV. The titration curve of the iron (III) chelate compound shows partial hydrolysis of the normal chelate compound, indicating that at least one hydroxide ion becomes

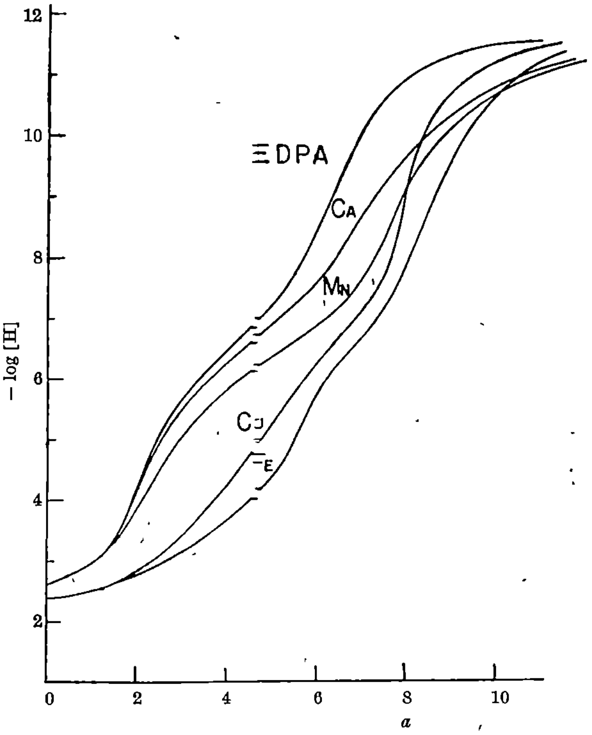


Fig. 1. Potentiometric titration of ethylene-diamine-tetra-methylene-phosphonic acid —log [H] vs. *a*, moles of potassium hydroxide added per mole of ligand

bound to the metal at high *p*H in spite of the large negative charge on the chelate compound. The logarithms of the normal chelate stability constants for combination of the metal ion with the octa-negative anion were calculated as: calcium (II), 6·09; manganese (II), 9·75; copper (II), > 10; and iron (III), > 10. It is apparent from the relative positions of the copper (II) and iron (III) titration curves that the chelate of the latter metal is considerably more stable. The stability is sufficiently high that a solution of the light yellow iron (III) chelate may be stored at a *p*H of about 11 for a number of months without developing any sign of the precipitation of ferric hydroxide. The apparent stability of the iron (III) chelate compounds in alkaline solution indicates possible usefulness as an iron carrier.

This work was supported by the Dow Chemical Co., Framingham, Mass.

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Clark University. Feb. 17.

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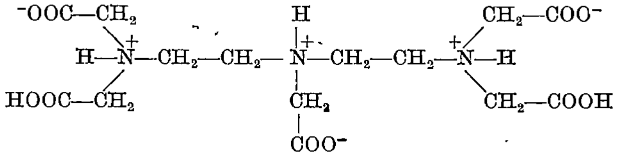
Polyaminopolycarboxylic Acids derived from Polyethyleneamines

THE effects of increasing length of the alkylene bridge on acid dissociation constants and metal chelate stability constants of homologues of ethylenediaminetetra-acetic acid derived from polymethylenediamines have been reported within recent years[1]. The effects of an increase in the polydentate and polyelectrolyte nature of polyaminopolycarboxylic acids derived from polyethylene polyamines have not been investigated except for a brief report on diethylenetriaminepenta-acetic acid[2]. An investigation of diethylenetriaminepenta-acetic acid and triethylenetetraminehexa-acetic acid was therefore undertaken because of their relationship to ethylenediaminetetra-acetic acid.

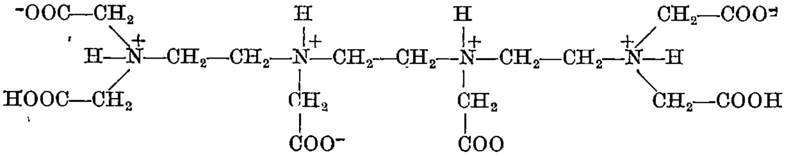
The acids were prepared by the reaction of diethylenetriamine and triethylenetetramine with sodium cyanide and formaldehyde under alkaline conditions according to the procedure of Bersworth[3]. The free acids were separated from the alkaline reaction products by means of the hydrogen form of 'Dowex-50' on a column process. Concentration of the eluate gave the acids as white crystals which were purified by recrystallization from a minimum volume of hot water.

The acid dissociation constants of diethylenetriaminepenta-acetic acid and triethylenetetraminehexa-acetic acid were determined from potentiometric data at 25° C. and 0·1 ionic strength (potassium nitrate) using a Beckman Model *G* *p*H meter. The equilibrium constants corresponding to the overlapping dissociation steps of the buffer regions were calculated by the graphical method of Schwarzenbach[4]. The acids are tri- and tetra-dipolar ions respectively having the formulæ:



$$(^{-}OOC-CH_2)(HOOC-CH_2)\overset{+}{N}H-CH_2-CH_2-\overset{+}{N}H(CH_2COO^{-})-CH_2-CH_2-\overset{+}{N}H(CH_2-COO^{-})(CH_2-COOH)$$

(I)



$$(^{-}OOC-CH_2)(HOOC-CH_2)\overset{+}{N}H-CH_2-CH_2-\overset{+}{N}H(CH_2COO^{-})-CH_2-CH_2-\overset{+}{N}H(CH_2COO)-CH_2-CH_2-\overset{+}{N}H(CH_2-COO^{-})(CH_2-COOH)$$

(II)

Neutralization of the pentabasic diethylenetri aminepenta-acetic acid occurs with one stron inflexion corresponding to formation of the tri potassium salt. Triethylenetetraminehexa-acetic acid a hexabasic acid, exhibits two inflexion points : weak inflexion occurring on the addition of three equivalents of potassium hydroxide and a well defined inflexion corresponding to the formation o the tetrapotassium salt.

The acid dissociation constants are listed in Table together with the values reported by Kroll[2] fo diethylenetriaminepenta-acetic acid.

Table 1. *pK* VALUES OF THE APPARENT IONIZATION CONSTANTS O DIETHYLENETRIAMINEPENTA-ACETIC ACID AND TRIETHYLENETETRA AMINEHEXA-ACETIC ACID AT 25° C. IN 0 1 M POTASSIUM NITRAT

Acid	pK_1	pK_2	pK_3	pK_4	pK_5	pK_6
DTPA	1·79	2·56	4·42	8·76	10·42	
DTPA[2]*	1·90	2·70	4·42	10·62	12·59	
TTHA	—	2·64	4 08	6 26	9 67	10 82

* Determined at 25° C. in 0 1 M potassium chloride

It appears that triethylenetetraminehexa-acetic acid is almost completely ionized at the concentration used in this study (approximately 3×10^{-4} M). Each compound possesses two strongly acidic carboxy groups (pK_1 and pK_2). The central ammonium groups are subject to the influence of the termina positively charged ammonium groups. The net result of this configuration with its relatively high positive potential is an increase in acidity of the central ammonium groups as reflected in the values of pK_3 for diethylenetriaminepenta-acetic acid and pK_3 and pK_4 for triethylenetetraminehexa-acetic acid.

The behaviour of the acids with various polyvalent metal ions is now under examination. The increase in metal chelate stability constants and the ability to enter into bimetallic chelate formation arising from the increase in polydentate character indicate utilization of these compounds as metal carriers and metal buffers.

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Characterization of 17-Oxosteroids by Derivatives formed in the Zimmermann Reaction

DURING a study of 17-oxosteroid levels in blood plasma it was found that the amount of individual ompounds available was frequently too small to permit determination and also identification by paper hromatography. After the determination of isolated 7-oxosteroids by Zimmermann reaction it is possible o recover these compounds as derivatives which an be used for characterizing the compounds measured.

The solution from the colorimeter cell was diluted with eight volumes of water and one volume of concentrated hydrochloric acid added. The acidified olution, which is colourless, was extracted with benzene ($3 \times \frac{1}{3}$ vol.) and the combined benzene xtracts washed with water until neutral. When he Zimmermann reaction was repeated on the material extracted by benzene, the extinction corresponded to 60–95 per cent recovery of steroid; he colour appeared immediately with alkali alone and maximum intensity was obtained under Zimmermann conditions in 20 min.

When the recovered Zimmermann complexes of the separated 17-oxosteroids (approximately 5 µgm.) were chromatographed on No. 2 Whatman paper in a hydrocarbon/aqueous methanol system[1] spots could be located as dark areas by viewing in ultra-violet ight of maximum intensity in the 240 mµ region Hanovia *OX*7 filter). These areas were also revealed as purple spots by dipping in ethanolic potassium hydroxide (10 per cent w/v). The immediate appearance of the purple colour together with the absorption of ultra-violet light suggests that the *m*-dinitrobenzene s combined with the steroid on the paper chromatogram. These complexes appear to be very stable as hey were not destroyed by hot acid hydrolysis (10 per cent hydrochloric acid v/v at 100° for 15 min.) or by the subsequent washing of benzene extracts by alkali.

Table 1, which gives the R_F values of the free 17-oxosteroids and of their derivatives when run in Bush partition systems, shows that whereas in the *A* system the free compounds run faster than their derivatives, in the B_1 system they run more slowly. This diverse behaviour appears to be associated with the partition system used and not with the C_{11}-oxygen function, for the 11-oxo-aetiocholanolone derivative runs in the *A* system more slowly than the corresponding free compound.

Table 1. R_F VALUES OF STEROIDS AND DERIVATIVES ON WHATMAN No. 2 PAPER

Equilibration time, 3 hr.; running time, 4 hr.; temperature, 37°)

	Free steroid	Derivative
Bush *A* system		
Dehydro*iso*androsterone	0 32	0·23
*iso*Androsterone	0 37	0·31
Aetiocholanolone	0·43	0·33
Androsterone	0 56	0·46
11-Oxo-aetiocholanolone	0·064	0 042
Modified Bush B_1 system		
11-Hydroxy-aetiocholanolone	0·40	0·70
11-Hydroxy-androsterone	0 50	0·78
11-Oxo-aetiocholanolone	0·64	0 83
11-Oxo-androsterone	0 70	0·88

Bush *A* system: 80–100° petroleum ether (10), methanol (8), water (2). Modified Bush B_1 system: 80–100° petroleum ether (5), benzene (5), methanol (7), water (3).

R_F values calculated against sudan IV, which was used for indicating the solvent front approximately.

The Zimmermann complexes formed from 5α-androst-3 : 17-dione, 5β-androst-3 : 17-dione, androst-4-ene-3 : 17-dione and androst-4-ene-3 : 11 : 17-trione did not move from the origin in Bush *A*, B_1 or B_5 systems.

This technique has enabled us to obtain further evidence of identity of steroids isolated from blood plasma by chromatography on alumina.

We wish to express our thanks to Dr. T. F. Gallagher, Sloan Kettering Institute, New York, and to Dr. W. Klyne, Hammersmith Postgraduate Medical School, for the gift of reference steroids, and to Sir Charles Dodds for his interest in this work.

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An Asymmetric Catalyst

ASYMMETRIC synthesis has hitherto succeeded only by using reagents or solvents having the asymmetric configuration.

We have been able to synthesize optically active amines and amino-acids by using an asymmetric catalyst, based on the fact that the optical activity of the biological substances originates in the asymmetric structure of the enzyme proteins.

The asymmetric catalyst was obtained by reduction of protein–palladium complex which was prepared by adsorption of palladium chloride on silk fibroin fibre.

Optically active glutamic acid, phenylalanine and diphenylethylenediamine were formed by hydrogenating their precursors, diethyl α-acetoximino-glutarate, ethyl α-acetoximinophenyl-propionate, 4-benzilidene-2-methyloxazol-5-one and α-benzildioxime, respectively, in the presence of this catalyst.

Preparation of catalyst. 100 mgm. of palladium chloride was adsorbed on 300 mgm. of silk fibroin fibre, and the complex was reduced with hydrogen in 50 ml. methanol at 50° C., 80 kgm./cm.^{2} for 1 hr.

Hydrogenation of diethyl α-acetoximinoglutarate. 10 gm. of diethyl α-acetoximinoglutarate was hydrogenated with the catalyst in 50 ml. methanol at 50° C., 80 kgm./cm.^{2}. The reaction mixture was filtered, evaporated *in vacuo*, hydrolysed for 1 hr., precipitated with hydrochloric acid, and extracted with acetone to remove organic acids. Then the product was recrystallized four times. Glutamic acid was obtained in a yield of 39 per cent. $[\alpha]^{15}_D =$ + 2·25° (c., 7 per cent in 2*N* HCl). Analysis: calculated for $C_5H_{10}O_4NCl$: N, 7·63; found: N, 7·36. This compound was identified by paper chromatography and infra-red spectroscopy. The manometric analysis (by glutamic acid decarboxylase of *E. coli*) showed the same value of L(+) content.

Hydrogenation of ethyl-α-acetoximinophenyl-propionate. 6 gm. of ethyl-α-acetoximinophenyl-propionate was hydrogenated with the catalyst in 50 ml. methanol at 70° C., 90 kgm./cm.^{2}. The reaction mixture was filtered, evaporated *in vacuo*, hydrolysed for 4 hr. with 30 ml. 10 per cent hydrochloric acid and evaporated *in vacuo* again. The residue was dissolved in 10 ml. water, decolorized, evaporated to half volume of the solution *in vacuo*, diluted with 5 ml. methanol, and adjusted to *p*H 7·0 with aqueous ammonia. After standing overnight, 1·5 gm. of phenylalanine was obtained; m.p. 261·5° C. $[\alpha]_D^{15} = +9{\cdot}25°$ (*c.*, 9 per cent in water). Analysis: calculated for $C_9H_{11}O_2N$: N, 8·48; found, N, 8·23. This compound had the same R_F value as the standard phenylalanine.

Hydrogenation of 4-*benzylidene*-2-*methyloxazol*-5-*one*. 5 gm. of 4-benzylidene-2-methyloxazol-5-one was hydrogenated with the same catalyst in 50 ml. methanol at 75° C., 90 kgm./cm.². The reaction mixture was filtered, evaporated *in vacuo*, hydrolysed for 4 hr. with 30 ml. 10 per cent hydrochloric acid. The acid solution was extracted with ether, and the water layer was evaporated *in vacuo*. The residue was dissolved in 10 ml. water, decolorized, concentrated to 3 ml., diluted with 3 ml. methanol, adjusted to *p*H 7 with aqueous ammonia. After standing overnight, 0·7 gm. of phenylalanine was obtained; m.p. 280° C. $[\alpha]_D^{20} = +12{\cdot}5$ (*c.*, 9 per cent in water). Analysis: calculated for $C_9H_{11}O_2N$: N, 8·48; found, N, 8·23. This compound was identified by paper chromatography.

Hydrogenation of α-benzildioxime. 5 gm. of α-benzildioxime was hydrogenated in 10 per cent ammoniacal methanol at 80° C., 80 kgm./cm.², with the same catalyst, and the product was recrystallized from *n*-butanol. Diphenylethylenediamine (2·5 gm.) was obtained. Analysis: calculated for $C_{14}H_{16}N_2$: C, 79·21; H, 7·60; N, 13·20; found: C, 78·05; H, 7·20; N, 12·12. $[\alpha]_D^{15} = +8{\cdot}75$ (800 mgm./100 ml. of ether); $[\alpha[_D^{15} = +431{\cdot}0$ (29·6 mgm./100 ml. of ether). (In this experiment, we observed the wide variation of $[\alpha]_D$ of diphenylethylenediamine with the concentration of the substance in diethylether.)

It appeared that the palladium adsorbed on the supporter having the asymmetric configuration was capable of catalysing the asymmetric reduction.

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A New Reagent for the Determination of Thorium

Several organic acids[1–4] have been used for the quantitative precipitation of thorium. By a careful control of the *p*H value, thorium may be separated from the rare earths. The precipitate in most cases is rather of indefinite composition, and for a quantitative determination, it has to be ignited to thorium oxide and weighed. We have been engaged in investigating derivatives of cinnamic acid to see if they possess any advantages over other acids which have been employed hitherto.

It was found that *m*-nitro cinnamic acid not only gives a clear-cut separation of thorium from other trivalent rare-earth ions, but also gives a thorium precipitate of definite composition. The precipitated thorium salt is the tetra-*m*-nitro cinnamate and is one of the very few examples of precipitation of thorium as the tetravalent salt.

An alcoholic solution of *m*-nitro cinnamic acid was added to a solution of thorium salt at *p*H 2·0 or less and this was carefully adjusted to 3·8–4. The higher *p*H value is specially necessary when sulphate ions are present. Thorium came down as a granular precipitate. The precipitate was filtered, washed with hot alcohol and weighed as thorium tetra-*m*-nitro cinnamate. It was then ignited and weighed as thorium oxide. The following are typical results.

Weight of thorium tetra-*m*-nitro cinnamate (gm)	0 1135
Weight of ThO_2 (by calculation) (gm.)	0 02997
Weight of ThO_2 (by ignition) (gm.)	0 0299

Thorium may therefore be determined by a direct weighing of the precipitate instead of by igniting, as has been done hitherto.

The same experimental procedure may be followed for separation of thorium from trivalent rare earths; if, however, the proportion of the rare earths is preponderantly high, a double precipitation may be followed.

Tetravalent ions like titanium, zirconium, cerium (ic), etc., are also precipitated by this reagent and would thus interfere.

Further details will be published elsewhere.

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Recording Differential Thermogravimetric Balances

In recent years, interest has been revived in the application of the thermogravimetric technique for the characterization of inorganic and organic compounds, and for studies concerning their thermal decomposition process. Several types of automatic balances have been developed—some of them now being commercially available—to give recorded curves of the cumulative weight-loss, with time or temperature, of a sample decomposing thermally under controlled conditions. It is often necessary to prepare, from this record, a curve of the rate of weight-loss as a function of time or temperature, by the somewhat tedious and relatively inaccurate process of graphical differentiation.

In order to assist our investigations on the thermal decomposition process of coal and related compounds, two types of thermogravimetric balances were devised to give automatically precise and continuous records of the differential weight-loss, together with

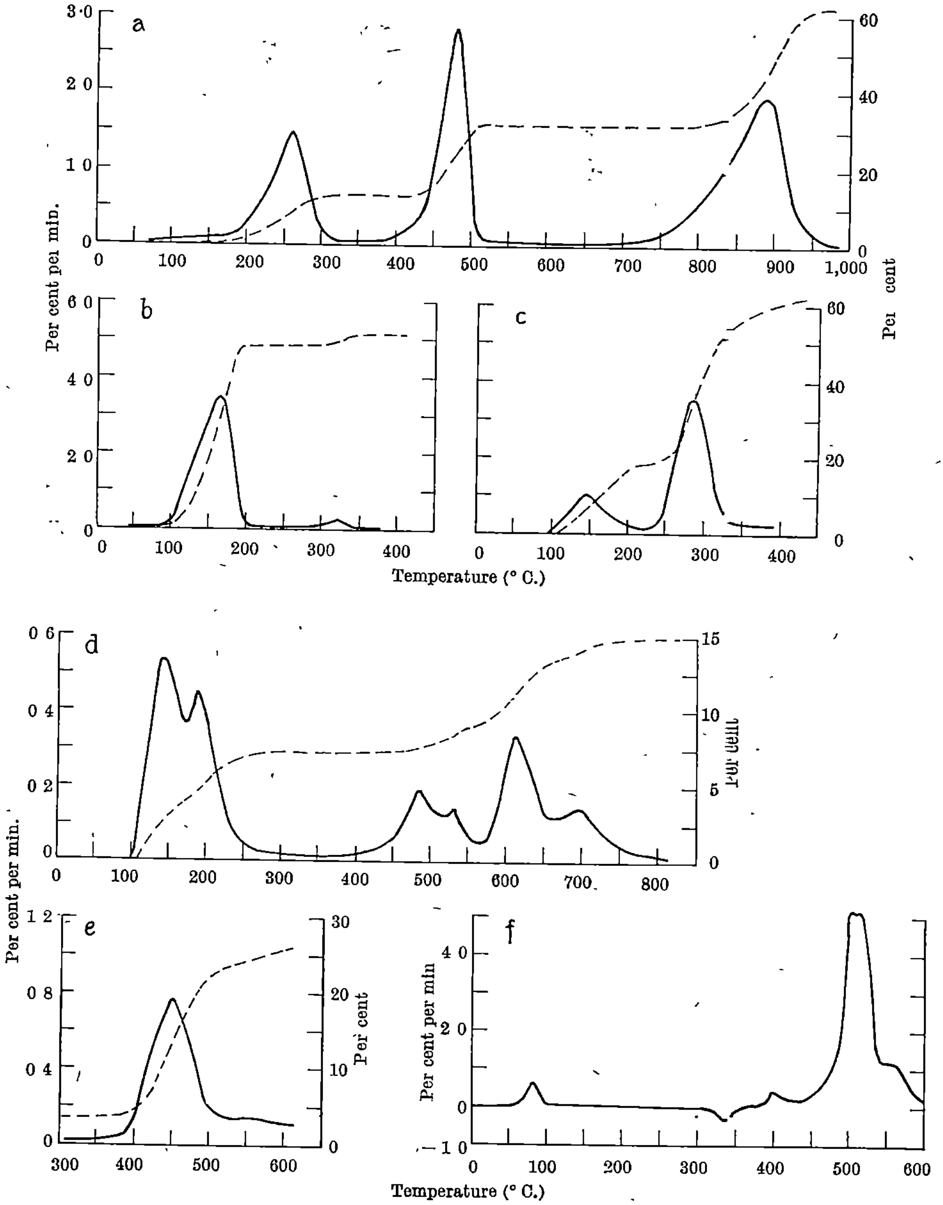

Fig. 1. Examples of differential thermogravimetric curves obtained with prototype balance. ———, Differential thermogravimetric curve; – – – –, cumulative weight-loss curve. (*a*) Calcium oxalate, monohydrate; heating-rate, 6 deg. C./min. (*b*) Dibasic sodium phosphate heptahydrate; heating-rate, 3 deg./min. (*c*) Starch, heating-rate, 3 deg./min. (*d*) Shale from Victoria Tunnel coal seam, N.S.W.; heating-rate, 6 deg./min. (*e*) Coal sample, Victoria Tunnel seam; heating-rate, 3 deg./min. (*f*) Coal sample, Victoria Tunnel seam; heated in air at 3 deg./min.

the usual cumulative weight-loss. These balances, briefly described herewith, differ in principle from the differential thermogravimetric balances already described by De Keyser[1], and Erdey *et al.*[2]. So far as I am aware, these are the only apparatuses of this kind which have been reported.

In the present apparatus, the balance system is maintained in a state of continuous equilibrium by means of a counterbalancing force, applied at the necessary rate, proportionally controlled by an electromotive force equivalent to the rate of loss in weight. It is virtually a null-point balancing system with regard to the rate of weight-loss. The methods of electro-mechanical linkage, however, differ in the two types.

In one design of balance, which has a torsion wire in its construction, the restoring couple necessary to maintain the beam at a certain point of balance was achieved by a special type of servo-motor rotating the torsion head. In the other type, an analytical balance was adapted in such a way that the sample was counterbalanced by the suspended electrode of a silver coulometer, arranged so as to minimize surface-tension effects: as the sample changed in weight, balance was maintained by a corresponding change in weight of the silver electrode due to a control current passing through the cell. The necessary voltage and current controls, in both these types of balances, were effected by a photocell movement detector, and magnetic amplifier with an output rectifier. An 'ohmic drop' in the output circuit enabled a proportion of the controlling voltage or current to be recorded as a measure of the differential weight-change. Integration of this function by electromechanical means also enabled an accurate record of the cumulative weight-change to be made simultaneously on the multi-point potentiometric recorder.

The prototype torsion-wire balance, which is now in continual routine service, can record total weight-changes of up to 0·5 gm. at a maximum rate of 30 mgm. a minute ; the cumulative weight-change may be read to an accuracy within 1 per cent, and the differential weight-change may be determined to within 0·2 mgm. per minute. The differential pyrolysis curves obtained by this instrument are of value in the characterization of coal by rank, and for studies of their mechanism of thermal decomposition. These curves are also particularly useful for providing information of a complementary nature which may be correlated with other thermal properties of coal measured by such techniques as differential thermal analysis and plastometry.

Although originally designed for coal research, the apparatus should also find useful application in other fields of work such as inorganic and organic analyses, mineralogy, adsorption studies and the analysis of the particle-size distribution of powders by sedimentation. Some examples of the decomposition of certain inorganic and organic substances under linear heating-rates are illustrated in Fig. 1. The apparatus and its application to studies of the thermal behaviour of coal and related compounds will be described in detail elsewhere.

The work described here was carried out as part of the programme of the Coal Research Section of the Commonwealth Scientific and Industrial Research Organization, Australia.

P. L. WATERS

Coal Research Section,
Commonwealth Scientific and
Industrial Research Organization,
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Chatswood, New South Wales.

March 22.

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[1] De Keyser W. L., *Bull. Soc. Franc Céram.*, **20**, 2 (1953); *Nature*, **172**, 364 (1953).

[2] Erdey, L., Paulik, F., and Paulik, J., *Nature*, **174**, 885 (1954).

Evidence for Substructure in Single Crystals of Potassium Chloride

MEASUREMENTS of the optical scattering and polarization of the ionic current in single crystals of potassium chloride have recently been made.

The variation of the intensity of the scattered light with the angle of scatter was measured for monochromatic ultra-violet ($\lambda = 3650$ A.). The crystal was suspended in benzene, which has a refractive index very close to that of potassium chloride ($n = 1{\cdot}55$). The scattered light intensity was measured with a sensitive photo-electric apparatus using a lock-in detector based on the 100 c./s. modulation of the mains-operated mercury arc light source. The curves in Figs. 1 and 2 show the difference of the intensities of the light scattered from the crystal immersed in the liquid and from the liquid alone. Curve I (Fig. 1) shows the angular distribution of the light scattered from a single crystal of potassium chloride cooled slowly after growth from the melt, and curve II shows the results for the same crystal after quenching in air from 700° C. to room temperature.

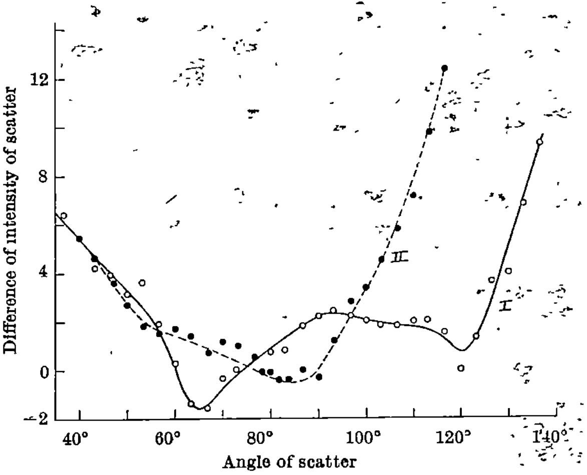

Fig. 1. O—O—, Untreated ; ●—●—, quenched

The deviations from a simple Rayleigh scattering curve indicate the presence of internal scattering structures of fairly uniform dimensions of the order of the wave-length of the light. The results are similar to those obtained by Humphrey-Owen[1] for the variation of the scattering at 90° with wave-length in single crystals of sodium chloride and suggest a comparison with Mie's scattering theory. This applies to isolated spherical particles (radius r) of refractive index differing from that of the surrounding medium. The theory predicts a scattering curve having one or more minima the angular positions of which depend on the parameter $\alpha = 2\pi r/\lambda$. Typical curves for $n = 1{\cdot}5$ plotted from the tables compiled by the National Bureau of Standards[2] are shown in Fig. 2. The position of the minimum in the experimental scattering curve I of Fig. 1 for the normal crystal corresponds to a value α of about 1·1 and hence to a diameter of about 1300 A. for the equivalent scattering spheres. Curve II shows that the dimensions of the scatterers are reduced by quenching ; the position of the minimum and the ratio of the light intensities scattered

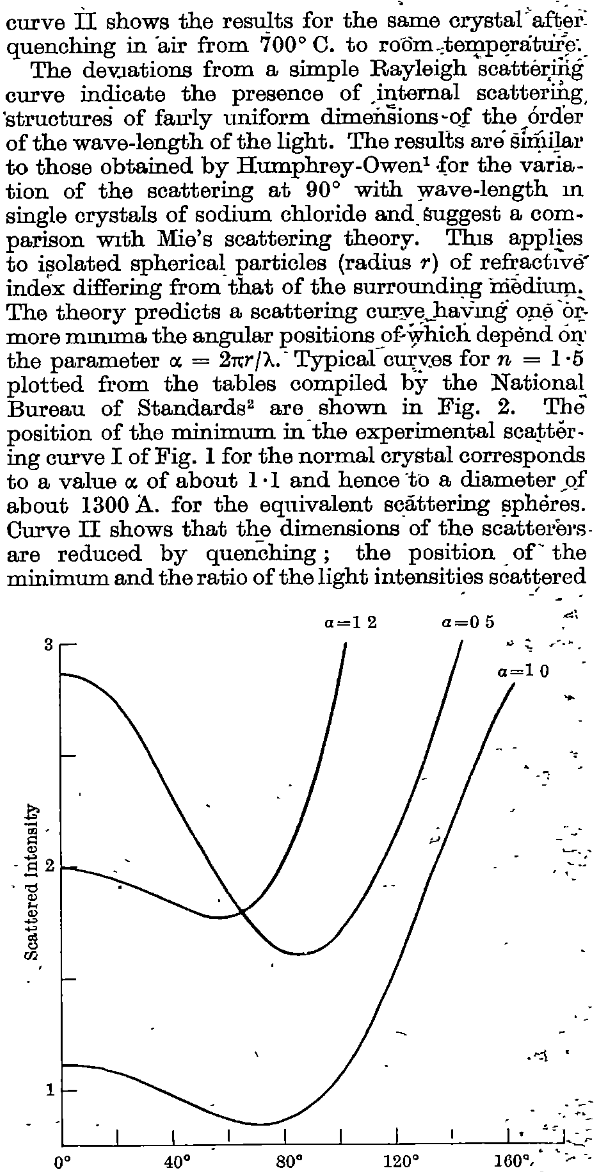

Fig 2

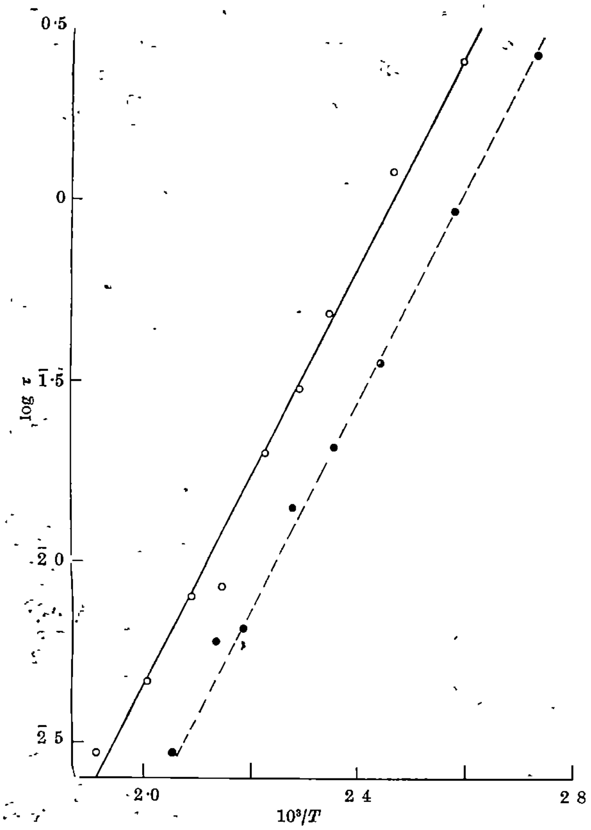

Fig 3. ○—○—, Untreated; ●—●—, quenched

in the forward and backward directions indicate that α lies between 0·5 and 0·8 and thus 2 r between 600 and 900 A.

The electrical measurements were carried out in connexion with investigations on the ionic conduction of single crystals of a number of alkali halides over the temperature-range 20°–300° C. The d.c. method used in these investigations, essentially as described by Cunnell and Schneider[3], allows ionic polarization effects to be observed in detail. Such effects were found in all alkali halides investigated and were established to be intrinsic and not electrode or surface effects. In its simplest form, polarization is observed as a decay of the ionic current, following the application of a constant potential ('step'), from a high initial value to a lower steady value. The rate of decay described quantitatively by a polarization time τ, the time of decay to a current-value half-way between initial and final currents, depends on the temperature of the applied potential and the thermal and mechanical history of the specimen. The temperature dependence follows $\tau = \tau_0 \exp(-u/kT)$ with an activation energy u near the migration energy of positive ion vacancies.

Measurements with specimens cleaved from the same single crystal of potassium chloride as the sample used in the scattering experiments have shown that the polarization time is markedly decreased by quenching, while over a wide temperature-range both the initial and final values of the ionic conductivity are unaffected. Fig. 3 is a plot of log τ *vs* $1/T$ for a potassium chloride crystal before and after quenching in air from 700° C.

Polarization may be explained as a blocking of the ionic current by internal boundaries. According to Jaffe's theory[5] of the rate of build-up of space charge involved in such blocking phenomena, the polarization time should be proportional to the square of the distance between the boundaries. The ratio of the observed polarization times in the untreated and quenched crystals is 2·24, which would indicate that the average distance between the blocking boundaries is decreased by quenching by a factor of 1·5. On the assumption that Jaffe's theory is applicable in detail, together with the accepted value for the diffusion coefficient of positive ion vacancies, the actual value of the distance between blocking boundaries is estimated to be of the order of 2000 A.

The fact that both the distance between internal boundaries which determines the polarization of the ionic current, and the dimensions of the structure giving optical scattering in potassium chloride, are reduced in about the same ratio by quenching, suggests that the same internal structure is responsible for both effects.

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April 5.

[1] Humphrey-Owen, S. P. F., *Proc Phys. Soc*, B, 68, 325 (1955).

[2] U.S. National Bureau of Standards, Applied Maths Series 4 (Jan. 1949).

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[5] Jaffe, G., *Ann. Physik*, 16, 217, 249 (1933).

The Minimum of Melting Point in Homologous Series

Last year, in a letter in *Nature*[1], Foster and Hammick pointed out the similarities of the curves of the melting points against the length of the hydrocarbon chain, with a minimum in C_5, for both the alkylanilines and alkylnaphthols. They seem not to be aware of similar comments made previously, notably by Lee[2]. Lee suggests that this characteristic results from a helicoidal structure of long hydrocarbon chains which, as in the tension theory of Baeyer on carbon rings, would have a periodicity of 5 carbon atoms.

Against this hypothesis there are the following objections: (*a*) The anomalies for the C_5 term ought to be observed for other properties also, and to be recurrent for the terms in C_{10}, C_{15} and so on, which is not the case. (*b*) In my book "Les Constantes Physiques des Composés Organiques Cristallisés" (Masson, Paris, 1953), pp. 270–304, are quoted some hundreds of series, with the necessary data, and it is shown that the minimum of melting point may equally well be at any term from C_1 to C_{12}. (*c*) Radiograms of long-chain organic compounds show that, in the crystalline state, their molecules may be considered as long rods without any helicoidal structure.

My interpretation of these facts is as follows: in long-chain derivatives the functional radical is of secondary importance only, and has a rather small influence on the melting point; all these series have parallel melting point curves, which converge to a common limit of about 120° C.; only the hydroxyl and amino derivatives have much higher melting points, resulting from hydrogen links, but converge to the same temperature limit. For the first term of a homologous series, on the contrary, the melting point is essentially fixed by composition, functional structure and stereochemical configuration; when a hydrogen atom is replaced by a short hydrocarbon chain, the symmetry of the molecule diminishes and the melting point falls progressively until the falling curve cuts the rising curve of the higher terms of the series. Therefore the position of the minimum is determined by the weight of the functional radical; the heavier the radical the higher in the series is the minimum, as with the α-brom-β-naphthylamides and the alkyl-iodides of mercury, where it is as far as C_{12}.

J. TIMMERMANS

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Evaporation from an Electric Arc in Vacuum

FOR some time, workers producing thin films *in vacuo* have questioned whether an electric arc could be used for evaporating metal films. The method is a possible solution to the problem of evaporating metals of low vapour pressure such as platinum, which cannot be easily evaporated from the commonly used metal filaments because they dissolve the support. Further, if both electrodes are of the metal to be deposited, the film will not be contaminated by other metals as occurs when a refractory metal heater is used.

It is therefore of interest to read the recent claim by Hiesinger[1] that metals can be evaporated "... in an arrangement whereby an electric spark is generated between electrodes which consist of the material which is to be deposited in a high vacuum", and, further, "The method can be used with advantage in the form where the ions produced by the electric spark are accelerated by an electric field, so that the energy of atomic impact on the substrate is increased beyond the normally available thermal energy".

Since this was published, Vodar *et al.*[2] have described an apparatus in which the arc was operated intermittently by vibrating the electrodes, using a relay coil. These workers found that the metal atoms were emitted from the cathode (although this was at the lower temperature) and were mainly negatively charged. When the receiver was a conductor and made positive with respect to the cathode "almost the whole of the deposited metal was concentrated on the support under tension".

Recently, I discovered an early patent by Edison[3] on a "Process of Duplicating Phonograms" from which the following is quoted: "The phonogram so impressed with the phonographic record is placed in a high vacuum, in which an electric arc, continuous or discontinuous, is produced between electrodes of metal or in which metal vapour is otherwise produced. The electric arc produces a vapour of the metal of which the electrodes are composed, which vapour is deposited on the indented surface of the phonogram".

It is doubtful if Edison's electric arc was operated at the pressure now generally understood as 'high vacuum', that is, 0·1 micron mercury or less (Vodar *et al.* operated their arc at 0·01 micron mercury), because apart from other factors the pumping apparatus was not sufficiently developed.

It would be useful to know the type of apparatus Edison used, because it is often difficult to operate continuously an arc in high vacuum; after the arc is struck the supply of metallic vapour may be insufficient for ionization to maintain the arc. Thus the use of an intermittent arc by Vodar *et al.* whereby the arc is periodically re-struck is a novel solution.

The same difficulty is not experienced when an arc is operated at higher pressures (> 10 microns mercury) because a supply of positive ions for the maintenance of the arc can be obtained from the gas. The discharge then occurs in mixed vapour and gas, and both anode and cathode can reach sufficient temperature to evaporate rapidly. Rossin[4] states that in the arc melting of metals the vapour emitted from the molten anode is the conductor and that it is confined in the arc by the gas molecules at a pressure of 10 mm. mercury; but at 10μ mercury the arc becomes unstable due to free evaporation of the metal. Evaporation may take place from a cathode during cathodic sputtering at high current densities in a glow discharge. Thus both zinc and cadmium cathodes will evaporate rapidly if their temperature is allowed to rise during cathodic sputtering. The metal vapour is ionized and the glow may change to an arc if the current is not limited.

It appears that there are at least three mechanisms by which vapour can be produced in electric arcs, namely: (1) sputtering from the cathode under ion bombardment; (2) thermal evaporation of the cathode; (3) thermal evaporation of the anode.

The recent work of Germer and Boyle[5] on short-field emission arcs indicates that thermal evaporation from the cathode electrode may be due to the melting of surface prominences by the field emission currents flowing through them. Thus the evaporation of the cathode electrode noted by Vodar *et al.* may not have been due to ion bombardment as they assumed. A further study of the electric arc *in vacuo* would be of value in view of its potential use as a vapour source for film deposition.

L. HOLLAND

Edwards High Vacuum, Ltd.,
Crawley, Sussex. April 24.

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[3] Edison, T. A., U.S. Patent No. 484,582, Oct. 18, 1892 (filed Jan. 30, 1888).

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A Simple Method of producing Visible Patterns of Tape-recorded Sounds

WHILE visiting our laboratory, R.-G. Busnel of France directed our attention to a brief note by Pasquinelly[1] on making visible the magnetically oriented areas on tape recordings by immersing the tape in a viscous liquid suspension of ferromagnetic powder and draining off the excess. We have found a modification of this method useful for studying sounds of animals recorded on magnetic tape. Immersion proved unsuitable, because it did not produce clear patterns, and the recorded tapes were difficult to clean afterward.

Dry carbonyl iron powder (General Aniline and Film Corp., Types *E* and *SF*), however, produces good images of tape-recorded sounds, and we propose the name 'ferrograms' for these visible patterns. The recorded surface of the tape is drawn through a thin layer of the powder spread on smooth paper and the excess powder blown or snapped off. The powder is held on the tape at the regions of uniform magnetic orientation, forming images of the recorded sounds.

The spacing of bands on the tape is related to the frequency and temporal distribution of the sound and sound pulses and the density of deposit to the intensity. We have used this successfully with four brands of recording tape, although the results are better with some than with others.

These images are either photographed or removed from the tape by applying to it the sticky surface of a strip of adhesive transparent tape ('Texcel' or 'Scotch'). The adhesive tape is fastened on white paper or transparent cellulose film for permanent storage and detailed study. When mounted on a transparent material, the ferrograms can be made directly into lantern slides. The adhesive tape should be relatively new and unheated, otherwise damage to the recording tape may result, and it is well to press the adhesive surface as gently as possible on to the recording tape. After the pattern has been copied or removed, the recording tape is wiped free of powder and seems to be unaffected.

Fig. 1 shows some ferrograms thus produced. The use of this method to study the 'song', a series of short noise pulses, of a grasshopper, *Neoconocephalus ensiger*, is illustrated. Knowing the tape speed, it is easy to measure directly the duration of the chirps in this 'song', even though these are only 0·02–0·1 sec. in length. With magnification, the number, duration and spacing of the pulses in the individual chirps and other details can be studied. Comparison of the ferrograms with the oscillograms produced by the usual methods shows that they give good representations of the duration of the chirps and pulses composing the chirps and their relative intensities. The remaining ferrograms in Fig. 1 illustrate patterns produced by other sounds. The sound of the tuning fork, in contrast with the others, is relatively simple, and the pattern can be used for determining the frequency as well.

The recording-level must be relatively high for development of the patterns. There is a threshold-level below which no adhesion of the powder occurs. The method seems particularly suitable for noise pulses, such as the stridulatory sounds of many nsects, where the instantaneous intensity of the ndividual pulse may be very high, although the average intensity is not, and where the chief interest ies not in analysis of frequency and intensity but n the distribution and duration of the sound pulses.

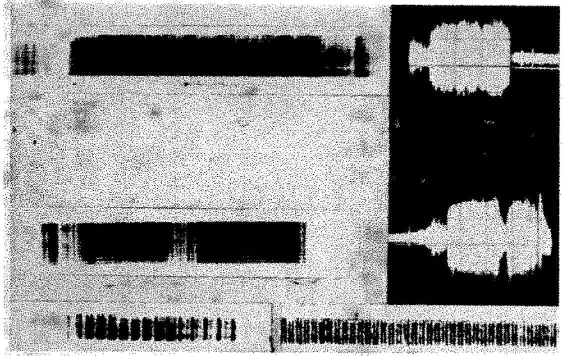

Fig. 1. Top and middle rows, ferrograms (left) and corresponding oscillograms (right) of chirps of *Neoconocephalus ensiger* at 18° C., recorded at 15 in./sec. tape speed; the duration of the chirps is about 1/10 sec. The upper record is the usual type for this species; the middle one is unusual in having a break in the main sound sequence. Bottom left, human voice saying syllable '*Ba*' recorded at 7½ in./sec. Bottom right, tuning fork (256 c./s.), recorded at 7½ in./sec. (All × 1½)

This method for the production of visible patterns of sounds is simple, direct, and uses no expensive equipment. Studies of the temporal characteristics, at least, of sounds can thus be made easily and cheaply by anyone who has a tape recorder.

This work was supported in part by Research Grant No. *E*-802 from the National Microbiological Institute of the National Institutes of Health, U.S. Public Health Service. We wish to thank Dr. Ackerman of this University and the General Aniline and Film Corporation for supplying the carbonyl iron powder, and Dr. Smyth of this Department for assistance in making the oscillograms.

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[1] Pasquinelly, F., in "L'Acoustique des Orthoptères", 50 (ed., R.-G. Busnel, Inst. Nat. Rech. Agron., Paris, 1955).

Combinatory Notation

CURRENT notation used in combinatory formulæ is by no means uniform, sometimes clumsy, as in $\binom{n}{r}$, and sometimes misleading in a factual sense as is ${}^nC_r$ or ${}_nC_r = {}^nP_{r.n-r}$. I have elsewhere pointed out advantages of using $n^{[r]} = n(n+1)\ .\ .\ .\ (n+r-1)$ by analogy with $n^{(r)} = n(n-1)\ .\ .\ .\ (n-r+1)$ and $n_{[r]} = n^{[r]} \div r\,!$ in conformity with Aitken's usage $n_{(r)} = n^{(r)} \div r\,!$. In this notation $r_{[d]} = F_{r.d}$ specifies the entire family of Pythagorean figurates defined by $F_{1.d} = 1 = F_{r.o}$ and $F_{r.d} = F_{(r-1).d} + F_{r.(d-1)}$, just as $r_{(d)}$ specifies the term of the rth column and dth row of the derivative Pascal triangle. In combinatory terms, we may write for the number of different r-fold samples from a set of n distinguishable objects:

	Without restriction on repetition	With no repetition
Permutations	n_r	$n_{(r)}$
Combinations	$n_{[r]}$	$n_{(r)}$
Sum of combinations (from $r = 0$ to $r = n$)	$(n+1)_{[n]} = \dfrac{(2n)!}{(n!)^2}$	2^n

The multinomial theorem is valid for $\rho = r$, (r) or $[r]$ in the form $(A + B + C\ .\ .\ .\ )_\rho$, and the combinatory interpretation of the general term becomes more explicit if we write $n_r = n^r \div r\,!$ by analogy with $n_{(r)}$ and $n_{[r]}$ defined as above. We may then write the general term of the following expansions as on the right below:

$$
\begin{array}{ll}
(A + B + C\ .\ .\ .)^r & r\,!\,A_u \,.\, B_v \,.\, C_w\ .\ .\ . \\
(A + B + C\ .\ .\ .)^{(r)} & r\,!\,A_{(u)} \,.\, B_{(v)} \,.\, C_{(w)}\ .\ .\ . \\
(A + B + C\ .\ .\ .)_{[r]} & A_{[u]} \,.\, B_{[v]} \,.\, C_{[w]}\ .\ .\ . \\
(A + B + C\ .\ .\ .)_{(r)} & A_{(u)} \,.\, B_{(v)} \,.\, C_{(w)}\ .\ .\ .
\end{array}
$$

By specifying the number of r-fold samples containing u of sub-set A, v of sub-set B, w of sub-set C, etc., of an n-fold set ($n = A + B + C\ .\ .\ .$), the following table then subsumes in an economical notation all the more familiar formulæ of linear combination and arrangements, including the two forms of what MacMahon calls the "Master Theorem".

	With no restriction on repetition	With no repetition
Permutations	$r\,!\,A_u.B_v.C_w\ .\ .\ .$	$r\,!\,A_{(u)}B_{(v)}C_{(w)}$
Combinations	$A_{[u]}B_{[v]}C_{[w]}\ .\ .\ .$	$A_{(u)}B_{(v)}C_{(w)}$

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June 1.

Selection for Fibre Number in Merino Sheep

CARTER[1] has reviewed work on the hair follicle group in sheep. This review emphasizes breed differences in the ratio of secondary to primary follicles, but does not mention any previous work on selection within a breed. Some preliminary results of a selection experiment are therefore presented, in which changes in both primary and secondary follicle counts per unit skin area have been demonstrated.

One section of a flock of medium-wool Australian merinos at the National Field Station, Cunnamulla, Queensland, consists of pairs of families, in which selection is for a high or low value of a single character. In one pair the character under selection is fibre number per unit area of taut skin (N), measured by the technique described by Turner *et al.*[2], which does not differentiate fibres from primary and secondary follicles. The groups were founded with animals drawn from one flock, chosen as being of average body-size, but ewes for the high group (HN) being required to have a fibre number above the mean plus one standard deviation, and those for the low group (LN), a fibre number below the mean minus one standard deviation. The foundation rams were chosen from the same flock as the ewes, the most extreme available being selected. Recruitment is from within each family, selection being made at 15–16 months of age.

Although follicle counts have not been required in selection, a skin sample has been taken from the centre of each clipped area immediately after removal of the wool sample. Counts per mm.^{2} of primary (P) and secondary (S) follicles have been made and the ratio S/P (R) calculated, using the techniques described by Carter and Dowling[3].

The mean fibre number for unselected progeny of the HN group each year has been consistently above the mean for those of the LN group. Of great interest is the fact that differences in both P and S contribute to the differences in N, the HN progeny having higher mean counts than the LN progeny for both types of follicle. Over the three sets of progeny now available, the weighted mean differences are $0{\cdot}50 \pm 0{\cdot}13$ for P and $19{\cdot}1 \pm 3{\cdot}3$ for S, both being significant at the 0·1 per cent level. The weighted mean difference in R is $3{\cdot}2 \pm 1{\cdot}1$ (significant at the 1 per cent level), the HN progeny again having a higher value than the LN.

The classic picture of the follicle population in the sheep is one of a series of groups, each containing a trio of primary follicles, with associated secondaries. If it is assumed that the number of primaries in a group remains unchanged, then changes in P indicate changes in the number of groups, while changes in R indicate changes in group-size. The two sources of change may possibly differ in their effect on the amount of wool produced per unit area of skin, and the relative importance of each is not yet known. Further investigations on this point are in progress.

Observed changes in S and P can be separated into those arising from the purely mechanical effect of changes in surface area, in which the total follicle number on the sheep is not altered, and those arising from environmental and genetic influences on the follicles themselves, in which the follicle number is altered. The purely mechanical effects have been eliminated in the present data by adjusting counts for difference in body-weight, taking surface area as approximately proportional to (body-weight)$^{2/3}$. It has sometimes been suggested that R should be used as an indicator of follicle or fibre population, because it is independent of mechanical changes due to variation in surface area. Since the present results have shown that P, S and R can all be influenced by selection, increases in R will not necessarily indicate increases in ($S + P$), as can be shown by the following discussion.

If we denote changes in P by δP, in S by δS and in R by δR, then we have :

$$R + \delta R = \frac{S + \delta S}{P + \delta P}$$

$$= R\left(1 + \frac{\delta S}{S} - \frac{\delta P}{P} - \frac{\delta S.\delta P}{S.P} + \frac{(\delta P)^2}{P^2} + \ldots\right)$$

Changes in R will thus depend on the relative size of $\frac{\delta S}{S}$ and $\frac{\delta P}{P}$, and the following will hold :

(1) If $\delta P = 0$, R will change with δS, and will be an indicator of ($P + S$).

(2) If $\left|\frac{\delta S}{S}\right| = \left|\frac{\delta P}{P}\right|$, both being of the same sign, R will be constant, irrespective of changes in ($P + S$). Proportional changes in S and P could arise from the mechanical effect of changes in body-size, in which case R would be of value in comparing follicle populations. Such changes could also arise, however, if the number of follicle groups increased but R remained the same ; in this case R could be misleading if used alone in comparing follicle populations.

(3) If $\left|\frac{\delta S}{S}\right| < \left|\frac{\delta P}{P}\right|$, both being of the same sign, R will *decrease* when ($P + S$) is *increasing* (that is, δS positive) but *increase* when ($P + S$) is *decreasing* (that is, δS negative).

Thus if follicle counts are used in comparing sheep, both P and R are necessary to obtain an estimate of the follicle population, together with body-weight, to enable an adjustment to be made for variation in surface area.

I thank various units of the Division of Animal Health and Production, Commonwealth Scientific and Industrial Research Organization, for their assistance. Counts were made at the Sheep Biology Laboratory, Prospect, while the sheep were maintained and sampled by the staff of the National Field Station.

HELEN NEWTON TURNER

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Industrial Research Organization,
McMaster Laboratory,
Parramatta Road,
Glebe, New South Wales.
April 9.

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[1] Carter, H. B., *Anim. Breed. Abstr.*, **23**, 101 (1955).

[2] Turner, Helen Newton, Hayman, R. H., Riches, J. H., Roberts, N. F., and Wilson, L. T., Comm. Sci. and Indust. Res. Org., Div. Animal Health and Prod., Div. Rep. No. 4, Series SW-2 (1953).

[3] Carter, H. B., and Dowling, D. F., *Aust. J. Agric. Res.*, **5**, 745 (1954).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT CHEMIST (Fuel Technologist) (preferably with a degree in fuel technology or equivalent qualification, and previous industrial experience) in the Divisional Chemical Laboratory, Skelton Grange Power Station, Leeds, to be responsible for directing the work of the Fuel Section of the laboratory and to investigate general problems of fuel technology—The Divisional Secretary (Establishments), Central Electricity House, St. Mary's Road, Leeds 7 (August 18).

ASSISTANT LECTURER (with a good honours degree in physics or physical chemistry, and prepared to undertake research work on fibres) IN PAPER TECHNOLOGY in the Department of Textile Chemistry—The Registrar, College of Technology, Manchester 1 (August 20).

DRAUGHTSMAN IN THE DEPARTMENT OF ARCHÆOLOGY, to prepare for publication, scale drawings of objects, plans, diagrams, etc.—The Secretary, National Museum of Wales, Cardiff (August 20).

RESEARCH ASSISTANT (with at least an ordinary degree in physics or equivalent qualification) IN ROCK MAGNETISM in the Geophysics Section of the Department of Geology, for work on problems in palæomagnetism—The Registrar, The University, Birmingham (August 20).

ASSISTANT PHYSICIST, Basic grade (with a good honours degree in physics, and preferably experience in electronics and nuclear physics techniques) in the Physics Department of the Sheffield National Centre for Radiotherapy—The Secretary, "Broom Cross", Tree Root Walk, Sheffield 10 (August 24).

CARTOGRAPHER IN THE DEPARTMENT OF GEOGRAPHY—The Head of the Department of Geography, The University, Hull (August 24).

COMPUTER IN THE DEPARTMENT OF ECONOMICS—The Registrar, University College, Singleton Park, Swansea (August 25).

LECTURER or ASSISTANT (with a good honours degree in botany or agricultural botany) IN AGRICULTURAL BOTANY—The Secretary of the University Court, The University, Glasgow (August 25).

SENIOR SCIENTIFIC OFFICER (with a university degree in science, preferably with honours, with physics as the major subject, together with considerable experience of applied research in the field of physics), to be responsible for the planning and execution of research and related work in physics—The Director, Institute for Industrial Research and Standards, Glasnevin House, Ballymun Road, Dublin, Ireland (August 25).

ASSISTANT IN ELECTRICAL ENGINEERING—The Secretary of the University Court, The University, Glasgow (August 31).

ASSISTANT (with a degree in horticulture or botany or equivalent experience) IN THE POMOLOGY SECTION, to help with field experiments and in the supervision of recorders—The Secretary, East Malling Research Station, near Maidstone, Kent (August 31).

LECTURER IN THE DEPARTMENT OF METALLURGY—The Registrar, The University, Liverpool (August 31).

SENIOR LECTURER IN THE DEPARTMENT OF VETERINARY HYGIENE AND PREVENTIVE MEDICINE—The Secretary, University of Edinburgh, Royal (Dick) School of Veterinary Studies, Edinburgh (August 31).

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DIRECTOR OF RESEARCH—The Chairman of Council, The British Electrical and Allied Industries Research Association, Thorncroft Manor, Dorking Road, Leatherhead, Surrey, marking envelope "Director—Confidential" (October 1).

KEEPER OF THE DEPARTMENT OF ANTIQUITIES in the Ashmolean Museum—The Registrar, University Registry, Oxford (October 1).

LECTURER IN METEOROLOGY—The Secretary of Faculties, University Registry, Oxford (October 1).

SENIOR LECTURER IN PSYCHOLOGY at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, October 1).

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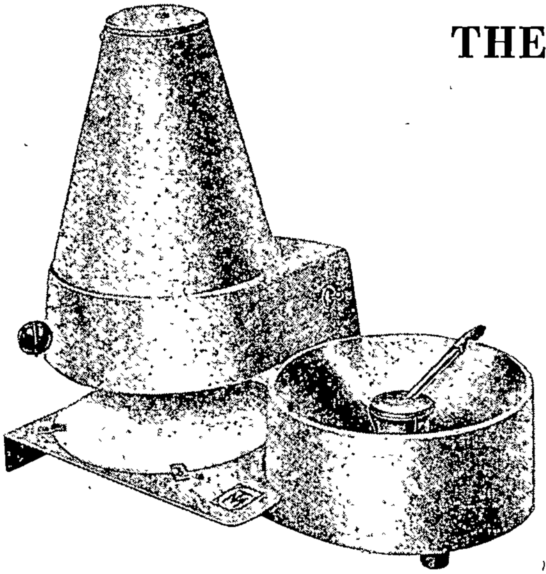

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A BALANCED EDUCATIONAL SYSTEM

THE debate on technical education in the House of Commons on June 21 drew from the Minister of Education and the Lord Privy Seal further details of the Government's plans for the development of technical and technological education in Britain (see *Nature*, 177, 1204 ; 1956). Sir David Eccles named eight colleges which he proposed to designate as colleges of advanced technology and indicated the probable geographical location of two more. Mr. R. A. Butler gave some figures for the proposed Government expenditure on buildings for university departments of technology and for higher technological education without, however, indicating clearly how far, or not, this overlaps with the building programme to which Sir David Eccles referred and which appears to cover the proposed colleges of advanced technology, to seven of which, as well as the Imperial College of Science and Technology, London, the Royal Technical College, Glasgow, and the Manchester College of Technology Mr. Butler specifically referred. The distinction between these three and the eight colleges of advanced technology which Sir David is proposing to designate is still not clear, except that, unlike the former, the latter colleges will confer diplomas in technology and not degrees.

The proposed Hives award was severely criticized in the debate. Sir David's defence of the decision to introduce this award was unconvincing and did not meet the reasoned argument in the debate that the institutions in which technological education is to be given should be in close relation with the universities and, if independent, should be capable of giving degrees in technology carrying the status of a degree given by a university department of technology. The objection to the diploma, however, would largely be avoided if more attention had been paid to the major professional institutions. The associateship and fellowship of these institutions are already regarded in industry and technology generally as having a status as high as that of a university degree. It is at least arguable that the new colleges of advanced technology would achieve the desired standing much more quickly if they relied either on such professional awards or on degrees conferred by an associated university rather than on a new award which, quite apart from the obvious prejudices it encounters at the start, must require many years to establish its standing.

Too much can be made of this point, however, for the real value of the award, by whatever name it is called, will depend on the value which industry places on the men who earn it. If they can hold their own with those now coming from the technological departments of the universities, from the Imperial College of Science and Technology, the Manchester College of Technology and the Royal Technical College, Glasgow, there will be no question of inferior status ; but, as Mr. M. Stewart rightly said in opening the debate, it is no use calling a college a 'college of advanced technology' if it cannot do the work. The Minister, however, probably realizes already some of the difficulties, for he made perfectly clear in the debate that the conditions which a college must fulfil to qualify for designation as a college of advanced technology will be stringent, as is to be seen from the circular issued simultaneously (see *Nature*, June 30, p. 1204).

Manifestly, the Minister carried the House with him in all this. The real question is whether he was carrying concentration sufficiently far. It is, to say the least, doubtful whether Britain has, or can have in the next few years, the resources to establish ten new major technological institutions, considering not merely the problem of staffing them adequately but also of equipping them. Both geographical criteria and the criteria of standard of work might well be applied much more searchingly than Sir David appears to contemplate doing. To do so might, moreover, ease the solution of his other problem—that of autonomy. While Manchester has shown that local authorities can, and do, take a national view, it may well be questioned whether it is reasonable to expect them to do so ; nor with the example of national parks administration before us can optimism be felt that the national interest will always prevail where it clashes with local desires. The complete free trade in students is far more likely to be assured if the colleges are given real autonomy, and without it there is reason for doubting whether they will attract staff of really high calibre. With a severely limited number of colleges of advanced technology, not only should there be more reasonable prospects of staffing them adequately but also there would be less over-riding of local interests. Local authorities would be able to demonstrate in the running of the technical colleges, particularly at the area and regional level, their ability to take wide views of their responsibilities.

The debate, which incidentally brought a further request for something on the lines of a Technological Grants Committee, as an independent body or a sub-committee of the University Grants Committee, showed that both sides of the House of Commons are now well aware of the danger of dissipating the educational resources of Britain, and also appreciate the importance of maintaining high standards and appropriate conditions of service to enable the new technological institutions to achieve their purpose. Moreover, in spite of something of a dichotomy between the colleges of technology and the university departments of technology in both Sir David's speech and in that of the Lord Privy Seal, there is a growing readiness to look at the expansion of technical and technological education as part of the expansion of education as a whole. This was apparent in Sir David Eccles's speech no less than in those from the Opposition benches ; for although Sir David dealt mainly with technical education, he made it clear at the outset, not merely that we must avoid dispersing our resources, particularly of teachers, over too many technical colleges, but also that we must try to keep a balance in the various advances we are trying to make between one part of the education service and another.

Sir David's speech was thus important as giving a clearer picture of the Government's general policy or structure in technical education. Broadly speaking, and leaving aside certain national colleges like the National Foundry College, the Minister said that there are at present three types of technical college, to which the White Paper proposed to add a fourth. First, there are in England and Wales some three hundred local colleges providing part-time or full-time courses up to the level of Ordinary National Certificate. These in the main train the technicians and craftsmen. Next, covering much the same ground but also providing more advanced courses, mostly part-time, come the area colleges, of which there are at present about a hundred and fifty. Many of these, however, are in need of expansion, and provision for this is made in the building programme to which Sir David referred later in his speech. Thirdly, there are the regional colleges, of which in a few years time there may be thirty. While these colleges would cover a good deal of the same ground as the area colleges, with more advanced work in the form of full-time or sandwich courses, some, such as the North Staffordshire Technical College at Stoke-on-Trent and the Treforest Technical College in Glamorgan, would provide advanced courses in single technologies which would be eligible for the 75 per cent grant. At the apex come the colleges to be designated colleges of advanced technology, which will concentrate entirely on advanced work, including postgraduate and research work, and which the Minister hopes to see built up to something like university status. Besides the eight colleges named in his speech, the Minister indicated that it is hoped to designate in the near future a college to meet the needs of the north-east coast, and also, if sufficient support is forthcoming from industry, the Bristol College of Technology, to meet the needs of the south-west.

If the Minister is to maintain his criteria of standards, it may become necessary to reduce this list and to revise it in order to meet the geographical criteria. Sir David was indeed optimistic as to the supply of teachers, which he admitted is the heart of the problem. He said that the figures for March 31, 1955, are really encouraging, showing about 10,000 full-time and 43,700 part-time teachers in technical colleges, an increase of 800 full-time teachers over the figures of the previous year. Of the part-time teachers, more than 11,000 are school-teachers employed part-time in colleges, most of the others, including many men and women of distinction, being employed in industry.

Sir David was also optimistic that industry would be able to help even more in supplying part-time teachers; but it is doubtful whether part-time teachers can make the contribution in advanced work that he expects. They can scarcely help to foster the residential community which the Minister obviously expects from the stress he laid on the provision of residential accommodation; indeed, the Government's reliance on part-time teaching is a weak point in the scheme, which unfortunately received little attention in the debate. Such teaching has its place, perhaps especially in postgraduate courses; but it has its limitations too, and its influence will be best felt when the part-time teacher is in a relatively small minority on the teaching staff. There is a place, too, for industrialists on the governing bodies of technical colleges, and particularly for men of technical knowledge.

It cannot be stressed too much that we cannot get an adequate system of technical or technological education in Britain on the cheap. There appears to be real danger in the Government's proposals that in trying to expand too fast at the top we may not merely lower standards but also carry into the new colleges something of the niggardliness and parsimony that have handicapped the technical colleges in the past and contributed to their difficulties in securing recognition by the public and in recruiting first-class staff. Moreover, Sir David Eccles did not justify his designations by any reference to the estimated relative demands of industry over the coming years for technicians and technologists, or to the probable increase in the number of 18-year olds in Britain from 640,000 in 1955 to 850,000 in 1965, in terms of either aptitude or inclination for technical and scientific careers. If £15 million for the building programmes for 1957–58 and 1958–59 which the Minister has now approved are wisely expended, the new technical colleges at all four levels should be much more efficient and productive places; though it may well be judged that the contribution to the supply of technicians will be larger and that to the supply of technologists smaller than the Minister expects.

The character and status of the teachers may be affected in the same way, though it should be noted that the Minister is already looking into the training of teachers for technical colleges and has asked the chairman of the National Advisory Council on the Training and Supply of Teachers and the chairman of the National Advisory Council on Education for Industry and Commerce to nominate a small joint committee to advise him urgently upon the recruitment and training of such teachers. He also indicated his awareness of the importance of salaries and other conditions of service, such as a more generous staffing ratio which affords opportunities for research and keeping in touch with industry; and, referring to the importance of the regional colleges and the colleges of advanced technology being available for all students, whether or not they lived in the area of the local authority responsible for the college, Sir David said that any restrictions, anywhere, must be seen to be very fully justified.

Sir David expressed confidence that complete agreement would be reached in the talks now in progress with the local authorities on this question. Even if his confidence is not fully justified, such agreement could well be helped by a much more vigorous Government campaign to persuade parents as to the opportunities and national importance of careers in science and technology. Unless that is undertaken with much more vigour and imagination han has yet been apparent, it is doubtful whether he impending bulge of school-leavers will fill the new places in the science and technological departments of the universities, the colleges of technology or the technical colleges. Sir David himself stressed the importance of first-class public relations in a voluntary system of further education; but he was thinking rather of co-operation with industry and of securing the close personal interest of industrial management both in the technical college and in the schools from which its students are drawn. Mr. S. C. George rightly stressed the need for greater efforts to attract the abler boys and girls into such careers, and Mr. R. A. Butler was ill-advised to gnore Mr. George's request for an assurance that a virile and imaginative campaign would be waged within the schools and among parents to that end.

On the question of teachers, Mr. George, however, was inclined to agree with Sir David Eccles, quoting the opinion of the director of the Royal Technical College, Glasgow, that he does not doubt the ability of Scotland, at any rate, to provide the staff for the new colleges when they are built. Apart from this, there was little support in the debate for the Minister's optimism; though the plea for greater efforts to educate parents as to what is at stake for the industrial future of Britain and so to use their home nfluence to discourage early leaving was repeatedly echoed, notably by Mr. J. C. Jennings. Sir David, in fact, found a large measure of support, particularly n regard to his stress on the need for a balanced policy and for a liberal conception of education which would equip the young men and women entering industry with the adaptability and versatility which they would need.

The importance of this has been emphasized by recent events in the motor-car industry, and there are, of course, measures outside the field of education which the Government could use to encourage adaptability. Broadly, however, the debate showed a large measure of agreement that the magnitude of the Government's programme is about right, having regard to the resources at present available; but that there are serious reservations as to the deployment of resources, more particularly those going nto the colleges of advanced technology. They probably should be fewer and more generously developed as regards amenities, staff and autonomy. Moreover, as regards technical colleges at all levels, here is much which could be done at slight expense o make them more effective and to remove the bleakness which hinders also the development of corporate student life.

Dr. F. Aylward, in a paper on education and ndustry published in *Chemistry and Industry* of May 5, which also stressed the importance of creating in the next few months an informed public opinion, in this connexion referred to the part which the common room and library play in a full education. The technical colleges, however, only too often possess inadequate libraries and reading rooms, comparing unfavourably with a local public library. These are the more important, however, when a large proportion of students are without the privacy for study in their homes and lodgings; and adequate budgets for technical college libraries would do much at small cost to increase the efficiency of the present colleges. Even here, however, the Government cannot wisely ignore the return which a national library system for science and technology, such as the Advisory Council for Scientific Policy has recommended, would bring.

In spite of the further information it contained, the Lord Privy Seal's speech replying on the debate was disappointing. Mr. Butler said that, in 1955–56, actual expenditure on technical education was £7 million, and the University Grants Committee has recently examined the building programme for 1957–59 with particular reference to technology. An increase of 60 per cent in student numbers is anticipated over the next five years, and the Government has already authorized further buildings to be started in 1957, not only for engineering and other technologies, but also for basic science, physics and chemistry, in which technologists require to be well grounded, at an estimated cost of £4·5 million. This figure does not include sums collected by the universities themselves, or the £15 million to be spent on the Imperial College. The London County Council has now given outline approval for the east and west blocks on the island site in South Kensington, and work can now proceed on that part of the plan; but the central part is regarded as somewhat overbuilding the site. The Council is, however, prepared to give permission for certain sites in Princes Gardens to be used for the provision of common rooms and refectories, and this would permit reduction of the density of development on the island site. A revised plan has been prepared which not only gives a lower density of development but also allows the central tower of the Collcutt building to be preserved by the College (see *Nature*, July 21, p. 123); it would be necessary, however, to obtain expert advice on the stability of the tower as a separate unit. It is also proposed to spend about £750,000 at Salford, about £1·5 million at Birmingham on the development of the technical colleges there, and further sums not only at Manchester, where the Corporation is reserving an area of 17½ acres for the development of the Manchester College of Science and Technology, but also at Bradford, Loughborough, the Chelsea Polytechnic and the Northampton Polytechnic in London, and the Cardiff College of Technology. £100,000 has been provided in 1956–57 for developments in Swansea Technical College.

Mr. Butler thus failed to meet the main points of criticism which, for the most part, were very reasonably advanced during the debate; nor did the information he gave indicate precisely the relation of the structure of technical education outlined by the Minister of Education to the university departments of technology, or the distinction between, for example, the Manchester College of Technology and the colleges of advanced technology. What seems beyond question is that the Government should acquire, as a matter of urgency, the factual information as to the nation's requirements in technicians and craftsmen as compared with technologists and scientists, and that meanwhile it should be conducting with energy and imagination the task of public education essential to secure the co-operation of parents and of industrialists. Unless that task is vigorously undertaken and guided by real insight and understanding, it is idle to expect that 'early-leaving' will be reduced, an adequate proportion of the brighter boys and girls attracted into scientific and technical careers or that the understanding and co-operation of industry and local authorities will be fully engaged, either in the management of the technical colleges or in their staffing. If the Government is to rely on voluntary day-time release, much more must be done to bring home to industry its importance; just as the local authorities must be helped to understand the need for regional, if not national, views in running local and regional colleges and parents the need for encouraging young people to stay at school. It is the failure of the Government to deal vigorously and with foresight with these matters, and with those ancillaries like the national library, which contribute so much, directly and indirectly, to the full efficiency of the educational institutions of Britain, that justifies doubts as to whether the urgency and vital importance of a balanced system of education, in which technical and technological education find their appropriate place, are fully appreciated.

ROBERT HOOKE

Robert Hooke

By Margaret 'Espinasse. (Contemporary Science Series.) Pp. ix+192+16 plates. (London: William Heinemann, Ltd., 1956.) 21*s*.

If a scientist who admittedly knew little of poetry were to write a book the chief aim of which was to defend Wordsworth against strictures from Byron and Shelley, the literary reviewers would, rightly, be savage in their attack. The scientists defend their realm less sternly. Of her biography of Hooke, Mrs. Margaret 'Espinasse writes: "My motive in the enterprise is my feeling for Hooke. . . . When I first read his Diary I was enchanted by the personality which seemed to emerge so clearly". This is a valid reason; but many people will find the sustained tendentiousness and lack of scientific depth both tedious and irritating, and those familiar with Hooke's work will wish for more information on it and less defence of his personality.

Hooke, like all the original members of the Royal Society, was a fascinatingly complex thinker and an excellent and original scientist, whose interest in science far outran the study of elasticity which has left us Hooke's Law: he worked in optics, dynamics, pneumatics, physiology, microscopy, horology and chemistry, and was a brilliant inventor and an excellent architect. He is very like Wren in his interests, as the author points out. The originality and inventiveness which Wren poured into architecture Hooke put, with equal success, into the less enduring field of mechanical invention. As Mrs. 'Espinasse rightly remarks, Hooke is particularly interesting as almost the only paid professional scientist of his day. He was lucky that his work aided his science, whereas most of his contemporaries were busy doctors, architects, business men, courtiers, men of affairs, or theologians, who could give only their spare time to science. Hooke, as curator of the Royal Society, was at the centre of a busy, vivid, stimulating intellectual circle, pulsating with ideas, regularly discussing all scientific subjects and advances, both those made at home and those reported from abroad.

Hooke disputed more about priority than the others, Newton excepted; as a professional scientist, it mattered more to him, and he was, besides, a touchy man, quick to feel slighted even by his best friends, and equally quick, usually, to make it up. But Hooke does not need the jealous defence here accorded him; nowadays we do not share the Victorian passion for heroes. We prefer a just appraisal of a man set fairly in his period, and modern scholarship of the past ten years (unfortunately little remarked here) has corrected the earlier Olympian view of Newton. We now know that Newton, like Hooke, was a discursive, experimental, inquisitive scientist, whose works are more systematic than his thought. Hooke, even more true to his age—less the formal mathematician, and more generous in publishing his scientific work (though he was more restrained in declaring his inventions, unfortunately) —eschewed systems. To-day we appreciate non-systematic scientists like Hooke and Huygens more than the eighteenth century could do.

There is much in this book to interest any reader; it is a pity that the author's judgments of Hooke's achievements are often faulty. The air-pump Hooke built is not a forerunner of the steam engine; nor was his nitro-aerial theory of combustion an anticipation of Lavoisier. On the other hand, his theory of light as pulsed waves is more modern, and much more interesting, than is indicated. The descriptions and appraisal of Hooke's mechanical inventions are more just and complete, and are supported by handsomely reproduced illustrations. It is to be hoped that this book will attract interest to the further study of Hooke and his contemporaries, so that we may properly appreciate our predecessors.

MARIE BOAS

ELECTRICITY IN GASES

Ionized Gases

By Dr. A. von Engel. Pp. x+281. (Oxford: Clarendon Press; London: Oxford University Press, 1955.) 42*s*. net.

Since the publications of Townsend and Thomson there have been few comprehensive books on this subject which achieve the same standards of clarity in elucidating the basic physical principles. Dr. A. von Engel's book is outstanding in this respect. In a modern work this cannot readily be achieved without considerable sacrifice, and in the present volume, as the author admits, simplifications have been made with consequent loss of detail.

The author states that the book is based on his lectures to undergraduates and, happily, this is true of its style as well as of its content. The result is a book which is delightfully pleasant to read, and makes good the promise in the preface to form an introduction to the subject.

The titles for the various chapters follow the almost inevitable pattern: excitation and ionization;

emission of charges from surfaces; mobility; diffusion; recombination; glow discharges; and arc discharges. It is perhaps appropriate that the author, who has worked for many years in the laboratory made famous by Townsend, should include chapters on conduction in feebly ionized gases and on ionization in an electric field. There is a reasonable degree of uniformity in the standard of treatment of the subject; the one exception to this being the chapter on recombination, which with seventeen pages appears comparatively inadequate. On the other hand, Chapter 3, which deals with individual collision processes, is particularly good and achieves a nice combination of clarity with sufficient detail. In this chapter also, the author's skill in explaining the physical basis of the quantum theory of atomic processes is particularly in evidence. It is not by any means always easy to do this in simple terms, and the explanation that electrons in metals are "so strongly bound that only an insignificant number can contribute to the specific heat of the metal" does not perhaps represent the most important feature of the Fermi levels.

In presenting the latest experimental information, the author has included some results which have since been found to be unreliable. On p. 141, for example, the table of values of electron recombination coefficients has one or two doubtful entries, and in the same category is the statement on p. 143 that molecular positive ions of helium are the principal ions in discharges of this gas at ordinary pressures.

However, these are minor points in an excellent book which will appeal particularly to final-year students and to those embarking on research in this subject. J. SAYERS

BACKGROUND AND PHILOSOPHY OF MODERN PHYSICS

Physics and Microphysics

By Prof. Louis de Broglie. Translated by Dr. Martin Davidson.) Pp. 286+9 plates. (London: Hutchinson's Scientific and Technical Publications, 1955.) 21*s.* net.

THE late Albert Einstein contributes an all too brief foreword to this book, but he aptly sums up the remarkable series of essays which it contains by referring to it as "a unique book". Louis de Broglie is primarily a theoretical physicist, and it was through his careful and critical analysis, in the early 1920's, of the necessity to reconcile the granular and undulatory aspects of light that he was led to suggest the extension of the idea of the duality of waves and corpuscles to all elements of matter. He predicted the relationship $\lambda = h/p$ between the wave-length λ of the wave associated by wave mechanics with a corpuscle of momentum p, which was very soon afterwards verified experimentally. This same brilliant analysis and exposition de Broglie applies in this volume to the discussion of the formal opposition between the physics of phenomena on the large scale where the classical ideas of localization in space and time, of determinism, and of the individual object, are fully valid, and the physics of the atomic and corpuscular scale where, because of the quantum of action, these ideas are obscured or must be verified.

The original French edition appeared in 1947 and was entitled "Physique et Microphysique". Dr. Martin Davidson, who is to be congratulated on his excellent translation of this important work, has with the consent of the author made some alterations to the original text. Chapter 12, which was entitled "Un Glorieux Moment de la Pensée Scientifique Française", has been omitted completely, and Chapters 9, 13, 14 and 15 have been summarized. Also, since with the rapid progress in atomic physics during recent years some of the statements and data presented in the original French version are now incorrect or require modification, Dr. Davidson has where necessary added suitable explanatory notes at the end of the appropriate chapters. The contents consists of seventeen essays or lectures divided into three parts appropriately headed—science, scientific philosophy and history of the sciences.

In the first part, de Broglie describes the early development of our knowledge of the elementary particles of matter and how progress in this direction has transformed our theoretical conceptions of the constitution of nuclei and of the fields that assure their stability. Other chapters deal with the part played by light in the physical world; wave mechanics and electron diffraction; the concept of quantity in physics; and the formation of images in corpuscular optics.

The opening chapter in the second part, "The Revelations in Microphysics", is worthy of considerable study. Bohr's idea of 'complementarity' is given some emphasis, and the philosophical implications of atomic physics and wave mechanics are outlined. de Broglie is a modest man, but it is necessary for him to look back in retrospect on the origins of wave mechanics; thus, Chapter 8, which is devoted to personal memories on the beginnings of wave mechanics, is excellent reading and shows up clearly the deep insight to physical problems that de Broglie possesses. In later chapters the ideas of Zeno and Bergson on time and motion are considered in relation to the new physical concepts, and with regard to chance and contingency in quantal physics von Neumann's views are discussed in some detail. Finally, in the third part, de Broglie tries to emphasize the link between pure science and its applications; the moral problems introduced by the atomic era; and the grandeur and nobility of pure and disinterested science. He concludes the last chapter, "The Great Adventure", with the words: "In the work of science man has been able to show the force of his intelligence; if he wishes to survive his own successes, it is necessary that he should now show the wisdom of his will".

This is a book that every physicist should read and ponder over. S. WEINTROUB

THE COLLECTED PAPERS OF H. A. KRAMERS

Collected Scientific Papers

By H. A. Kramers. Pp. xi+969. (Amsterdam: North-Holland Publishing Company, 1956.) 45 Dutch florins; 90*s.*

THE world of physics has good reason to be grateful to the editor of these collected papers, N. G. van Kampen, and to the various Dutch funds and institutions which generously supported the publication of this monumental volume.

A number of Kramers's papers were published in not too accessible journals, but will now be readily available. Among those are his thesis, the paper on the Kramers–Kronig relations, and the papers on his renormalization theory (Como, 1937; Solvay, 1948). Indeed, the fact that modern mass- and charge-normalization procedures were anticipated by Kramers in his radiation theory of 1937 is only too little realized.

The papers are broadly arranged according to subject, and within each group chronologically. The first group contains the papers from Kramers's Copenhagen period on the quantum theory and later papers on quantum mechanics. It includes his paper in the *Philosophical Magazine* on X-ray absorption, the Kramers–Heisenberg paper, and the paper on the *W–K–B* method. It also includes his papers in the *Proceedings of the Amsterdam Academy* on the so-called symbolical method. The second group deals with paramagnetism and ferromagnetism. The last group is a mixed one. It includes his papers on quantum electrodynamics, the Kramers–Wannier paper on order–disorder, and the paper on charge conjugation in the Dirac hole theory.

It is impossible to do justice to this book in a short review. It shows better than any obituary could do the many-sidedness of Kramers's work as a physicist. Unfortunately, it was decided not to include Kramers's philosophical and popular papers. These show his wide understanding of the human aspects of physics. They are practically inaccessible, especially to those without a reading knowledge of Dutch, and a selection of them (in translation) would have been a very valuable addition. (His Leyden inaugural lecture, "Physicists as Stylists", was translated (*Naturwiss.*, 24, 297; 1935) and rewards the reader with a broad vista of physicists as human beings.)

His semi-popular book on early quantum mechanics, written in collaboration with Helge Holst, has long been available in many languages, and his text-book on the foundations of quantum mechanics is about to be published in an English translation, so that Kramers's complete works will now be readily available, apart from his popular papers.

D. ter Haar

TRENDS IN ANATOMICAL TEACHING

Lehrbuch und Atlas der Anatomie des Menschen

Von Dr. Fr. Kopsch. In zwei bänden. Band 1: Allgemeines, Skeletsystem, Muskelsystem, Gefassystem. Pp. viii + 736. 64.50 D.M. Band 2: Eingeweide, Nervensystem, Sinnesorgane. Pp. viii + 768. 64.50 D.M. Neunzehnte Auflage. (Stuttgart: Georg Thieme Verlag, 1955.)

These volumes have an interesting pedigree for the British reader. It was in 1870 that Carl Ernst Emil Hoffman prepared the first German edition of this work, which he based upon the seventh edition of Quain's "Anatomy". The Quain–Hoffman text was then, in 1892, taken in hand and revised by Dr. Rauber. The present editor, Prof. Fr. Kopsch, became responsible for the seventh edition in 1906, and has remained in charge of the work until this, the so-called nineteenth edition, so that he has had ample time in which to impress upon it to the full his own anatomical personality.

Printed on good-quality art paper, the two volumes between them contain more than fifteen hundred pages. The type is clear, the binding is robust, and the format of the volumes as a whole is a pleasing one. The illustrations have been conceived and executed on a generous scale. Many of them occupy an entire page, and they appear to have been drawn with great care, though Figs. 528 and 529, showing the segmental areas of skin innervation, seem to be somewhat at variance with what is generally accepted in Britain.

Vol. 1 begins with a general section (pp. 1–100) and then continues with osteology, arthrology, myology and angiology; Vol. 2 deals with splanchnology, the nervous system and the sense organs. The general section gives an account of the basic properties of the cell, and a description of the different cell types—including an estimate of 8 billion as the total number of cells in the human adult (excluding the blood cells). This section also includes a description of the body as a whole, a brief consideration of body build, various body measurements and an account of anatomical terms. In addition to the general histology contained in this section, the special histology of the various organs, beautifully illustrated, is given throughout the text together with the gross anatomy.

A review of an anatomical text-book is an appropriate occasion for recalling that anatomy is one of the oldest of the scientific disciplines, and that the publication in 1543 of the "De Corporis Humani Fabrica" of Andreas Vesalius was one of the great landmarks in the history of modern science. During the centuries which followed, anatomy has had its ups and downs, periods of stagnation alternating with periods of progress.

Towards the end of the nineteenth century, when the young and vigorous sister science of physiology broke away to enter upon a period of rapid expansion, most anatomists devoted their attention to the study of form, as opposed to function. But even when the study of anatomy was confined almost exclusively to the dead body, the boundary between these two facets of biology was never perfectly clear-cut, and in recent years has become blurred to an increasing extent. There has been an anatomical revival, which has steadily been gaining momentum, based on a variety of new techniques for the study of the living organism and its component tissues. As a result of this development, the fields of anatomical and physiological studies have tended to overlap more and more.

However, not all anatomists have welcomed the newer developments with the same degree of enthusiasm, or thought it necessary to incorporate them into anatomical teaching to quite the same extent. Prof. Kopsch takes care to emphasize in the preface that he is adhering in the main to well-tried morphological methods of presentation, and is concerned with form rather than function. But the changes in form which occur during life can only be studied intelligently against a background of function, and if one is too resolute in the avoidance of functional considerations, one is bound to lose much valuable information in the field of living morphology. Thus, to give but one example, there is no reference in the present work to cholecystography.

Subject to considerations of this nature, and within the author's self-imposed limitations, these volumes constitute an impressive tribute to the deservedly high standing of Prof. Kopsch in the anatomical world.

J. M. Yoffey

Old Fourlegs

The Story of the Coelacanth. By Prof. J. L. B. Smith. Pp. x+260+6 plates. (London and New York: Longmans, Green and Co., Ltd., 1956.) 21*s*. net.

THIS is a popular account of the discovery of the Coelacanth as a living fish. It is also a record of the intellectual agonies suffered by a sensitive man of science when confronted with a phenomenon which made nonsense of his previous academic training and experience. Smith tells not only of the way in which the first fish was brought to his notice and of the way in which he pursued the second but also of his investigations, which showed that this animal was no denizen of the deep, as suggested by many authorities, but lived in the reefs off the remote Comoro archipelago approximately midway between Portuguese East Africa and northern Madagascar.

Among the difficulties which Smith had to overcome before obtaining his second fish was getting permission from Prime Minister Malan to use a military aircraft for a quick and essential journey to Comores, and an excursion into diplomatic channels to persuade the French Governor of the Comores that the fish could belong to no other than Smith despite his South African nationality. Many of Smith's personal difficulties are dramatically described and a number appear to have been of his own devising. Against this, it is almost certain that the writing of yet one more chapter in the story of the natural evolution of animals would not have been made without his fanatical devotion to the Coelacanth. His relentless pursuit after factual evidence is worthy of the true man of science and it is good that Smith has set down a record of his fears and hopes and disappointments and triumphs as encouragement for others. The story is not well told but is so romantic in itself that the telling scarcely matters.

T. H. HAWKINS

Electric Dipole Moments

By Dr. J. W. Smith. Pp. vii+370. (London: Butterworths Scientific Publications, 1955.) 42*s*.

DR. J. W. SMITH has provided a sound, solid and comprehensive account of dipole moments, an important field which has gathered fresh impetus during recent years. The first three chapters of his book deal with the general physical theory, with the conventional method for measuring dipole moments, and with various unconventional methods, mostly recent. The headings of the remaining chapters are: general results; the origin of electric dipole moments; solvent effects; induction and mesomerism; dipole moments in relation to molecular structures and configurations; atom polarization; restricted rotation about single bonds; molecular association and molecular interaction. There is an appendix on wave mechanical principles, and a table of bond refractions.

On the whole, this is a good book: it is well written, well produced, and covers the subject in a very satisfactory manner. One could wish that the author were more critical, particularly in the sections on evaluation of results and on solvent effects: the general reader would find them tedious; the specialist would find them inadequate. The appendix on quantum theory is quite useless, and the space could have been used better in other ways; for example, the experimental section is marred by failure to quote the types of valve used in many of the circuits and the dimensions of the dielectric cells. The general accuracy of the measurements is nowhere properly discussed. The account of carbon monoxide and nitric oxides on pp. 112–4 is very confused.

However, these failings are not serious, and the book can be confidently recommended to all chemists who have any interest whatever in the subject. The price is not unreasonable.

M. J. S. DEWAR

Magnetic Materials in the Electrical Industry

By P. R. Bardell. Pp. 288. (London: Macdonald and Co. (Publishers), Ltd., 1955.) 32*s*. 6*d*. net.

THE intention of the author of this book is to help students of physics and electrical engineering, and also physicists and engineers in industry, to a fuller knowledge of magnetic materials, their properties and their applications. It also sets out to resolve some of the difficulties arising from proprietary names of materials and confusion among technical terms and units. Prof. James Greig, in a foreword, welcomes the book as relating engineering practice to scientific principles and physical phenomena.

The chapters on permanent-magnet and high-permeability materials describe the development of these materials and their ability to meet the requirements of various applications. The characteristics of many materials are presented in tabular form by type and maker's name. There are two chapters on the application of soft magnetic materials at power and communication frequencies; they include the properties of powder cores and ferrites. The effects of flux density and frequency on loss are well brought out, but the effect of saturation on wave-form is not considered. Various methods of measuring soft magnetic materials are described. Magnetic recording is also dealt with clearly and simply. The testing of materials by magnetic means is considered under the headings of magnetic discontinuity and of magnetic characteristic, and examples of each are described.

The principles of magnetic amplifiers and transducers and some typical equipments are described. At the end of each chapter is a list of references; an appendix contains a glossary of terms referred to in the text, and there is an adequate index. The tabulated information of the characteristics of magnetically hard and soft materials is well presented, and there are good illustrations of various items of equipment such as power transformers, telephone relays, choking coils and powder cores.

This book will be found most useful by students and others to whom the properties of many industrial magnetic materials are not readily available.

H. M. C.

Elizabethan Copper

The History of the Company of Mines Royal, 1568–1605. By Prof. M. B. Donald. Pp. vii+405+9 plates. (London: Pergamon Press, Ltd., 1955.) 60*s*. net.

THE history of metalliferous mining in Britain has not, as yet, received the attention it deserves, and it awaits an author who will deal with the subject comprehensively and as a whole. Meantime, an important contribution to the story has been made by Prof. M. B. Donald, who has brought to his task not only a practical interest in historical research, but also the necessary technical background acquired during a career that has embraced both the commercial and academic sides of technology.

This book tells, with much detail, the story of the opening up of copper mines in the Lake District in the sixteenth century, and of the formation of the Company of Mines Royal which was incorporated in 1568 to exploit these mines. In addition, the reader is given an account of the commercial and legal background, together with biographical details of the principal participants in the activities, including the technical advisers who came to Britain from Germany to superintend operations. The tale unfolded discloses that the promotion and exploitation of mines were carried out, in Elizabethan times, in a manner not very dissimilar from that employed to-day. A later chapter in the book describes the opening of copper mines in Cornwall during the same century.

Many manuscript sources, some new and unpublished, have been consulted in compiling this book, which is both an interesting and important contribution to the history of technology. It is likely to remain for a long time to come a standard source book for the field it covers. V. A. EYLES

Chemical Trade Names and Commercial Synonyms

A Dictionary of American Usage. By Williams Haynes. Second edition, revised and enlarged. Pp. vi+466. (Princeton, N.J.: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd., 1955.) 60*s.* net.

THE title of this book indicates its scope reasonably well, but the intention is to limit the terms listed to those of chemicals and chemical preparations sold industrially rather than by retail; pharmaceutical products, either as individual chemicals or compounded, are not included.

A trade name is accompanied by an indication of the American supplier and, ideally, the definition gives first, the composition and then the chief uses. There are gaps in definitions that could be filled; for example, Santowax P, described as a "coal-tar resin", is known to be *p*-diphenylbenzene, and the identity of Musk Tibetene has been published (Fuson, 1947). There are also obvious errors; thus methacrolein is stated to be *iso*butylene oxide, heptyl alcohol to be octanol and methionine to be sulphur-free. There is an occasional weird definition as, for example (p. 95), "hydrosulphite product free from heavy *m*-dianisidine", and there are double entries such as for methoxychlor, oxone and durene. There are innumerable printing errors, each petty in itself but aggravating in the aggregate, and there is more than one indication that at least some such errors have arisen from the setting of copy as received.

Much useful information has been collected here for anyone who has contacts, however indirect, with the American chemical market; but, as already indicated, there is plenty of room for improvement in detail. Moreover, does that market deal in acetic acid as "vinegar of Venus", in formic acid as "spirit of ants" and in carbon dioxide as "acid of air"? Maybe it does, since there is apparently still a call for woad. B. A. ELLIS

Quantitative Methods of Organic Microanalysis

By Dr. S. J. Clark. Pp. x+253. (London: Butterworths Scientific Publications, 1956.) 30*s.*

ON looking at the library of books on quantitative organic microanalysis, one would not say that there is a surfeit of literature, and so a new volume by a new author immediately arouses interest. By incorporating the latest methods with older proved ones, this book fills a much-needed gap, especially if allowance is made for the speed with which modifications are published in the journals. However, some of the methods are so new, and so much reference is made to "unpublished works", that for the moment they cannot inspire a great deal of confidence in them.

As the author has included both old and new methods in a book of only 250 pages, one gets the impression of a skimping of detail. For example, the use of nickel ammonium sulphate as an absorbent for ammonia is given on p. 93, but no reasons are stated for its choice. On p. 104, one is left guessing as to whether the hydrogen peroxide is neutralized before use, and boiled after absorption to destroy excess, as is done in the standard procedure. The first five chapters deal with the usual routine weighing, general apparatus techniques and ashing. Except for the inclusion of the Karl Fischer water determination, and ion exchange for determination of metals, they remain virtually unchanged. Six chapters are devoted to elementary analysis, and the following five to the determination of functional groups. Of particular interest is the inclusion of fluorine with the halogens, the direct determination of oxygen, and titrations in non-aqueous solvents.

The microanalyst is of necessity an individualist, and although he may not use completely any one particular method, he can obtain from this book much useful information to try out for himself. It is recommended for a place on the bookshelf. F. H. OLIVER

Photographie et Cinématographie Ultra-Rapides

Actes du deuxième Congrès International de Photographie et Cinématographie Ultra-Rapides, Paris, Septembre 1954. Présentés par Pierre Naslin et Jean Vivie. Pp. xxviii+456. (Paris: Dunod, 1956.) n.p.

THIS volume is a record of the second International Congress of High-Speed Photography held in Paris in 1954 and contains more than sixty contributions dealing with many branches of high-speed photography and cinematography and their applications. Each article begins with a summary in each of the three languages of the conference, English, French and German, and is printed in full in one of them.

The value of this volume lies not only in the wide field which is covered but also in the fact that the articles are authoritative, many being contributed by acknowledged experts in this field of photography. In addition to being a source of reference to modern techniques, this book will also be of great use to anyone searching for a method of recording for some new investigation. It is often by taking a technique which has been developed in reference to one particular subject and by adapting it to another that advances are made, and here one can see what methods are being used in fields of investigation which are very remote from each other.

On the whole, the volume is well produced; but a slightly more substantial paper might have resulted in better reproduction of some of the illustrations. The coloured plates, for which special paper has been used, are well produced. The index is not very adequate; but perhaps if a more elaborate one had been attempted the production of the book might have been delayed and this would have been undesirable for, as is well known, the third International Congress is to be held in September of this year in London under the auspices of the Department of Scientific and Industrial Research.

HUMAN PROBLEMS OF INDUSTRIAL COMMUNITIES

H.R.H. The Duke of Edinburgh's Study Conference on the Human Problems of Industrial Communities within the Commonwealth and Empire —to give it its full title—looked at first sight an intellectually unmanageable proposition. The intention was to collect about 280 members, ninety from the United Kingdom and the remainder from overseas, half managers and half trade unionists, for three weeks, of which the first and last period would be in Oxford and the centre ten days spent, in twenty groups, visiting factories and social institutions in twenty principal cities of England, Scotland and Wales. The members were not to be intellectuals or research workers, but men in the early prime of life actively engaged in industry either as managers or worker/trade unionists. The bill of fare for the Conference fell into four stages. First, the circulation, three months in advance, of twenty-five "Background Papers", dealing either with practical problems as seen by a practical man ("Stabilization of Labour in the Rhodesian Copperbelt", by Sir Ronald Prain), or with more general problems seen academically ("The Will to Work", by Prof. C. A. Mace; "Work and Community in a Primitive Society", by Prof. Raymond Firth). Second, a series of ten major addresses in plenary sessions at Oxford, with some very short group-discussion periods to enable the members to meet one another. Third, the "Study Tours", in which the whole Conference dispersed in groups of fourteen members with the addition of a specially selected United Kingdom chairman, each group spending about five days in a provincial city and its neighbourhood and four days in London. Fourth, a period of three days intensive group discussion in Oxford, followed by oral reports from groups and a general summary.

At first sight, the Conference ran with outstanding success. After more than two years of intensive preparation, the members, in almost exactly the planned proportions, and of very high quality, arrived in Oxford on July 8 and were swept through the programme, from the impressive opening ceremony in the Sheldonian to the final dinner in Christ Church on July 27, without a major hitch. All the incidental values (and they are not to be undervalued) were realized: the mixing of nationalities and industrial 'sides', the total absence of colour-consciousness, the sense of fellowship and common search. Nevertheless, it remains to ask three important questions: Was the subject-matter, so handled, manageable? Did the members absorb new ideas to any useful extent? What lasting effects can the Conference hope to have achieved?

Possible criticisms are obvious and formidable. It is acknowledgedly a difficult matter to hold the attention of such differing groups as sugar plantation workers in the Caribbean and Canadian electronic engineers. How could any programme the wit of man could devise suit both? Again, it is supposedly true that education, particularly via discussion groups, does not go very well when the gap in background and intellectual sophistication between the students is too wide—and it is hard to imagine wider gaps than those which existed in this Conference. Finally, the practical experience of the study tours was, of necessity, a rapid survey of certain problems of the United Kingdom, utterly unlike those of Pakistan or Sierra Leone or Johannesburg, and of necessity dimly comprehended and inaccurately interpreted.

Common Problems

These are formidable objections. Yet the conviction of a great number of intelligent members contradicts them flatly. My own answer to this conundrum was found in the recollection that industrialism is, in the full sense, a culture. It is so easy to recognize this about the past—historians and anthropologists speak readily of, say, pastoralism and the complex of religious, social and economic patterns of life associated with it. 'Industrialism', too, means more than certain manufacturing techniques; it has been based on a certain philosophy, it has raised certain political problems, it has set a certain social pattern wherever it has appeared. Examination of some of these associated effects of industrialization may be the best way of explaining why this diverse body of Conference members, from diverse backgrounds, in fact found a common language.

In the first place, the factory itself is a major and new political event. To hold some hundreds of men together, over long periods of time, in co-operation towards a single end, has only been achieved in history—on any wide scale—by three methods: slavery, military discipline or monastic discipline. The factory poses entirely new problems. From whence is the authority of 'the management' derived? What are its sanctions, and its limits? If we are to speak of leadership rather than authority, what are the common purposes between leader and led which can provide the continuing reason for consent? These are common problems "whether on the shores of Asia or in the Edgware Road". Within them lies the problem of personal and group satisfaction at work.

Again, and still in the political field, industrialization involves a shift of power away from old landowning and aristocratic groups; it means a rapid erosion of the influence of hereditary status (birth, chieftainship, caste) and the emergence of a new group of technical, administrative and professional leaders. This is true in Britain, and it is becoming clear in India (Mr. Tata explicitly commented on it in his address), in Africa and in Fiji. It is interesting that the newer societies, such as Australia, never greatly felt this problem, because industrialization has developed in almost pure form with no earlier culture to compete with. Moreover, not only does power shift, but also it tends to become centralized, both in the community and in government, by the growth of industrial combines and by the increasing need for State intervention and planning. This has been seen in Britain in developed form, despite our conscious efforts—not wholly unsuccessful—to retain and bolster local government and local initiative.

This leads directly to a third common effect. The industrial 'exchange economy' leads to a final break with the older subsistence economy based on the land. Once the 'worker' becomes wholly dependent on 'finding work', and has neither land nor tools of production to fall back upon, he is perilously dependent on the stability of the economy—the maintenance of 'full employment'. Far richer, but far more complex, the man-made industrial economy demands a man-devised fashioning of society—all the insurances against temporary breakdown which we call social security, diversification of industry, indeed every form of planned social control. Hence the growth of a planning and executive central State.

Three more common problems must be mentioned briefly, because all three occupied so much of the discussions in the Conference: the impact on family life, the change in the nature of community life, and the quest for social ideals. In certain ways they are connected. As both the mother and the younger members of the family are sucked into independent wage-earning employment, the authority of the head of the family weakens, the older people, once 'retired', tend to be pushed on one side, and ideals of individual personal development weigh more and more heavily against the institution of family and 'home'. So also the peculiar form of industrial urbanization in the big city swamps the institutions of village social life and is apt to leave a mass of atomized individuals instead of a social structure. Both these changes, so obviously connected with the needs of industry both for concentration and for mobility, raise the question of social ideals: Are the needs of production, the aim of material success, to dominate and exclude age-old values of personal and social life?

The Impact of Industrialization

It was around these common problems that the main addresses to the Conference fell. After the opening address by the Duke of Edinburgh—by common consent a brilliant and obviously personal contribution—with its emphasis on humility and study, and on the aims of a civilization rather than the wealth of an economy, Sir John Maud struck the keynote of the Conference work by his speech on "The Impact of Industrialization". Outstanding in my memory of this memorable address, and in its effect on the Conference, were a series of paradoxes. Industrialization can bring, said Sir John, more freedom and more slavery: more loneliness and more fellowship: more civilization and more barbarism. Which way the balance tilts hangs on the personal philosophy, courage, faith and effort of the myriad individuals within society.

Thereafter came a series of addresses, the titles of which show their drift. "The Varying Pattern of Industry", by Lord Citrine; "The Human Problems of Industry", by Mr. Waring, Mr. J. M. Campbell, Sir Alfred Roberts, Mr. J. Crawford, Colonel Grierson; "Everyday Relations of Industry and the Community Around It", by Sir Harry Pilkington and Dame Florence Hancock; "The Two Partnerships—Man with Man and Man with Nature", by Sir Harold Hartley. In the last period at Oxford the discussions were supplemented by five more addresses in a series of "Overseas Viewpoints": "The New Industrial Communities in West Africa", by Mr. R. K. A. Gardiner (Gold Coast); "The Future Responsibilities of Trade Unions", by Mr. A. E. Monk (Australia) (owing to illness, this paper was circulated in written form); "Industrial Problems in a Multi-racial Society", by Mr. H. F. Oppenheimer (South Africa); "Thoughts on the Industrialization of a Predominantly Rural Society", by Mr. J. R. D. Tata (India); "The Effects of Technical Change", by Mr. W. J. Bennett (Canada).

All these addresses were more than able; but beyond question, if we take the addresses of the Duke of Edinburgh and Sir John Maud as the first high points, Sir Harold Hartley's as the second, then Mr. Gardiner's speech, closely followed by Mr. Oppenheimer, was the third, and in certain respects, the highest. Speaking with the most palpable sincerity and controlled feeling, Mr. Gardiner put forward the thesis for equal respect for the human dignity of the individual of whatever race, religion or colour, as the only real basis upon which the future of the Commonwealth could rest. "The individual ought to feel that certain things cannot happen to him as a person, not because he belongs to a privileged group or race." "We can form a society on a set of rules; but if we intend to form a community—and that is what, to me, a Commonwealth means—that can only be formed on the basis of a common understanding or outlook, a common ethos. Is it going to be possible for us to develop this common outlook, to make it possible for us to continue to set an example to the rest of the world?"

"For *us* to continue . . ." Perhaps these words do not look startling in print; but from the speaker, on the occasion, they moved the whole Conference to an ovation reserved for no other speaker save the Duke of Edinburgh himself. Followed, as they were, by a practical, statesmanlike and liberal speech by Mr. Oppenheimer, tackling the problem of Southern Africa foursquare (and, if it had not been tackled, it would have been an abscess in the Conference), they confirmed finally a sense, already growing, that this Conference was not merely a successful façade but an event in which things of lasting importance were happening as day followed day.

Industry and Social Service

Each group of members, fifteen in number including their chairman, spent ten days 'on tour', seeing representative men and women in industry and social service in a very intensive programme based primarily on discussion, with only enough sight-seeing of factories or schools to give atmosphere and background. In fact, the discussion seems to have been admirably frank and full—several factories referred to it afterwards as more like an inquisition than a visit. Each group was given three subjects for special study, and the final reporting, dealing with these special subjects in groups and consecutively, covered the main field of the whole conference.

What came out of these reports? A remarkable unanimity in five or six directions. Smaller working groups where the supervisor really can supervise personally and the manager can manage; personal relationships and personal trust as a factor transcending all other 'incentives' and 'conditions at work'; independent social activity by the community, not managed by the factory; opposition to the employment of married women with young children; restoration of the central importance of family life; the need for spiritual values. When the oral reports are published, these will be some of the leading themes.

It is true that to many people these are platitudes. But fifteen years ago they were in the mouths, not often of 'practical men' but of the so-called intellectuals, social scientists, psychiatrists and anthropologists. It is of real importance that this is now the talk of practical men from all corners of the

Earth—trade unionists and managers alike. Ideas have moved not only out through society from their intellectual fountainhead, but outwards throughout the Commonwealth; and they are the same ideas, whether in Nigeria or Pakistan.

Writing fresh from the impact of this meeting, which developed an atmosphere of common effort which, in the Duke of Edinburgh's words, you could cut with a knife, I am bound to over-estimate the effects of this event. Yet that it was an event, with its own tiny place in the story of the Commonwealth, I am convinced. The members, when they return to the intrigues, the disappointments, the prejudices and the passion of real life in their countries (conferences are never real life) will carry back with them not only an experience of friendship—and that was abundantly evident—but also a reinforcement of faith and hope. Is anything of more value?

GUY HUNTER

PHYSICS OF GAS FLOW AT VERY HIGH SPEEDS

THE summer discussion meeting of the Physical Society was held in the University of Manchester during July 16–17 under the auspices of the Departments of Applied Mathematics and of the Mechanics of Fluids. The subject was "The Physics of Gas Flow at very High Speeds", that is to say, speeds so high that changes in kinetic energy are comparable with the energy required to produce interesting physical changes such as dissociation, ionization and substantial emission of radiation. The implications for the aerodynamics of man-made projectiles travelling at extreme speeds, and also of meteors, were included in the discussion. The shock tube, the principal research tool in this field, was discussed at length, both as regards design and instrumentation for use with very strong shock waves, and in connexion with the results so far discovered by its use. Prof. S. Devons, vice-president of the Society, presided over the meeting.

As Prof. M. J. Lighthill, of the Department of Mathematics, University of Manchester, said in his introductory remarks, the object of the meeting was to promote studies in a field where two great new scientific disciplines of the twentieth century meet and overlap. These disciplines are, on one hand, chemical kinetics, as grounded theoretically on the study of collision processes and experimentally on spectroscopy as interpreted by the quantum theory of radiative transitions; and on the other hand, fluid dynamics, as it has grown up since the discovery of the basic concepts of the boundary layer and the shock wave during the first decade of this century, using the wind-tunnel as the principal experimental tool. Neither subject had yet reached the dignified status of a science in the nineteenth century, when as Sir Cyril Hinshelwood has observed, chemical reactions were classified mainly into those that go and those that do not go, and when fluid dynamicists were divided into hydraulic engineers who observed things that could not be explained and mathematicians who explained things that could not be observed. In the great, and largely successful, struggles of the past fifty years to reach some sort of systematic understanding in both these two fields, the scientists involved were naturally disinclined to complicate their problems by introducing ideas from quite different disciplines. So until very recently it has been the rule for fluid dynamicists to know almost no physical chemistry, and physical chemists almost no fluid dynamics.

During the past five years, however, a movement has grown up with the object of making new advances by pooling the knowledge that has been acquired in these fields. To this end, fluid dynamicists have set themselves to learn about chemical kinetics and students of chemical kinetics have started to study fluid dynamics. These herculean labours have already begun to make important improvements in our knowledge of combustion processes, and a number of conferences have been held in this field. More recently still, external aerodynamics (that is, the study of flow around projectiles moving through the atmosphere) has reached the stage where this pooling of ideas is necessary. To mention an extreme example, it has been announced in the House of Commons that the Americans propose to shoot at Ascension Island from their missile-testing station in Florida. A simple computation of the elliptic orbit which such a missile would have to follow (after it has left the atmosphere and its rocket motors have burnt out) shows that it would have to re-enter the atmosphere with a speed of at least 6 km./sec. But a speed of half this would already be sufficient to cause considerable chemical changes in the air around a projectile. These changes would involve dissociation of oxygen and nitrogen molecules into free atoms, as well as the formation of nitric oxide. At speeds of 6 km./sec. the dissociation of oxygen near the front of the projectile would be nearly complete, and that of nitrogen well advanced. These changes may be expected to have important effects on the airflow about the body, and hence on the aerodynamic heating which is, of course, what constitutes the main difficulty of flight at these speeds. They constitute the main reason why aerodynamicists have been learning chemistry.

The reason for the converse process is the development of the shock tube, which physical chemists have found increasingly useful for studying fast gas reactions since Kantrowitz advocated its use for this purpose five years ago. Developed originally for studying the fluid dynamics of shock waves under conditions far more flexible than could be obtained in wind-tunnels, it has found additional use as a means of studying how reactions proceed in time after the pressure and the translational temperature of a gas mixture have been instantaneously raised by known amounts. For example, the shock tube has been used in this way to determine the rates of dissociation of iodine, bromine and nitrogen tetroxide. Since the shock tube is so useful both in this kind of work and in studying problems of very-high-speed aerodynamics, two of the five main lectures at this conference were devoted to it.

After giving this introduction Prof. Lighthill then proceeded to read his own lecture on the dynamics of a dissociating gas. He began by outlining the scientific advantages of starting, in such a difficult subject, by studying, both experimentally and theoretically, the behaviour of a pure diatomic gas capable of dissociation into free atoms. The theory falls naturally into three parts: equilibrium theory; quasi-equilibrium theory of the transport properties, including radiative transfer; and flow theory involving large departures from equilibrium.

The first part includes the fundamental thermodynamics and statistical mechanics of the atom–molecule mixture, and also the theory of the flow outside the boundary layer between a body flying at extreme speeds and the shock wave which travels ahead of it, in cases where equilibrium is reached behind this shock wave in a negligible time. Prof. Lighthill described the Busemann theory of this flow, in which the shock wave is wrapped around the body like a piece of paper around a parcel, and also the recent developments by Freeman and Chester in which second and third approximations to the flow pattern, based on Busemann's approach as a first approximation, have been found, yielding more accurate equations for the shape of the shock wave. He gave also an alternative theory of the flow near the stagnation point on a sphere, in which the only approximation used is the assumption of incompressible flow behind the shock wave. The good agreement between these two theories, based on the neglect of quite different features of the flow, in their region of overlap, gives one increased confidence in both.

Prof. Lighthill discussed briefly the kinetic theory of the diffusive heat transfer (stressing the importance of interdiffusion of atoms and molecules) and its application to the theory of the laminar boundary-layer near the front stagnation point on a bluff body, touched on the physical mechanisms of radiative transfer, and then turned to theories of flow involving large departures from equilibrium. Freeman had calculated the passage to equilibrium behind a uniform plane shock wave, an important feature of this process being the decrease in relaxation-rate as the translational temperature drops. He was now engaged in applying similar methods of calculation to the curved detached shock wave ahead of a projectile.

Mr. H. K. Zienkiewicz, of the Department of Mechanics of Fluids, University of Manchester, then gave a lecture on aerodynamics at extreme speeds. This was based on slides prepared to illustrate detailed flows which he had computed using tables of the composition and thermodynamic properties of air in dissociative equilibrium over a wide range of pressures and temperatures. He discussed plane shock waves and expansions in this way and various flows obtained by combining them, and ended by giving a theory for axisymmetrical flow around a cone. In all cases he made a comparison between the behaviour to be expected of air and that which would be predicted if changes in composition were neglected or if the specific heats remained constant.

The lectures on design and instrumentation of shock tubes were given by members of the High Speed Section of the Aerodynamics Division of the National Physical Laboratory, Teddington. Dr. B. D. Henshall first spoke of the reasons for the popularity of the shock tube as a means for producing flows with high stagnation temperature (of the order of ten or twenty thousand degrees). He described the elementary theory of the shock tube, and its modifications by the effect of the walls, stressing the importance of wall resistance to the turbulent flow in the neighbourhood of the contact surface, with its somewhat surprising effect of decelerating the shock wave but accelerating the contact surface itself. He described the use of hypersonic nozzles at the downstream end of shock tubes to attain very high local Mach numbers at the expense of low Reynolds number, and pointed out that, if these nozzles are to 'start' satisfactorily, an initial back-pressure of a fraction of a micron of mercury is necessary. He described shock tubes using more than one diaphragm, and discussed the factors influencing diaphragm design.

Dr. Henshall then described in detail the proposed 6 in. square shock tube at the National Physical Laboratory, and discussed how different aspects of problems of free flight at extreme speeds can be simulated, using the straight portion of the shock tube or the flow after one or two subsequent expansions. Dr. O. L. Schultz described the timing and triggering devices which will be used in this shock tube, the pressure and temperature gauges which are at present proposed, and the way in which the latter will be used to measure transient heat transfer rate. He also described a method of inferring overall drag by measuring the acceleration of a freely floating model.

In the subsequent discussion Mr. C. H. E. Warren, Royal Aircraft Establishment, Farnborough, described the design of the shock tube under construction there. He was against the use of multiple diaphragms and favoured the straightforward use of hydrogen as a driver, raised to high temperature and pressure by combustion with oxygen. He agreed with Dr. Henshall that valuable work on simulating flight at extreme speeds could be done if the stagnation temperature and Reynolds number were reproduced accurately, even though the Mach number in the experiment was far too low. Inaccuracy of Mach number might be got over by changing the geometry.

Mr. E. M. Dowlen, of the English Electric Co., Ltd., Luton, then described the parallel work going on in his laboratory. He stressed the convenience of using small tubes (for example, of 2 in. diameter), and agreed with workers at Teddington on the advantages of surplus gun-barrels as the material of the high-pressure sections. Later, Dr. R. Hide, of the Atomic Energy Research Establishment, Harwell, described the shock tubes in use there, and the work going on concerning the application of magnetic fields to the highly ionized gas behind a very strong shock wave.

A different aspect of gas flow at very high speeds was discussed in the lecture by Dr. J. G. Davies, of the Jodrell Bank Experimental Station, Manchester University. After a general account of the astronomy of meteors, he described the techniques for observing, visually, photographically and by radio echoes from their ionized trails, the entry of meteors into the atmosphere at speeds between 11 and 72 km./sec. He mentioned the importance of observations of the drift of meteor trails as a source of information on winds in the upper atmosphere.

Dr. Davies pointed out that almost all meteors are less than a centimetre in diameter and evaporate completely (owing to heat transfer by direct collision with atoms and molecules of the atmosphere) at altitudes where the mean free path is large compared with the diameter. He described a theory of this process, from which a theoretical expression for the variation of light intensity with distance along the meteor trail can be determined. In some cases this theory is inapplicable because fragmentation of the meteor occurs, leading to greatly increased radiation and quicker evaporation. Bodies large enough to enter the denser region of the atmosphere, where they acquire a compressed-air cap ahead of them which largely shields them from the direct blows of atmospheric molecules, are those producing trails much brighter than the brightest stars, and they are observed far too rarely for any systematic knowledge of their aerodynamics to have been found. The larger ones reach the Earth in the form of meteorites, which are mostly of irregular shape, often pitted with deep, roughly spherical holes. Prolonged discussion at the meeting of whether information concerning the aerodynamical experiences of these bodies can be found led to no very helpful conclusions.

The last lecture was by Dr. Wayland Griffith, of the Palmer Physical Laboratory, Princeton University, where much of the pioneering work with shock tubes was done under the direction of Dr. Walker Bleakney. Dr. Griffith has been studying in Britain for the past year. He described fundamental work on the experimental verification of the Rankine–Hugoniot equations for a shock wave passing through various gases, using their known equilibrium thermodynamics. This work shows, for example, that although the transverse vibrations of the carbon dioxide molecule are excited in such experiments with a relaxation time equal to that found from acoustic attenuation work, the longitudinal (valence) vibrations still remained unexcited after a time long compared with this (of the order of milliseconds).

Dr. Griffith discussed experimental determinations in shock tubes, by Davidson, Hornig and others, of dissociation rates, and gave theories, both of the chemical kinetics of dissociation, and of the fluid dynamics of the process which may be postulated to infer the rates from the experimental observations. He then described the work which had been done in Dr. A. R. Kantrowitz's laboratory at Cornell University on ionization produced by strong shock waves in argon. The observed time-delays before equilibrium ionization has suggested improved approaches to the kinetics of the ionization process. The luminosity of the shock front itself, which has sometimes been observed, is the result of impurities. The measurements of conductivity of a gas with high electron density has shown satisfactory agreement with theory.

In his concluding address Prof. Devons remarked on the impressive degree of collaboration between applied mathematicians, physicists, chemists and engineers which seems already to have taken place in this field. He emphasized, however, that an even greater degree of co-operation will be necessary, both if the maximum effectiveness for man-made projectiles travelling at extreme speeds is to be achieved, and if the shock tube is to be fully utilized for uncovering the secrets of high-speed gas reactions.

THE WEIZMANN INSTITUTE OF SCIENCE

TO mark the tenth anniversary of the foundation of the Weizmann Institute of Science, the Board of Governors, together with representatives of supporting groups in Great Britain, the United States, Canada and Switzerland, held a conference in London early in July.

The Weizmann Institute had its origin in the Daniel Sieff Research Institute at Rehovoth, a town about twelve miles south of Tel Aviv. The Sieff Research Institute had been set up in 1934 by Mr. and Mrs. Israel N. Sieff, of London, as a memorial for their youngest son, who had died the year before. Dr. Chaim Weizmann (1874–1952), with whom Mr. and Mrs. Sieff consulted before founding the Institute, assumed its direction and was responsible for its first scientific programme.

In 1944 a group of Dr. Weizmann's friends in the United States launched a project to mark his seventieth birthday and raised five million dollars for the purpose. It was then decided to establish the Weizmann Institute of Science, the Daniel Sieff Research Institute being retained as the parent unit.

The foundation stone for the expanded establishment was laid on June 3, 1946, and the Weizmann Institute was formally inaugurated and began functioning in November 1949. The Institute now covers an area of some ninety acres, with four large buildings in addition to the parent structure, the Sieff Institute, and an Institute of Physics in construction. Compared with the Sieff Institute's original staff of ten scientists and some twenty technical and administrative workers, there are now 130 scientists and more than 350 other personnel.

The recent conference was divided into five sessions. Two of these sessions were under the chairmanship respectively of Sir Francis Simon and Sir Solly Zuckerman, and dealt with the Institute's scientific interests.

The Institute engages primarily in research and has no teaching responsibilities, apart from the affiliation of several of its departmental heads to the Hebrew University in Jerusalem as visiting professors. Its main research interests are in the exact sciences—mathematics, physics, nearly all branches of chemistry, and some branches of biology. The desire has lately been expressed by scientific staff at various levels for the introduction of postgraduate teaching as a means of augmenting Israel's reservoir of trained professional man-power and also as a stimulus to their own work. As a result of a recommendation of a Committee which was set up under the chairmanship of Sir Ben Lockspeiser, the Board of Governors has now decided to provide more opportunities for postgraduate training than were available in the past. This Committee also recommended "that the provision of special courses as a useful service for the country, as, for example, in the fields of radio chemistry, plastics chemistry, electronic computing and numerical analysis, be encouraged within the capacity of the Institute". Some time ago the U.S. Government decided to include support of the Radioisotope School at the Weizmann Institute, for training professional men in the use of isotopes, as part of a series of grants it was making for higher learning and research in Israel.

In addition to the heads of departments of the Institute who came from Israel, the conference was attended, among others, by Prof. P. M. S. Blackett, London; Prof. E. B. Chain, Rome; Prof. Louis Fieser, Harvard University; Prof. H. A. Krebs, Oxford; Sir Ben Lockspeiser; Prof. David Rittenberg, New York; and Sir Robert Robinson, London. Prof. Saul Adler, of the Hebrew University at Jerusalem, and Prof. S. G. Zondek, of Tel Aviv, attended in their capacities as members of the Institute's Board of Governors.

In addition to the resolution extending postgraduate teaching, the Board of Governors dealt with and decided upon certain administrative reorganization and the consolidation of the financing policy.

When eventually put into effect, the postgraduate teaching curriculum will be of great advantage to Israel, which has still to develop and broaden this aspect of its higher learning.

OBITUARIES

Sir Henry Guy, C.B.E., F.R.S.

BRITAIN has always been rich in engineers whose interests lay in the field of practical construction. It has never been quite so prolific in engineers concerned with engineering science. Although in recent years ill-health put a severe restriction on his activities, the death on July 20 of Sir Henry Guy has removed one from the smaller band of those who took an active and prominent part in the encouragement and organization of engineering research.

His interest was no theoretical interest. It was founded on a wide practical experience as an engineering designer. For more than twenty years he occupied the responsible position of chief mechanical engineer to the Metropolitan-Vickers Electrical Co., Ltd., where, in the quest for ever-increasing thermal efficiency, he designed steam turbines which were not only notable advances in regard to the steam pressures and superheat temperatures that were used, but also in regard to the size of the units. The 100,000-kW. turbo-generator which is now accepted as the standard unit for large power stations had already been designed by Sir Henry Guy and constructed by his Company during the 1930's. When the Soviet Government invited competitive designs for a turbo-generator unit to be used as a basis for the development of power stations in the U.S.S.R., it was his design put forward by Metropolitan-Vickers that won the award and the contracts against world-wide competition.

No one was better able to assess the gaps in our knowledge of engineering science than Sir Harry, as his opinion was fortified by his recollection of those many occasions when faith in his own intuition had to replace the experimental knowledge that was wanting.

When the Advisory Council of the Department of Scientific and Industrial Research, of which Sir Henry Guy was a member at the time, considered during the last year of the Second World War how the pattern of research should be developed in Britain, the need for more research on engineering subjects was specially emphasized. A committee under Sir Henry's chairmanship was set up to consider what practical action should be taken, and it was the recommendation of the Guy Committee that led to the foundation of the Mechanical Engineering Research Laboratory now sited at East Kilbride.

No one better could have been chosen as chairman for this purpose. His wide and detailed knowledge of engineering in its many branches made him visualize the sections into which research on fundamental science could be divided without multiplicity, and his guidance was invaluable. The creation of the Mechanical Engineering Research Laboratory became one of his principal interests in later years, and the fact that the pattern of its organization has not been changed since it started has confirmed the wisdom of his views and outlook.

Sir Henry Guy was naturally chosen as the first chairman of the Mechanical Engineering Research Board, and his kindly and tolerant manner in the chair and the sincerity of his desire to convert those who differed from him, or to be himself converted, helped the new organization to surmount successfully its teething troubles. Even during the period when his health was causing anxiety, nothing gave him greater pleasure than to hear from time to time of its success.

He served as secretary of the Institution of Mechanical Engineers during the period 1942–51.

A. MCCANCE

Mr. C. F. Charter, O.B.E.

CECIL FREDERICK CHARTER died in London after a brief illness on January 27. He was then director of Soil and Land-Use Survey in the Gold Coast. That country has lost a good friend, a good organizer and an outstanding scientist.

Charter was educated at the Lowestoft Secondary School and at Trinity Hall, Cambridge. After teaching at the Tientsin Grammar School in North China and at the Antigua Grammar School, Charter accepted an invitation to undertake a study of the soils of Antigua and Barbuda. Charter's report on the soil survey of Antigua and Barbuda published in 1937 was reprinted in 1947; in collaboration with P. E. Turner he published in 1939 observations on soils of sugar estates in Trinidad. During 1933–44 he was local scientific officer of the Antigua Sugar Cane Investigation Committee. In 1940 he visited British Honduras and wrote an illuminating report on the soils, many of which are impoverished by long exposure to heavy rain. Charter described as a maturity sequence the soils formed on non-calcareous alluvium of various ages. The alluvium covers a wide area and carries swamp forest, well-drained broad-leaf forest, conifers or poor savannah. Of these, the last two indicate moderate or severe impoverishment accompanied by development of a heavy, feebly permeable, brightly mottled subsoil.

In 1944 Charter was appointed soil chemist in the Gold Coast Department of Agriculture and worked in the West African Cocoa Research Institute. In 1949 he was promoted chief soil scientist of the Soil Survey Division, Department of Agriculture. In 1951 he was made director of a newly created Department of Soil and Land-Use Survey and was made O.B.E. He paid brief visits to the Belgian Congo, South Africa, Tanganyika and British Guiana in

1948–50, and in 1955 made an extensive study tour of the United States of America under the auspices of the Foreign Operations Administration.

In the Gold Coast, Charter developed a new technique in soil survey, employing methods adapted from those used in ecological surveys. Soil, vegetation and land-use were sampled or recorded at regular intervals along traverse lines and at regular intervals across the grain of the topography. Soils were mapped by topographical associations, but within each of the latter, sample strips a mile long by a quarter mile broad were mapped in complete detail to illustrate the soil, vegetation and land-use patterns occurring. Such work involved the use of large numbers of semi-skilled local assistants, the majority of whom Charter had to train himself.

One important detail of the procedure evolved by Charter was the orderly preservation of samples of soil and rock and the regular comparison of each day's findings with the selected standard samples. He was fortunate in that all his African junior assistants could read and write English; their work, however, was closely checked by those with better education or longer experience. The work was done with accuracy and enthusiasm and was generously supported by the Gold Coast Government, which constructed at Kumasi excellent laboratories and offices for Charter's department. At the time of his death, the department had an establishment of some twenty professional staff and 150 junior technical assistants of varying grades.

At the Cocoa Conference of 1949 Charter described the principal cocoa soils of the Gold Coast and discussed the phenomenon of soil creep occurring there and in Central America and the West Indies. After a visit to Tanganyika in 1950, he came to realize that many tropical soils were not truly sedentary but had developed in 'drift' parent materials. In a paper submitted to the Conference of the Consultative Committee for Tropical Africa on the mechanization of agriculture (Entebbe, 1955), Charter advocated bush fallows for maintenance of fertility in peasant agriculture. In an important paper presented at the Cocoa Conference of 1955 he noted that in the Gold Coast cocoa had failed to survive on acid soils ('oxysols') deficient in divalent bases, but had survived on the less acid and more fertile 'ochrosols'. He stressed the importance of including magnesium in fertilizer trials with cocoa. Charter associated the 'oxysols' with the reddish-yellow latosols of Kellogg and Davol (1949). He noted that the relatively infertile 'oxysols' are formed, where annual rainfalls exceed 70–80 in., from the weathering products of highly siliceous rock (quartzites) or from those of pyritiferous sediments which set free sulphuric acid during decomposition. In fact, appreciable amounts of sulphate in the subsoil of Gold Coast 'oxysols' had been found by the analyses of Charter's colleague, A. S. de Endredy (unpublished observation). A brief statement of Charter's views on the broader aspects of soil classification is given in the Proceedings of the Fifth International Congress of Soil Science (4, 497–499). A further account of Charter's views has been prepared for the Sixth International Congress of Soil Science by his colleague, H. Brammer.

Charter was born on December 4, 1905. A son and daughter, children of his first marriage, survive him.

HERBERT GREENE

NEWS and VIEWS

Metallurgy at Leeds : Prof. N. J. Petch

THE Department of Coal, Gas, and Fuel Industries with Metallurgy in the University of Leeds is to be re-organized into the three Departments of Fuel, of Chemical Engineering and of Metallurgy. Collectively they will form the Houldsworth School of Applied Science. Dr. N. J. Petch, at present reader in metallurgy, has been appointed to the new chair of metallurgy created during this re-organization.

After taking a degree in chemistry at Queen Mary College, London, in 1936, Dr. Petch spent a year studying engineering and then read metallurgy at the University of Sheffield, where he took his B.Met. in 1939 and was awarded the Mappin Medal. This varied training was completed by three years as a research assistant in the Crystallographic Department at the Cavendish Laboratory. His researches during this period culminated in papers on the positions of the carbon atoms in cementite, austenite and martensite. Dr. Petch then went to the Royal Aircraft Establishment, where he organized a new section of the Metallurgy Department, dealing with X-ray diffraction problems and routine radiography. He also began to take an interest in the field of fracture in metals, with which his name is now particularly associated. Initially this interest was stimulated by investigations of the mechanism of the hydrogen embrittlement of steels; but during the period 1946–49 which Dr. Petch spent in the Cavendish Laboratory with the team led by Dr. E. Orowan, his interests widened to include many fundamental aspects of fracture. Since 1949, when he was appointed reader in metallurgy in the University of Leeds, Dr. Petch has continued his studies of fracture and has published many important papers in the field. A problem common to all university departments teaching the applied sciences is to maintain an adequate balance in lectures between the rapidly expanding new knowledge and the established classical material. Dr. Petch, who is responsible for the teaching courses in metallurgy, has, during the tenure of the readership, carried out a careful re-organization to maintain the balance.

Geography at Liverpool : Prof. R. W. Steel

MR. R. W. STEEL has been appointed John Rankine professor of geography in the University of Liverpool as from January of next year, a post which has been vacant since the death in 1955 of Prof. W. Smith. Mr. Steel has spent his academic life in Oxford. He was an open exhibitioner of Jesus College, Oxford, and while still an undergraduate won the Royal Geographical Society's Essay Prize in 1936. In 1938, he was Draper's Research Scholar and carried out some research work in Sierra Leone. He made a second expedition to West Africa, jointly with an economist and an anthropologist, during 1945–46, and has recently returned from a further visit to Central Africa and East Africa. He has for many years been lecturer in Colonial geography in the

University of Oxford, and was elected a Fellow of Jesus College in 1954. He is the author of a number of papers dealing with various problems of African geography, and no doubt will be able to maintain his connexion with Africa when he takes up his new post.

University of Poona : New Building for Chemistry

THE opening of the new building of the Chemistry Department of the University of Poona by Pandit Jawaharlal Nehru on August 1 marks the first stage in the development of the University in the old Government House at Ganeshkhind, Poona-7. The University has built this department at a cost of Rs. 4 lakhs, and though it is still incomplete, the Government of India has agreed to pay two-thirds of the cost to complete the building by addition of the lecture halls. The Ranade Industrial and Economic Institute has been shifted to one wing of the new building. Through the gift of Rs. 3 lakhs from the Government of India, the laboratory is equipped with up-to-date apparatus and equipment for research and the training of postgraduate students in X-ray diffraction, magnetochemistry, ultrasonics, dielectric work, electrochemistry, absorption and fluorescence spectra, optical dispersion, microchemistry, chromatography, chemistry of sugars and gul, enzymes, and chemical instrumentation. There are well-equipped workshops and ample stores. The Government of India has awarded one national research fellowship of Rs. 400 a month and three senior fellowships of Rs. 200 a month. Six University research fellowships and two Shembekar scholarships have been awarded for Ph.D. students. During the past five years six students in the Department have obtained the degree of Ph.D. and twelve that of M.Sc. by research. Ninety students gained their M.Sc. by examinations in different branches of chemistry. More than fifty research papers have been published both in India and abroad. Five students are carrying out postgraduate research for their D.Sc., twenty-five (including six women) for their Ph.D. and five for M.Sc. (by research). There are at present 104 students in the postgraduate classes, twelve of whom are women.

Belgian Youth Federation for the Study and Protection of Nature

A BELGIAN YOUTH FEDERATION for the Study and Protection of Nature, a section of l'Entente Nationale pour la Protection de Nature, has recently been founded in Brussels. This organization, which will receive both material and moral assistance from l'Entente Nationale, will be run entirely by young Belgians between the ages of twelve and twenty-eight. The new Federation is also under the patronage of the International Union for Conservation of Nature and Natural Resources, which, since its foundation in 1948, has had its headquarters in Brussels. The aim of the Federation is to affiliate all youth societies throughout Belgium which share the same objectives, and thus Belgium will be able to send a more fully representative delegation to the camp which is being held in Austria this month when a federation on a larger scale, the International Youth Federation for the Study and Protection of Nature, will be founded under the auspices of the International Union for the Conservation of Nature and Natural Resources. The new international organization is a direct development of the International Youth Camps for the Study and Protection of Nature, to which the Union has each year given its sponsorship and its financial support, sometimes with the aid of Unesco. At present, thirteen European countries are participating.

Commercial Irradiation of Diamonds

THE United Kingdom Atomic Energy Authority has decided to accept requests for the irradiation of diamonds for commercial purposes, so far as other demands on the available irradiation facilities permit. In the past, the Authority has only consented to irradiate small quantities of diamonds for fundamental research purposes. Charges for this new service will be fixed by arrangement. The general phenomenon of irradiation-induced colour changes in gems was first discovered more than fifty years ago when effects of this kind due to radiations from naturally radioactive substances were first observed. Radiations from particle-accelerating machines, nuclear reactors and artificial radioactive isotopes may now be used to induce these effects. Diamonds irradiated inside a nuclear reactor are coloured green, and subsequent heat treatment may change the colour to brown ; on the other hand, the action of radiation from particle-accelerating machines may induce a blue or blue-green colour. Diamonds irradiated in a nuclear reactor become temporarily radioactive, but this radioactivity decays to insignificance within a few days. Inquiries should be addressed to the Technical Irradiation Group, Isotope Division, A.E.R.E., Harwell.

Employment of Chemists in Great Britain

AN analysis given in the *Journal of the Royal Institute of Chemistry* of the 8,555 entries in the 1954 edition of the Register of the Royal Institute of Chemistry, which were sufficiently complete for the purpose, indicates that the proportion of chemists employed by industrial firms has fallen to 58 per cent compared with 60·3 per cent in 1948. Government departments and nationalized industries, excluding the Department of Scientific and Industrial Research and the research associations, employed 13·8 per cent in 1948 and 13·2 per cent in 1954, the new intake being mainly to the Atomic Energy Authority : the percentage in the nationalized industries has increased from 3·6 in 1952 to 3·9 in 1954, and in the Department of Scientific and Industrial Research and the research associations from 4·6 to 5·1. The percentage engaged as public analysts and in consulting work rose from 3·5 in 1948 to 4·4 in 1952 and is now 3·5. The most notable increase since 1952 is in the percentage of technical college teachers—from 4·2 to 5·8 per cent—but the proportion in universities shows little change, and that in schools continued to decrease and is now 3·5 per cent. Entries for those resident outside Great Britain and Ireland were disregarded.

Oil Consumption in Britain during 1954 and 1955

THE Petroleum Information Bureau has published a booklet on the "U.K. Petroleum Industry Statistics relating to Consumption and Refinery Production, 1954 and 1955" (pp. 9 ; from the Bureau, London ; 1956) which shows that in 1955 a record was set up in oil consumption in Britain. The total inland consumption of petroleum products (exclusive of bunkering ships engaged on foreign trade) was 23,237,144 tons compared with 21,044,243 tons in 1954, an increase of more than 10 per cent. Demand for oil for central heating totalled 847,710 tons and has more than doubled during the past five years. Motor spirit consumed was 6,240,391 tons, 5 per cent above the 1954 figure. The booklet shows that sales of premier-grade petroleum were up by 10 per cent over standard grades, which showed a decline on the previous year. The growing popularity of diesel-engine commercial vehicles is revealed by the fuel consumption of the diesel-engined road vehicle ('Derv'), which increased by 188,000 tons in 1955; despite the much-criticized restrictions on major highway construction in Britain, asphaltic bitumen, so commonly employed in road-surfacing, actually showed a 7 per cent rise in consumption over the previous year.

A Medieval East African Coastal Civilization

The Rev. Gervase Mathew contributes to the May number of *Man* an interesting article on some early cultures of the East African littoral. To-day the whole region is under the influence of Zanzibar; but during the seventeenth and eighteenth centuries—between the fading away of the power of Portugal and the rise of Zanzibar—there existed a number of town settlements which were nominally Islamic in religion and influenced at least in part by South Arabia. Formerly, they have been classed as medieval Persian settlements; but Mathew is convinced that they represent a series of small autonomous Swahili States, oligarchic in their social structure, and using a currency of beads and rolls of cloth when trading in ivory and slaves. Did some of the Southern Rhodesian gold pass that way? Many of the buildings and their decoration and contents are impressive, and indicate wealth and a high degree of culture. Naturally, the influence of the Portuguese, who with the Spanish occupied the area from 1592 until about 1637, was considerable. But even before their arrival it would seem that there had existed an important series of townships in the region, as these are described in the early Portuguese annals. There were great walled cities and a population both dark (African) and white (Persian ?), the latter being the ruling caste. It is to be hoped that the author will some day write a monograph on the subject. But before this can be done, excavation will have to be undertaken at a number of key sites, and in the meanwhile every effort should be made to preserve as far as is possible the monuments which have survived.

Research on the Formation of Hurricanes

The spring number of *Oceanus*, a magazine published quarterly by the Woods Hole Oceanographic Institution, Massachusetts, for distribution to the associates of the Institution and others interested in oceanography, is devoted to meteorology and includes an article by the director of the Institution, Dr. C. O'D. Iselin, on projected research into the formation of hurricanes. Dr. Iselin describes an ingenious theory, which it is hoped to investigate on voyages in the converted 125-ft. cutter, *Crawford* (see *Nature*, July 28, p. 181). The theory is that the essential precursor of a hurricane is a period of abnormally light winds in a part of the northern half of the trade-wind belt in which sea-surface temperature exceeds 27° C. These light winds mean that so few large sea-salt condensation nuclei would form that less than the usual number of the cumulus clouds would precipitate rain, leading to development of unusually high humidity in the lower atmosphere. It is then supposed that an 'easterly wave' disturbance moves along in the trade winds, stirring up the sea and producing many nuclei and stimulating convection by release of latent heat. The intense convection then produces a whirl in the usual way. Dr. Iselin envisages that, if the theory is true, it might be possible, by maintaining random convection in the early stage, to stop the development of the abnormally high humidity and so prevent hurricanes from forming.

Freshwater Biological Research by a School-boy

The magazine of the Oundle School Natural History Society contains a useful comparative study by a school-boy, M. J. Fenwick, of the biology of species of *Asellus*, *Eucrangonyx* and *Gammarus*. These show that *Asellus* seems to favour almost any kind of water, but it is most frequently found in deep, almost stagnant water among plant debris; *Gammarus* favours very shallow and fairly swift water, usually with a sandy or shingle bottom; and *Eucrangonyx* favours a deeper, almost stagnant pond or pit, where there is plenty of shelter from bright daylight. Experiments showed that *Asellus* survives in water with a low oxygen concentration; *Eucrangonyx* can survive in water of almost any oxygen concentration; while *Gammarus* only survives in water of a very high oxygen concentration. *Eucrangonyx* appears to be strongly negatively phototropic, and *Gammarus* and *Asellus* are slightly negatively phototropic. Another series of experiments showed that *Asellus* is quite tolerant of any temperature from 0° C. to 30° C. *Eucrangonyx* is not quite so tolerant and only survives in temperatures between about 5° C. and 20° C.; and *Gammarus* is much less tolerant and will only survive in temperatures between about 10° C. and 20° C.—considerably lower than the temperatures tolerated by *Asellus* and *Eucrangonyx*. The observations show that each animal fills its ecological niche, and that the three are very rarely found together.

Recent Investigations of Cocoa

There was a time, not so very long ago, when new research information about the botany and horticulture of cocoa (*Theobroma cacao*) was relatively scanty and hard to come by. That time may now be said to have receded into the past. During recent months several full and important reports have appeared, including the Annual Report of the West African Cocoa Research Institute for 1954–55 (Crown Agents, 4 Millbank, London, S.W.1; 5*s*.), a Report on Cacao Research, 1954 (Imperial College of Tropical Agriculture, Trinidad, B.S.I.; also from the London Office, 40 Norfolk Street, W.C.2; 12*s*. 6*d*.), the Proceedings of the West African International Cacao Research Conference, 1953 (Crown Agents; 12*s*. 6*d*.), and the Cocoa Conference, 1955 (The Cocoa, Chocolate and Confectionery Alliance, 11 Green Street, London, W.1). From these several publications a comprehensive impression of the very considerable research effort that is now being devoted to all aspects of this important and valuable tropical crop may be obtained. The subject-matter ranges from such topics as soils and fertilizers and vegetative propagation by novel methods, to breeding and selection, the control of fungal and virus diseases and pests, and the processing of the eventual product, the cocoa bean.

Factors in Cell Division

THE importance of nucleic acid in growth and cell division is becoming increasingly recognized. Where division in permanent cells has been induced by the application of auxin, there appears to have been an attendant acceleration of nucleic acid synthesis. A. K. Sharma and A. Mookerjea (*Bull. Bot. Soc. Bengal.*, 8, 24; April–Oct. 1954; issued Dec. 1955 as Acharya G. C. Bose Centenary Commemoration Volume) have attempted to explore the relationship of nucleic acid to cell division and to overcome the difficulties of the penetration of cells by the large nucleic acid molecule, by growing onion root tips in solutions in which the constituents of nucleic acid, or their allies, were present, singly and in different combinations. Some fifteen different sugars, four bases (uracil, guanine, adenine and thymine) and ammonium phosphate were used in different concentrations and combinations. The results, obtained after periods of treatment of 1–168 hours, are set out in considerable detail. Counts of polyploid prophases and metaphases were taken from each root-tip specimen after appropriate treatment, and various other nuclear abnormalities were recorded. Practically all the sugars had some effect in inducing division in differentiated cells, but lævulose proved the most active in this respect. In general, however, no correlation was established between the nature of the chemical used and the induction of division. The significance of the results obtained is discussed in some detail.

Research Defence Society

WHILE a great deal is known about anti-vivisection societies, not so much is known about the Research Defence Society. This Society was founded in 1908 by Stephen Paget and exists to "make known the facts about experimental research involving the use of animals and the conditions and regulations under which animal experiments are conducted in the United Kingdom; to emphasize the importance of such experiments to the welfare of mankind and animals and the great saving of human and animal life and health and the prevention of suffering already due to them; and to defend research workers in the medical, veterinary and biological sciences against attacks by anti-vivisectionists". The Society is pledged not only to make known the facts of medical research and the part played in it by animal experiments but also to ensure that full use is made of medical discoveries of benefit to mankind and animals. It is therefore producing a series of pamphlets which will emphasize the need for making use of medical knowledge gained. The first of these pamphlets will be entitled "Vaccination against Poliomyelitis"; others will deal with diseases the comparative rarity of which to-day has made people dangerously complacent or the defeat of which is in the nature of a containment rather than a total elimination; diseases like diphtheria, smallpox, tuberculosis, diabetes and many others. With the publication of the pamphlets, the Society's journal, *Conquest*, will no longer appear quarterly but will be produced at least once a year.

The American Academy of Arts and Sciences

THE following, among others, have been elected foreign honorary members of the American Academy of Arts and Sciences: Prof. M. J. C. R. Courrier, professor of experimental morphology and endocrinology in the Collège de France, Paris; and Sir Geoffrey Taylor, Yarrow research professor of the Royal Society. The following have been elected officers of the Academy for 1956–57: *President*, J. E. Burchard, dean of the School of Humanities and Social Studies, Massachusetts Institute of Technology; *Vice-President for Class I* (Mathematical and Physical Sciences), J. H. Van Vleck, dean of engineering and applied physics, Harvard University; *Vice-President for Class II* (Biological Sciences), H. Hoagland, director of the Worcester Foundation for Experimental Biology; *Vice-President for Class III* (Social Arts and Sciences), D. F. Edwards, chairman of the Board, Saco-Lowell Shops, Boston; *Vice-President for Class IV* (Humanities), W. F. Twaddell, professor of linguistics, Brown University; *Secretary*, B. H. Billings, vice-president and general manager of Baird Associates, Cambridge, Mass.; *Treasurer*, T. B. Adams, treasurer of the Sheraton Corporation, Boston; and *Librarian and Editor*, W. M. Whitehill, director of the Boston Athenæum.

The Institution of Mining and Metallurgy

MR. G. KEITH ALLEN, reader in mining in the Royal School of Mines, London, and formerly resident director and chief engineer of the West African Gold Corporation, Ltd., has been elected president of the Institution of Mining and Metallurgy for 1957–58. Mr. Allen, who is a graduate in mining and metallurgy of the University of Melbourne, has spent most of his professional career with mining concerns in various parts of Africa. Mr. B. W. Kerrigan has been appointed secretary of the Institution of Mining and Metallurgy and will take up his duties at the beginning of this September. Since 1953 Mr. Kerrigan has worked in the planning office of the Imperial College of Science and Technology, London, and has been responsible for much of the administration of the extensive scheme for the expansion of the College.

The Society for Applied Bacteriology: Officers

THE following have been elected officers and members of committee of the Society for Applied Bacteriology: *President*, Dr. M. Ingram; *Secretary*, G. Sykes (Microbiology Division, Boots Pure Drug Co., Ltd., Nottingham); *Treasurer*, C. S. Miles; *Editors*, Dr. S. E. Jacobs and Dr. L. F. L. Clegg; *Publications Manager*, E. A. Whitlock; *Advertising Manager*, E. J. Mann; *Committee*, Dr. Ella M. Barnes, Dr. C. A. E. Briggs, J. W. Egdell, L. D. Galloway, H. B. Hawley, J. Liston, W. H. Pierce, C. A. Scarlett and Dr. Helen R. B. White.

The Animal Health Trust: Awards

THE Animal Health Trust has awarded research training scholarships for 1956/57 to the following: Miss J. A. Bailey, for work on parasites, at the Imperial College of Science and Technology, London; R. S. Anderson, for work at the School of Veterinary Medicine in the University of Glasgow on the problem of metabolic disease in animals and, in particular, the electrolyte/water balance in animal tissues; J. W. Boyd, to study for Part II of the Tripos Examination in Pathology at the University of Cambridge preparatory to undertaking research into metabolic disease of animals; Muhammad Irfan, for research at the Royal Veterinary College, London, on the blood picture of dogs, with particular reference to tumours and leucosis conditions; Miss S. R. Wooldridge, to study problems connected with the effects of radiation upon cells in tissue culture, paying particular attention to changes concerned with cellular division and multiplication and their late application to cellular pathology. The Trust has also awarded Evans final-year studentships to the following: P. G. H. Mann (Royal Veterinary College, London), K. Brown (Royal (Dick) Veterinary School, Edinburgh), M. Fussell (University of Cambridge), E. C. Pickering (University of Glasgow Veterinary School), J. McC. Howell (University of Liverpool) and P. L. Doherty (Veterinary College of Ireland).

Announcements

The Smithson Research Fund Committee of the Royal Society and the University of Cambridge has awarded the Smithson Research Fellowship to Dr. Anita I. Bailey, of Newnham College, Cambridge. Dr. Bailey, who is a graduate of the University of Witwatersrand, South Africa, is to carry out an investigation, in the Department of Physical Chemistry, University of Cambridge, on the surface energy of some solid materials and of the variations in this quantity which may occur when physical conditions are varied.

The twenty-third general meeting of the Society for General Microbiology will be held in the University of Exeter during September 20–22. Sessions for reading original papers will be held on September 20. The proceedings on September 21 will consist of a symposium on "Plankton".

The Mechanical Engineering Research Laboratory (Department of Scientific and Industrial Research) at East Kilbride, Glasgow, is to hold its first open days during September 20–21. Applications for invitations, stating which day is preferred, should be sent to the Director.

The British Mycological Society will hold its "Autumn Foray" this year in Sheffield during September 6–12. The meeting will be centred on the University Hall for Women, Endcliffe Vale Road, Sheffield 10, where a workroom is available. Application forms and further information can be obtained from Dr. J. Webster, Botany Department, The University, Sheffield 10.

The annual conference of the Society of Leather Trades' Chemists will be held in the University of Leeds during September 21–22. During the meeting the seventh Procter Memorial Lecture will be given by Dr. G. W. Kenner (University Chemical Laboratories, Cambridge), his subject being "The Present and Future Scope of Peptide Synthesis". Further information can be obtained from the honorary secretary of the Society, G. H. W. Humphreys, Forestal Central Laboratories, Harpenden, Herts.

An international colloquium on semiconductors and phosphors will be held in Germany at Garmisch-Partenkirchen during August 28–September 1. The introductory address will be given by Prof. W. Schottky, and some ninety papers will be read. Workers from a number of European countries and from Japan and the United States will be attending. Further information can be obtained from the organizing committee at Arcisstrasse 21, Munich 2.

The third Lignin Round Table will be held during September 24–26 at the Institute of Paper Chemistry, Appleton, Wisconsin, the subject being "The Biogenesis of Lignin". The meeting is sponsored jointly by the Committee on the Chemistry of Plant Products of the National Research Council and the Fundamental Research Committee of the Technical Association of the Pulp and Paper Industry. Further information can be obtained from Harry F. Lewis, Institute of Paper Chemistry, Appleton, Wisconsin.

An international conference on the fatigue of metals, organized by the Institution of Mechanical Engineers, will be held in London at the Institution's headquarters during September 10–14. Before the papers an address reviewing present knowledge on fatigue will be given by Dr. H. J. Gough, a past-president and honorary member of the Institution. The papers will cover the following fields: stress effects; effect of temperature and environment; metallurgical aspects; basic studies (mechanism, statistical theories and crack propagation); and the engineering and industrial significance of fatigue. Further information can be obtained from the Institution at 1 Birdcage Walk, Westminster, London, S.W.1.

The fourth of the national conferences on chemotherapy, organized by the Italian Society of Chemotherapy under the direction of Prof. Emilio Trabucchi (director of Pharmacological Institute, University of Milan), will be held in Rome at Palazzo Congressi all'E.U.R. during September 26–27, the subject being anti-tumoural chemotherapy. Afterwards, there will be a one-day symposium on actinomycin, which is being organized by Prof. S. A. Waksman, of Rutgers University, N.J. Further information can be obtained from the Secretary of the Italian Society of Chemotherapy, Pharmacological Institute, Via Andrea del Sarto 21, University of Milan.

The Second International Congress of Dietetics will be held in Rome during September 10–14 in the Palazzo dei Congressi dell' Esposizione Universale di Roma. The organization of the Congress is in the hands of the Italian Dietetic Association, which is also arranging an exhibition on food and food service equipment, to be held in conjunction with the Congress. The programme of the Congress is in four main sections: recent findings of nutritional research; methods of education in nutrition; principles and problems of feeding large numbers of people; and problems of training dietitians. All inquiries regarding the exhibition should be addressed to the Rassegna Internazionale di Alimentazione e Dietetica, S.A.I.C.A., via Giacinto Pullino 5, Rome. Further information on the Congress can be obtained from the Associazione Dietetica Italiana, via dei Penitenzieri 13, Rome.

The Institute of Biology is holding a symposium on "The Biology of Ageing" in the Anatomy Theatre, University College, London, during September 27–28. The papers to be given in the first session deal with ageing in bacteria, higher plants and animals. A second session will be devoted to physiological topics, followed by a series of papers on medical and sociological aspects of ageing in man. The final session will deal with psychological changes, the effects of nutrition and genetic variations in ageing. The symposium will, it is hoped, bring together biologists from differing disciplines to discuss a subject of common interest and will also provide a meeting ground for biologists, medical practitioners and sociologists. Further information can be obtained from the General Secretary, Institute of Biology, 41 Queen's Gate, London, S.W.7.

Erratum. In the communication entitled "A Method for following Lipolysis induced by Heparin", by Drs. G. Kubie, V. Felt and D. Reichl in *Nature* of July 28, p. 210, in each of the tables the phrase "*in vitro*" should read "intravenously".

NON-DESTRUCTIVE TESTING OF MATERIALS

THE summer meeting of the Non-Destructive Testing Group of the Institute of Physics was held this year in the University of Bristol during July 11–14, and the programme of the meeting was presented under the title of "Some New Aspects of Non-Destructive Testing". Dr. S. G. Hooker, director and chief engineer of Bristol Aero-Engines, Ltd., was the guest speaker at the introductory session, which was held during the evening of July 11. Dr. Hooker reviewed the many important problems of inspection which confront the aircraft manufacturer, and he showed that, in fulfilling the requirements of modern engineering development, existing inspection techniques are far from adequate. He made a plea for physicists to put every effort into the task of providing scientific information of a kind which will not only enable better use to be made of existing techniques but which will also make possible the development of new, and more suitable, inspection methods. By invitation of the Bristol Aeroplane Co., Ltd., a visit to the production plants of the Company, during the afternoon of July 13, formed a part of the programme of the meeting. Dr. Hooker said that the tour of his Company's works had been so arranged as to give emphasis to inspection procedure, and he hoped that the visit would add stimulus to the work with which the Non-Destructive Testing Group is concerned.

This was the first summer meeting of the Institute of Physics which has been devoted to what the Non-Destructive Testing Group decided to call "new aspects of non-destructive testing". The words "new aspects" were included in the title because, until now, it seems to have been the custom to regard non-destructive testing as concerned only with the detection of defects in engineering materials and components. This, of course, is not the case. The detection of defects forms but a part, albeit an important part, of the field covered by non-destructive testing, and a major aim of the meeting was that of directing the attention of physicists to the fact that the whole of physics is involved, in one way or another, in the scientific background of industrial inspection. If progress in the technology of inspection is to be maintained, considerable attention must be devoted to this background, and the right kind of scientific information must be made available to the technologists who fulfil the very important functions of developing inspection techniques and of putting these techniques into practice.

The interests of the Group are not confined to the application of physics in industry. During the past two years the application of physics in medical diagnosis has formed part of the Group's activities, and an evening discourse on "Physical Problems in Medical Diagnosis" was given, on July 12, by Prof. C. B. Allsopp (Department of Physics, Guy's Hospital Medical School, London). Prof. Allsopp showed, by referring to the work of his own Department, how this important application of the physics of non-destructive testing is put to good use by research workers in medical schools, and he aroused the interest of his audience by demonstrating the fact that an exchange of information between physicists engaged on industrial problems and physicists engaged on medical problems can be of mutual value. This was the first time an evening discourse had been included in the programme of a summer meeting of the Non-Destructive Testing Group, and Prof. Allsopp's lecture made it an outstanding event of the meeting.

In almost all the uses to which materials are put, their mechanical strength and mechanical behaviour are important factors—usually the most important factors—to be considered. Nearly all mechanical tests involve the destruction of the material under examination, so that if the mechanical behaviour of the actual material which goes into service is to be determined with the certainty required nowadays, then, in addition to the mechanical tests which are at present used, there is a need for a system of non-destructive testing which will provide an assessment of mechanical behaviour. The establishment of such a system presents a formidable problem; but present beliefs are that much success can be achieved by studying the influence of variations in the constitution and structure of materials on their mechanical and physical properties. If the changes brought about in these two types of property can be related empirically, then it will be possible to use those physical properties, which can be measured non-destructively, as a basis for the development of tests which will detect non-uniformity in the quality of complete batches of materials and will assess the significance of non-uniformity in terms of mechanical strength and mechanical behaviour.

Both Prof. W. Sucksmith (University of Sheffield) in his paper on magnetic properties and the structure of metals, and Dr. D. E. Thomas (Aluminium Laboratories, Ltd.) in his paper on the relationship between electrical resistivity and the mechanical properties of aluminium alloys, sounded a severe note of caution in this respect. Although magnetic and electromagnetic non-destructive testing instruments are already in use in industry for detecting non-uniformity in the quality of materials and components, Prof. Sucksmith and Dr. Thomas showed that indiscriminate use of any method of testing based on the detection of variations in either magnetic or electrical properties cannot, at this stage in our knowledge, be regarded as constituting a reliable inspection technique.

On the question of the assessment of the mechanical behaviour of materials the detection of fatigue in metals was chosen for discussion, and a complete session of the programme was devoted to it.

Dr. R. H. Hanstock (High Duty Alloys, Ltd.) described the fatigue process in metals and showed that the structural changes responsible for the formation of a fissure are highly localized. Physical properties, such as damping capacity, which provide a measure of the energy dissipated during a stress cycle, are an obvious choice for the detection of the onset of fatigue failure; but Dr. Hanstock produced evidence from his own work which showed that, whereas it is sometimes possible to obtain a rough estimate of the fatigue life of a material from initial values of hysteresis loss, in general, because of the localized nature of fatigue failure, insufficient change occurs in the overall energy dissipated per stress cycle for detection to be possible by existing methods of measurement.

Dr. N. Thompson (University of Bristol), reading a paper on structural changes and energy dissipation during fatigue, prepared by him and Dr. N. J. Wadsworth, described the work carried out at the H. H. Wills Physical Laboratory in which simultaneous observations were made of the metallographic changes visible on the surface, and of the changes in energy dissipation which take place during the fatiguing of copper, nickel and cadmium. From the results of this work Dr. Thompson showed that there is no direct connexion between the changes in energy dissipation and the progress towards fatigue failure.

The development of non-destructive inspection methods for non-metallic materials presents a difficult but, nevertheless, intensely interesting field of investigation for physicists. As in the case of metals, the promise of improved techniques is most likely to be found from studies made of the effects of structure on physical properties. Dr. P. T. Barrett (Terylene Council, Imperial Chemical Industries, Ltd.) reviewed the work which has been carried out on the development of tests for plastic fibres. In his paper on the testing of fibres and their molecular structure, he described the methods of physical measurement which provide information about the structure of fibres, and he discussed the mechanical properties of fibres in terms of their molecular structure.

It is one of the aims of the Non-Destructive Testing Group to encourage discussion on research investigations which have not necessarily been embarked upon for the purposes of non-destructive testing, but which are likely to produce results of use in the development of new non-destructive testing methods. In this connexion, four papers were presented at the meeting. Three of these described work in progress at the Atomic Energy Research Establishment, Harwell, and the fourth work which has been carried out at the National Physical Laboratory, Teddington.

Dr. L. E. Drain's paper on the principles and applications of nuclear magnetic resonance made an impressive contribution to the aims of the meeting. He enumerated twelve applications to which the measurements involved in his work could be put, and six of these applications were of direct use for the purposes of non-destructive testing. Mr. W. A. Runciman read a paper on optical fluorescence in non-destructive testing, in which he described the phenomenon of optical fluorescence and showed that, in addition to its use for detecting surface defects, it can be applied to problems of chemical and microscopic examination of materials. Mr. S. F. Pugh, in his paper on the effects of penetrating radiations on materials, reviewed present knowledge on radiation damage and indicated how the results of work in progress on this subject are likely to provide information on the structure of materials. Finally, Mr. M. F. Markham (National Physical Laboratory) gave a paper on the measurement of elastic constants by the ultrasonic pulse method. In this Mr. Markham described the propagation of stress pulses in æolotropic media, and the information he provided is not only of value from the point of view of establishing new techniques for the measurement of elastic constants, but also its application to the technology of ultrasonic inspection is of considerable importance.

The attendance at this meeting was one of the largest which the Non-Destructive Testing Group has had at its summer meetings, and it is the hope of the Group that the enthusiasm shown throughout the whole programme by those present is indicative of the fact that in the future there will be ample support given to the Group in its task of disseminating information on the physics of non-destructive testing.

E. G. Stanford

PLANT BREEDERS' CONFERENCE AT CAMBRIDGE

When the first conference of plant breeders was called by the Agricultural Research Council in 1947, forty workers met at the Plant Breeding Institute, Cambridge, then a research institute of the School of Agriculture, to discuss their common problems and to learn something of the work in progress there. In the intervening years the conference met annually until 1950 and biennially since then, inspecting work and discussing mutual problems ; the meetings have been held at the John Innes Horticultural Institution, first at Merton and later at Bayfordbury, at the Welsh and Scottish Plant Breeding Stations, and at the station at Loughgall of the Plant Breeding Division of the Ministry of Agriculture, Northern Ireland. With the seventh meeting held on July 4 and 5 at the Plant Breeding Institute, Cambridge, the initial cycle has been completed. The expansion of effort in plant breeding is indicated by the increase in the number of participants to 105 at this meeting, and by the fact that since the first meeting the four main plant breeding centres in Great Britain have been transferred to new stations to provide facilities adequate for the expansion that has occurred.

During the morning sessions, members of the staff of the Plant Breeding Institute gave short talks, which were followed by informal discussions. The afternoons were divided between tours of the field-plots and glasshouses, designed mainly to provide an indication of the scope of the work, and laboratory demonstrations and informal discussions between specialists to allow them to fill in the details of particular interest.

R. Riley gave an outline of the work on alien chromosome addition with reference to wheat breeding. Here the object has been to introduce new genes for particular desirable characters from primitive related species into wheat. From the results so far obtained in the production of new synthetic amphidiploids, the introduction of complete genotypes appears to bring in too many undesirable characters with the good. The work discussed concerns the addition to hexaploid wheat of single pairs of chromosomes from rye ; new plants with the addition to wheat of six of the seven rye chromosomes, both as disomics and as monosomics, were shown, as well as some in which only a part of a rye chromosome had been added. Initially the new forms tend to revert to the euploid condition, but it seems likely that balance may eventually be achieved.

K. F. Thompson discussed sporophytic incompatibility with special reference to the possibility of using a set of clones to produce commercial quantities of double-cross seed of uniform types of marrow stem kale. The interpretation of the data so far accumulated is complicated by the range of partial compatibility shown in some crosses, and by the finding that in other members of the family the degree of compatibility varies, probably with environmental differences.

In a survey of the outlook for herbage breeding, J. L. Fyfe stressed the advantages to the breeder of having clearly defined objectives to aim at in his work; a survey of the distribution and relative importance of the diseases of forage crops would facilitate the planning of the programme. He went on to discuss the general possibilities of new breeding methods based on the system used in the production of hybrid corn as compared with the older methods based on crossing and pedigree selection. Some degree of inbreeding can be of considerable value in any programme of breeding with crops which are normally cross-pollinated, even where the aim is not the exploitation of heterosis but only the production of a good variety. Inbreeding tends to provide new and otherwise inaccessible information about the material being studied; at the same time it may so reduce the genetic variability within the breeding lines that plot-size in trials can be reduced, with a consequent reduction in the cost of the trials. Once obtained, the inbred lines are available for use in strain building in the older systems, or after the newer techniques of the polycross or diallel crosses. In the discussion that followed, Dr. William Davies, director of the Grassland Research Institute, emphasized that the most important aspect of forage yield was not the absolute amount, but its distribution throughout the year—factors such as the influence of one cut upon the next and subsequent harvests must be taken into account. Other speakers mentioned difficulties in seed production; the cost may be materially affected by a character, such as stiffness of straw, having little relevance to the vegetative production of a crop.

Miss J. M. Drayner gave an account of observations on the breeding system and heterosis in field beans. Both selfing and crossing occur in the crop, and a balance is maintained because the hybrids tend to be self-pollinated and the inbreds tend to cross. Marked heterosis can be seen in hybrids between third-generation inbreds. It may be possible to produce high-yielding stocks by utilizing the tendency of inbreds to cross, coupled with the use of male sterility, recently discovered in the breeding material.

G. E. Russell discussed virus strain relationships in connexion with the virus yellows problem in sugar beet. Because there has so far been no indication that any form of immunity or resistance to this disease may exist, the work is at present concentrated on the search for tolerance to the disease. To cover a wide field as rapidly as possible, a severe necrotic strain of the virus is being used for the routine inoculations, because it normally produces distinct and severe symptoms in a few days. Although this strain is a convenient one for use in the screening tests, the proper orientation of the breeding programme must depend on a better knowledge of the distribution and importance of the strains in the field. Dr. A. R. Trim spoke of his work on the nucleic acids of sugar beet, both in relation to genetic problems and in connexion with the problems of virus yellows. The indications are that the virus may be a ribonucleoprotein, but analysis of nucleic acids recovered from beet has not progressed far enough to provide definite evidence for this.

Selection for yield in breeding cereals was discussed by F. G. H. Lupton, who paid particular attention to modifications in the method of pedigree selection and to the improvement of techniques in yield trials. Wheat hybrids from a wide range of parent varieties are now being handled at the Plant Breeding Institute, and to speed up the work selection in the F_2 and F_3 generations is made by eye; but from the F_4 generation onward bulks of families are included in yield trials, with only a small proportion of sub-cultures retained for multiplication. Some of the newer trial lay-outs have given improved precision, but the analysis of others is so tedious that alternative methods of comparison are being tried. Other detailed discussion included questions of plot-size and shape, and the effects of guard rows and their omission.

The problem of choice of parental combinations was mentioned by Lupton and taken a stage further by R. N. H. Whitehouse, who described a first attempt at the analysis of diallel crosses in order to assess the comparative value of four wheat varieties, differing in various characters, as parents for the production of new hybrids. He suggested that plant breeders may find the method of value in dealing with other crops.

H. W. Howard gave an account of his investigation of a potato chimera, similar to the variety Red King, that arose in a stock of the variety King Edward. In breeding behaviour the new potato resembles King Edward, indicating that only the outer layer of the apical meristem is involved in the change. In using Asseyeva's technique of eye removal to stimulate the production of adventitious buds in the lower tissues, some plants with white-skinned tubers were produced, as well as plants with tubers of the King Edward type, white splashed with pink. The mechanism of the 'mutation' for the origin of the white type remains in doubt, particularly because such types are also produced when tubers from a seedling with a splashed tuber are subjected to the Asseyeva technique.

Work demonstrated in the field and laboratory included the breeding of new winter and spring wheats with good field-characters; selection techniques have been improved by the introduction of controlled tests of resistance to rust and eye spot, and by the use of special equipment for small-scale milling and dough testing. In the improvement of barleys, yield, strength of straw, and resistance to mildew are among the desired characters in the field; to aid selection in the laboratory, routine nitrogen determinations are made and a micro-malting test has been introduced. Improvement of hardiness of winter types and resistance to frit fly in spring types are among the main points in the work on oats, where quality is being assessed by laboratory determinations of oil content and husk percentage. In the work on the cytogenetics of the Triticinae, the addition of rye chromosomes to wheat was demonstrated, and a number of synthetic amphidiploids were also shown.

An outline was given of the work on beans and clover, where the main emphasis has been on yield and resistance to pests and diseases. In lucerne the main problems concern breeding techniques and seed production; but here, as with timothy and cocksfoot, there is the important question of achieving a balance in seasonal production in the drier parts of Britain. In marrow stem kale, uniform inbred lines differing in habit were shown; hardiness and quality are being studied in this crop. Work on potatoes has recently been extended to include resistance to eelworm in addition to the work on blight and the study of cooking quality. In sugar beet selection for resistance to bolting and the search for tolerance to virus yellows were shown.

PEST INFESTATION RESEARCH

THE greater part of the report for 1955 on "Pest Infestation Research"* is devoted to the collected summaries of some ninety investigations in progress at the Department of Scientific and Industrial Research Pest Infestation Laboratory at Slough during 1955. Many of these investigations were continued from earlier years, and among those reaching completion last year was the detailed study of the behaviour of the carpet beetle. The complex life-cycle of this insect, which involves the deposition of eggs in birds' nests in the eaves of houses, is described and correlated with the mode of infestation. Other biological problems studied include the elucidation of the life-histories and physical limits of several species of beetles and mites which are important pests of foodstuffs.

Problems associated with the bulk storage of various types of grain formed a prominent part of the Laboratory's work. Field experiments on the use of underground grain-storage pits, originally started in Africa, were continued at Slough. The success of this method was found to be due to the rapid decrease in the oxygen concentration, which led to the death of the infesting insects.

Much of the work of the Insecticide Section is of immediate practical importance, being concerned with such problems as the insect penetration of multi-ply paper sacs, the toxicity of malathion to insects, the control of the cacao moth in warehouses and the assessment of spraying and dusting equipment. A major item in this Section's programme of work was an investigation on the means of controlling insect damage to stored groundnuts in Gambia. The chief damage was caused by the groundnut beetle (*Coryedon fuscus*), which attacks the surface layers in the piles of bulk-stored nuts, where up to 94·5 per cent damage was reported after four months storage. Several experimental trials were initiated and a satisfactory degree of control was achieved using insecticidal dusts. Attempts to protect shelled nuts by using bags of various materials did not prove so successful.

The biochemical work of the Pest Infestation Laboratory was largely concerned with studies on the chemical reactions of insecticides with foodstuffs and with fundamental research into the mode of action of insecticides. A particular example of the latter is the investigation on the effects of DDT on phosphorus metabolism in insects, which is likely to prove a valuable addition to our knowledge of the mechanism of insecticidal poisoning in insects. As the report points out, insect biochemistry remains a relatively unexplored field and much research on the normal insect is required before the biochemical effects of insecticidal action can be properly appreciated. It is gratifying to read, therefore, that a proportion of the biochemical work at Slough falls into this category.

An interesting development announced in the report is the proposal to form a pool of entomologists and chemists. The members of the pool will be attached to the Laboratory at Slough and will be available to visit the Colonial territories to undertake specific investigations as the need for them arises. This policy is of obvious importance to Great Britain in view of the large imports of raw foodstuffs, and it is clearly desirable to be able to control infestation at the source. Colonial liaison is, however, not a recent departure, for it has long been an important part of the work of the Pest Infestation Laboratory. During 1955 several investigations were in progress in various Colonial territories, and a great deal of the work done at Slough was directed towards solving problems of food storage in the Colonies.

J. E. TREHERNE

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* Department of Scientific and Industrial Research. Report of the Pest Infestation Research Board with the Report of the Director of Pest Infestation Research for the year 1955. Pp. iv+62+8 plates. (London: H.M. Stationery Office, 1956.) 4s. net.

VISUAL DEMONSTRATION OF ALLELIC DIFFERENCES WITHIN CELL NUCLEI

By PROF. H. G. CALLAN and L. LLOYD
Department of Natural History, The University, St. Andrews

THE characteristic patterns of cross-banding on the salivary gland chromosomes of dipteran larvæ have been shown beyond reasonable doubt to reflect the linear genetic differentiation of these chromosomes. Some of the strongest evidence in favour of this view comes from the cytological study of chromosomes which, as a result of genetical experiment, have been supposed to possess gene arrangements differing from a standard sequence by inversion, translocation, duplication or deletion. Some of these structural rearrangements are associated with clear-cut phenotypic effects: of these, the 'Bar' mutants of *Drosophila melanogaster*[1] were the first to be so recognized.

The great majority of *Drosophila* mutants cannot, however, be differentiated from wild-type flies when the salivary gland chromosomes of mutant and wild-type are compared. This is certainly not due to inadequate techniques or insufficiently painstaking studies: often enough the chromosome region in which a particular mutant gene is located has been very precisely known.

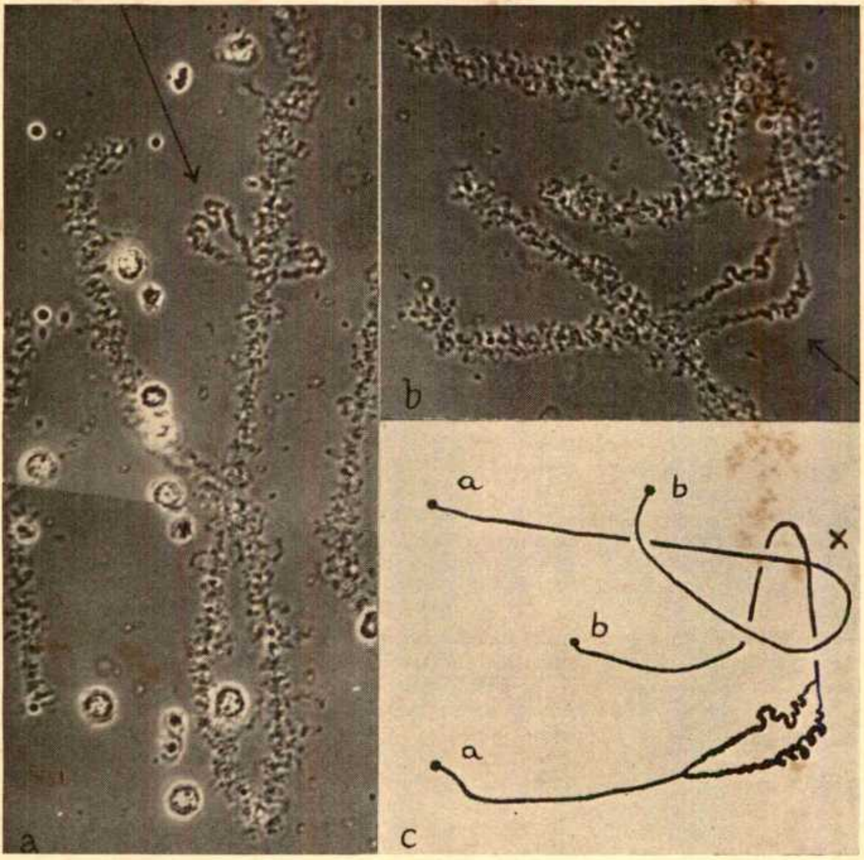

Fig. 1

(*a*) Phase-contrast photograph (× 375) of bivalent X of *T. c. carnifex*, individual *E*. The large loop-pair marked with an arrow on one chromosome is absent from the partner chromosome. The homologous free chromosome arms appear to be of unequal length, but this is merely due to fore-shortening

(*b*) Phase-contrast photograph (× 375) of bivalent X from another oocyte from the same newt. The chromomere from which the large loop-pair originated has suffered breakage transverse to the chromosome axis, in the way very characteristic of lampbrush chromosomes, so that the large loops, marked with an arrow, form a double connecting bridge over the axial break. These large loops are again absent from the partner chromosome

(*c*) Schematic diagram of the bivalent shown in (*b*). Homologous arms are marked *a*, *a*, and *b*, *b*, while the single point of association between homologues is marked *x*

The lampbrush chromosomes of amphibian and other oocyte nuclei also show linear differentiation. This differentiation is most clearly to be seen in the diverse morphologies of the pairs of loops arising from chromomeres in the chromosome axes. There is strong circumstantial evidence that each loop consists of a reflected fibre originating from a chromomere. Around this fibre the primary products of gene activity accumulate (and from which they disperse into the nuclear sap in various forms), the nature and rates of synthesis and of dispersal of the accumulated products determining loop morphology[2]. By studying the distribution of loops of characteristic morphology we have been able to identify each of the twelve bivalent lampbrush chromosomes of the newt *Triturus cristatus carnifex*. We have not attempted to construct comprehensive maps of any of these chromosomes: this would indeed be a very difficult task in view of the varying morphologies of these chromosomes at different stages in the growth of the oocytes. We have instead paid particular attention to the most conspicuous and characteristic loop structures and have so far deliberately concentrated our attention on oocytes of a limited size-range.

In nuclei from oocytes of a given size taken from an individual newt's ovary, homologous chromosomes may be morphologically identical (at least to the extent that we have not noticed differences between them) or they may be clearly non-identical. The non-identity may consist in the presence of a conspicuous pair of loops at a particular locus on one homologue and the absence of comparable loops on the partner chromosome. A typical example of this condition is shown in the accompanying phase-contrast photographs (Fig. 1) of bivalent X (tenth longest, bivalent I being the longest) of *T. c. carnifex*, individual *E*. Inter-homologue differences such as the one illustrated characterize individual newts and are constant from oocyte to oocyte. Individual newts differ from one another in respect of these inter-homologue differences. We have paid careful attention to this matter in five specimens of *T. c. carnifex*, and each of these newts is recognizably distinct. Bivalent I is heteromorphic in all five specimens, though the loci at which it is heteromorphic differ from one individual to another. Bivalent X is heteromorphic in two of the five individuals and bivalent XII is heteromorphic in one. Although the other bivalents appear superficially to be homomorphic, we have little doubt that consistent differences between homologues would also be noticed in these if the cytological study were sufficiently thorough.

The condition described above cannot be due to structural rearrangements of gene sequence by inversion, duplication or translocation such as can be recognized so readily in the salivary gland chromosomes of Diptera: loops of highly characteristic morphology may be found at one chromosome locus in one of two partner chromosomes and nowhere else within the entire complement. Deletions might account for the absence of a particular loop at a given locus; but if this explanation of the phenomenon is to be accepted, four specimens of *T. c. carnifex* must be deletion homozygotes for a locus on bivalent XII which in the fifth specimen regularly bears a pair of conspicuous spherical objects on one homologue, these being equally regularly absent from its partner.

We suggest an alternative explanation: that non-identity of loop pairs at homologous chromosome loci is a direct expression of genetic heterozygosity at these loci, that is, that different alleles of a given gene may produce loops of differing morphology. As mentioned earlier, differences of loop morphology in all probability depend on differences in the nature or rate of synthesis or of dispersal of the accumulated primary products of gene activity. If this explanation be accepted, then why should allelic differences be visible in lampbrush chromosomes but not in *Drosophila* salivary gland chromosomes? There is evidence, both from studies on salivary gland chromosomes[3] and on lampbrush chromosomes, that genes in a physiologically active state take the form of extended fibres: compact chromomeres which are not spun out into fibres may represent genes in a state of inactivity. The chromomeres of salivary gland chromosomes are for the most part compact, whereas those of lampbrush chromosomes during the active growth phase of oocytes are for the most part extended into the fibre cores of the lateral loops. Thus allelic differences in salivary gland chromosomes are only likely to be detectable if they concern genes which are physiologically active in salivary gland nuclei; for example, loci involved in nucleolus- and Balbiani-ring formation: and Beermann[3,4] has demonstrated what are probably allelic differences at precisely such loci in the salivary gland chromosomes of chironomids. In oocyte nuclei, on the other hand, where the great majority of the genes may be adjudged to be physiologically active, we may reasonably expect allelic differences to be generally discernible. [June 30

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MUTATIONS IN *DROSOPHILA MELANOGASTER* GROWN ON MEDIA CONTAINING CARBON-14-LABELLED SUGARS

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SINCE Muller in 1927 and Stadler in 1928 published their classical studies on the strong mutagenic action of X-rays, high-energy radiation has been the foremost means of inducing mutations experimentally. At first only external irradiation was used; but in recent years the mutagenic action of radioactive materials absorbed by the cells has also been studied. These investigations, reviewed by Muller[1], have dealt with the mutagenic action of radioactive phosphorus and sulphur. Especially interesting is the question whether the transmutation of a radioactive atom located at a strategic point within a gene would result in the mutation of this gene. Although it has been difficult to decide whether the observed mutagenic action was entirely caused by the released beta-radiation or in part also by the transmutation of radioactive atoms located in the chromosomes, certain experiments dealing with the effects of radioactive phosphorus on *Drosophila* have shown that at least under the conditions used the mutations were induced at a rate which could be approximately accounted for by the released beta-radiation alone[2-4]. Thus King found that the radiation from internally located phosphorus-32 atoms was mutagenically effective, but that in the case of male *Drosophila* fed upon phosphorus-32 as adults for 24 hr. there was no indication that internal phosphorus-32 were mutagenically more efficient than external phosphorus-32.

In the experiments to be reported here the mutagenic action of carbon-14 was investigated by rearing *Drosophila melanogaster* individuals from eggs to adults on media containing carbon-14-labelled sugars.

The medium used was a modification of Spencer's[5] medium and was prepared as follows. 2 gm. of powdered agar were added to 320 ml. of water, and the mixture brought to boiling point. 15 ml. of living brewer's yeast were stirred in, and the mixture was boiled for 15 min. 40 ml. of syrup were added. 40 ml. of semolina were thoroughly mixed with 40 ml. of water. This was stirred into the hot medium, and the mixture was brought to boiling point. Then 1·6 gm. of dry 'Bonomold *OM*' (AB Bofors Nobelkrut, Sweden) were added and thoroughly stirred in, after which the medium was boiled for 10 min. Then a small amount of solution containing carbon-14-labelled sugars was added and after thorough mixing the medium was immediately poured into culture bottles, each of which received about 50 ml. of medium.

The carbon-14-labelled sugars were prepared photosynthetically by means of *Canna indica* leaves. Hassid's[6] procedure was mainly followed. After photosynthesis the leaves were extracted with 80 per cent ethanol, the extract was concentrated on the steam-bath, and water was added. Lipids, pigments, and other materials were removed by treating the aqueous residue with ether in a Kutscher–Steudel extraction apparatus. A small quantity of glucose was added as carrier to the aqueous solution, which then was evaporated to dryness under vacuum.

The radioactive sugars were added to the culture media at two levels of activity, namely, approximately 1 millicurie and 0·1 millicurie per culture bottle.

The culture bottles were kept in an incubator at 23–24° C. Cultures with the same medium from which radioactive sugars had been omitted served as controls. Three *Drosophila melanogaster* pairs were introduced into each culture bottle. They were of the young wild-type individuals of Oregon-*K* stock. The new generation developed in fifteen days.

The males grown from eggs to adults on the media containing radioactive sugars as well as the control males were tested for the presence of the X-chromosome lethals by means of the Muller-5 technique (cf. Demerec[7]). In the experiments, F_1 females from the crosses between one Muller-5 female and one treated male (these F_1 females were offspring of several treated males) were individually mated, each with one Muller-5 male. The presence of the X-chromosome lethals was determined according to the criteria presented by Demerec[7].

The results are shown in Table 1.

Table 1. THE PRESENCE OF X-CHROMOSOME LETHALS IN THE FIRST GENERATION REARED ON THE MEDIA CONTAINING CARBON-14-LABELLED SUGARS

^{14}C activity of medium per culture bottle	F_1 females tested	F_1 females with offspring	Free from X-lethals	X-lethals No.	X-lethals per cent
1 mc.	202	180	175	5	2·8
0·1 mc.	152	139	138	1	0·72
None	90	82	82	0	0

The experiment was continued by placing the flies reared from eggs to adults on the media containing carbon-14-labelled sugars into new culture bottles containing the same media, either radioactive media of two different levels of activity or a non-radioactive control medium. Three pairs of flies were introduced into each bottle. Their male offspring, which thus represented the second successive generation reared on the carbon-14-labelled media, were tested for the presence of the X-chromosome lethals.

The results are shown in Table 2.

Table 2. THE PRESENCE OF X-CHROMOSOME LETHALS IN THE SECOND GENERATION REARED ON THE MEDIA CONTAINING CARBON-14-LABELLED SUGARS

^{14}C activity of medium per culture bottle	F_1 females tested	F_1 females with offspring	Free from X-lethals	X-lethals No.	X-lethals per cent
1 mc.	209	183	179	4	2·2
0·1 mc.	163	149	148	1	0·67
None	80	69	69	0	0

To assess the activity of the media and of the flies, samples of both were taken at the end of the experiments. These samples were dried and oxidized with the Van Slyke–Folch[8] mixture. The liberated carbon dioxide was absorbed into barium hydroxide solution and the barium carbonate precipitate formed was collected on a filter paper disk. After drying, its activity was measured by means of a thin end-window Geiger–Müller counter. The counts were converted into absolute counts by comparing them with counts obtained from a calibrated barium carbonate standard (from Tracerlab, Boston, Mass.) under the same counting conditions. The results of the activity determinations are shown in Table 3.

Table 3. THE ACTIVITY OF THE MEDIA CONTAINING CARBON-14-LABELLED SUGARS AND OF THE FLIES REARED ON THESE MEDIA

	Specific activity (absolute) per mgm. of carbon	
	disintegrations/sec.	microcuries
First generation		
0·1-millicurie medium		
Medium	909	0·0246
Flies	971	0·0262
1-millicurie medium		
Medium	9,628	0·260
Flies	9,601	0·259
Second generation		
0·1-millicurie medium		
Medium	893	0·0241
Flies	904	0·0244
1-millicurie medium		
Medium	9,801	0·265
Flies	10,081	0·272

For the purpose of computing the radiation dose received by the flies during their development from eggs to adults under those experimental conditions, we note that the average activities of the media were 0·263 and 0·0244 microcuries per mgm. of carbon, respectively. Since it was calculated that the media contained 73 mgm. of carbon per gm., the activities of the media were 19·2 and 1·78 microcuries per gm. Taking 0·05 MeV. as the value for the mean energy of the carbon-14 beta-particle, we find that the amounts of energy liberated in these media were 4,920 and 456 ergs per gm. in 24 hr., which would be equivalent to 53 and 4·9 r. in 24 hr., respectively. Thus, if the carbon concentrations in the flies were the same as that of the medium, the flies during their 15-day period of development had received a total radiation dose of about 800 r. on the '1-millicurie medium' and of about 75 r. on the '0·1-millicurie medium'. Actually, the carbon concentration must have been somewhat higher in the flies and, consequently, the radiation dose also larger, perhaps by some 50 per cent.

The frequencies of the X-chromosome lethal mutations were very similar in both series of experiments. The numbers of mutations observed in flies reared on the '0·1-millicurie medium' are not significantly different from zero. On the other hand, the numbers of mutations on the '1-millicurie medium' are statistically significant if the results of both experiments are pooled ($\chi^2 = 3{\cdot}83$, degrees of freedom 1, $P = 0{\cdot}05$). Thus we feel justified in concluding that the incorporation of radioactive carbon-14 into the medium and through it also into the flies increases the frequency of mutations.

As described above, the total radiation dose which the flies received during their 15-day period of development on the '1-millicurie medium', was about 800 r. The frequency of the X-chromosome lethals observed in our experiments, 2·2–2·8 per cent, is approximately the same as those found by several investigators after a dose of 1,000 r.[9–13]. In most of these experiments little attention has been paid to the age of the irradiated flies, which has been shown to influence considerably the number of mutations[13,14]. This remark also applies to our own experiments, in which, however, the *Drosophila* flies received irradiation at the same dosage during their whole period of development. The above comparison indicates that the increase in the number of mutations observed in our experiments can be accounted for, at least mainly, by the mutagenic action of released beta-radiation. This comparison, however, cannot be perhaps considered quite exact, since the irradiation in our experiment, in contrast to all the above-mentioned studies, was distributed over the whole period of development.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Biochemical Evolution : Position of the Tunicates

THE biochemical differentiation[1] between the vertebrates and the invertebrates rested upon the finding that phosphocreatine and phosphoarginine were characteristic of these two classes respectively. Recently, the discovery of phosphagens other than phosphoarginine in invertebrates has suggested some modification of this generalization; but there are no reports in the literature suggesting the presence of a phosphagen other than phosphocreatine in the vertebrates.

The work[2,3] on members of the intermediate group of protochordates, which indicated the presence of phosphoarginine in the atrial muscle of tunicates, created an anomalous situation, inasmuch as the tunicates appeared to reverse the general chordate pattern[4] biochemically characterized by the presence of phosphocreatine.

In connexion with investigations on creatine phosphokinase[5] and arginine phosphokinase (unpublished results), the opportunity occurred to examine two tunicates, *Pyura* sp. and *Pyura stolonifera* (Heller), for the presence of arginine phosphokinase and phosphoarginine. The atrial muscles were removed immediately after collection (from the south coast of New South Wales) and frozen in liquid nitrogen to prevent decomposition of the phosphagen. A portion of this frozen material was extracted in the cold with trichloroacetic acid (10 per cent) and the extracts neutralized after filtration. A water-soluble ethanol-insoluble fraction of barium salts was obtained which contained a phosphorus compound unstable in 0·1 N hydrochloric acid at 60°. The compound was identified as phosphocreatine by ascending paper chromatography in a number of solvent systems. The compound, moreover, did not react with adenosine diphosphate in the presence of arginine phosphokinase isolated from crayfish muscle, but did react with it in the presence of creatine phosphokinase from rabbit muscle.

Another portion of the muscle was extracted with boiling water, and from the filtered extracts, after treatment with ion-exchange resins, a picrate was obtained which possessed a melting point identical with creatine picrate. Chromatography of the initial extract in six solvent systems revealed only one spot reacting with α-naphthol and diacetyl and corresponding in position with authentic creatine. This spot did not give a Sakaguchi reaction, nor did it react with ninhydrin. The guanidine was phosphorylated by creatine phosphokinase but not by arginine phosphokinase.

A third portion of the frozen muscle was finely ground and extracted with 1·5 vol. of water in the cold room for 18 hr. After centrifugation, the extract was treated with ammonium sulphate and a protein fraction obtained which showed creatine phosphokinase activity. No trace of arginine phosphokinase activity was detected in either the crude or partially purified extracts. The enzyme was active not only with authentic phosphocreatine and creatine as substrates, but also with the free base and its phosphorylated derivative isolated from the muscle.

The generalization of Needham *et al.*[3] (that the tunicates contain phosphoarginine) is based on equivocal chemical evidence gained from an investigation of one species but has been generally accepted[4,6]. The present results indicate the absence of arginine, phosphoarginine and arginine phosphokinase in the tunicates as represented by two species. On the other hand, they prove conclusively the presence of creatine, phosphocreatine and an enzyme possessing creatine phosphokinase activity.

Though it is perhaps not permissible to conclude that the tunicates as a class possess creatine, etc., the present work is consistent with, and provides biochemical support for, the accepted phylogenetic classification of the tunicates and therefore removes the anomaly referred to by Wald[4].

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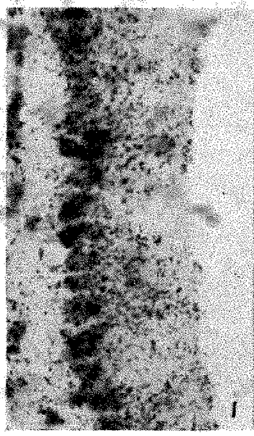
Effect of X-Rays on the Metabolism of Cell Nuclei of Non-dividing Tissues

ADULT mice were given single intraperitoneal injections of either a solution containing ^{35}S-DL-methionine or [8-^{14}C]adenine. Some of the animals were given whole-body irradiation immediately before injection. The animals were killed at various times after injection, and organs fixed for 1 hr. in acetic acid–alcohol (1 : 3) followed by formol saline; autoradiographs were prepared by the stripping film technique. The methods employed have been described previously[1].

After injection of labelled methionine some tissues with extremely low mitotic indexes, such as thyroid, seminal vesicle, tracheal epithelium, nerve cells and epididymis, give nuclear autoradiographs suggesting protein metabolism. Although nucleus and cytoplasm are labelled, the resolving power of the method is undoubtedly sufficient to localize sulphur-35 in parts of the cells. Only some of the nuclei are positive in those tissues, the proportion varying within wide limits.

The effect of X-rays on nuclear protein metabolism in the columnar epithelium in the trachea 4 hr. after irradiation and injection is shown in Figs. 1 and 2; numerical values are given in Table 1. Weakly positive nuclei were scored as negative, since the photographic grains above them might have been due to sulphur-35 in adjacent cytoplasm. The strength of the autoradiograph above the cytoplasm of the epithelial cells in the trachea is not markedly affected by the irradiation (cf. Figs. 1 and 2). It is about equal to that in positive nuclei in animals killed four hours after injection. Two hours after injection the concentration of sulphur-35 is higher in the cytoplasm of all cells than in positive nuclei. Fewer



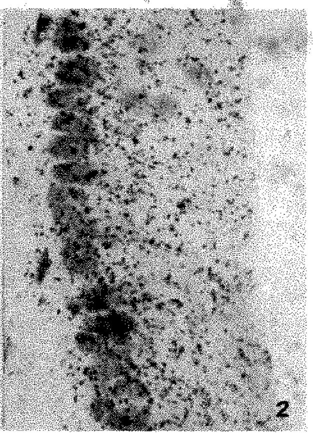


Fig. 1. Stripping-film autoradiograph of the tracheal epithelium of a mouse 4 hr. after injection of ^{35}S-DL-methionine. No irradiation. Hæmatoxylin and eosin stain after photographic processing

Fig. 2. As Fig. 1, but 1,000 r. X-rays before injection

positive nuclei are observed 16 and 24 hr. after injection, but marked accumulations of sulphur-35 are noticeable in the cytoplasm surrounding the nuclei. The secretion is labelled. Table 2 summarizes the changes in the strength of autoradiograph.

No cells in division were seen in the tracheal epithelium in sections stained by the Feulgen reaction, whereas a number of mitoses was observed in the strongly labelled squamous epithelium of the œsophagus of unirradiated animals; mitosis, therefore, is not influenced by the injected radioactive material. It can be concluded that neither the observed nuclear uptake of labelled methionine nor the effect of X-rays on this incorporation is connected with mitosis.

Twenty-four to seventy-two hours after injection of [8-^{14}C]-adenine, a nuclear autoradiograph indicating nucleic acid metabolism was observed in the seminal vesicle and tracheal epithelium in slides treated with ribonuclease before applying the film. Staining with methyl-green pyronine shows that the ribonuclease had hydrolysed the ribose nucleic acid in the nuclei in the preparation.

The connexion between amounts of the nucleic acids and protein metabolism was first pointed out by Brachet[2] and Caspersson[3]. Recently, Gale[4] and Mirsky[5] have shown that the incorporation of amino-acids into cell suspensions derived from dividing cells depends on the presence of intact nucleic acid.

Table 1. EFFECT OF X-RAYS ON NUCLEAR PROTEIN METABOLISM IN THE TRACHEAL EPITHELIUM

Dose (r.)	No. of animals	Percentage positive nuclei	
		Single animals	Mean
0	4	77, 66, 69, 55	67
200	1	31	31
1,000	3	20, 17, 24	20

The percentages are based on counts of 300–400 cells per animal.

Table 2. CHANGES IN THE STRENGTH OF AUTORADIOGRAPH IN THE TRACHEAL EPITHELIUM AFTER INJECTION OF ^{35}S-DL-METHIONINE

Time after injection of methionine	Cytoplasm	Perinuclear	Positive nuclei	Secretion
2 hr.	++	−	+	+
4 hr.	++	−	++	+
16 hr.	++	+++	+→++	++
1 day	++	+++	+→++	++
2 days	+	++→+++	+	+
8 days	+	+	+*	+

−, Negative; +, ++, +++, strength of autoradiograph as estimated. These values are not based on grain counts.
*Very few positive nuclei.

Preliminary results on other tissues show significant differences in the incorporation of methionine as well as the connexion indicated with nucleic acid metabolism as shown by incorporation of [8-^{14}C]-adenine, and the findings reported here cannot be taken to be of general validity for all tissues showing signs of nuclear protein metabolism. It is more likely, judging from preliminary observations, that the various differentiated tissues show combinations of nucleic acid and protein metabolism peculiar to themselves.

I wish to thank Dr. A. Glücksmann and Dr. N. B. Myant for much helpful discussion.

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Mutagenic Effect of Thermal Neutrons on Wet and Dry Tomato Seed

SEEDS of two different lots (line 208 and line 215) of the same autodiploid *L. pimpinellifolium* were exposed to thermal neutrons in the reactor at Brookhaven National Laboratory in February 1955. Part of the seed was exposed dry (about 8 per cent moisture) and another part exposed wet (soaked 24 hr. at 25° C. and then sealed in plastic bags at 3° C. for irradiation). Wet seeds were saturated with water and, except for the 24-hr. soaking period and the period of irradiation exposure, were kept at 3° C. until dry again.

In treating line 208, three different wet pretreatments were used: 0·2 per cent colchicine, 0·2 per cent paradichlorobenzene, and distilled water. However, most of the results were homogeneous among the three pretreatments so they have been grouped and reported together as a single wet treatment. One item, mean days to germinate, did vary among the wet pretreatments, seed treated with paradichlorobenzene requiring about 1·5 days longer to germinate.

The principal results from the line 208 experiment are given in Table 1. Germination, survival and sterility data are comparable for both wet and dry seeds, except for the slower germination of wet-treated seeds, which is entirely due to the delay, noted above, associated with the paradichlorobenzene subtreatment.

Mutation data were taken by selfing R_1 plants and observing 36–72 seedling progeny from each R_1 plant for lethal and visible mutations. Lethals were expressed as a 25 per cent reduction in germination and visibles as 25 per cent of the progeny. Visibles were classified as 'chlorotic lethals', 'morphological lethals', 'chlorotics' and 'morphologicals'. The results, given in the last column of Table 1, indicate a much higher

Table 1. EFFECT OF THERMAL NEUTRONS ON WET AND DRY PRETREATED TOMATO SEED, LINE 208

Pretreatment	Thermal neutron dose (10^{13}/cm.^{2})	No. planted	Per cent germ.	Mean days to germ.	Per cent survival	Per cent plants sterile	No. tested for mutation	Per cent having seedling mutation
Dry	0	84	99	7·18	100	0	10	10·0
	3·30	84	96	7·50	100	5	26	65·4
	7·05	84	94	8·41	99	28	26	38·5
	11·00	84	77	9·38	80	90	1	100·0
	14·80	84	39	10·36	6	100		
Wet	0	252	97	8·66	100	0	56	0·0
	3·30	252	99	8·75	100	10	73	19·2
	7·05	252	90	9·86	99	27	55	27·3
	11·00	252	87	9·51	73	80	3	33·3
	14·80	252	69	10·39	6	100		

Table 2. EFFECT OF THERMAL NEUTRONS ON WET AND DRY PRETREATED TOMATO SEED, LINE 215

Pretreatment	Thermal neutron dose (10^{13}/cm.^{2})	No. planted	Per cent germ.	Mean days to germ.	Per cent survival	Per cent plants sterile	No. tested for mutation	Per cent having seedling mutation
Control	0	648	97	5·77	100	0	51	0·0
Wet and dry								
Dry	11·00	72	93	7·24	100	72	18	38·9
Wet	11·00	576	76	7·40	87	53	75	54·7

mutation-rate for dry-treated seed than for wet-treated seed, although these differences are in no way indicated in the foregoing germination, survival and sterility data from R_1 plants.

Line 215, which is genetically identical to line 208, was used in a different experiment performed at the same time but involving a different series of wet treatments and only one irradiation exposure of 11·00 × 10^{13} thermal neutrons/cm.^{2}. Wet treatments included water and equimolar solutions of the iron, calcium and potassium chlorides, nitrates and sulphates. Since some of these salts produced response differences, the 'wet' results given in Table 2 are summations from only those treatments that were not dissimilar from distilled water.

It is evident in these results (Table 2) that tomato seeds will withstand extremely high doses of thermal neutrons. Barley seed, which is roughly typical of most other seed in this respect, fails to produce plants[1] after about 1·9 × 10^{13} thermal neutrons/cm.^{2}. Line 215 tomato seed, however, produces functional plants, almost half of which are fertile, after an exposure that is five times greater than the lethal dose for barley. Furthermore, mutation-rate, which in barley at the top dose[1] of 1·4 × 10^{13} is about 13 per cent, is about 55 per cent in line 215 at dose 11·0 × 10^{13}. This strongly suggests that the functional resistance enjoyed by tomato seeds is cytoplasmic in origin and that genetic damage increases as an approximately linear function of dose in spite of somatic protection.

The difference in sensitivity of two lots of genetically identical seed (lines 208 and 215), which is shown by comparison of the 11·00 × 10^{13}/cm.^{2} treatments in Tables 1 and 2, is characteristic of tomato results, sensitivity differences depending mostly on non-genetic factors.

With regard to the effect of hydration on response to thermal neutron irradiation, the results from wet and dry treatments show a striking similarity. Wet- and dry-treated seeds (Tables 1 and 2) germinate about as well and about as rapidly, and the plants survive about as well. However, there is a suggestion in both sets of results that plants from wet-treated seeds at high doses are less likely to be sterile and, at lower doses (Table 1), are less likely to have a recessive seedling mutation. Whether this amounts to a real genetic protection by hydration remains to be determined; but, at least, it seems evident that hydration does not increase either somatic or genetic sensitivity of these seeds. Ehrenberg *et al.*[2] have X-ray data, somewhat comparable to these, for mutagenic sensitivity of pre-soaked and dormant barley seed. They show that, at low doses, water increases the genetic effect but, at higher doses (about 15,000 r.), mutation-rate in presoaked seed is "often lower than in dormant seeds". Our results from thermal neutron irradiations at much higher levels than those of Ehrenberg indicate that the genetic protection by water, which began to appear at his high doses, may actually exist. Such protection, however, cannot yet be construed to indicate genetic protection on a cellular level, because the relationship between mutations induced and mutations recovered is still not established in plants.

This work was aided by contract *AT*(11-1)–335, Atomic Energy Commission. I wish to acknowledge facilities made available in the Biology Department, Brookhaven National Laboratory, where the seed treatments were carried out. The technical assistance of Miss Isobel Allan and Mrs. Mary Roser has been invaluable.

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Adsorption of Red-Cell Components by Siliceous Earths

IN a recent paper by Lovelock[1], the hæmolysis of suspensions of washed human red cells by alumina has been described. The conclusion is drawn from this work that alumina adsorbs dissolved lipids, derived from the erythrocyte membrane, thus hastening the process whereby lipids pass from the cell membrane into (aqueous) solution, leading to the breakdown of the cell.

Prior to my knowledge of this work, I had investigated an accidentally observed phenomenon, the hæmolysis of human red cells by suspensions of a diatomaceous-earth filter-aid, 'Hyflo Super-Cel'[2], used in chromatography. It was possible to show the adsorption of quite large amounts of lipid material on to the powder after mixing with red cells for a few minutes. Extraction of the recovered powder was performed with chloroform/methyl alcohol mixtures, and the extracts analysed for cholesterol, phospholipid and nitrogen. Control experiments in which the powder was shaken with 0·15 M sodium chloride solution used for washing the cells prior to treatment yielded negligible values for the various substances. In two experiments of the type described, alumina was used for comparison.

In addition, some of the lipid material, after extraction from the powder, was freed from cholesterol and dissolved in a mixture of 10 per cent *iso*-propyl alcohol in benzene. Small quantities of this were used for making spread-films on water; the ability of suspensions of 'Hyflo Super-Cel' to lower the surface pressure of these films was measured with a Langmuir film balance. It was found that, while simply introducing a suspension of the powder into the water below the powder had no effect, directing a stream of the particles upwards towards the underside of the film lowered the surface pressure rapidly and considerably.

The results of this work suggest that, at any rate in the case of the siliceous material used, hæmolysis results from an interaction between the cell surface and the powder particle, with direct adsorption of components of the membrane. Particle-size appears to be an important factor in this process.

Details of this work have been submitted for publication elsewhere, and further quantitative investigations of the factors controlling interaction between cell surfaces and solid adsorbents is proceeding.

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Induced Change from Culture Form to Blood-stream Form in *Trypanosoma mega*

In its vertebrate host, a trypanosome multiplies in the trypanosoma form while, in its invertebrate host, it first takes the crithidial form, which is no longer infective, to reappear as metacyclic forms at the end of its cycle. Similarly, in culture, the blood-stream trypanosomes lose their infective power and their typical shape and become transformed into the crithidial form.

We have tried to elucidate the factors responsible for those transformations and succeeded in inducing the development from culture to blood-stream form, by addition of vertebrate serum. We used *Trypanosoma mega*, a parasite of amphibians. This trypanosome has been kept through fifty subcultures in a serum-free medium[1].

Slide cultures were made with various media, examined under a phase-contrast microscope and as stained smears. In young, actively growing cultures, the flagellates multiply as round bodies, often clustering into regular-shaped rosettes. After a few days the rosettes disintegrate, and the crithidia become elongated and free-swimming (Fig. 2).

The addition of fresh toad serum agglutinates the crithidia and induces the development, after a day or two, of numerous trypanosoma forms with undulating membrane and posterior kinetoplast. In 1911, França[2] observed a similar phenomenon in *T. rotatorium*. This author transferred crithidia from the digestive tract of a leech into frog serum kept continuously agitated. He ascribed the transformation to the agitation and not to the serum.

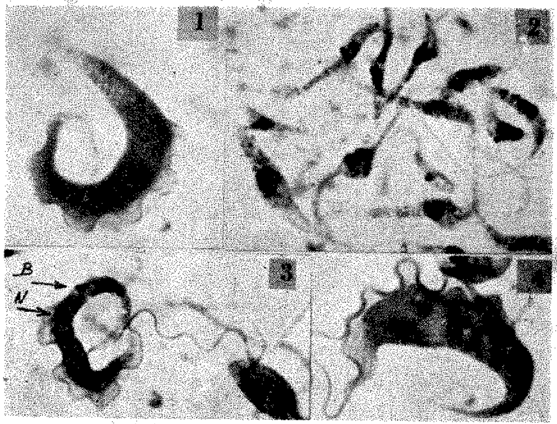

Fig. 1. Induced transformation of *Trypanosoma mega*: 1, blood-stream form in *Bufo regularis*; 2, culture form, crithidia; 3, trypanosoma form induced by toad serum; 4, trypanosoma form induced by calf serum. (Giemsa stain. × *c.* 1015)

We next noticed that the action was not specific of toad serum: the sera of various mammals, such as mouse, horse, calf, had the same action on the crithidia. This led us to choose calf serum for our next experiments.

Calf serum added to the culture medium in adequate proportion (50 per cent or more) agglutinates and kills the flagellates in a few minutes. The same serum heated to 56° C. for 30 min. agglutinates without lethal effect and, 24 hr. after its addition, numerous blood-stream forms appear in the culture (Fig. 4). Finally, this serum, exposed at 0° C. to large quantities of culture flagellates, has lost its specific agglutinins but retains its ability to change crithidia into trypanosoma form.

After dialysis, calf serum loses none of its form-changing activity. On the other hand, the serum fraction soluble in 50 per cent ethanol does not modify the form of culture crithidia.

The serum proteins were next fractionated by salting out with ammonium sulphate, followed by dialysis and lyophilization. Preliminary experiments showed that the activity is linked with the globulin fraction.

We observed that, in a culture, a certain number only of the crithidia were transformed into trypanosomes by the action of serum. This percentage seems to be closely connected with the age of the culture: a young culture, rich in dividing forms (rosettes), yields only very few trypanosoma forms. This would mean that, apart from the specific property of the serum, the transformation of the trypanosome requires a corresponding intrinsic factor. An analogy exists between this fact and the appearance of metacyclic trypanosomes at the end of the invertebrate cycle.

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Relationship between the Amine Contents of the Two Adrenal Glands of the Cat

Workers[1] vary in their methods of calculating the adrenaline and noradrenaline content of adrenal glands. Some express them in micrograms per unit weight of gland, some in micrograms per gland and some even in micrograms per kilogram of body-weight. Since, frequently, there is a difference between the weight of the left and of the right gland of each cat, it was thought desirable to determine whether the percentage of noradrenaline is the same in the two glands, and whether the total amine content is the same for both glands or whether the heavier gland contains more amine.

Both adrenal glands from thirty-six adult cats were dissected free of connective tissue, and 50 mgm./ml. extracts were prepared in $0 \cdot 1\,N$ hydrochloric acid. The adrenaline and noradrenaline content of each extract was assayed biologically, using the cat blood pressure and nictitating membrane as test preparations. The results were calculated by the formula of Bülbring[2]. At least two determinations were made on each preparation and the results were treated statistically.

As can be seen from Fig. 1, the percentages of noradrenaline in the right and left glands are equal. From the thirty-six pairs of results the mean percentage of noradrenaline in the left gland was 44·5 per cent and in the right gland was 44·0 per cent. The correlation between the pair of glands is independent of the degree of methylation and of any difference in the weight of the two glands.

In some cats, the two adrenals may not vary by more than a few milligrams. However, in others the difference may be considerable. In this series of experiments the greatest absolute difference in weight was 52 mgm. and the greatest difference, expressed as a percentage, was 36·4 per cent. In other experiments[3], absolute differences as great as 100 mgm. were observed.

As can be seen from Fig. 2, where the results from glands which differed in weight by more than 1 per cent are recorded, there is a much closer correlation between the amount of amine in the two glands when expressed as per gland than when expressed as per 100 mgm. of gland. This is true whether the difference in the weight of the two glands is small or large. Although only mean results are shown in the above two figures, the results from individual pairs of glands show the same picture.

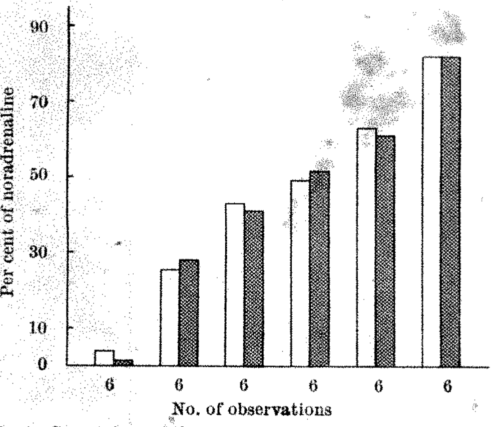

Fig. 1. Comparison of the percentage of noradrenaline in the left and right adrenal glands of the adult cat. The hatched area represents the left gland and the shaded area the right gland

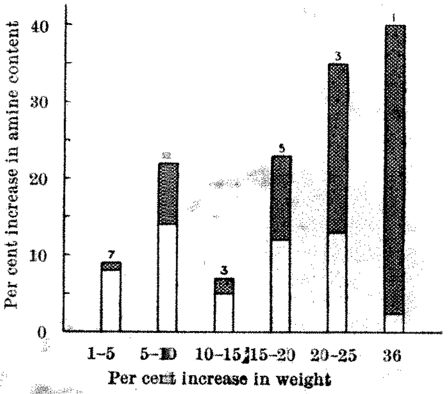

Fig. 2. Comparison of the amine contents of the two adrenal glands of the cat. The shaded area represents the difference in the amine content of the right and left glands, expressed as per 100 mgm. of gland, and the clear area represents the difference expressed as per gland. In all cases the difference is expressed as a percentage increase. The number above each column is the number of observations from which the mean value was obtained

Thus it may be concluded that, in the cat, the adrenaline and noradrenaline content of the two adrenal glands should be calculated as per gland and not as per unit weight of gland. This is of importance when one gland of the animal is used as a control and the effects of drugs on the other are studied[3].

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Comparative Hyperfibrinogenæmic Action of D- and L-Adrenaline

In a previous work on the hyperfibrinogenæmic effect of several sympathomimetic amines, it was reported[1] that adrenaline, when injected subcutaneously into the rat, has the highest activity in increasing blood plasma fibrinogen. We have now compared the activity of D- and L-adrenaline in relation to the hyperfibrinogenæmic response. After a preliminary experiment to find roughly the relative hyperfibrinogenæmic effect of the two forms of adrenaline, the following experiment was carried out. Forty female albino rats of 150–200 gm. body-weight were divided by randomization into four groups of ten rats each. Two groups received subcutaneously respectively 0·03 and 0·06 mgm. of adrenaline (expressed as base)/100 gm. body-weight. The other two groups were injected respectively with 1 and 2 mgm. of D-adrenaline (base). 24 hr. later, the rats were bled from the aorta under pentobarbitone-sodium anæsthesia (4 mgm./100 gm. body-weight) using syringes coated with 'Dry Film 9987', clotting being prevented by the addition of 0·01 ml. of 30 per

Table 1

Substance	Dose (mgm./100 gm.)	Fibrinogen (mgm./100 ml.) ± stand. error
L-Adrenaline	0·030 0·060	285 ± 17·6 343 ± 17·4
D-Adrenaline	1·0 2·0	285 ± 17·2 338 ± 20·3

cent potassium oxalate per ml. of blood; the D- and L-adrenaline were Winthrop Research Products. The fibrinogen was determined by the classical technique of Cullen and Van Slyke, with ashing by the method of Campbell and Hanna[2], distillation and titration of ammonia. The results are summarized in Table 1. The relative potency of D-adrenaline as compared to L-adrenaline was calculated by standard statistical methods for a four-point assay. Our results indicate that the dextro-compound has 2·8 per cent of the activity of the lævo-compound, with the exact fiducial limits of 1·8 and 5·9 per cent. This potency ratio of 1 : 36, obtained for the hyperfibrinogenæmic effect of the dextro-compound in relation to the lævo-compound, is lower than the ratio 1 : 20 obtained by Tainter[3] for the pressor response in the cat. It is, however, comparable to the 1 : 30 to 1 : 40 ratio found by Fromherz[4] for the pressor response in dogs.

We thank Winthrop Products, Inc., New York, for the gift of the D- and L-adrenaline.

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Photoperiodism and Thermal Resistance of Goldfish

IT is well known that the resistance of fish to extremes of heat or cold can be markedly altered by acclimatizing them to progressively higher or lower temperatures. In an attempt to discover the mechanism involved, it became evident that several factors in addition to thermal acclimatization may alter the resistance of goldfish to extreme temperatures. Diet[1] and size, sex and season[2] affect the thermal resistance of goldfish maintained at a constant temperature of 20° C.

Factors responsible for the seasonal differences are being investigated. Over a period of several years, goldfish maintained at a temperature of 20° C. and fed on a standard diet were relatively more resistant to cold in winter and to heat in summer. Cyclical seasonal changes in thermal tolerance seem to be at least partially independent of environmental temperatures. Since the seasonal variation in length of day was the only obvious environmental variable, experiments were designed to test the effects of different photoperiods.

In October 1955 two groups of goldfish (mean weight 14·2 gm.) were subjected to different photoperiods. The first group received 8 hr. illumination (70 ft. candles at the water surface) and 16 hr. darkness, while the second group received 16 hr. illumination (same intensity) alternating with 8 hr. darkness. The first situation corresponded to the hours of sunlight in winter, and the second to the sunlight period of summer. Temperatures varied from 18° to 20° C. in the room but were the same in all tanks. The diet was pablum and shrimp meal.

The thermal resistance of the two groups was compared after forty days and after fifty days. In tests of thermal resistance, the two groups (marked by distinctive fin clips) were placed together (fifteen of each group) in a lethal-temperature bath. The temperature in the cold bath fell from about 4° C. to 1° C.; that of the warm bath was about 36·5° C. Other details of testing were similar to those given elsewhere; fish here referred to as 'killed' or 'dead' are actually 'removals'.

In Table 1 we have recorded the number of minutes exposure required to kill different percentages of the samples. Thus, in the heat test *A*, 25 per cent of the short-day fish were dead at 31 min., while the same percentage of long-day fish survived until 41 min.—a difference of 10 min. in the 25 per cent lethal times. The temperature of the lethal bath at 41 min. was 36·5° C.; the initial temperature of this bath was 34·5° C. In the cold test, carried out at the same time, 25 per cent of the sample of short-day fish were dead at 198 min., while the same percentage of long-day fish had died at 102 min. The temperature of the bath at 198 min. was 1·2° C.

In detail, the table shows that the short-day period fish (winter fish) are consistently more resistant to cold and less resistant to heat, whereas the reverse is true of the long-day period fish (summer fish). The precise differences in lethal times may be varied by changing the severity of the test, as shown by the two sets of lower lethal temperature data. In each case, however, the thermal tolerance of the two groups of fish differs in a manner similar to the seasonal variations described elsewhere[2]. It is concluded that the seasonal variations in thermal

Table 1. COMPARISONS OF THERMAL RESISTANCE OF GOLDFISH
Short diurnal light period (8 hr.) or long diurnal light period (16 hr.) for 40 days (test *A*); and for 50 days (test *B*). Further description in text.

Per cent dead	Heat test				Cold test			
	Initial exposure to death in min.				Initial exposure to death in min.			
	Short-day fish	Long-day fish	Difference in lethal time	Corresponding temp. (° C.)	Short-day fish	Long-day fish	Difference in lethal time	Corresponding temp. (° C.)
Test *A*. Initial temperatures of lethal baths, 34·5° C. and 3·0° C.								
25	31	41	10	36·5	198	102	96	1·2
50	39	49	10	36·5	330	168	162	1·8
75	48	65·5	17·5	36·3	462	258	204	1·4
Test *B*. Initial temperatures of lethal baths, 35·5° C. and 4·0° C.								
25	67	71	4	36·9	372	342	30	0·8
50	77	88	11	36·1	446	418	28	0·2
75	86	119	33	36·5	492	461	31	0·5

tolerance previously noted in fish maintained under constant temperature conditions are photoperiodically controlled, probably through the pituitary gland. The endocrinology and biochemistry of the fish are now being investigated.

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Hormonal Depression due to Treatment of Animals with Chlorpromazine

IN an earlier paper, we have shown that in human patients chlorpromazine impairs the hypothalamus and through it the anterior pituitary lobe[1]. This depressing effect balances itself in accordance with the push–pull principle so far as the following tropins are concerned: follicle-stimulating hormone, luteinizing hormone, adrenocorticotropic hormone and thyroid-stimulating hormone, since they produce secondary hormones. This is impossible, however, with regard to luteotropic hormone and somatotrophic hormone, as neither of them produces peripheral secondary hormones.

The present communication describes the endocrine effects after three months of continuous treatment with chlorpromazine in animals which received subcutaneously 10 mgm./kgm. daily. For every group, five rats were used and the weights of their organs are given as average values. A detailed histological report on these effects will be published in collaboration with Prof. H. Ungar.

Follicle-stimulating hormone. (*a*) In infantile female rats it is only partly suppressed, as evidenced by spontaneous opening of the vagina on maturation and later by a tendency to permanent œstrous; the ovaries weighed 35 mgm. (controls 90 mgm.).

(*b*) In the male rat, the suppression is strong enough to produce atrophy of the testes (700 mgm. instead of 1,500 mgm.).

Luteinizing hormone. (*a*) In the female rat, suppression is complete, as no corpora lutea are formed.

(*b*) In the male rat, the suppression of interstitial-cell stimulating hormone is also complete, as the prostate and seminal vesicles become atrophied (500 mgm. instead of 2,000 mgm.).

Adrenocorticotropic hormone. In both sexes, the suppression is marked, as the adrenals weighed on an average 35 mgm. (control 45 mgm.).

Thyroid-stimulating hormone. In both sexes suppression is slight, since the thyroid glands weighed 28 mgm. as compared with the control (34 mgm.).

Somatotrophic hormone. In both sexes growth was definitely stunted by treatment. The females reached a steady weight at 95 gm. (controls, 125 gm.); the males at 125 gm. (controls, 200 gm.).

Subcutaneous injections of 5 rabbit units somatotrophic hormone (Wilson) daily along with the chlorpromazine treatment restored the weight within two months.

Luteotropic hormone. This hormone was tested in rabbits which received daily 0·5 mgm. progesterone. The second phase of the endometrium, which disappears normally after seventeen days treatment, was preserved for thirty-four days and longer by additional injections of chlorpromazine. This seems to indicate endogenous production of luteotropic hormone. Hence luteotropic hormone shows a pattern of reaction different from that of all other tropins[2].

After three months treatment there are no differences in pituitary weights between the animals treated with chlorpromazine and their controls (10 mgm.).

The fact that chlorpromazine was able to suppress the growth hormone may indicate that somatotrophic hormone is balanced by a secondary peripheral hormone. It has been suggested that such a relation exists with glucagon.

The above findings confirm the current view that chlorpromazine depresses the function of the hypothalamus. The endocrine disturbances thus brought about in the pituitary of animals may also appear in man if dosage is excessive.

We wish to thank the Specia Co., Paris, which supplied the Largactil, and the Wilson Laboratories, Chicago, which supplied the growth hormone. Our thanks are also due to Messrs. E. Zawojski, A. Eviatar and O. Hinckley for assistance.

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Intracellular Distribution of Choline Acetylase

WITH the development of methods for the measurement of choline acetylase independently of the enzymic formation of acetyl-coenzyme A[1–3], it has become possible to determine the intracellular distribution of the enzyme. In the present experiments, rabbit brain homogenates in 0·25 *M* sucrose were fractionated by differential centrifugation. In exp. 1 the procedure of Brody and Bain[4] was followed; in exp. 2, somewhat different centrifugal forces were applied as shown in Table 1. Each particulate fraction was washed by resuspension in 0·25 *M* sucrose and recentrifugation at the same speed; the washings were then pooled with the original supernatant for the next stage of the centrifugation.

Choline acetylase activity was determined by incubating the fractions in a system in which the substrate acetyl-coenzyme A had already been formed during a preliminary incubation at 37° C. of aged pigeon liver enzyme with citrate, acetate, choline acetylase and adenosine triphosphate[2,3]. After this induction period of 10 min. for the formation of acetyl-coenzyme A, the brain fraction to be tested was added to the system, incubation continued for a further 60 min. and the amount of acetylcholine formed determined by assay (frog rectus abdominis).

Whole homogenates tested in this way have only one-quarter to one-half of the activity of extracts made from acetone-dried brain. However, when they are treated with ether (0·2 ml./ml.), a procedure used in earlier studies on the synthesis of acetylcholine[5,6], the activity of the homogenates is equivalent to that obtained with acetone powders. The

Table 1. THE ACTIVITY OF CHOLINE ACETYLASE IN FRACTIONS OF RABBIT BRAIN HOMOGENATES

Centrifugal force. *g* (time in min.)	Exp. 1. ACh synthesis by centrifugates		Exp. 2. ACh synthesis by centrifugates	
	μgm./gm. brain/hr.	Per cent of total	μgm./gm. brain/hr.	Per cent of total
600 (10)	—	—	18	3
800 (10)	62	8	—	—
1,500 (10)	28	4	—	—
12,000 (20)	400	52	—	—
15,000 (30)	—	—	441	69
25,000 (60)	64	8	42	7
Final supernatant	214	28	134	21
Total of fractions	768	100	635	100
Whole homogenate	880		705	

isolated fractions are also maximally active only after ether treatment, and the results shown in Table 1 refer to values so obtained.

The results given in Table 1 show that the sum of the activities of the separate fractions is equivalent to about 90 per cent of the activity of the whole homogenate. The fraction with the highest activity is that sedimented at 12,000–15,000 *g*. Using biochemical and histological criteria, Brody and Bain[4] obtained evidence that this fraction of rabbit brain homogenates contains only mitochondria; histological examination of our preparations confirms this finding. The mitochondrial fraction contains 50–70 per cent of the enzyme activity. Evidence that the enzyme is firmly bound to the particles sedimented at 12,000–15,000 *g* has been obtained by demonstrating that little or no activity is lost from this fraction after repeated washing. The only other fraction containing an appreciable proportion of the activity is the final supernatant (21–28 per cent); the remaining activity is distributed between the other fractions.

This evidence for the presence of choline acetylase in mitochondria is a further step in understanding the metabolism and function of acetylcholine in nervous tissue.

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Cholinesterase and Sodium Transport by Frog Muscle

IN a variety of tissues (frog skin[1], red cells[2], *Chironomus* anal papillæ[3], and *Eriocheir* gills[3]) the active transport of sodium is blocked by inhibitors of cholinesterase. This communication concerns the role of cholinesterase in the sodium pump of the sartorius muscle of the frog, *Rana pipiens*. Sodium transport is readily demonstrated by placing the muscle in a Ringer's solution in which one-half of the sodium chloride has been replaced by sucrose[4]. Though the concentration of sodium in this sodium-deficient Ringer's still exceeds that within the muscle fibre, the muscle responds by actively transporting sodium ions into the external medium, so that after 30 min. the sodium content of the muscle, measured by flame photometry, has markedly decreased.

Table 1. THE SODIUM CONTENT OF MUSCLES AFTER 30 MIN. IN SODIUM-DEFICIENT RINGER'S AT 25° C. SODIUM DETERMINED BY FLAME PHOTOMETRY; MUSCLE WATER DETERMINED BY THE DIFFERENCE BETWEEN WET AND DRY WEIGHTS OF THE MUSCLE

Inhibitor	Sodium (m.equiv./kgm. muscle water) ± S.E.
None	23 ± 1
Previously exposed for 15 min. to 5×10^{-4} *M* hexaethyl tetraphosphate	35 ± 2
10^{-3} *M* physostigmine in sodium-deficient Ringer's	34 ± 2
Exposed to 10^{-3} *M* physostigmine for 30 min., washed and transferred to sodium-deficient Ringer's	22 ± 3
10^{-3} *M* prostigmine in sodium-deficient Ringer's	25 ± 2

This decrease in sodium content was prevented by previous exposure of the muscle to the irreversible anti-cholinesterase hexaethyl tetraphosphate, or by the addition of the reversible inhibitor physostigmine to the sodium-deficient Ringer's (Table 1). The block produced by physostigmine was reversed when the muscles were washed after exposing them to the inhibitor. However, a third anti-cholinesterase, prostigmine, failed to block sodium extrusion. Since it is known that quaternary nitrogen compounds, like prostigmine, are unable to penetrate the membranes of excitable tissues[5], we can conclude that only the anti-cholinesterases which penetrate into the muscle fibre and inhibit the intracellular enzyme are capable of blocking the sodium pump.

Though these experiments suggest that inhibitors of intracellular cholinesterase block sodium extrusion, they do not establish that cholinesterase participates in the pumping mechanism. Inhibitor studies, as Danielli has stressed[6], must be supported by evidence showing that the inhibitor actually does lower the activity of the enzyme and that the decrease in enzymatic activity is paralleled by a decrease in the rate of active transport.

Therefore, the effects of graded concentrations of physostigmine on the transport of sodium and on the activity of cholinesterase were measured. As is shown in Fig. 1, when the concentration of physostigmine was decreased the amount of sodium

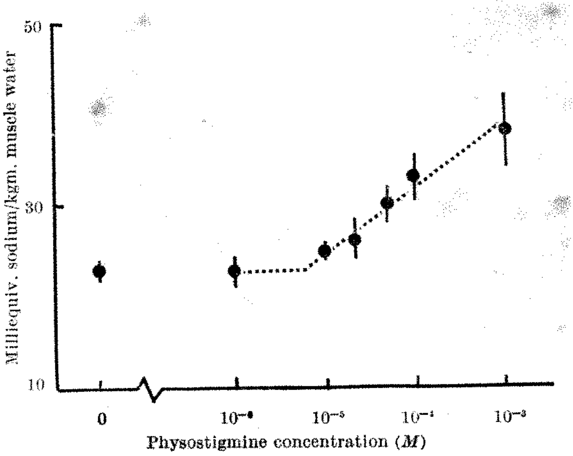

Fig. 1. The mean sodium content of the muscle water—after 30 min. in sodium-deficient Ringer's—as a function of the concentration of physostigmine. In every experiment 10^{-3} *M* prostigmine was present. The line between 10^{-3} *M* and 10^{-5} *M* physostigmine was calculated by the method of least squares. The vertical lines on the points indicate the standard errors

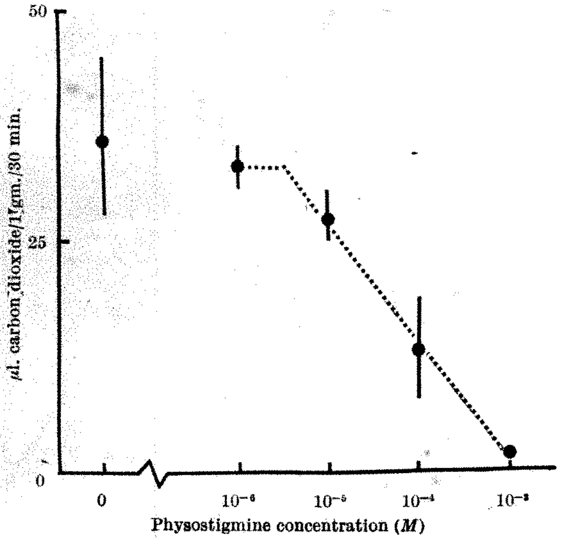

Fig. 2. The mean cholinesterase activity of muscles as a function of the concentration of physostigmine. Activity was measured gasometrically with 0·015 *M* ethylchloroacetate as the substrate. In every experiment the medium contained 10^{-3} *M* prostigmine and the muscles were exposed to the inhibitors for 60 min. before the addition of the substrate. Symbols and method of plotting as in Fig. 1

remaining in the muscle decreased, until in 10^{-5} *M* physostigmine the sodium transport was scarcely affected. The measurements of cholinesterase activity were also taken on intact muscles, using ethylchloroacetate as a substrate[7]. Ethylchloroacetate can penetrate into the muscle fibres, and therefore the cholinesterase activities of intact muscles and of homogenates, when measured with this substrate, are almost identical. The results are presented in Fig. 2. In each instance 10^{-3} *M* prostigmine was also present to inhibit the extracellular cholinesterase which, though it makes up 40–60 per cent of the total enzyme activity, has already been shown to be unimportant in sodium transport. However, the concentrations of physostigmine which inhibited sodium extrusion produced a comparable inhibition in the activity of the intracellular cholinesterase. In fact, the concentrations of physostigmine producing a 50 per cent inhibition of sodium transport and a 50 per cent inhibition of intracellular cholinesterase were almost identical.

The sodium transport in frog muscle was also inhibited by iodoacetic acid[4]. As is shown in Table 2, iodoacetic acid is not as effective an inhibitor as are the anti-cholinesterases. Moreover, the block produced by iodoacetic acid was by-passed by adding pyruvate to the medium. In normal circumstances the sodium pump was scarcely affected by cyanide, but this inhibitor was strongly effective when iodoacetic acid and pyruvate were present. Clearly any source of high-energy phosphate bonds is sufficient: either glycolysis in the presence of cyanide or the Krebs cycle when pyruvate is available.

Table 2. THE SODIUM CONTENT OF MUSCLES FOLLOWING 30 MIN. AT 25° C. IN SODIUM-DEFICIENT RINGER'S WHICH CONTAINED METABOLIC INHIBITORS

Inhibitor	Sodium (m.equiv./kgm. muscle water) ± S.E.
10^{-3} *M* iodoacetic acid	28 ± 1
10^{-3} *M* iodoacetic acid; 10^{-3} *M* pyruvate	23 ± 2
10^{-3} *M* potassium cyanide	25 ± 1
10^{-3} *M* iodoacetic acid; 10^{-3} *M* pyruvate; 10^{-3} *M* potassium cyanide	34 ± 3

In summary, the present data indicate that the activity of cholinesterase is prerequisite for the working of the sodium pump in muscle. It is apparent that a source of high-energy phosphate bonds is also essential, though the means by which this energy is invested in the transport of sodium remains obscure.

This study was aided by Grant *B*-703, from the Institute of Neurological Diseases and Blindness, of the National Institutes of Health, Public Health Service.

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A Simple and Effective Movement-restricting Collar

IT is frequently vital in research to restrict the experimental animal's movements and to keep him from damaging the experimental site, such as an externalized organ, tube or catheter. Much valuable work and time is often nullified in a short time by the animal pulling at the operative site which he will invariably do if he has access to the area.

In our work on ureteral regeneration it is necessary to prevent the dog from reaching and pulling the ureteral splint which is necessarily exposed on the flank for six weeks. Muzzles, pneumatic collars, disk collars and heavy dressings have been employed without success and with some discomfort to the animal as they would constantly worry the restricting apparatus. Since 60–70 per cent of our original operated animals pulled their tubes, a new collar was devised and has proved very satisfactory during the past eight months.

A template of heavy wrapping paper is made to fit to the size of the dog (Fig. 1). The measurements to fit the various size dogs from the smallest to the largest are accomplished with comparative ease as the collar is sufficiently adaptable in three sizes from large to small. This is traced on 18-gauge aluminium, which cuts easily with tin shears. $\frac{1}{8}$-in. holes can be drilled or punched with a common nail. The holes are measured at one and one-half inch intervals and one inch from the edge of the entire periphery. These are made to hold felt or sponge rubber, and we have found the former to hold best. Continuous No. 10 cotton thread holds up well under most conditions. At the ends, four $\frac{1}{8}$-in. holes are made on the overlapping end and two or three rows are made on the underlying flap. This gives an additional chance for adjustment or to use the collar on other animals. Two large holes, $\frac{1}{2}$ in., are made at the point of the collar to permit the fastening of the chest ropes. This is an essential part of the collar to prevent rotation, as the collar is made to allow the dog free access of motion in all quadrants except the operation site. The flange can be changed or moved to suit the need. The chest band can be simply a short rope

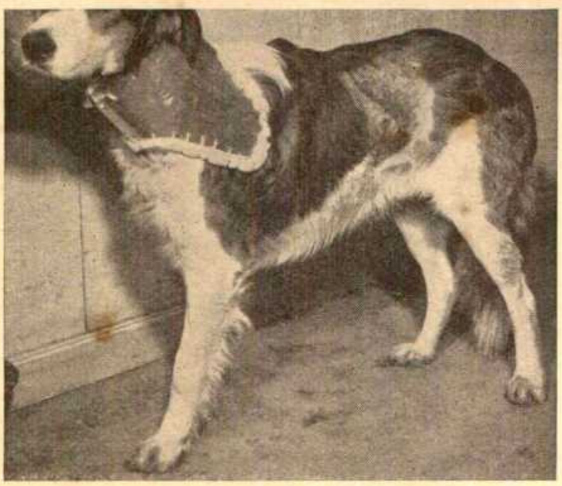

Fig. 1. Dog with movement-restricting collar attached. Note the flange extends well over the scapula

placed through the ½-in. hole on one side of the collar and brought across the chest in the back of and between the fore-leg to the hole on the opposite side of the flange. A canvas strap three inches wide with metal loops to accommodate snaps or short leather thongs which are crossed under and between the forelegs can be employed as an alternative to the rope.

This collar has proved very satisfactory by first being well tolerated by laboratory animals under conditions of restricted quarters. The dog fretted very little and apparently had sufficient latitude of movement to enable reasonable activity and comfort in eating and resting. These dogs were observed for a continuous six-week period, at the end of which time the fur and skin under the collar was not irritated in any way.

The optimum requirements for such a collar are for the lightest possible material which would produce the least amount of bulk. The only other effective type is the disk collar, but it was seen in our series of animals to be only 30 per cent effective against 92 per cent with the wrap-around type. A comparison of some values shows the disk type to weigh 1¾ lb. against 8 oz. Moreover, the cost of the latter is much lower. The ease of application and construction is far greater in the wrap-around and it can be changed rapidly if the occasion demands.

Two factors have to be avoided : (1) To make the strings to the chest strap secure, as without these the collar can rotate on the neck, thus allowing the animal access to the protected site. (2) To make the flange sufficiently long to restrict motion successfully.

This investigation was supported by a research grant (*RG* 4300) from the National Institutes of Health, Public Health Service.

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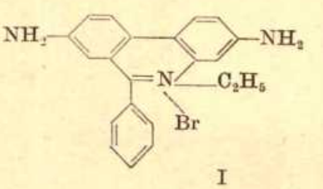
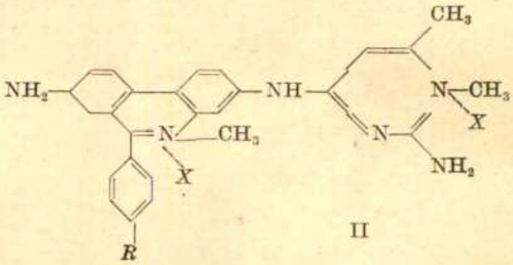
Prophylaxis of Trypanosome Infections in Cattle

THE introduction of 'Ethidium' (I) in 1952 made available to veterinarians in Africa a drug with very high therapeutic activity against the two most important trypanosomes of cattle, *Trypanosoma congolense* and *T. vivax*, and this drug is now widely used. There still seemed to be the need, however, for a drug which would confer a prolonged period of protection to dosed animals, and we have therefore, worked to this end. One particular series of drugs (II) showed, in mice, therapeutic activity of a very high order, and also a prophylactic action greater than that of any other drug available. Two of the most active of this series, '*R.D.* 2787' and '*R.D.* 2801', were sent to Africa for trials in cattle. '*R.D.* 2801', which had appeared the better of the two in tests in mice, has shown considerable promise in tests in Tanganyika and in Nigeria, against both *T. congolense* and *T. vivax*. In one trial, for example, a single dose of 2 mgm./kgm. protected cattle for at least six months. Trials are still in progress, and full results of both these trials and of our laboratory findings will be published elsewhere.



I



II

R.D. 2787 *R* = NO_2
R.D. 2801 *R* = NH_2

X = an anion such as bromide, chloride, methanesulphonate, etc.

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Dehydrochlorination of DDT by Resistant Houseflies and Mosquitoes

THE recent characterization of DDT dehydrochlorinase in resistant houseflies[1] has prompted an investigation of this enzyme and of the production of 2,2-bis(*p*-chlorophenyl)-1,1-dichloroethylene (DDE) in mosquitoes, in which DDT-resistance is now developing[2]. As an initial step, two strains of resistant houseflies were assessed for DDT-dehydrochlorinase content. The DDT-45 strain showed no less activity than originally reported[1], the DDE production in 3 hr. by the equivalent of six flies averaging 98 μgm. for homogenates and 52 μgm. for acetone powders. The Dilan strain, developed by two years of dilan pressure without any exposure to DDT, showed an enzymic DDE production of 100 μgm. for homogenates and 34 μgm. for acetone powders. This Dilan strain resembled the DDT-45 strain in having an *LD*90 exceeding 50 μgm. and being able to convert 90 per cent of 10 μgm. of DDT topically applied to DDE in 24 hr.

Two instances of DDT-resistance in mosquitoes were then investigated. (1) Resistant salt-marsh mosquitoes (*A. taeniorhynchus* admixed with *A. sollicitans*) from Cocoa Beach, Florida, where DDT-resistance was first reported in 1949 and which has since been liberally treated with lindane, dieldrin and heptachlor[3]; they were compared with salt-marsh mosquitoes from the Oatland Island marshes, Savannah, Georgia, where DDT has never been used. (2) Resistant *Aedes aegypti* from El Socorro and Aranguez[4], Trinidad; they were compared with a normal laboratory stock (*CD* strain) obtained from Camp Detrick, Maryland.

The susceptibility of these strains was determined by exposing fourth-instar larvæ for 24 hr. to various concentrations of DDT added in 1 c.c. of acetone to 1 litre of tap water in enamel pans. The *LC*50 values were thirteen times greater than normal for the salt-marsh mosquitoes from Cocoa Beach, and five hundred times greater than normal for the *A. aegypti* from Trinidad. Accordingly, 140–200 larvæ of each strain were exposed to DDT in three 1-litre pans of tap-water for 24 hr., and their DDT uptake and DDE production were determined by the Schechter–Haller method after washing them in a stream of distilled water, grinding them in a mortar with sand and anhydrous sodium sulphate, extracting with carbon tetrachloride and purifying in a 'Celite'-sulphuric acid column.

Table 1

	A. taeniorhynchus		*A. aegypti*	
	Normal	Resistant	Normal	Resistant
*LC*50, p.p.m. DDT	0·003	0·04	0·004	2·0
Larvæ exposed, No.	140	140	200	150
Concentration, p.p.m. DDT	0·005	0·03	0·003	1·0
DDT uptake (μgm.)	5·6	73·3	2·0	1,553
DDE produced (μgm.)	2·4	15·9	1·3	149·3

Both normal strains produced an insignificant amount of DDE, their uptake of DDT being small. The resistant strains, exposed to higher concentrations, accumulated much DDT; the resistant *A. aegypti* took up slightly more than one half the 3 mgm. of DDT to which the 150 larvæ were exposed. Both resistant strains produced considerable amounts of DDE, the ratio DDE/DDT being 22 per cent for the salt-marsh mosquitoes and 10 per cent for *A. aegypti*. On the average, one larva of the resistant *A. aegypti* produced approximately 1 μgm. of DDE in 24 hr. In comparison, an adult housefly of the *DDT*-45 strain, which weighs 4·5 times as much, can produce 4·5 μgm. of DDE per 24 hr. from DDT topically applied[5].

DDT-dehydrochlorinase activity was then assessed by means of acetone powders and homogenates at various concentrations incubated with DDT in ethanol or on glass beads. A total of thirteen such tests were made, but in no case was there any significant production of DDE. It is therefore suggested that the DDT-dehydrochlorinase of these mosquitoes requires different conditions from these suitable for housefly material. This view is supported by the recent observation of Kearns that homogenates of the resistant Mexican bean beetle, *Epilachna varivestris*, will not produce DDE under conditions suitable for the housefly, but can be induced to do so by a mixture of eighteen ions and compounds selected for their liability to activate or protect against inhibition (Kearns, C. W., personal communication).

The detailed results of this investigation are being made available by the World Health Organization.

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Carotenoids and Reproduction in *Pyronema confluens*

Robinson[1] found that light was necessary for both orange pigmentation and fruit-body (apothecium) formation in *Pyronema confluens* Pers. ex Tul. Since he was unable to obtain these effects separately, he postulated a causal relationship between them. Later work on the effects of light on *Pyronema*[2] has not been concerned with testing this hypothesis. Recent work by one of us[3] has shown that there is no direct relationship between pigmentation and spore production in *Fusarium oxysporum*, and it appeared useful, therefore, to investigate the problem in *P. confluens*.

Apothecium formation was observed using a double-dish technique[4]; the inner dish contained a medium favouring vegetative growth (Czapek–Dox agar with 2 per cent glucose) and the outer dish a medium favouring reproduction (plain agar). Inoculation of the inner dish with wild-type *P. confluens* and exposure either to daylight or to a lamp emitting light between 360 and 580 mμ gave rise to a faintly orange mycelium, and to orange apothecia in the outer dish.

Exposure of the *P. confluens* to a lamp emitting ultra-violet radiation between 300 and 400 mμ produced a white mycelium and white apothecia. When grown in darkness, the mycelium was again not coloured; but in this case no apothecia were formed.

The pigments, both from coloured apothecia produced as described, and from surface mycelial mats, without apothecia, grown in the light in Roux bottles containing a liquid Dox medium with 5 per cent glucose, were extracted with cold acetone. The pigments were transferred into light petroleum by addition of water. After saponification with methanolic potassium hydroxide and partition with water and petrol two groups of pigments were found. One was present in the petrol and the other remained in the alkaline hypophase.

Chromatographic analysis of the epiphasic portion showed that it contained five pigments of which four have been identified. They are β-carotene, γ-carotene, torulene and a *cis*-isomer of the latter, probably neo-torulene[5]. This component was slightly less adsorbed than torulene; its absorption spectrum (maxima 451, 477 and 509 mμ in light petroleum) yielded on iodine catalysis a curve indistinguishable from that given by torulene under similar conditions (455, 480 and 511 mμ). The fifth component, which has a similar absorption spectrum (maxima 456, 484 and 516 mμ in light petroleum) to that of torulene, could not be separated, on chromatograms of either calcium carbonate or cellulose powder, from a celaxanthin-like fraction[6] we have isolated from berries of *Celastrus rosthornianus*.

The hypophasic pigments were extracted with petrol after acidification of the methanolic alkali. The absorption spectrum of the total fraction corresponded with values given for torularhodin, an acidic carotenoid fraction found in various Rhodotorulae[7]. We were able to separate this fraction into two major bands using an adsorption chromatogram of cellulose powder. The two fractions had similar absorption spectra, the maxima (in light petroleum) being: lower band, 496 and 526 mμ, inflexion at 460 mμ; upper band, 497 and 530 mμ, inflexion at 460 mμ.

Fractions similar to both these acidic compounds have been found in cultures of *Rhodotorula rubra* (J. F., unpublished observations).

Bean and Brooks[8] reported an albino *Pyronema* capable of normal reproduction. We have produced an albino mutant by exposing ascospore suspensions to an ultra-violet lamp emitting mainly at 254 mμ. The albino mutant required light to produce apothecia; but on examination of the acetone extracts no colourless polyenes were found. We were also unable to detect colourless polyenes in unilluminated cultures of either wild-type or albino *P. confluens*.

We conclude that in *Pyronema confluens* we have two distinct and unrelated photochemical effects. One leads to the synthesis of carotenoids and the other to the formation of apothecia. As a result of these observations we suggest that Robinson's hypothesis is invalid.

We wish to thank Drs. E. C. Bate-Smith, N. F. Robertson and T. Swain for their interest in this work. For one of us (J. F.) the work described in this paper forms part of the programme of the Food Investigation Organization of the Department of Scientific and Industrial Research.

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Isolation of Plant Starches

In the course of studies on the apple fruit, the need arose for a quantity of apple starch. None of the published methods of preparation we tried was entirely satisfactory, and a simple, rapid method was evolved which seems to have a general application. Starches have been prepared from a number of materials, which are listed in Table 1, together with the nitrogen content of the starches.

Table 1

Source	Nitrogen (per cent dry wt.)	Source	Nitrogen (per cent dry wt.)
Green apple	<0·01	Chestnut	0·02
Green tomato	<0·01	Butternut root bark	<0·01
Carrot	0·03	Sumac bark	0·06
Potato	0·03	Marigold leaves	0·06
Wheat (mature)	0·05	Tobacco leaves	0·02
Maize (mature, soaked)	0·06		

The tissue was ground in a Waring blendor with sufficient cold 1 per cent solution of ammonium oxalate to produce a thin mixture, which was then filtered through muslin. This process was repeated on the residue. Occasionally a third extraction was required in order to remove the starch completely. The suspension was centrifuged in conical tubes at 200–300 *g*. Starch became packed in a tight layer at the bottom, and impurities were readily removed from its surface by gentle washing. The starch was suspended in water, centrifuged out at about 1,500 *g* and the surface washed. This was repeated: a total of four or five times was sufficient for the materials listed in the table. The presence of impurities on the surface of the starch layer was easily seen. Occasionally a small amount of impurity settled below the starch. This was removed by suspending the whole in a small amount of water and centrifuging three or four times for a few seconds, the suspension being poured each time into a clean tube. The purified starch was washed finally with alcohol and ether.

In polarized light all starches except those from leaves showed a characteristic maltese cross. The granules of the leaf starches were flat and showed rotation of polarized light only when viewed on edge. Examination of stained preparations of all samples indicated a high degree of purity and the granules were undamaged mechanically.

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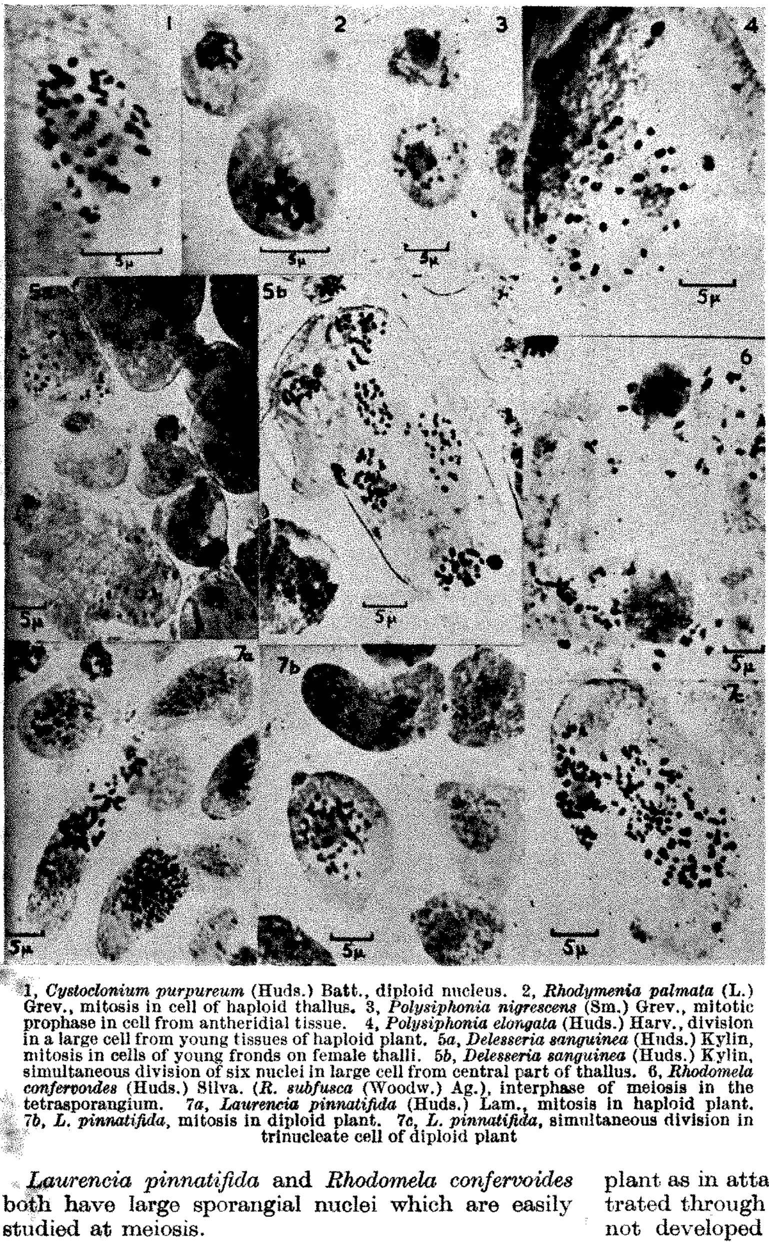
Chromosome Counts in the Rhodophyceae

Nuclei of the Rhodophyceae are often difficult to observe either on account of their small size, the presence of excessive mucilage or the cartilaginous nature of the tissues in which they occur. Using squash techniques and staining with ferric ammonium sulphate and aceto-carmine[1], or with aceto-carmine alone, both mitotic and meiotic divisions have been observed in a number of red algae.

January and February were found to be good months for obtaining rapidly growing tissues, antheridial material being especially suitable. Fixation was in acetic–alcohol (1 : 3) or Carnoy's fluid.

Chromosome counts of the following species, arranged according to the Preliminary Check List of British Marine Algae[2], have been made.

	n	$2n$	Previous counts (ref. 3)
Cystoclonium purpureum (Huds.) Batt.	—	50	—
Rhodymenia palmata (L.) Grev.	21	—	—
Ceramium rubrum (Huds.) Ag.	34	—	—
Cryptopleura ramosa (Huds.) Silva.	30	—	—
Membranoptera alata (Huds.) Stackh.	32	—	—
Delesseria sanguinea (Huds.) Kylin (ref. 4)	31	—	$2n = 40$
Laurencia hybrida (DC.) Lenorm ex Duby.	31	—	$2n = 40$
Laurencia pinnatifida (Huds.) Lam.	29	58	$2n = 40$
Polysiphonia elongata (Huds.) Harv.	37	—	—
Polysiphonia lanosa (L.) Tandy.	27	—	—
Polysiphonia nigrescens (Sm.) Grev.	30	60	—
Rhodomela confervoides (Huds.) Silva.	32	—	$2n = 40$



1, *Cystoclonium purpureum* (Huds.) Batt., diploid nucleus. 2, *Rhodymenia palmata* (L.) Grev., mitosis in cell of haploid thallus. 3, *Polysiphonia nigrescens* (Sm.) Grev., mitotic prophase in cell from antheridial tissue. 4, *Polysiphonia elongata* (Huds.) Harv., division in a large cell from young tissues of haploid plant. 5*a*, *Delesseria sanguinea* (Huds.) Kylin, mitosis in cells of young fronds on female thalli. 5*b*, *Delesseria sanguinea* (Huds.) Kylin, simultaneous division of six nuclei in large cell from central part of thallus. 6, *Rhodomela confervoides* (Huds.) Silva. (*R. subfusca* (Woodw.) Ag.), interphase of meiosis in the tetrasporangium. 7*a*, *Laurencia pinnatifida* (Huds.) Lam., mitosis in haploid plant. 7*b*, *L. pinnatifida*, mitosis in diploid plant. 7*c*, *L. pinnatifida*, simultaneous division in trinucleate cell of diploid plant

Laurencia pinnatifida and *Rhodomela confervoides* both have large sporangial nuclei which are easily studied at meiosis.

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Apical Cell of Salt Marsh Fucoids

In 1950, S. Baker described the universal occurrence of a three-sided apical cell in a number of salt marsh fucoids[1]. Since no further publication on the anatomy of these plants has appeared, the following observations may be of interest.

On several occasions *Fucus vesiculosus* L. var. *muscoides* Cotton was collected from Clachan Sound, Argyllshire, where the plants form a tufted carpet stretching high up the shore together with *Armeria maritima*. An examination of these plants showed a series in development from those with a cylindrical thallus only 1 cm. in length which branched profusely in a very irregular manner to those 5 cm. or more in length, with branching confined to one plane and with a flattened thallus showing some differentiation into midribs and wings. Sections through the apices of these plants showed a parallel series in development. The smallest plants had a very shallow apical groove at the base of which no distinct apical cell could be discerned. Slightly larger forms had the apical groove lined with hairs but still no differentiation of a distinct apical cell. The smallest of the forms which showed a tendency to flattening of the thallus had a distinct three-sided apical cell such as Baker describes[1]. Sometimes this was accompanied by apical hairs still lining the apical groove. Small attached plants nearby had a four-sided apical cell, as is characteristic of the adult fucoid thallus. In fact, the apices of these plants of *F. vesiculosus ecad muscoides* demonstrated the successive stages through which the apex of the attached form of *F. vesiculosus* passes during its development from the sporeling to the adult thallus[2].

The retention of the juvenile form of the apex is accompanied by little secondary activity of the various tissues. Very rarely was any evidence of secondary cortex seen, and few, if any, secondary hyphæ were found. Where the latter did occur, they often arose in tufts from a single cell of the innermost cortex and ramified in all directions through the thallus and not mainly towards the base of the plant as in attached forms. Occasionally hyphæ penetrated through the base of the plant, but these were not developed in sufficient numbers to interweave and form an attaching disk.

Baker and Bohling[3] ascribed the origin of salt marsh fucoids to the production of adventitious branches from cast-up thalli, the branches separating with the decay of the parent plant. The anatomical structure of these plants of *F. vesiculosus* var. *muscoides* suggests the possibility that they originated from fertilized eggs which were cast high up the shore by spray and exceptional tides, into a zone unfavourable for normal growth and development. Under these conditions they survive and grow slowly, retaining the juvenile form and structure of the species and never reaching maturity and the formation of reproductive cells.

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The Indo-Pacific Loggerhead Turtle in Tasmanian Waters

THERE appears to be only one published record of a chelonian in Tasmania[1], that of a leathery turtle, *Dermochelys coriacea* (Linné, 1766), which came ashore at Fortescue Bay in March 1889 (specimen in Tasmanian Museum, Hobart). From unpublished information supplied by Mr. John Fazackerly, it seems probable a large turtle observed by him to emerge from the sea at this locality in or about 1945 was a second example of this species.

We are now able to present reports of the appearance, within the past five years, of no fewer than eleven other turtles on the coasts of Tasmania—three entries being based on available specimens or parts thereof, the remainder on hearsay only. Material examined comprises: (1) skull of the first animal to come under our notice, a fairly fresh example found stranded by one of us (B. C. M.) about half a mile north of Mount Cameron West on November 24, 1951; (2) skull and greater part of the carapace from near the mouth of the Arthur River (Mr. Bailey, per Mr. M. Olsen, probably November 1951); (3) complete young animal from Adventure Bay, Bruny Island (Tasmanian Museum, Hobart, August 24, 1955). These have been determined as the Indo-Pacific red-brown loggerhead, *Caretta caretta gigas* Deraniyagala, 1933. Reports, unsupported by material, but thought probably to be this species (or this species and the green turtle ?) comprise: (4–7) four individuals stranded at Studland Bay (Mr. G. Wainwright, about September 1951); (8) one swimming near Stanley (Mr. M. Hardy, 1951); (9) one stranded at Port Davey (Mr. C. Clayton, February or March, 1940); (10) one stranded near the mouth of the Arthur River (Mr. Bailey, date unknown); (11) one stranded at Currie, King Island (Mr. R. Clarke, 1951).

A paper dealing directly with the records enumerated above will appear in Vol. 90 of the *Papers and Proceedings of the Royal Society of Tasmania*; and it is hoped a further study of some of the problems raised by an examination of the material will later be published elsewhere.

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Hobart.

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Extraneous X-Ray Diffraction Patterns from Algal Flagella

WE should like to sound a warning that might save other workers in this new and difficult field from some of the troubles that have beset our own investigations. Our aim has been to obtain X-ray diffraction diagrams of oriented preparations of the flagella of algae, sperm, etc., of a standard comparable with those already obtained with bacterial flagella[1], and it was in fact believed that an encouraging advance towards this end had been achieved a few years ago[2]. Now, however, it has become apparent that it is much easier to discover diagrams of metabolic by-products and various other artefacts than of the flagella substance proper.

For example, flagella prepared from *Polytoma* grown in yeast/acetate/'Bacto-tryptone'/distilled water give a clean though non-specific protein diagram (diffuse, disoriented 'side-chain' and 'backbone' reflexions); but if tap water is used instead—and Leeds water is quite soft—then the protein diagram is lost in a strong pattern of an apatite type, to judge by its resemblance to patterns given by bone and dentine. The effect was finally tracked down to the intervention not of tap water alone but of tap water plus 'Bacto-tryptone'; but it was found that the pattern was given also by the lighter, more flocculent fraction of the precipitate formed when a distilled-water solution of 'Bacto-tryptone' was treated with $0{\cdot}1\ M$ ammonia. In the electron microscope this precipitate seemed amorphous, but electron micrographs of the flagella which gave the apatite-type X-ray pattern showed them to be crusted over with hexagonal-looking platelets—built up more slowly, of course, and under the conditions generated by the growing flagella. These conditions are known to bring the *p*H up to about 9, but evidently some contribution from the tap water is involved too.

Probably these results mean nothing more than that growing organisms produce things other than themselves, and that one must therefore watch with especial care in pioneer X-ray studies of this kind; but they could conceivably be pointing to something much more significant, for the artefact here is a by-product of organisms growing on constituents which include 'Bacto-tryptone', a pancreatic digest of casein; and it may be that the 'bone-like' nature of the pattern really is an expression of a remote relationship with large-scale biological apatite formation in multicellular creatures.

In any event, a more immediately important consequence has been the realization that it must have been 'Bacto-tryptone', too, that was ultimately responsible for the X-ray pattern we thought[2] came from the actual flagella of *Polytoma*, etc. It is clear now that this pattern was not authentic, but was of a metabolic by-product trapped in, or adhering to, the flagellar structure. Because of the difficulty of reproducing exactly the conditions and materials of the earlier experiments it is not certain exactly how, but the fact remains that a roughly similar pattern is given by fresh 'Bacto-tryptone', and a very similar pattern by what is left when the supernatant from an algal culture has been evaporated to dryness.

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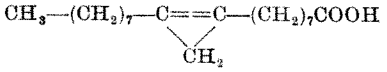
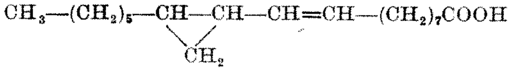
Sterculic Acid and its Halphen Reaction

THE structure of sterculic acid has recently been confirmed in this laboratory[1] as (I), proposed by Nunn[2], rather than as (II), suggested by Verma, Nath and Aggarwal[3].



$$CH_3—(CH_2)_7—C{=}C—(CH_2)_7COOH \quad \text{(I)}$$



$$CH_3—(CH_2)_5—CH—CH—CH{=}CH—(CH_2)_7COOH \quad \text{(II)}$$

This investigation revealed a band at $5{\cdot}35\mu$ in the spectrum of fresh sterculic acid, which is believed to be characteristic of a *cyclo*propene group. A strong band was also present at 9·92μ, as reported by other workers[3,4]. The latter band has been assigned by Verma *et al.*[3] to the *cyclo*propane group conjugated with a C=C double bond as in (II), by analogy with the absorption reported for this group at 9·9μ by Van Volkenburgh *et al.*[5] from the spectrum of vinyl*cyclo*propane vapour. A more accurate value for this band would seem to be that of Slabey[6] at 9·77μ, since it was obtained from a considerably better resolved spectrum of the same substance taken in solution.

Five other similarly conjugated *cyclo*propyl alkenes also have bands at 9·77–9·79μ, while the corresponding alkanes absorb at 9·82 or 9·83μ[7]. These values are all in close agreement with that found for dihydrosterculic acid at 9·80μ. However, the shift in wavelength of the *cyclo*propane group resulting from conjugation does not support structure (II) for sterculic acid; this shift, which was noted in one instance by Dijkstra and Duin[4], seems to be generally smaller than, and in the opposite direction to, that found in the transition from dihydrosterculic to sterculic acid.

Verma *et al.*[3] have stated that the Halphen reaction which is given by many seed oils is possibly due to some component of the non-saponifiable matter present in the oil. However, the reaction is given by fresh sterculic acid as well as by *Sterculia foetida* oil. Recently, too, the positive test obtained with cotton-seed oil has been attributed by Gunstone[8] to the presence of very small amounts of an acid with a *cyclo*propene ring; and Shenstone and Vickery[9] have found on testing the oils of two *Malva* sp. that the Halphen reaction is given invariably by the saponifiable fraction, and is due to an unsaturated acid present to about 3 per cent of the total mixed fatty acids. This acid, like sterculic acid, shows a prominent band at 9·92μ. It seems probable that the positive test found with so many other seed oils is also due to acids similar to these, present perhaps in small amounts only, for the test is very sensitive.

The addition of sulphur and amyl alcohol does not appear to be essential for the Halphen test. A solution of sterculic acid in distilled carbon disulphide, which was left for several weeks at room temperature, was already slightly orange on the day after its preparation, and quite a bright orange-red after four weeks. The reaction taking place was definitely associated with the presence of the *cyclo*propene ring in the sterculic acid: no colour was given by the polymerized acid, in which this ring had been destroyed[1], and the bands at 5·35μ and 9·92μ disappeared progressively from the spectrum of the sterculic acid as the colour of the solution intensified. Simultaneously a new band seemed to appear gradually (it was somewhat obscured by the heavy carbon disulphide absorption starting here) near 6·15μ; this is in the C=C double bond region of the spectrum, and suggests that, as with the polymerization[1], the reaction involved an opening of the ring across the single bonds. Numerous other spectral changes were also observed, the most remarkable being the rapid appearance of a strong band at 4·88μ, which increased in intensity for several days but later decreased again. This spectral region is normally very empty, and no mention was found in the literature of a likely group absorbing here, even though the band was very strong and sharp. The absorption has been tentatively assigned to the double bond in the grouping $-\mathrm{S}-\overset{|}{\mathrm{C}}=\mathrm{S}$, which is first formed by reaction between the carbon disulphide and the *cyclo*propene ring, and afterwards polymerizes across the C=S double bond. Another unknown broad band appeared progressively at 12·95μ: this is probably an antisymmetric C—S stretching absorption, which would predominate over the symmetric vibration in the polymer because of the unusual alternation of several carbon and sulphur atoms.

The exact mechanism of this reaction has not yet been established; but further investigation is proceeding.

I wish to thank Dr. J. C. Smith for providing the various samples of acids for infra-red analysis and the Scientific and Research Department, ISCOR, Pretoria, for the use of its infra-red spectrophotometer. This communication is published by permission of the South African Council for Scientific and Industrial Research.

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Constitution of Chaksine

In the course of investigations on the constitution of the quaternary base chaksine, $C_{11}H_{21}O_3N_3OH$, isolated from *Cassia absus*, Linn.[1], pyrolytic degradation of its iodide has been studied. On pyrolysis with silver or copper filings, at 310–320° C., in a nitrogen atmosphere it gave ammonia, carbon dioxide and an oily product of deep red colour and soluble in ether, with a strong caraway-like smell, in about 10 per cent yield. This product on boiling with 20 per cent methanolic potassium hydroxide for 12 hr. yielded an acid soluble in petrol-ether (60°–80° C.) (melting point, 116° C. dec.) and an oily phenolic fraction soluble in petrol-ether. On using electrolytic copper in place of silver or copper filings in this degradation, the resulting ether-soluble oily product gave on hydrolysis, under the conditions described above, no acid soluble in petroleum ether but a much larger yield of the acid melting at 195° C. (dec.), which was identified as phthalic acid, finally through its anhydride. Accounting as it does for 8 out of 11 or possibly 12 carbon atoms of chaksine[1], this finding marks a significant stage in the elucidation of its constitution.

Full details of this work and other findings relating to investigations on the constitution of chaksine are being communicated elsewhere.

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Absorption Spectra of Free PH_2 and PD Radicals

ALTHOUGH a large number of diatomic free radical spectra are known[1], very few spectra of polyatomic free radicals have been positively identified. The spectra are of interest since they are a potential source of information concerning the electronic states of these radicals and their dissociation energies, the vibrational and rotational constants of these states and their bond-lengths and bond-angles. The only polyatomic free-radical spectrum for which a vibrational and rotational analysis has been carried out is that of HCO [2] (and DCO), although partial analyses have been given for NH_2 [3,4], CF_2 [5,6], C_3 [7,8], SiC_2 [9], HS_2 [10], and a number of larger radicals, for example, CH_3O [11].

One powerful method for obtaining the spectra of free radicals in absorption utilizes the method of flash photolysis for the production of the free radicals, the White system of mirrors for obtaining long absorption paths, and a spectrograph of high resolving power for detecting fine absorption lines[2]. To obtain the best spectra, the maximum possible energy should be discharged through the photolysis flash tube in a time comparable to the life-time of the radical. In the 'microsecond' flash photolysis apparatus at Ottawa, ~ 1,000 joules of energy (40 μF., 7,000 V.) are discharged through the photolysis flash tube in 10–20 microseconds. The absorption spectrum is recorded by a second flash tube through which ~ 100 joules of energy (2 μF., 10,000 V.) are discharged, causing a continuum to be emitted for 3–5 microseconds.

The spectrum of PH_2 was observed during the flash photolysis of phosphine at ~ 5 mm. pressure. The half-life of the radicals under these conditions was ~ 50 microseconds. The length of the absorption path was 6 m. and the spectra were photographed in the second order of a 21-ft. grating spectrograph. Eleven bands were observed in the region 3600 to 5500 A. With fully deuterated phosphine (PD_3) prepared by the action of D_2O on PI_3, thirteen bands of PD_2 were observed in the same spectral region. Reproductions of the strongest PH_2 and PD_2 bands are given in Fig. 1.

The spectra are very complex, and as yet no rotational analysis has been carried out. The most characteristic feature is the clustering of groups of strong lines, probably Q branches, at regular intervals along the spectrum. The long wave-length edge of these strong groups has been used for the purposes of vibrational analysis; the vacuum wave numbers are given in Table 1. It is seen that the bands form regular progressions, the vibrational spacing varying from 887 to 976 cm.$^{-1}$ for PH_2 and from 626 to 690 cm.$^{-1}$ for PD_2.

Table 1. VACUUM WAVE NUMBERS AND ASSIGNMENTS OF PH_2 AND PD_2 BANDS

v_2'	PH_2		PD_2	
	ν_{vac}	ΔG	ν_{vac}	ΔG
0	18,271·8	951·3	18,271·6	690·3
1	19,223·1	937·6	18,961·9	684·5
2	20,160·7	928·7	19,646·4	676·2
3	21,089·4	915·5	20,322·6	673·2
4	22,004·9	901·6	20,995·8	665·9
5	22,906·5	888·9	21,661·7	657·2
6	23,795·4	887·4	22,318·9	647·5
7	24,682·8	905·1	22,966·4	636·6
8	25,587·9	938·6	23,603·0	627·3
9	26,526·5	976·4	24,230·3	626·5
10	27,502·9		24,856·8	634·0
11			25,490·8	655·4
12			26,146·2	

Units: cm.$^{-1}$

The assignment of these new bands to PH_2 and PD_2 is based on (1) the method of production of the bands by the photo-dissociation of PH_3 and PD_3, (2) the isotope shift when hydrogen is replaced by deuterium, (3) the rotational fine structure, which is too complex for diatomic PH, (4) the observed vibrational intervals, which are rather low to be assigned to PH stretching frequencies but which may be reasonably assigned to PH_2 and PD_2 deformation frequencies, and (5) the similarity of the spectrum to that known for NH_2.

The spectra may be interpreted as long progressions of the bending frequencies of PH_2 and PD_2 in the upper electronic state of the bands. Provisional assignments of the quantum number v_2' for the bending vibration are given in Table 1. It is interesting to note that for low vibrational quantum numbers, the vibrational intervals decrease with increasing v_2', while for higher vibrational quantum numbers ($v_2' > 7$ for PH_2 and $v_2' > 9$ for PD_2), the vibrational intervals increase with increasing v_2'. The energy at which this transition occurs is the same for PH_2 as for PD_2, indicating that the transition is a function of the potential energy curve of the upper electronic state. With large values of v_2', the amplitude of the bending vibration will be considerable, and at sufficiently high quantum numbers a stage will be reached when the hydrogen or deuterium atoms come into close contact during part of the vibration. This will cause appreciable repulsive forces to operate and will

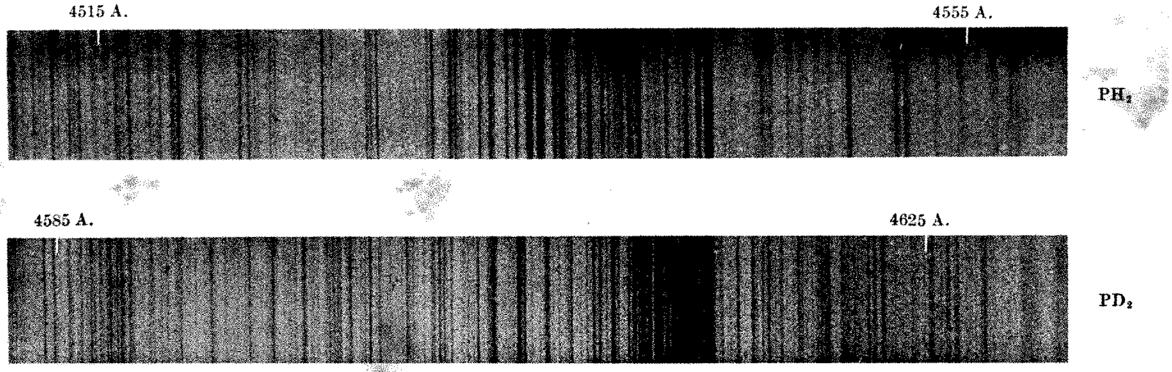

Fig. 1. Strongest absorption bands of PH_2 and PD_2 photographed in the second order of a 21-ft. grating spectrograph. The bands were observed during the flash photolysis of PH_3 and PD_3 at ~ 5 mm. mercury pressure. The length of the absorption path was 6 m.

result in an increase in the vibrational frequency. It is suggested that such repulsive forces are responsible for the observed increase in the vibrational frequencies of PH_2 and PD_2 at high vibrational quantum numbers.

I wish to thank Dr. G. Herzberg for helpful discussions.

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Paper Chromatography of Pyrethrins and their Derivatives

Various methods have been described for the chromatographic separation of pyrethrin-type compounds. Alumina, silica and kieselguhr have been used as adsorbents for separation of 'pyrethrin I' from 'pyrethrin II' [1–3]. A separation of cinerin I from 'pyrethrin I', and 'cinerin II' from 'pyrethrin II', has almost certainly been achieved by Ward[2], using displacement chromatography on alumina. The 'pyrethrins' have also been separated by paper chromatography using alumina-impregnated paper[1] and 'Vaseline'-impregnated paper[4]. Hitherto, untreated paper has only been used with success for the separation of the 'pyrethrin' 2,4-dinitrophenylhydrazones, using light petroleum (b.p. 80°–100° C.) as solvent[1]. The present communication records a simple chromatographic system for separating pyrethrin-type compounds on untreated paper.

The main problems associated with partition chromatography of the 'pyrethrins' arise from their partition coefficients being very much in favour of the less polar phase of the commoner liquid–liquid systems. The applicability of methods which have been used in the steroid field[5,6], where similar problems are encountered, has now been investigated. It is found that an ascending solvent system of light petroleum (b.p. 80°–100° C.) saturated with methanol gives good results with 'pyrethrins' on Whatman No. 1 paper; a similar system has previously been used for œstrogen separations[7]. It is essential to equilibrate the papers overnight in an atmosphere of the two solvent phases.

The time necessary for pre-equilibration of the papers can be shortened to one hour by operating under reduced pressure, as suggested by Winteringham *et al.*[8]. Their apparatus has been modified (Fig. 1) so as to handle volatile two-phase systems, and also to permit the starting of the chromatogram, after a desired equilibration period, without breaking the vacuum. Two paper strips are hung on the horizontal portion of the tube *B* and kept apart by clipping the lower ends around a piece of glass rod. The ends should come to within ½ cm. of the solvent at *D*. The apparatus is evacuated through *A* to an extent governed by the boiling points of the solvent phases in *C* and *D*. After a suitable equilibration period, the chromatogram is started by running in sufficient of the appropriate solvent phase from a funnel fitted into the ground-glass joint on *A*. The liquid is discharged down the side of the vessel from the tube *B*, which is tapered to a jet. The starting line on which the samples are applied is drawn 6 cm. up the paper on account of the initial speed of solvent migration. The R_F values for a number of the compounds run at room temperature and atmospheric pressure were:

'Pyrethrin I'	0·85
'Pyrethrin II'	0·70
± *trans*-Chrysanthemic acid	0·54
± *cis*-Chrysanthemic acid	0·56
Chrysanthemum dicarboxylic acid	0–0·04
Methyl pyrethrate	0·73
α-DL-*trans*-Allethrin	0·82
Allethrolone	0·09

Considerable quantities of material remained on, or near, the origin with old samples of 'pyrethrins', due undoubtedly to the presence of polymerized products. Under reduced pressure, R_F values were higher than those obtained at atmospheric pressure; for example, 'pyrethrin I', 0·94; 'pyrethrin II', 0·87.

The compounds were detected by two methods:

(*a*) A method due to Winteringham *et al.*[9], which consists of dipping the papers in 0·1 per cent aqueous potassium permanganate, washing free of permanganate with water and partially drying. The papers are then treated with 0·5 per cent benzidine in acetone containing 5 per cent glacial acetic acid. The manganese dioxide formed in the presence of unsaturated compounds shows as intense blue zones. This method gives excellent results, although more permanent and intense colour resulted from using 0·5 per cent benzidine hydrochloride in aqueous solution.

(*b*) Use of the light petroleum–methanol system (both solvents being free from aromatics) allows the

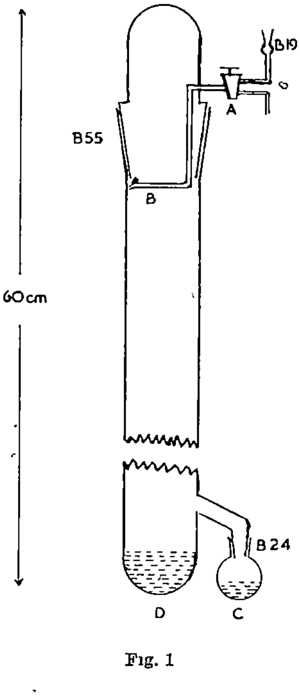

Fig. 1

technique of ultra-violet photography, which is widely used for derivatives of purine bases, to be applied. The pyrethrin-type compounds absorb strongly in the region of 230 mμ, due mainly to the *cyclo*-pentenolone grouping, and can be detected by exposure of the chromatogram, placed in contact with reflex document paper, to a Hanovia 'Chromatolite' ultra-violet lamp. The resulting photographs show the 'pyrethrins' as pale spots on a darker background. This technique, which cannot be applied to 'Vaseline'-impregnated paper, has the advantage that the separated compounds can afterwards be eluted unchanged from the paper. This method, however, is not so sensitive as method (a), a minimum of about 50 μgm. being needed; also, it does not detect chrysanthemic or pyrethric acids.

This work forms part of a research programme supported by the Pyrethrum Board and Department of Agriculture, Kenya, associated bodies in Tanganyika, and the Colonial Office, to which acknowledgment is made. I wish to thank Dr. L. Crombie, of the Imperial College, London, and Dr. M. Elliott, of Rothamsted Experimental Station, Harpenden, for gifts of samples, and also various colleagues in this Laboratory for their advice.

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Occurrence of Nitropyrogallol Disulphate in Preparations of Nitrocatechol Sulphate

DURING an investigation of ox-liver sulphatase A [1,2] it became apparent that the substrate, nitrocatechol sulphate, was impure. As this was prepared by persulphate oxidation of p-nitrophenol[3,4] it seemed that a likely contaminant might be nitropyrogallol disulphate, formed by the oxidation of the phenol in both *ortho* positions.

When samples of nitrocatechol sulphate were submitted to paper electrophoresis at pH 4·2 the presence of two components was obvious, the yellow nitro compounds being readily seen after drying at 110°. In 4 hr. at a potential difference of 250 volts the major and minor components moved 4 cm. and 9 cm. respectively towards the cathode. The two bands were eluted with water and the phenols liberated from the sulphate esters by heating for 1 hr. at 100° in N hydrochloric acid. The phenol from the major component had an absorption spectrum in alkali identical with that of 4-nitrocatechol[5]. That of the minor component had a single sharp maximum and 430 mμ and was identical with the absorption spectrum of authentic 5-nitropyrogallol, kindly provided by Dr. T. S. Gardner. Partition chromatography on paper[6] confirmed the identity of the two phenols with 4-nitrocatechol and 5-nitropyrogallol. The major component of the substrate was therefore nitrocatechol sulphate.

The sulphate contents of samples of the acid hydrolysate of the minor component were determined by Dr. J. W. Minnis. The samples contained 318 μgm. nitropyrogallol and yielded 1,017 μgm. barium sulphate. These results were consistent with the view that the minor component of the substrate was nitropyrogallol disulphate.

Colorimetric determinations of the two components following electrophoretic separation showed that of three routine preparations of nitrocatechol sulphate two contained approximately 10 per cent, and one about 0·1 per cent of nitropyrogallol disulphate. A preparation by Dr. Brian Spencer contained approximately 2 per cent of the disulphate. The effect of nitropyrogallol disulphate on the kinetics of nitrocatechol sulphate hydrolysis by sulphatase A is under investigation; but electrophoretically purified samples of nitrocatechol sulphate exhibit the same anomalous kinetics as do unpurified preparations.

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Modification of Glass Surfaces by p-Nitrobenzyl Bromide

IN the course of a study on the nature of the surface hydroxyl group of silicate glasses, it has been found that glass surfaces become permanently hydrophobic after being treated for 1 hr. with a dry, 30 per cent toluene solution of p-nitrobenzyl bromide at a temperature of 100° C. The effect was found with vitreous silica, borosilicate glasses and glasses of other composition. The most pronounced results were obtained with glass surfaces which had been freshly cleaved under distilled water and vacuum-dried before treatment with the above solution. The treated surfaces remained hydrophobic after prolonged exposure to common organic solvents and water.

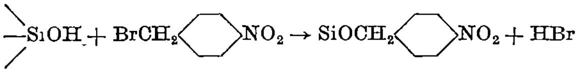
In order to obtain more information on the nature of the surface modification and especially in order to distinguish between chemical reaction and adsorption, comparative studies on glass surfaces treated with p-nitrobenzyl bromide and glass surfaces treated with aqueous solutions of the quaternary ammonium compound cetyl-pyridinium hydrochloride were made. The two types of surfaces were affected by prolonged exposure to distilled water in distinctly different ways. The progress of the reaction between the surface and the water was followed by periodic measurements of the contact angle. A special apparatus was designed to measure the contact angles while the glass was continuously exposed to a stream of freshly redistilled water. The reproducibility of the measured contact angles was within 2 deg.

The hydrophobicity of a glass surface treated with *p*-nitrobenzyl bromide decreases slightly during the initial period of exposure, reaching a terminal value after sixty hours. After the terminal value is reached, no further decrease of hydrophobicity is observed. The hydrophobicity of the glass treated with cetylpyridinium hydrochloride, however, which is initially higher than that of glass treated with *p*-nitrobenzyl bromide, decreases continuously upon exposure to the distilled water, and the wettability of the surface approaches that of untreated glass surfaces.

The stability of the reaction product suggests the presence of an organic surface derivative of the glass, rather than an ion-exchange or adsorption layer, as is known to be the case with glass surfaces treated with quaternary ammonium compounds. The slight initial decline of the hydrophobicity of the glass surfaces treated with *p*-nitrobenzyl bromide at the beginning of the extraction is most likely to be due to the removal of adsorbed, unreacted *p*-nitrobenzyl bromide or other organic matter. It is unlikely to be caused by deposited layers of decomposition products of the *p*-nitrobenzyl bromide, for thin layers of this kind would gradually disappear upon extraction and thick layers would give a constant high value of hydrophobicity without any initial decrease. Experiments are under way to test this assumption.

The fact that in a further series of experiments no degree of hydrophobicity could be obtained by treating glass surfaces with *p*-nitrotoluene supports the view that the reactivity of the *p*-nitrobenzyl bromide depends on its —CH_2Br group and not the nitro-group. Further, it is significant that glass surfaces which were prepared under conditions expected to yield the largest number of hydroxyl groups per unit surface area yielded the most hydrophobic products after being treated with *p*-nitrobenzyl bromide.

On the basis of the above experiments, it is proposed that the mechanism of the reaction is the formation of a derivative of the surface hydroxyl of the glass according to the following reaction:



One of us (H. C. D.) thanks the Owens-Illinois Glass Company for a graduate fellowship.

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Regions of the Ionosphere responsible for Radio Star Scintillations

THERE is at present conflicting evidence as to the region of the ionosphere which is responsible for the scintillation of radio stars. Thus workers in the northern hemisphere[1,2] observing sources at fairly high angles of elevation, and also Mills and Thomas[3] in the southern hemisphere observing the Cygnus source at an altitude of 15°, have found a marked correlation between the occurrence of scintillations and of spread *F* echoes. On the other hand, Bolton *et al.*[4] at the same southern location as Mills, but observing sources within 10° of the horizon, found an equally marked correlation with sporadic *E*, but not with spread *F*.

We report here an analysis of some recent observations of scintillations[5], which appears to offer a solution to this problem. We find a correlation of night-time scintillations with spread *F* only, and of day-time scintillations with sporadic *E* only.

In the observations referred to, the source Cygnus *A* was observed from Dapto, New South Wales (lat. 34° 28·5′ S., long. 150° 47·5′ E.). The observations were restricted to ± 1 hr. from transit, when the altitude of the source is 15°. As reported earlier, the prevalence and intensity of scintillations vary markedly from day to day, but show two well-defined maxima, one when transit occurs near midday (December, summer), and one when transit occurs near midnight (June, winter) (Fig. 1). We are unable to determine whether these variations are diurnal or seasonal: for brevity, we shall refer to them as if they were diurnal.

In view of the occurrence of two such distinct maxima in the fluctuation index, the correlation between scintillations and ionospheric phenomena has been studied for day and night periods separately.

Day-time scintillations. Rays from Cygnus penetrate the *F* region (400-km. level) approximately 650 km. south-east of Townsville and 400 km. north-west of Brisbane, where routine ionospheric recorders are located. At no time during our day observations were spread *F* echoes reported from either of these stations.

For the *E* layer, the point of penetration lies 500 km. south-south-west of Brisbane and 500 km. north-north-east of Canberra, the nearest ionospheric recording stations. Table 1, which compares the sporadic *E* observed at these stations with the occurrence of scintillations, shows that the two are closely associated. There is a marked tendency for high fluctuation indices to occur when the critical frequency of sporadic *E* echoes is high. When the data are tested by either the χ^2 or the 'exact' test[6], it is found that the probability of the observed values occurring by chance if the two phenomena are independent is less than 1 in 10^4.

Because of the patchy nature of sporadic *E*, we have included in Table 1 only those days for which values of *fEs* (or *fE2s*) were available from both

Table 1. CORRELATION OF DAY-TIME FLUCTUATION INDICES WITH SPORADIC *E* AT BOTH BRISBANE AND CANBERRA. THE FIGURES GIVE THE NUMBER OF OBSERVING DAYS FALLING WITHIN THE DIFFERENT CATEGORIES

Fluctuation index	*fEs* (and *fE2s*) ≯ 5 Mc./s. at either Brisbane or Canberra	*fEs* (or *fE2s*) > 5 Mc./s. at both Brisbane and Canberra
0	15	3
1, 2 or 3	5	18

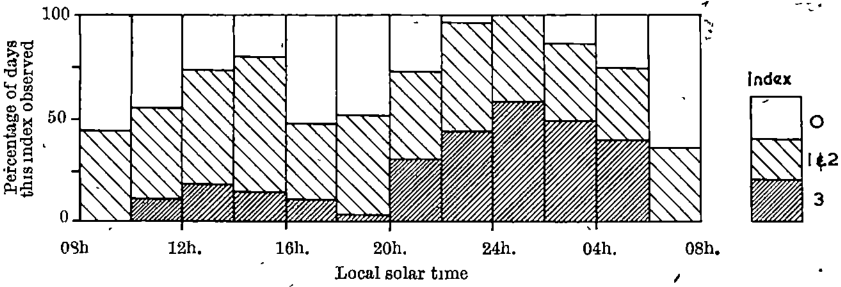

Fig. 1. Solar time variation of the fluctuation index. The index measures the prevalence and intensity of fluctuations on a scale increasing from 0 (no fluctuations) to 3 (very severe fluctuations). The observing days have been grouped according to the 2-hr. period in which transit occurred. Observations were made on 227 days during September 1952–February 1955

Brisbane and Canberra and for which either: (*a*) no value of *fEs* (or of *fE2s*) in excess of 5 Mc./s. was found at either of these stations during our observing period, or (*b*) a value of *fEs* (or *fE2s*) greater than 5 Mc./s. was recorded at both stations during our observations. The value 5 Mc./s. was chosen to divide the data into approximately equal parts: similar considerations decided the grouping of fluctuation indices used in Table 1.

Night-time scintillations. For night-time scintillations the correlation with spread *F* at Townsville is given in Table 2. In this case there is clearly a close association between the occurrence of high fluctuation indices and the appearance of spread *F*. According to either of the statistical tests mentioned, the probability of the figures occurring by chance alone is less than 1 in 10^6. There is a similar, but rather weaker, correlation with spread *F* at Brisbane.

Table 2. Correlation of Night-time Scintillations with the Occurrence of Spread *F* at Townsville

Fluctuation index	No spread *F*	Spread *F*
0 or 1	32	8
2 or 3	11	32

The results for sporadic *E* are given in Table 3, which shows no evidence of any correlation with night-time scintillations. Here 3 Mc./s. has been taken as the dividing value of *fEs*, again on the basis of separating the data into approximately equal parts. Other values were tried, and also other groupings of the fluctuation index, but none showed any evidence of a correlation between the two phenomena. The probability of figures such as those in Table 3 occurring by chance in uncorrelated data is about 0·6.

Table 3. Night-time Scintillations compared with Sporadic *E* at Brisbane and Canberra

Fluctuation index	*fEs* (and *fE2s*) $\ngtr$ 3 Mc./s. at either Brisbane or Canberra	*fEs* (or *fE2s*) > 3 Mc./s. at both Brisbane and Canberra
0 or 1	12	9
2 or 3	15	15

These results suggest that night-time scintillations arise in the *F*-layer and day-time scintillations in the *E*-layer. They are consistent with the observation that, at night-time only, there is a pronounced west-to-east component (some 80 m.sec.$^{-1}$) in the motion of the scintillation patterns across the ground[5]. Such a motion would be caused by the Earth's rotation if the irregularities were located at a height of about 500 km. and did not drift. It may also be noted that the current conception of sporadic *E* irregularities in terms of thin horizontal strata is in agreement with the fact that day-time scintillations have been reported only by workers observing at relatively low angles of incidence.

The ionospheric data for this analysis were taken from "Ionospheric Predictions, Series D", supplied by courtesy of the Ionospheric Prediction Service of the Australian Commonwealth Observatory.

The work described in this paper was carried out as part of the programme of the Division of Radiophysics of the Commonwealth Scientific and Industrial Research Organization, Australia.

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Ultrasonic Absorption in Liquids from Thermal Steady States

In a recent communication[1] in *Nature*, we confirmed a new method developed in this Laboratory for the determination of ultrasonic absorption (α) in liquids. Subsequent work[2] has shown that the quantities of energy absorbed in cells, of small lengths, placed in the path of the sound beam with their incident faces occupying identical places, are in the proportion of their lengths. Utilizing this idea, we have evolved yet another technique for the measurement of α in liquids.

In this new method, a fairly strong beam of ultrasonic waves is produced in a liquid contained in a tank, surrounded by a constant-temperature bath. A small cylindrical double-walled brass cell fitted with thin mica windows to let the ultrasonic beam in and out of the cell is filled with the same liquid as that contained in the tank. The cell is placed co-axially in the path of the ultrasonic beam and, due to continuous passage of the ultrasonic beam through the liquid, the latter heats up, reaching a constant temperature when the heating of the liquid is balanced by the conduction loss. The temperature-difference in the steady state between the liquid in the cell and that in the tank is measured accurately by means of a sensitive thermocouple arrangement. If I_0 is the intensity of the ultrasonic beam on entering the first mica window of the cell and θ_1 the steady deflexion in the galvanometer, then:

$$I_0\{1 - \exp(-2\alpha l)\} = K\theta_1$$

where α is the absorption coefficient of the liquid, l the length of the cell and K is a constant.

Similarly, if θ_2 is the steady deflexion when the cell is placed at a distance x from the first position, we have :

$$I_0 \exp(-2\alpha x) \{1 - \exp(-2\alpha l)\} = K\theta_2$$

The absorption coefficient can then be calculated from these relations ; thus

$$\alpha = \frac{\ln \theta_1 - \ln \theta_2}{2x}$$

Necessary precautions were taken for the proper alignment of the cell, so that its movement was along the axis of the sound beam. Reflexion of the ultrasonic waves from the remote end of the large tank was also avoided.

This technique has been used for determining the absorption coefficient of ultrasonic waves at 5 Mc./s. in benzene, carbon tetrachloride, amyl acetate and xylene, thus covering a wide range of absorption coefficients (Table 1). The values are in good agreement with those obtained by other methods[3]. It is seen from the results that the method is capable of a high degree of accuracy, as the values can be reproduced to within ± 5 per cent of the mean value.

Table 1

Liquid	Temp. (° C.)	$\alpha/\nu^2 \times 10^{17}$ at 5 Mc./s.	Average	$\alpha/\nu^2 \times 10^{17}$ by other methods (ref. 3)
1. Benzene	19	849 766 820	812	900 at 22° C
2. Carbon tetrachloride	18	422 414 416	417	500 at 20° C.
3. Amyl acetate	19	183 177 178	179	166 at 29° C.
4. Xylene	18	95 92 91 96	94	78 at 25° C.

A detailed paper will be published elsewhere.

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Unit-cell Dimensions and Space Group of 6-Mercaptopurine Monohydrate

Recent studies have directed attention to the possible chemotherapeutic activity of 6-mercaptopurine. The compound has been synthesized[1] and found to be a purine antagonist in *Lactobacillus casei*[2]. It acts as a moderate inhibitor on sarcoma 180 [3] and on some types of carcinoma[4]. A preliminary X-ray investigation of the substance was undertaken in view of its biochemical importance.

A sample of 6-mercaptopurine was given to us by Dr. Leonard Hamilton, of the Sloan-Kettering Institute for Cancer Research ; crystals were obtained from hot saturated aqueous solution upon slow cooling in a Dewar flask. Most of the crystals were yellow needles, elongated in the c-axis direction, with forms {0 0 1}, {1 1 0}, and sometimes {1 0 0} developed.

The crystals are monoclinic. Unit-cell dimensions were derived from rotation photographs and from zero-layer and first-layer Weissenberg photographs taken about the b- and c-axes with copper $K\alpha$ radiation. The crystallographic data obtained are listed below (together with their standard deviations).

a_0 = 15·29 ± 0·03 A. β = 102° 24′ ± 15′
b_0 = 7·76 ± 0·02 A. Density (by flotation) = 1·574 gm. cm.$^{-3}$
c_0 = 12·43 ± 0·04 A. Space group, $C_{2h}^{6} - C2/c$

Each unit cell contains eight molecules (calculated 8·07 for 6-mercaptopurine.1H_2O).

Because of the unfavourable dimensions of the unit cell, a complete determination of the structure of this crystal is not contemplated at present.

This investigation was aided by a grant from the National Foundation for Infantile Paralysis.

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Magnetic Properties of Ferrichrome and Ferroverdin

Some time ago, Neilands and his associates isolated from the smut fungus, *Ustilago sphaerogena*, two pigments which he called ferrichrome[1] and ferrichrome *A* [2] because of their red colour and iron content (7·35 and 5·3 per cent respectively). Both ferrichromes have probably one iron atom per molecule, and are soluble in phosphate buffer in a presumably monomeric form[3]. They are easily decolorized by hydrosulphite and the reduced forms are autoxidizable[1,2]. The ferrichromes are also bleached by treatment with great excess of strong ferric ion-binding reagents, such as thenoyltrifluoracetone and versene. The red colour is restored on addition of ferric ions, or of ferrous ions in the presence of oxygen (Neilands, J. B., personal communication). There is thus very strong evidence that the iron in the oxidized ferrichromes is trivalent. Magnetic measurements were undertaken in order to confirm this and to elucidate the structure of the complexes.

The paramagnetic susceptibilities of the compounds and their reduced derivatives were determined in 0·1 M phosphate buffer, pH 6·9, at 20° C. No diamagnetic corrections were made and Curie's law was assumed to be valid in the calculation of the effective magnetic moments. The results are given in Table 1.

The values for the oxidized ferrichromes are in the region expected for trivalent iron with five unpaired electrons. The decrease in susceptibility of about 3,500 × 10^{-6} c.g.s. e.m.u. upon reduction is typical of a change from fully paramagnetic trivalent iron to fully paramagnetic divalent iron. If the decrease had been due to the disappearance of a free

Table 1

Compounds	χ (iron) (c.g.s. e.m.u. × 10^{-6})	μ_{eff} (Bohr magnetons)
Ferrichrome	13,630	5·68
,, + sodium dithionite	10,270	4·93
Ferrichrome *A*	13,860	5·73
,, + sodium dithionite	10,270	4·93

radical in the organic molecule, it would have been expected to be only about 1,300 × 10^{-6}.

The susceptibility values indicate further that only weak covalent bonds are involved around the iron, since all the 3*d* orbitals are occupied by unpaired electrons.

When 1 *M* fluoride was added to ferrichrome at *p*H 6·9, no change in spectral absorption or magnetic susceptibility could be observed. This behaviour contrasts with that of methæmoglobin or metmyoglobin, in which a co-ordinated water molecule is believed to be replaced by fluoride. It cannot be concluded, however, that water molecules or hydroxyl ions are not co-ordinated to the iron of ferrichrome.

Ferrichrome reduced by dithionite at *p*H 9·5 in presence of 0·1 *M* potassium cyanide was found to be completely diamagnetic. According to Neilands, aeration of such a sample does not restore the colour[3], and this has been confirmed. Addition of ferric ions, however, brought back the colour. The sample also gave the usual reactions of ferrocyanide upon acidification. The most likely explanation is that all the ferrous iron takes part in the formation of diamagnetic ferrocyanide; if a cyanide compound of ferrous ferrichrome exists to any extent in equilibrium with the ferrocyanide, it must be diamagnetic, have strong covalent bonds and be non-autoxidizable, but still be easily converted into ferrocyanide, properties that seem to be somewhat contradictory.

Recently, Chain *et al.* isolated from a new type of streptomycete another pigment of quite a different character[3]. Because of its iron content (9·3 per cent) and green colour they named it ferroverdin. It is insoluble in water but soluble in many organic solvents. When the pigment is reduced catalytically by hydrogen, twelve equivalents are used up and the green colour disappears and does not come back upon aeration[3]. The iron might thus be either divalent or trivalent; but the present investigation makes it possible to decide this question and also to draw some conclusions about the structure of the complex.

The magnetic susceptibility of the iron of ferroverdin was found to be 125 (± 160) × 10^{-6} c.g.s. e.m.u. in methanol solution and 20 (± 80) × 10^{-6} in ethylene glycol solution without any diamagnetic corrections being made. The preparation used contained only 6·6 per cent iron, and therefore the correction would not exceed 700 × 10^{-6} even if the partial specific volume of ferroverdin were equal to zero. A ferric compound with one unpaired electron should give a paramagnetic susceptibility of at least 1,300 × 10^{-6}. It may thus be concluded that the iron of ferroverdin is divalent and diamagnetic, and that two of the 3*d* orbitals are involved in covalent bonding. The complex is probably octahedral with d^2sp^3 bonds, and in this case, since ferroverdin contains no sulphur and only two nitrogen atoms per iron atom[3], at least four of the six chelating groups have oxygen or carbon co-ordinated to the iron by covalent bonds.

Ferroverdin in glycol solution reacted with hydrosulphite upon gentle heating. The colour turned brownish and the susceptibility increased to 9,500 × 10^{-6}. This implies that the covalent bonds are weakened or released under these conditions.

I am indebted to Dr. J. B. Neilands for the ferrichrome samples, to Prof. E. B. Chain for a sample of ferroverdin, and to Prof. H. Theorell for his interest in the work.

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Internally Coated Cathodes

RECENT publications[1] have indicated that internally coated cathodes would be useful as sources of annular, high current-density electron beams in millimetre wave-length klystrons. For this application their behaviour in magnetic confining fields and their life are important. To study these factors, the cathode shown in Fig. 1 was used; in the first set of experiments, cathodes were made from 'O' nickel and coated with a standard triple-carbonate mixture. Cathode temperatures were measured with 0·005 in. diameter platinum–platinum 13 per cent rhodium thermocouples.

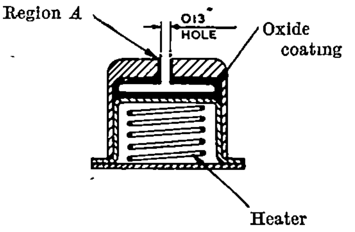

Fig 1. Geometry of an internally coated cathode

Fig. 2 shows current-voltage properties of the cathode, some of which have already been reported[2]. The current, which after a rapid initial rise increases linearly with voltage, is greater than the space-charge-limited current obtainable from a conventional cathode of the same area, and no evidence of saturation has been found up to fields of 50 kV./cm. Abnormally high cathode temperatures are required, however, to obtain high current-density beams. When immersion magnetic fields are applied, the form of the characteristic is unaltered, but the current obtainable at a given voltage and temperature decreases linearly with field; the maximum observed decrease was about 20 per cent at 3,800 gauss. Characteristics were studied over the ranges of current and temperature shown in Fig. 2 using d.c. voltages, and pulsed voltages of 1 m.sec. duration with duty cycles from 0·1 to 0·002; identical results were obtained.

At values of magnetic field and current used (less than 2,000 gauss, 10 m.amp., 6 kV.) the beam is annular, though cross-section studies[3] show that the peripheral distribution of current is not uniform. The

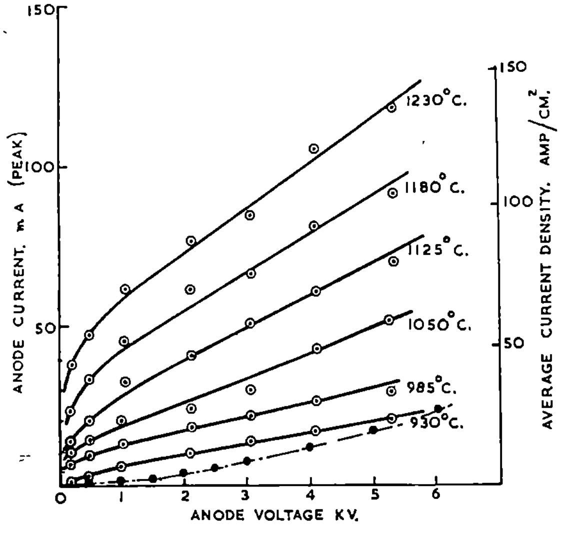

Fig. 2. Current-voltage characteristics of an internally coated cathode, with zero magnetic field: ———, experimental curves; — — ·, space-charge-limited current for an 'equivalent' diode

annular characteristic becomes less pronounced at higher values of magnetic field and current.

At 900° C., lives of 1,000 hr. were obtained at 5 amp./cm.² (assuming uniform emission over the aperture). At higher temperatures, lives were impractically short, for example, 10 hr. at 1,100° C., and were independent of the current-density drawn (5 amp./cm.² to 50 amp./cm.²). Examination of valves opened after testing showed that a layer of nickel had formed over the edges of the coating (region *A* in Fig. 1), at points where this lay slightly below the metal surface.

It has been suggested[1] that emission arises mainly from coating at the edges of the aperture. The present investigations support this in that (1) covering the coating near the aperture significantly reduces the emission, (2) the beam is annular at low currents, and (3) strong immersion fields cause only slight reductions in current. An explanation for the magnitude of the observed currents may also be given. Beam cross-section studies with small plane cathodes have shown that currents considerably greater than the space-charge-limited values may be obtained. With a 0·050-in. diameter cathode at 900° C. the current-density in an annulus 0·006 in. wide near the edge was about six times the space-charge-limited value. Thus edge effects can predominate in the internally coated cathode, because the width of the emitting area is generally small (0·002 in.); hence currents much in excess of the space-charge-limited values might be expected.

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Irreversibility and Mechanics

Prof. K. R. Popper has recently pointed out the error in the belief that " 'classical' mechanics . . . can describe physical processes only in so far as they are reversible in time"[1]. He cites the spreading of water waves resulting from a dropped stone as an example of a 'classical' process which is irreversible. This example is, however, not altogether convincing, since it is not obvious that a reversed set of water waves cannot be set up by a system of generators, coherently operating on the periphery of the water wave system; also, the propagation of water waves is in any event irreversible by virtue of being a dissipative process, while Popper's argument was for irreversibility of the waves on other grounds.

Morpurgo, Radicati and Touschek have discussed[2] time reversal, using the following definition. Let $\mathbf{r}$ be the position vector of a particle and $\dot{\mathbf{r}}$ its velocity; the property of time symmetry, or invariance under time reversal, requires that if equations of motion lead in a time interval t from a state $\mathbf{r}_1$, $\dot{\mathbf{r}}_1$ to a state $\mathbf{r}_2$, $\dot{\mathbf{r}}_2$, then in the same interval they also lead from $\mathbf{r}_2$, $-\dot{\mathbf{r}}_2$ to $\mathbf{r}_1$, $-\dot{\mathbf{r}}_1$. Using this definition as a criterion for path reversibility, we find that a clear example of lack of reversibility in mechanics is provided by certain solutions of the equation of Newton's second law.

We may write the law in the simple one-dimensional form,

$$F = m\ddot{x} \tag{1}$$

where F is a force in the x direction and m is a mass. Equation (1) is time reversible in the sense that it is the same with the use of either two positive or two negative differential increments of time. Further, (1) is reversible in that if it is integrated with an F that is a function of x, the path obtained after a velocity reversal is the reverse of the original path, as required by our adopted definition of path reversibility. Thus, with a gravitational force which is an $F(x)$, we have path reversibility. If, however, F is a function of t, one does not obtain such reversibility in the solution of (1), as will now be shown.

We take m to be a constant, and write $F(t)/m$ as $a(t)$, so that (1) becomes $a(t) = \dot{x}$. A first integration gives

$$\dot{x} = \int_0^t a(t)\mathrm{d}t + \dot{x}_i \tag{2}$$

where $\dot{x}_i$ is velocity at $t = 0$ and $\dot{x}$ is velocity at t. A second integration gives:

$$x_f = \int_0^{t_f}\left[\int_0^t a(t)\mathrm{d}t + \dot{x}_i\right]\mathrm{d}t + x_i, \tag{3}$$

where $x = x_i$ at $t = 0$ and $x = x_f$ at $t = t_f$. For the reversed motion, indicated by primed symbols, a first integration gives $\dot{x}' = \int_0^t a(t)\mathrm{d}t + \dot{x}'_i$. We integrate through the same time interval t_f as before, but with $\dot{x}_i' = -\dot{x}_f$ at $t = 0$, where $\dot{x}_f$ is the final velocity of the previous motion. A second integration, after replacement of $\dot{x}_i'$ by $-\dot{x}_f$ as determined from (2), gives:

$$x'_f = \int_0^{t_f}\left[\int_0^t a(t)\mathrm{d}t - \int_0^{t_f} a(t)\mathrm{d}t - \dot{x}_i\right]\mathrm{d}t + x'_i. \tag{4}$$

Since x'_i is equal to x_f, we may substitute x_f as given by (3) for x'_i in (4). We then find for the final position, x'_f, in the reversed motion:

$$x'_f = \int_0^{t_f}\left[2\int_0^t a(t)\mathrm{d}t - \int_0^{t_f} a(t)\mathrm{d}t\right]\mathrm{d}t + x_i. \qquad (5)$$

It is apparent from (5) that, with an $F(t)$, solutions of (1) will not in general have the property of path reversibility; for the reversed motion does not, after time t_f, give $x'_f = x_i$. (A sinusoidal force, $F = b\sin\omega t$, provides a simple example of an $F(t)$.) In the special case that $a(t)$ is a constant, (5) reduces to $x'_f = x_i$; and, as noted, we do have path reversibility when (1) is solved with an $F(x)$. It appears that motions under various kinds of physical forces must be individually examined for their reversibility properties.

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[1] Popper, K. R., *Nature*, **177**, 538 (1956).

[2] Morpurgo, G., Radicati, L. A., and Touschek, B. F., *Nuovo Cimento*, **12**, 677 (1954).

MR. R. SCHLEGEL's definition of temporal reversibility, which he credits to Morpurgo, Radicati and Touschek, is clearly too narrow. It has to be extended, so as to cover a (conservative) physical system rather than one single particle.

Take the case of a planetary system: if we reverse the velocity of one of the planets, at the time t_f and at the position x_f, the planet will clearly not reverse its path precisely: upon reaching, at the time $t_f + \Delta t$, the position $x_f + \Delta x$, which we may assume to be very nearly the same as the one which it occupied at $t_f - \Delta t$, the planet will not be acted upon by the same force which acted upon it at the time $t_f - \Delta t$. If, however, we reverse the motions of all the planets in the system, then the force will be the same; the system is reversible.

This shows that the problem of reversibility or irreversibility arises only with respect to a (conservative) physical system. It is obvious that, in a classical model, the motion of one planet or of one particle cannot be reversed.

Mr. Schlegel proposes to consider the reversibility of the motion of one particle under the action of a time-dependent force. There are, clearly, two cases to be considered. In the first case, the temporal changes of the force in question are explicable (that is, deducible, or predictable) in terms of the changes within the system; in classical mechanics, in terms of the changing positions of the various particles. Classical mechanics is reversible in the sense that if the velocity vectors of all particles are reversed, the temporal and positional changes of the forces (but not their directions, of course) are also reversed, and all the particles return on the paths on which they came. In the second case, the changes of the force in question are not explicable in terms of the changes in the system. In this case, the problem of reversibility, and of the 'arrow of time', does not arise: irreversibility is trivial, except under the assumption that the temporal changes of the force are also reversed.

Mr. Schlegel operates with a changing force the changes of which he does not reverse. He therefore obtains the obvious result: the motion of his particle will not in general be reversible.

Concerning Mr. Schlegel's comments on my own communication, I wish to make four remarks.

(1) I have found since that nearly half a century ago, Einstein used a somewhat similar argument[1]. Had I known this, I would not have written my communication.

(2) The difference between Einstein's argument and mine is that I have pointed out (*a*) that the generators would have to be coherent, and (*b*) that the demand that the coherence of the generators should be explained, and the explanation incorporated into the model, must either be given up (which means accepting the process as irreversible) or it will lead to an infinite regress. Mr. Schlegel mentions coherence, but he does not appear to have fully appreciated my admittedly very brief sketch of the way in which we are led to an infinite regress, if we do not wish to accept the coherence of the generators as an ultimate and inexplicable conspiracy of causally unrelated conspirators.

(3) As to dissipating processes, there are two kinds of dissipation which do not always seem to be clearly distinguished. Dissipation in the form of increasing disorder (entropy increase) is one of them, and dissipation by expansion without increase of disorder is the other. For an increase of disorder, walls of some kind are essential: a sufficiently thin gas expanding in a 'vessel without walls' (that is, the universe) does not increase its disorder. In the absence of walls, collisions become rapidly extremely improbable, and the degree of order of the system begins to increase in time, in the sense that the fastest particles will all be found near the periphery of the expanding gas ball and the slowest particles near its centre. If this development is prevented by the insertion of 'walls' of some kind (the 'walls' may be gravitational fields preventing the escape of particles) then the disorder will increase.

(4) My earlier brief communication was merely an attempt to point out the untenability of the widespread, though surely not universal, belief that the 'arrow of time' is closely connected with, or dependent upon, the law that disorder (entropy) tends to increase. Beyond this, I did not attempt to cover the subject.

K. R. POPPER

University of London.

[1] Einstein, A., *Phys. Z.*, **10**, 821 (1909).

Application of Impedance Measurements to Corrosion Phenomena

IN connexion with a recent communication[1] it should be pointed out that the application of impedance measurements to corrosion phenomena is not new. Extensive measurements of the resistance and capacity of painted steel specimens have been carried out for a number of years[2] and have proved most useful in studying the breakdown of paint films.

In the course of this work, the possibility was raised of extending the method to other thin films such as anodic oxide films. The present work[1] demonstrates the usefulness of the method in the study of phenomena within oxide films formed during corrosion.

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[1] Wanklyn, J. N., *Nature*, **177**, 849 (1956).

[2] Wormwell, F., and Brasher, D. M., *Nature*, **159**, 678 (1947); see also "Chemistry Research, 1947", 11 (H.M.S.O., London, 1949); *J. Iron and Steel Inst.*, (2) **164**, 141 (1950), and **169**, 228 (1951).

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APPLICATIONS are invited for the following appointments on or before the dates mentioned:

MAP CURATOR AND LIBRARIAN (preferably with qualifications in geography and in librarianship) IN THE DEPARTMENT OF GEOGRAPHY—The Registrar, The University, Sheffield (August 25).

LECTURER (with a good degree in physics, teaching and research or industrial experience, and preferably special qualifications in some branch of applied physics) IN PHYSICS—The Principal, Acton Technical College, High Street, Acton, London, W.3 (August 25).

PLANT PHYSIOLOGIST (with a good honours degree in botany or agricultural botany)—The Registrar, University College of Wales, Aberystwyth (August 25).

CHEMISTS (with a first- or second-class honours degree) at the North Thames Gas Board's Chemical By-Products Works, Beckton, East Ham, London, E.6, for research on problems in connexion with coal tar distillation, and the manufacture of phenols, naphthalene and bases—The Staff Controller, North Thames Gas Board, 30 Kensington Church Street, London, W.8, quoting Ref. 666/288 (August 27).

ASSISTANT IN ELECTRICAL ENGINEERING—The Secretary of the University Court, The University, Glasgow (August 31).

ASSISTANT LECTURER IN THE DEPARTMENT OF PHILOSOPHY—The Registrar, University College of Wales, Aberystwyth (August 31).

ASSISTANT LIBRARIAN (with some experience in a scientific or technical library) IN THE SCIENCE AND TECHNOLOGY SECTION of the University Library—The Librarian, The University, Edmund Street, Birmingham 3 (August 31).

DISTRICT (Forest) OFFICERS (with, or obtain in summer 1956, a university degree or diploma in forestry, or a postgraduate degree in a forestry subject)—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting Ref. No. 146/56/1 (August 31).

LECTURER IN THE DEPARTMENT OF METALLURGY to lecture in X-ray metallography and the thermodynamics of alloys—The Registrar, The University, Liverpool (August 31).

LECTURER IN ANIMAL HUSBANDRY AND PREVENTIVE MEDICINE at the University Veterinary School—The Secretary of the University Court, The University, Glasgow (August 31).

LECTURER (preferably with experience in tropical plant physiology) IN PLANT PHYSIOLOGY at University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (August 31).

ASSISTANT PHYSICIST, Basic grade (with a good honours degree in physics and preferably experience in electronics and nuclear physics techniques) IN THE PHYSICS DEPARTMENT of the Sheffield National Centre for Radiotherapy—The Secretary, Sheffield Regional Hospital Board, "Broom Cross", Tree Root Walk, Sheffield 10 (September 1).

BIOCHEMIST (with an appropriate science degree of a university of Great Britain or associateship of the R.I.C.) for duties at the Harrogate and District General Hospital and Royal Bath Hospital—The Group Secretary, Harrogate and Ripon Hospital Management Committee, Hereford Lodge, Cornwall Road, Harrogate (September 1).

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RESEARCH FELLOW or JUNIOR RESEARCH FELLOW (organic chemist with research experience, preferably on natural products) at the University College of the West Indies—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (September 10).

PHYSICIST or PHYSICAL CHEMIST (with an honours degree in physics and a good knowledge of instrumentation) to work in the new Research Department of Anæsthetics—The Secretary, Faculty of Anæsthetists, Royal College of Surgeons, Lincoln's Inn Fields, London, W.C.2 (September 12).

UNIVERSITY DEMONSTRATOR (with an honours degree in pure science with organic chemistry and biochemistry as principal subjects) IN ANIMAL NUTRITION—The Secretary, School of Agriculture, The University, Cambridge (September 12).

SENIOR LECTURER (graduate in agriculture or pure science) in charge of an Agricultural Research Station to be established in the Forest Region of the Gold Coast (University College of the Gold Coast), for the study of soils and crop production—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (September 27).

HEAD OF THE DEPARTMENT OF PHYSIOLOGY; and a SENIOR PRINCIPAL SCIENTIFIC OFFICER IN THE EXPERIMENTAL PATHOLOGY DEPARTMENT—The Director, Institute of Animal Physiology, Babraham Hall, Babraham, Cambridge (November 15).

ASSISTANT PROFESSOR (with teaching experience and research interests in inorganic or physical chemistry) IN CHEMISTRY—Prof. C. A. McDowell, Department of Chemistry, University of British Columbia, Vancouver 8, B.C., Canada.

BOTANIST (with postgraduate research experience) for work on the seasonal accumulation, translocation and utilization of reserve materials in fruit trees, to extend the knowledge of tree growth, flowering and fruiting already being obtained by methods of growth analysis; and a BIOCHEMIST (with postgraduate research experience) for work on the metabolism of fruit plants—The Secretary, East Malling Research Station, near Maidstone, Kent.

CHEMICAL ENGINEER (with a degree in chemical engineering and research experience) at a research institute in Aberdeen for research on smell suppression in the manufacture of fish meal—The Herring Industry Board, 1 Glenfinlas Street, Edinburgh 3.

CHEMIST (with an honours degree in chemistry or agriculture with a strong chemical bias, followed by postgraduate training in soils work and general ecology) IN THE DEPARTMENT OF AGRICULTURE, Tanganyika, to work as a member of a team investigating soil fertility problems and surveying new development areas—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.63/8/20.

DEPUTY DIRECTOR (with good academic qualifications and record for research work, preferably experience of tropical tree crops, including cocoa, and the working of a research institute) OF THE WEST AFRICAN COCOA RESEARCH INSTITUTE, Gold Coast, to take charge of the research work and administration of the Institute's Sub-station at Ibadan, Nigeria—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.197/200/016.

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SENIOR and JUNIOR RESEARCH FELLOWS (Chemists and Physicists) IN THE DEPARTMENT OF GLASS TECHNOLOGY, to work on the problems of the glassy state—Prof. R. W. Douglas, Department of Glass Technology, The University, Sheffield 10.

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SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER (with a first- or second-class honours degree in physics and background experience in solid-state physics with at least three years postgraduate research experience, and preferably experience of spectrography or electronics) to investigate certain physical aspects of the detonation of solid high explosives and of the propagation of intense shock waves through solids and gases—The Senior Recruitment Office, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting Ref. 1228/34.

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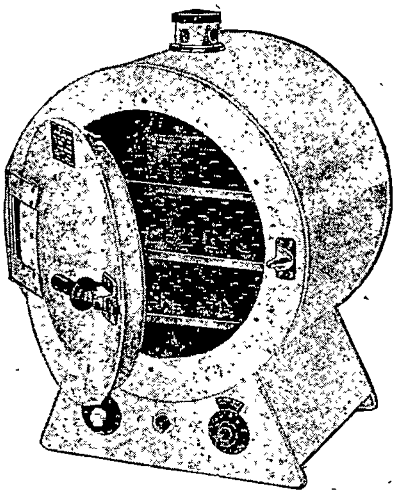

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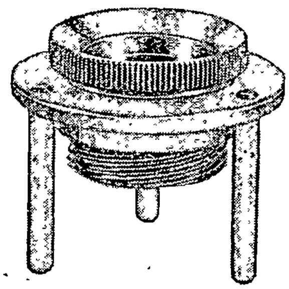

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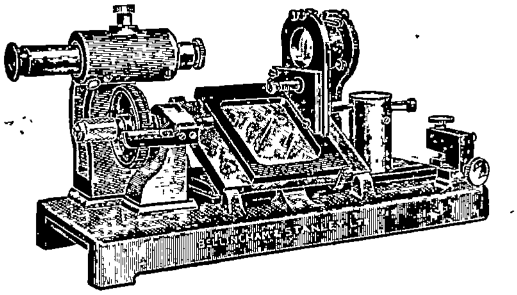

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SHORTAGE OF MATHEMATICS AND SCIENCE TEACHERS

THE Dunsheath Committee which considered the shortage of mathematics and science teachers concentrated upon the more advanced studies of future specialists; it paid little attention to their earlier education and the scientific education of the remainder of the population. Realizing that this might well be the core of this difficult problem, the Association of Teachers in Colleges and Departments of Education set up a committee to examine the problem and to report. Its report, which has been prepared by five people connected with the work of training colleges, is probably more alarming in its revelations than anything so far published on a question where no real solutions have yet been proposed*.

The report surveys the total output of trained teachers in England and Wales for one whole year and analyses the courses taken by those training college students who have made any substantial study of mathematics or of a science during their training. It also gives information about the mathematical and scientific attainments of all students on entry to the colleges, and discusses the staffing of the colleges.

The information received shows clearly that very few girls both able and willing to specialize in mathematics or in the physical sciences are attracted to teaching as a career, and that the qualifications of men teachers who have taken mathematics or science degrees are, on the average, very much inferior to those of men in training who have specialized in other subjects. There are insufficient women to maintain present staffing requirements, and the shortage of mathematics and science staffs in girls' schools is rapidly becoming worse. There are insufficient men to provide any expansion of staff to teach the very much larger age-groups of children that will be entering secondary schools in 1957 and subsequent years or to provide trained teachers able to contribute to the expanding facilities for scientific and technological education which the Government has recently promised. The value of the report lies both in its novel effort to examine the basic reasons why students are not becoming teachers of mathematics and science in numbers and quality to suit the national interest, and in the sincerity and humility with which it criticizes those defects in the training colleges and departments of education that help to aggravate an apparently intractable problem.

The Committee is unanimous that the failure to attract sufficient properly qualified recruits is a reflexion of the status and prestige of teaching as a profession relative to other careers open to men and women with some scientific ability.

Although nearly half the women students entering training colleges have passed in mathematics at their General Certificate examination, the attitude of a large number of them to the subject is undesirable; dislike and even hostility to mathematics and arithmetic is characteristic of many. This attitude is often established before entry to a grammar school. Students who as children, were inadequately taught at school do not willingly take up a serious study of mathematics in training colleges; and, unless this attitude is modified during training, they leave college and take with them into schools their negative attitude towards arithmetic and have to teach with this personal background.

The key to the situation lies in the supply of trained mathematics and science graduates from universities, a supply which has remained consistently low for some years; the supply is low because teaching has virtually ceased to attract either mathematics or science honours graduates. Once present shortages have been made good, the scales of the teaching situation would be turned by the additional recruitment each year of about fifty men and fifty women honours mathematicians—two of each sex from each university in Great Britain—with rather fewer physicists and chemists and a few extra biologists; about 250 extra recruits are required each year out of the total of more than 6,000 science and technological graduates. For lack of this number the whole future of the nation's supply of scientists and technologists is being jeopardized.

Some help could be given by those training colleges which provide concurrent degree and certificate courses; the Committee urges that they should be given financial and other inducements not only to continue this work but also to extend it to provide as many graduate scientists and mathematicians as possible.

For the great majority of student teachers, basic courses in mathematics and science will provide the only opportunity in training colleges of presenting to them afresh the subjects they will teach in schools but which are not their main subject of study. This work can only be successfully accomplished if adequate time can be devoted to it, and, in view of the considerable amount of remedial work and re-education in mathematics and arithmetic which now appears necessary, particularly with a majority of women students, the Committee considers that the promised extension of the period of training from two to three years will alone provide sufficient time for these courses to be planned on an adequate scale. With the expectation that this reform will be effected within about the next four years, it is recommended that a national committee be set up to investigate resources and collate ideas preparatory to the revision of syllabuses by institutes of education. By the time the three-year course is introduced, it is essential that all training college staffs should include experienced graduate lecturers competent to teach mathematics and science students.

---

* The Supply of Mathematics and Science Teachers: a Survey of Students in Training. By a Sub-Committee of the Association of Teachers in Colleges and Departments of Education. Pp. vi+56. (London: Methuen and Co., Ltd., 1956. Published for the Association of Teachers in Colleges and Departments of Education.) 3s. 6d. net.

The short-term problem calls for immediate measures to be taken. One-third of the women's training colleges are without a member of staff who has graduate qualifications in mathematics, and in a majority of colleges no mathematician or scientist is among those members of the staff whose special responsibility is pedagogy and the principles and practice of education. Until this staffing shortage is remedied, only a proportion of students will be able to benefit from other steps which may be taken.

At the present time a number of colleges are experimenting with new courses and combinations of courses, and here the Association of Teachers in Colleges and Departments of Education could do much to co-ordinate developments. Third-year supplementary courses both in mathematics and science, including some extending over three years, are planned to begin next year in some colleges. These courses should be widely advertised, and more teachers should be encouraged to enrol for them.

The largest age-group will not be entering secondary schools until 1958, and it should not prove impossible during the next two years for local authorities to second a number of experienced teachers to take supplementary courses designed to enable them to become competent mathematics or science specialists for secondary schools; this would help to ease the burden.

Of the subjects usually taught in schools, mathematics is the only one selected by fewer than about 10 per cent of training college students. For mathematics less than one woman teacher in twenty-five at present qualifying will have any substantial knowledge of this key subject of the curriculum. This is scarcely enough to provide one medium-sized school in three with a teacher whose main interest can be expected to lie in the teaching of mathematics and arithmetic. The Committee feels that "It is pertinent to ask whether it is in harmony with the needs of the second half of the twentieth century that, in the training of teachers, art and craft should be studied by nine times as many women as those who study mathematics, geography three times as many as mathematics and history more than all the sciences and mathematics put together".

The report suggests that science and mathematics lecturers should be given opportunities to see entrants at the earliest possible occasion, either immediately the students enter college or on the occasion of the interview when students are selected for admission. Headmistresses of girls' grammar schools could also give active encouragement to a number of their pupils during their final year at school.

A further difficulty is that few books of any sort are available which open up new vistas and present mathematics afresh to training college students who are only accustomed to the standard grammar-school books. There is a great need for someone who loves mathematics and is in close touch with the needs of training college students to write attractive text-books calculated to woo women students from their apparent distaste of everything mathematical.

If training colleges are not to be prevented from fulfilling their vital task of producing trained teachers of mathematics and science, more highly qualified men and women must be attracted to them as lecturers. It is most desirable that the training of students be entrusted to well-qualified mathematicians and scientists who are thoroughly experienced teachers; but the present Pelham scales of training college salaries cannot compete with the inducements which may be offered, under the Burnham scales, to a sixth-form graduate teacher with whom a school does not wish to part, and who would be very difficult to replace. For some years to come the training colleges will have to provide all the mathematics and science teachers for secondary modern schools and also supplement the supply of graduate teachers to the grammar schools. It is essential that training colleges be provided with the qualified and experienced staff necessary to make this much-needed contribution of trained teachers of mathematics and science. As long as those women's colleges which do offer main courses in mathematics have only classes as frustratingly small as is often the case, many graduate teachers will prefer to remain in grammar schools where their classes are larger and include potential university scholars; not until teachers have served in a training college can they fully appreciate the interest of its varied work.

The shortage of science lecturers and the lack of balance between the subjects they profess will take some time to correct. As an immediate measure, it is recommended that each institute of education should survey the number and qualifications of science lecturers within its own area, that principals and governing bodies of training colleges should be informed of the balance and distribution of science lecturing resources and that area training organizations should encourage some measure of collective responsibility for the provision of balanced facilities for the various scientific disciplines.

Whatever particular solutions are eventually reached, it is essential to recognize the existence of an emergency and to be prepared to take bold steps to meet it. Any solution which introduces new ideas may well lead to new forms of partnership between the universities and training colleges of Britain, which may later prove of value in other respects.

THE CIVIL SERVICE

The Civil Service

Some Human Aspects. By Frank Dunnill. Pp. 226. (London: George Allen and Unwin, Ltd., 1956.) 18*s*. net.

FOR the scientific worker, as such, the interest of this book is limited by the exclusion from its scope of the Scientific Civil Service, though the picture Mr. Frank Dunnill gives of the recruitment, training, methods and working conditions of the Civil Service in general should be useful to any scientist who is brought into contact with the Civil

Service, whether he is himself a member of the Scientific Civil Service or not. Moreover, Mr. Dunnill discusses with understanding and a certain dry humour the relations between the Civil servant and Parliament and between the departments and the organized public, as well as with the individual, in a way that should assist those outside the Service to understand its ways and its point of view and at the same time help those within to avoid actions or attitudes that create friction. He has a keen sense of the human problems involved, and his criticism is usually constructive and well directed, though his suggestion for a series of advisory departmental committees, empowered to ask questions on the department's relations with the public and to secure authoritative explanations of the advantages or inherent impossibility of particular procedures, may be debatable as a means of securing the continuous re-examination of practices and the removal of misunderstandings without hindering administration.

The book is of value for its discussion of the factors which are changing the Service to-day and its relations with the public it serves, particularly of the effect of social change on the administrative and executive branches. Mr. Dunnill is convinced that any effective reform of the Civil Service must come from within and not in response to pressure from without—as a result of its executive and administrative officers putting their minds on the work that is being done and eliminating practices no longer useful or relevant. What is lacking, he remarks, of those few thousand higher executive officers in charge of many thousands of junior officers is not, for the most part, the mental capacity to reorganize and deploy their juniors more economically and more intelligently, but training, encouragement and the conviction that management is a primary part of their job and one to which they should actively apply themselves. Real economy in man-power and woman-power comes not at some sudden point from outside but as a result of careful forethought and study of the intelligent and efficient employment and development of human beings, having regard also to the important responsibilities which they may later have to bear outside as well inside the Service.

Mr. Dunnill's major hopes for the future appear to rest in the fact that "the younger higher executive officers, promoted since the Second World War, belong for the most part to the best crop of middle-grade officers the Service has had for a very long time". The great danger is that before they reach positions of high responsibility they lose some of their force and energy, enlightenment and sympathy. If this is to be avoided, it will be mainly through what happens within rather than without the Service, though such books as this could contribute to the real understanding of the Civil Service which will enhance its prestige and standing in the nation and limit the amount of ill-informed criticism and often ill-judged financial cuts. The basic problems, however, are human ones, and Mr. Dunnill's main conclusion is that the key to full efficiency in the Civil Service lies in the intelligent use of the people in it. He indicates very clearly the factors, both external and internal, which can help to that end, and scientists and technologists will note with interest his comments about the professional groups, though he seems to overlook the influence which a freer passage from such groups into the administrative branch, particularly of the scientific officers, might exert.

Although it has much general interest, Mr. Dunnill's book is perhaps primarily for those within or in direct contact with the Civil Service. It should help to a fuller understanding on the part of those outside and stimulate fresh thought and initiative within. Unfortunately, not only is there no bibliography, but even where Mr. Dunnill quotes he does not trouble to cite his source. The value of the book would also have been enhanced had an index been included.

R. Brightman

BIBLIOTHECA WALLERIANA

Bibliotheca Walleriana

The Books Illustrating the History of Medicine and Science collected by Dr. Erik Waller and bequeathed to the Library of the Royal University of Uppsala. Compiled by Hans Sallander. (Acta Bibliothecae R. Universitatis Upsaliensis, Vols. 8–9.) Vol. 1: Pp. xii+471+plates 1–48. Vol. 2: Pp. viii+494+plates 49–55. (Stockholm: Almqvist and Wiksell, 1955.) 200 Sw. Kr. the two volumes.

No catalogue exists that contains all works ever published on either early science or early medicine, nor is it likely that one will ever be compiled, still less published. Moreover, the needs of those who require accurate bibliographical descriptions of the books that such a catalogue would contain are even less adequately provided for. In consequence, potential users of this hypothetical catalogue—students of the history of science and medicine, librarians, bibliographers, book collectors and antiquarian booksellers—owe a lasting debt to the great book collectors who have made specialized collections of which catalogues have been published; or who have prepared bibliographies of the works of great scientists of the past. As examples, one may mention Prof. J. F. Fulton's bibliographical studies, particularly his bibliography of the works of Robert Boyle; John Ferguson's "Bibliotheca Chemica"; Dr. G. L. Keynes's bibliography of the works of John Ray; and, in the field of medicine, the latter's bibliographical account of the publications of William Harvey; and Sir William Osler's "Bibliotheca Osleriana". To these must now be added the "Bibliotheca Walleriana".

Dr. Erik Waller was born at Önum in the province of Västergötland, in Sweden, on November 29, 1875. He graduated M.B. at Upsala in 1900, and continued his studies at the Karolinska Institutet in Stockholm until 1905. Afterwards he practised as a surgeon in various parts of Sweden until 1909, when he returned to his native province. Here he became surgeon in the Lidkoping Hospital, where he remained until his retirement. He was librarian to the Swedish Medical Association in Stockholm during 1940–46; and in 1951 he returned to Lidköping, where he died on January 28, 1955.

It would be interesting to know whether great book-lovers such as Dr. Waller are born with some inherent propensity to collect; or whether their interest in the historical development of a special field of knowledge is the driving force that leads them on to amass a library of books on their subject and perhaps to write about it. Dr. Waller must have acquired, in the course of his lifetime, an exceptionally wide knowledge of the development of medical science; but he appears to have written next to nothing on the subject. In his case, therefore, the first explanation is possibly the more probable, though the mere labour of getting together such a collection can scarcely have left a practising surgeon much time for writing. In any event, Dr. Waller became active as a collector when quite young, in the early 1900's. Originally, manuscripts and autograph letters were his main interest, and he amassed nearly twenty thousand letters ranging in date from the early sixteenth century to the beginning of the nineteenth century. Many of these were written by, or addressed to, men famous in the history of medicine; but they also covered a wider field, including almost all aspects of modern cultural life. This collection, which included medieval codices and scientific manuscripts as well as letters, was acquired for the Royal University Library of Upsala by purchase.

Dr. Waller's main achievement, however, was his collection of old medical books. This, like his collection of autograph letters and manuscripts, he extended to include works on many other branches of knowledge more or less directly related to medicine, including general natural science, specific natural and physical sciences, the history of the natural sciences and of medicine, the biography of medical men and scientists, and the bibliography of medicine and science; and there is even a section in his "Bibliotheca" dealing with the literature pertaining to the study of manuscripts and autograph letters.

Dr. Waller was always generous in making his collections accessible for study by scholars, and it was with this intention that he decided in 1950 to present the whole of his collection of books to the University Library at Upsala, where it is now permanently available for this purpose. The University is indeed fortunate in having become the custodian of such an outstanding collection. It far exceeds in size and importance those made by Sir William Osler and Dr. Harvey Cushing, for example. There are 150 incunabula, more than a hundred editions of Hippocrates, thirty-six editions of the works of Vesalius, including a copy of his doctoral dissertation; forty-three editions of Ambroise Paré's books; and what is claimed to be the world's largest collection of the writings of William Harvey, totalling fifty different editions. These examples emphasize the size of the collection; but other important writers are also well represented, and there are a great many extremely rare books on a variety of medical topics, some of them unique. A number of the books in the collection are of especial interest because of the notes by former owners which they contain. Among them are books formerly owned by William Harvey and Vesalius.

The main part of the library, the old medical books, together with the incunabula, are catalogued in Volume 1, which has 10,721 entries. These are listed alphabetically by author, excepting only the incunabula, which are catalogued separately. There are also forty-eight plates in this volume, mainly reproductions of the title pages of old medical books. Volume 2 is divided into several alphabets, according to subject, and contains all books other than the old medical works. It brings the total number of entries up to 20,428. These are numbered consecutively throughout the two volumes, irrespective of subject, so that it is possible to refer to any one book in the collection by its number alone. Volume 2 contains seven plates, bringing the total up to fifty-five. Finally, there is an exhaustive index of names and subjects, with many cross-references, extending to ninety-four pages. This has been modelled on the index of the "Bibliotheca Osleriana", and it adds immensely to the value of the catalogue as a work of reference.

The bibliographical descriptions of individual entries in the catalogue are given concisely, as follows: title (in full, unless exceptionally long); edition; place and date of publication; format; pagination; illustrations; other relevant information. The names of former owners are also indicated in some cases. Printers' names have been given for all works earlier than 1700. The catalogue does not include the several thousand reprints that form part of the Waller collection, except for a few considered especially important by Dr. Waller himself.

The "Bibliotheca Walleriana" forms Volumes 8 and 9 of the *Acta Bibliothecae R. Universitatis Upsaliensis*, and 1,600 copies only have been printed. It has been prepared by Mr. Hans Sallander, of the University Library, Upsala; and all notes and other remarks additional to the actual book titles are in English. It is a reference work of outstanding importance which, no doubt, many large reference libraries, particularly those used by medical and scientific students, will wish to acquire. It will also appeal to many book collectors, and, if its price seems rather high, this should be considered in relation to the vast amount of information it contains, and the immense care that has evidently gone into its production. It forms a worthy monument to the memory of Dr. Erik Waller, through whose labours and generosity this great collection is now available for consultation by all interested students.

V. A. Eyles

CHEMICAL AND BIOLOGICAL ACTION OF RADIATIONS

Actions Chimiques et Biologiques des Radiations
Collection dirigée par M. Haïssinsky. Première Série. 1: Aspects Physiques de la Radiobiologie. Par L. H. Gray. 2: Chimie des Radiations des Solutions Aqueuses. Aspects Actuels des Résultats Expérimentaux. Par M. Lefort. 3: Modern Trends in Radiation-Biochemistry. By W. M. Dale. Pp. viii+254. (Paris: Masson et Cie, 1955.) 2800 francs.

As the title indicates, this is the first volume of a series which, as pointed out by the editor, Dr. M. Haïssinsky, is to be a comprehensive collection of monographs dealing with all aspects of this field.

During recent years, the chemical and the biological action of radiations have become subjects of considerable theoretical and practical importance, and it has also become apparent that these two fields are, in many ways, closely related to each other. Until comparatively recently, the basic concepts in radiobiology were almost entirely founded on the 'target theory', which, although capable of providing some kind of formal representation of certain aspects of radiobiology, did not seem to advance this subject any further. It was not until the knowledge of the chemical action of ionizing radiations was put on a new theoretical and experimental basis that a deeper understanding of the fundamentals of radiobiology was possible.

The chemical effects are dealt with in Part 2 by Dr. M. Lefort, who discusses what has now become known as the radiation chemistry of aqueous solutions.

Part 1, by Dr. L. H. Gray, represents something between text-book material and a monograph. The discussion is based essentially on the earlier concepts of D. E. Lea; there is no reference to the more recent work of Kramers which, from the physical point of view, is rather fundamental for the action of ionizing radiations in liquid systems. In Part 1, and particularly in Part 3, by Dr. W. M. Dale, there is probably too great a tendency to apply results obtained on very dilute aqueous solutions to biological systems.

It would, perhaps, not have been inappropriate to give rather more prominence to the work of Hollaender and Latarjet on the possible relationship between radiobiology and photobiology. It is clear that, in general, the behaviour of biological systems towards radiation does not depend so much on the energy of the incident primary particle or quantum but rather on the energy-levels of the particular compounds which are involved. Thus, even in the case of high-energy radiations, electronic levels of only a few electron volts may ultimately be of great importance for the chemical and related biological effects.

Part 3 deals mainly with the chemical action of ionizing radiations on certain selected organic compounds (for example, thiourea) in aqueous solution. There is little discussion of the actual biochemical effects produced by ionizing radiations, a subject which has become known, to a large extent, through the work of Hevesy and Forssberg; only one very brief reference to Hevesy's work has been given, and this dates back to 1945.

In spite of certain shortcomings, this volume contains much stimulating information and a useful collection of references, and one is indebted to the authors for having undertaken a difficult and somewhat unrewarding task. The specialist concerned with one aspect of the wide and diverse field of the chemical and biological action of radiations often feels the need for comprehensive accounts of the many other fields of work closely related to his own. This new series, when complete, should go a long way towards fulfilling this need. A special word of praise and encouragement is due to Dr. Haïssinsky, who is to be wished every success in the further development of this collection of monographs.

J. Weiss

HANDBOOK OF REACTOR PHYSICS

Reactor Handbook: Physics

Prepared by the United States Atomic Energy Commission. (Selected Reference Material on Atomic Energy.) Pp. xvi+790. (London: McGraw-Hill Publishing Company, Ltd., 1955.) 90*s*.

This handbook is one volume in a series sponsored by the United States Atomic Energy Commission with the avowed intention of providing a condensed source of reliable data and reference information in the field of reactors. The volume is devoted to reactor physics and radiation shielding, the latter subject occupying approximately a quarter of the book.

The first two chapters are devoted to experimental methods and nuclear physics. The former refers to neutron sources and detectors and, in outline, to methods of measurement of fundamental and integral nuclear and reactor data. The latter is primarily concerned with an extensive compilation of the properties of nuclei in tabular and graphical form.

The remainder of the section on reactor physics is devoted to the kinetic theory of neutrons and reactor statics and dynamics. The kinetic theory of neutrons discusses some of the approximations which are commonly used in the analytical solution of Boltzmann's equation. This treatment is rather sketchy for the mathematician, but the principles are discussed and references to more detailed papers are given. The application of these approximations to steady-state reactor problems is given, but attention is concentrated on homogeneous reactors. No theoretical treatment of heterogeneous reactors is given, but the results of various integral measurements, including experiments to determine critical factors, are prefaced by a statement of simple formulæ for computing the characteristics of an infinite lattice reactor. Many results are given, but it is disappointing that no attempt is made to correlate these results with theoretical estimates made in different ways. The chapter on reactor dynamics contains a useful discussion, with numerical examples, of the effect of changes in reactivity on the neutron intensity. Consideration is also given to the criteria for stability in a power-producing reactor, taking into account the problem of heat dissipation and the power and temperature reactivity coefficient. Typical calculations for control rods complete this chapter.

The section of the book on shielding contains chapters dealing with sources of neutrons and gamma-rays in a reactor, radiation tolerances, neutron and gamma attenuation and heating including the effect of geometry and ducts, optimum dimensions of shields and a tabulation of general properties of shielding materials. As in the previous section, the tabulation of data is extensive and in general very useful. The number of experimental results from shielding experiments which are quoted is rather small, and little attempt is made to recommend procedures.

The authors of the handbook are clearly aware of the limitations imposed on the contents and on its presentation by the rigid target date for the production of this edition. As a consequence, however, some of the information given is difficult to digest, and the reader must be experienced in the field and prepared to work hard in order to extract the information really required from such a handbook. An outstanding exception to this is the tabulation of many useful general and nuclear properties of materials used in reactors. Modifications to any future editions, which would make this handbook of outstanding value both to newcomers and to the experts in this field, are a general unifying introduction, a constructive criticism of theories and experiments and their limitations, and, in particular, a recommendation of specific methods and data which correlate with experiment for specific problems.

The production of this handbook was obviously a formidable task, and the authors are to be congratulated on producing a volume of this kind in the time available. Nevertheless, as the members of the review board have indicated in their preface, "the ultimate success of the handbook will depend a great deal upon the refinements in subject-matter and presentation which will come about in subsequent revisions".

Peter W. Mummery

Chemical Engineering

By J. M. Coulson and J. F. Richardson. Vol. 2: Unit Operations. Pp. xvi+387–975+65 plates. (London: Pergamon Press, Ltd., 1955.) 60*s*. net.

THE second volume of "Chemical Engineering" completes the treatment of unit operations of which the more fundamental fluid flow and mass transfer were the main theme of Vol. 1 (*Nature*, 175, 228 (1955)). Flow of fluids past particles includes filtration, sedimentation, and gas cleaning; mass transfer across an interface includes distillation, absorption, liquid-liquid extraction and leaching. Finally we have evaporation, crystallization, drying, size reduction of solids and mixing. Physical reactions only are considered owing to a paucity of rigorous methods of solution where chemical reactions are involved; similarly such subjects as automatic control and the design of reactors have been specifically excluded.

As with the first volume, each chapter contains a list of the more important references and a list of symbols and is very well illustrated with line diagrams, sectional drawings and photographs of equipment used in chemical engineering operations. An appendix contains 121 problems of university degree standard.

The more fundamental treatment in Vol. 1 is utilized as required in the second volume, as in the application of mass transfer in Chapter 7 to absorption in Chapter 19. The treatment throughout is mathematical with a slight tendency to underplay the physical conditions underlying the various operations. Thus, in so far as bubbles and drops are concerned, whereas Stokes's law is thoroughly considered and Hadamard's allowance for internal circulation is discussed, no mention is made of the limited range of internal circulation for which Bond and Newton postulated an interfacial tension factor. This is a very minor note of criticism since a good balance has been achieved between the various sections and the essential unity of the mass transfer and of this operation is well brought out.

These two volumes are outstanding in this field and present a formidable challenge to all previous chemical engineering text-books. F. H. GARNER

Selecta Hermann Weyl

(Herausgegeben zu seinem siebzigsten Geburtstag von der Eidgenössischen Technischen Hochschule in Zürich und vom Institute for Advanced Study in Princeton.) Pp. 592. (Basel und Stuttgart: Birkhäuser Verlag, 1956.) 48.90 francs; 48.90 D.M.

THIS selection from the published papers of the late Hermann Weyl was prepared by a committee of his friends: Eckmann, Hopf and Plancherel in Zurich, and Morse, von Neumann and Selberg in Princeton. Their purpose was to choose from Weyl's works whatever was of permanent and historical importance, within the limits set by the size of a single volume. Weyl himself helped them with advice and approved their choice. He also added illuminating comments to some of the earlier papers, explaining how he came to write them and how his feelings about them changed in the light of later history. The volume was prepared for Weyl's seventieth birthday, and an advance copy was handed to him at the official celebration in Zurich. The public edition, appearing now after his death, will serve as an altogether fitting memorial to him.

Nineteen papers are reprinted, covering all Weyl's major interests in physics and mathematics. There is a bibliography of those which were left out. The well-known classical papers are all here. The reviewer started reading, not the famous papers, but those he had never heard of before. The same procedure is recommended to others. Every paper is then a surprise, filled with fresh insights and unexpected beauty.

Tragic Safari

By Albert Mahuzier. (Translated by Alec Brown.) Pp. 144+16 plates. (London: Elek Books, Ltd., 1956.) 16*s*. net.

THIS book is an account of a trip to French Equatorial Africa to make colour films of wild animals, especially at night by flashlight. All the plans went wrong, and the white hunter was mauled by a lion and bled to death for lack of proper 'first aid'. The author has unusual ideas about filming animals in the field: he apparently aims at getting his pictures after the white hunter has mortally wounded the victims, or after he has caught a leopard in a 'panther trap', an enormous gin anchored to a log of wood. Some of the illustrations of animals show living, tame, captives; the rest are portraits of corpses. The translation is poor and full of gallicisms; the translator has not bothered to find the English equivalents of many of the French names of animals so that the text speaks of the guib, bubale, cephalophus, potamocherus, and so on. The value of the book may be judged by the caption beneath a photograph of the body of a warthog; it informs the reader that the picture shows a "dead rhinoceros".

The blurb on the jacket says "It is Mahuzier himself who gives us 'the loveliest girl of Maripanda', her beater raised in one hand, while the fingers of the other caress the taut tom-tom skin to produce the intoxicating double-rhythm". Reference to the picture, however, shows "the belle of Maribanda" pounding mealies in a wooden mortar with her free hand on the edge to prevent the contents spilling as she reduces them to meal. Further comment is needless. L. HARRISON MATTHEWS

Advances in Catalysis and Related Subjects

Edited by W. G. Frankenburg, E. K. Rideal and V. I. Komarewsky. Vol. 7, 1955. Pp. xi+362. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1955.) 9 dollars; 72*s*.

THIS volume contains a series of monographs having as their general theme the nature of the chemical bonds formed between catalysts and adsorbed substrates, special attention being paid to electron-transfer processes involved in chemisorption on the surface of metals and semiconductors. Summaries are given of newer techniques for the study of chemisorption, including the use of the field emission microscope, by means of which it becomes possible to see images of individual molecules and to obtain valuable information on their constitution and configuration in the adsorbed state. In this way, a stage has been reached at which changes in state on adsorption can be followed by experimental observation.

Good reviews are also given of the theory of chemisorption and of modern high-vacuum working with clean surfaces. In the case of adsorption and catalysis on metals, it is perhaps a little unfortunate from the point of view of practical catalysis that this necessary provision of a clean adsorbing surface involves the use mainly of tungsten, which can easily be cleaned by high-temperature desorption but which is not a good catalyst for reactions such as general catalytic hydrogenation. However, this is unavoidable; and the results obtained with tungsten can in many cases, although with some presumption, be applied to good general catalysts such as platinum.

The book is to be recommended. There is, in parts, some overlap in the matter presented in individual sections, but this is incidental and indeed conducive to clarity.

E. B. MAXTED

The Dorset Coast

A Geological Guide. By G. M. Davies. Second edition. Pp. vii+128+7 plates. (London: Adam and Charles Black, Ltd., 1956.) 9*s.* 6*d.* net.

THE appearance of a second edition of "The Dorset Coast" will be welcomed alike by the amateur and professional student; to quote from the preface to the first edition, "it enables the lone hunter to find his quarry without having to refer to the scattered literature on the subject". The format of the book remains unchanged, a feature being the division of the coast into western, central and eastern sections, with numerous day excursions based on Bridport, Weymouth and Swanage, respectively. The author's extensive experience of conducting geological expeditions, as well as the breadth of his knowledge, are placed at the reader's disposal, so that the resulting guide-book presents a fascinating picture of a coast-line where "the beginner sees folds and faults as clearly recognizable as in text-book diagrams, while the advanced student finds many problems still inviting investigation".

The plates have been carefully chosen and are well produced; the frontispiece to this new edition contains striking views of Lulworth Cove and Stair Hole. The maps and diagrams supplement the text and include appropriate tables of strata and zones of fossils. In particular, the diagrammatic sections which illustrate the various excursions greatly assist in the identification of strata.

The young and active of all ages will find in "The Dorset Coast" a happy combination of serious study and stimulus to exploration, which will enrich and repay a visit to one of the finest stretches of English coastal scenery.

Flore des Spermatophytes du Parc National Albert

3: Monocotylées. Par Dr. Walter Robyns, avec la collaboration de Roland Tournay. Pp. 571 (76 plates). (Bruxelles: Institut des Parcs Nationaux do Congo Belge, 1955.) n.p.

THE third volume of the Flora of the Albert National Park in the Belgian Congo maintains the high tradition set up by the two former volumes. The production of the volume is of a very high standard, the printing being excellent, and the botanical treatment is that to be expected from a botanist of Prof. W. Robyns's international reputation.

The present volume is concerned with the monocotyledonous plants of this vast area, lavishly illustrated by excellent line-drawings and half-tone plates. Without doubt this work will find a place in all institutions concerned with the vegetation of Africa, and it can be recommended to the numerous visitors to one of the show-places in the Belgian Congo.

N. L. BOR

Reports on the Progress of Applied Chemistry

Vol. 39: 1954. Pp. 1125. (London: Society of Chemical Industry, 1955.) 60*s.* (40*s.* to members).

PRINTING difficulties have not, fortunately, greatly delayed the appearance of this well-known yearly expected survey of applied chemistry. The publication by the Society of Chemical Industry of this comprehensive and authoritative annual review is the result of a remarkable effort of collaboration by the hundred or so contributors, the indexers and the editor.

In these days, applied chemistry has wide ramifications among related sciences, and one finds in these pages sections on antibiotics, on the control of agricultural and horticultural pests, on general microbiological processes and on toxicological hazards; although, as one would expect, attention is mainly given to such topics as acids, alkalis and salts, metals, fuels, tar, petroleum, organic chemicals, intermediates and drugs, to mention only a few. Indeed, all aspects of applied chemistry are covered in sections of appropriate length, and the usefulness of the compilation is enhanced by the provision of very extensive bibliographies with each section (that on petroleum, for example, has five hundred references to original literature) and a detailed subject index for the work as a whole.

Every chemical library will need this volume; every active chemist, no matter what his speciality, will find it a source without rival of digested, up-to-date knowledge.

Ciba Foundation Symposium on Porphyrin Biosynthesis and Metabolism

Edited by G. E. W. Wolstenholme and Elaine C. P. Millar. Pp. xii+308. (London: J. and A. Churchill, Ltd., 1955.) 30*s.* net

THE Ciba Foundation symposium on porphyrin biosynthesis and metabolism in February 1955 covered a wide field of biological interest. About one-third of the nineteen papers dealt with the biosynthetic pathway in hæm synthesis and the role of δ-aminolævulic acid, porphobilinogen and porphyrins in hæm formation. A paper on the succinate–glycine cycle stressed the view that the formation of δ-aminolævulic acid represents a major aspect of glycine metabolism.

To the bacteriologist and plant biochemist the papers on the formation of porphyrins by photosynthetic bacteria and of porphyrins and chlorophyll in the alga *Chlorella* will be of interest. There are two papers on aspects of hæmoglobin metabolism which should prove of particular note to the hæmatologist. The reports of the properties of δ-aminolævulic acid dehydrase, of the metabolism of δ-aminolævulic acid and porphobilinogen and of the mechanisms of experimentally produced porphyria are of importance to the eventual understanding of the human diseases of porphyrin metabolism. There are also papers on the biosynthesis of hæmin chromoproteins in animal tissues, with special reference to cytochrome *c*, and also one on the synthesis of uroporphyrin II and IV.

The full reports of the lively discussions after each paper add much to the value of this book. They reveal the areas of acceptance and controversy and clearly suggest fruitful lines for further work in this rapidly developing field.

A. GOLDBERG

POWER PRODUCTION AND CONSUMPTION

THE Fifth World Power Conference took place in Vienna during June last, the only other meeting since the Second World War having been held in London in 1950. There were thus the results of six years of progress to consider. Some 275 papers from thirty-five nations, including the U.S.S.R., were presented, covering a very wide field divided for convenience into five divisions, each division being sub-divided into several sections. The classification was as follows: Division I: The Present Status and Development of Power Production and Utilization in National Economy (58 papers); Division II: Preparation and Conversion of Fuels (55 papers); Division III: Utilization of Primary Sources of Energy (137 papers); Division IV: Purification of Waste Water and Exhaust Gas (8 papers); Division V: International Co-operation in the Production and Use of Energy (11 papers). It is only possible in this review to comment briefly on the trends noticeable in the general reports covering the contents of the several papers presented in each section.

The picture presented of the relation between power consumed and the available resources of fossil fuels is on one hand encouraging, in that there has been an increase in the power consumed in the whole world, and on the other hand perturbing, in that the proved reserves of all fossil fuels show little signs of supplying economically the required energy for any considerable period of time. Estimates of fuel reserves differ, and some countries are much better off than others; but it appears as a virtual certainty that the exploitation of nuclear resources and the vast but inconvenient, and at present uneconomic, potentials of water, wind and sun will be rapidly forced upon industrial nations.

Coal production is a major problem in most countries, except in the United States, where the known reserves are 10,000 tons per capita as against, for example, 0·43 in Austria. In India and in Britain coal production has actually declined. Perhaps the most important general observation of the world coal situation which may be made is that it is the difficulty of obtaining the right type of coal for particular applications which is of greater moment than the actual quantity produced. For example, the rapid increase in steel production together with the decrease in availability of suitable coking coals are causing considerable research to adapt less suitable coal to coking methods. In 1955 pulverized coal consumption was 19 million tons in Britain as opposed to 8 million tons in 1950. In twenty years in the Federal German Republic, refuse in hard coal mines rose to 24 per cent—double its previous figure. Methods of handling, washing, cleaning and processing coal are therefore being improved as its value appreciates, and quality falls.

The use of petroleum is increasing at a greater rate than that of coal and now accounts for about one-third of the total world energy demand. An interesting point is that while the United States is still incomparably the world's largest consumer of petroleum products (53 per cent), the proved reserves of Saudi Arabia and Kuwait are together more than double those of North America.

The trend in the utilization of raw oil varies slightly in different countries. In Great Britain since 1950 there has been a decline in the proportion of oil used for petrol, a small increase in that used for diesel fuel, and a larger increase in the proportion of distillates and residuals for furnace oil; a similar trend occurred in the German Federal Republic. This was in contrast with the United States, where the percentage demand for residuals rose only slowly, while the demand for petroleum fuels and medium distillates increased briskly due to use for jet aircraft, diesel locomotives and motor fuels. There appears to be a relative increase in the use of diesel engines in all the major industrial countries, excluding Japan, where curiously there is a pronounced decrease.

The most striking development of the petroleum industry is the advance in the refining technique and the improved method of production of various grades of end-products. In particular, catalytic cracking and re-forming plants have largely replaced thermal plants. Demand for and production of high-octane motor petrols have both increased, the premium grade octane number now being greater than 90, compared with 80 in 1940. The diesel fuel situation shows less improvement, as diesel running costs are kept low by engines prepared to digest a wide fuel cut. However, desulphurization processes are likely to be improved.

The gas industry is often regarded by the general public as an obsolescent concern. In fact, this is far from the truth. The extension in the use of natural gas in those countries blessed with this resource is quite remarkable. In the United States, some 25 per cent of the total power supplied comes from combustion of natural gas. In Britain, experiments have been carried out to obtain gas from coal of high ash content directly out of the seam. It is perhaps significant that it has been found necessary to devote a complete section to the discussion of long-distance transmission of gas. Natural gas reserves are being exploited, particularly in the United States, Italy and France, and a long-distance line of some 1,100 miles has been completed in the Argentine. With such developments it may soon be feasible to transport natural gas from the Middle East oil-fields to the extreme west of Europe. It is already possible to transport cooled liquefied ethylene in railway trucks, and some authorities expect that liquid methane will be transported by tanker from the Middle East. An interesting problem, to quote the general report, will be "to find some use for this large quantity of cold which will be liberated when vaporizing the liquid methane at the place of delivery".

In countries with no natural gas supplies, the use of gas is also increasing. This is due to gas production as a by-product from the coke and oil-refining industries, and the realization that the gases from blast furnaces may be integrated into a gas grid system. Several countries are considering use for the methane obtained from mine ventilation; possibly this may be burnt in a gas turbine if the mixture is weak, or, as in the Saar, supplied to cracking plants, before feeding to the grid. The economic use of sewage gas is discussed only in a paper from Britain, where sludge gas is used to drive dual-fuel engines or gas turbines.

The fact that the percentage produced by water of the total electrical power consumed has decreased in both Europe and America, should not conceal the great advances made in the quantity of power produced hydraulically, or the improvements in that science. Most countries have made extensive investigation of their hydraulic resources. Improvements in long-distance transmission of electricity have encouraged developments of hydraulic projects distant from industrial centres. The general tendency is for schemes to be planned as multi-purpose works where flood control, irrigation or navigation benefit, in addition to the production of electric power. Data of water power available, compared with that utilized, show that while Europe, particularly in Italy, Sweden and Switzerland, is near the possible economic limit of development, less water power is produced in Africa than in any other continent, though its potential is by far the largest. The potential of South America is considered to be less than that of Europe. Experimental techniques, such as the use of models and photo-elastic analysis of dam stresses, are now more in evidence in the design stage, while during construction improvements have been rather in details and in constructional technique than in fundamentals. One feature is the popularity of underground power houses. The huge Kemano project in Canada envisages a chamber 1,146 ft. × 82 ft. × 131 ft. to house 2·4 million h.p. The capacity of the units in the larger projects has been raised; for example, Kaplan turbines of 111,000 h.p. at McNary, U.S.A., Francis turbines of 165,000 h.p. at Grand Coulee, U.S.A., and Pelton wheels of 150,000 h.p. at Kemano and Cimego, Italy. The efficiencies of machines have also risen, average figures quoted being 93 per cent for Kaplan turbines, 92 per cent for Francis turbines, 91 per cent for Pelton wheels. The maximum single-generator capacity is 160 MW. (Stornorrfors, Norway), while plants with an overall output of 100 MW. are now considered of medium size. Kaplan turbines handle heads up to 776 ft., Francis turbines up to 1,476 ft. and Pelton wheels up to 5,740 ft.

Apart from the orthodox hydraulic schemes, some progress has been made with the long discussed possibility of harnessing tides. Electricité de France intends to erect a tidal-power plant at the mouth of the Rance. Turbine and generator will be reversible, so that power may be produced both on flood and ebb tides. There are thirty-eight units, each consisting of a Kaplan turbine and alternator, the total output being 9,000 kW. Further schemes for the Chausey and Minquiers Islands are projected.

The sections on atomic energy are not quite so large as might have been expected in view of the intense interest aroused by this subject. This is probably due to the short interval since the end of the International Congress on the Peaceful Uses of Atomic Energy held in Geneva last year. In view of the evident shortage of world coal and oil supplies, the importance of the discovery of large resources of fissile material cannot be over-emphasized. It can scarcely be expected that these resources have been determined to even a fraction of the degree of accuracy to which those of petroleum and coal are known. Nevertheless, conservative estimates suggest that the energy available, even with relatively low station efficiencies of 18 per cent, is at least an order greater than that from fossil fuel resources.

The state of reactor design would appear most satisfactory: precisely because no one type has yet been shown to have decisive advantages. Thus many variations are under construction or in use in a single country. Broadly, reactors are of two types, the heterogeneous reactor, in which rods of the fuel element are distributed throughout the moderator and a coolant is passed through the reactor core, and the homogeneous reactor where the fuel and moderator are intimately mixed, for example, as a solution, the solution itself being circulated through a heat exchanger. Within this broad classification many important differences of design may arise. It is, for example, by no means clear what are the most suitable combinations of moderator and coolant, or what is the better choice between thermal and fast reactors. In Britain, the Calder Hall Station uses natural uranium with a graphite moderator and compressed carbon dioxide as a coolant. This type of reactor suggests a relatively low cost per kW. output and a high safety factor, an over-riding consideration in a densely populated country. Graphite reactors with water and liquid sodium cooling are in use in the U.S.S.R. and the United States. Water may be used as both moderator and as coolant and, if allowed to boil, may be fed directly to a turbine. In the United States, a boiling-water 2-MW. plant is in operation, a 5-MW. plant under construction and a 180-MW. plant planned. Fast reactors are also undergoing development; but no report on their progress was submitted to the Vienna Conference.

After further development, homogeneous reactors are likely to be as popular as the heterogeneous reactors; they have certain technical advantages, but to cope with the high pressures at which they must operate to ensure good thermodynamic efficiency and to provide them with heavy water solvent or enriched uranium, the capital cost is high. Both the United States and the Netherlands are carrying out such development.

The main problem in the application of the reactor to power production is the low temperatures which can be withstood by the constructional materials of the reactors while still preserving low neutron absorption and hence fuel economy. The problem is largely a metallurgical one, and progress is being made. The attention paid to building nuclear power stations varies directly with the degree of a nation's industrialization, and with the scarcity of its available reserves of fossil fuels. It is thus not surprising to find Britain in the forefront of commercial development with a proposed programme of twelve plants of a maximum possible output of 2,000 MW. by 1957, and that by 1975 it is planned that equal amounts of electricity shall be yielded by coal and atomic plants. International opinion differs as to the desirability of producing atomic power. The correct solution must depend upon the local economics. The situation in Britain, where coal production is on the decline, must involve an entirely different solution from that in the United States, where in some cases it is only economic to exploit 55 per cent of a coal seam, so plentiful are reserves.

Whatever the form of thermal energy producer most economic in the future, the energy produced will be largely utilized as electrical energy. In Europe (not including the U.S.S.R.) there seems to be an annual increment of 8 per cent in the electricity consumed, which suggests that the electrical output may about double itself in a decade. The demand for electrical energy, 5 per cent of the total energy demand in Europe, is rising at almost twice the rate of the total energy demand. Excluding the U.S.S.R., China and Eastern Europe, the 1954 index was 137 units compared with 100 in 1948.

There is, therefore, more than ever a widespread interest in thermal power stations, of which the turbines and generators at least are likely to be the instruments of power conversion from nuclear reactors. With the decrease in availability of coals, it is becoming essential that power stations shall generate at the maximum efficiency and thus steam-plant design is becoming more complicated. Multiple reheat and bleed-steam preheating systems using up to nine stages are being applied, more perhaps in the United States than in Europe, to approach more closely the Carnot cycle.

A whole section was devoted to the construction and operation of steam boilers. In the search for higher efficiencies, steam generating temperatures have risen by 18° F. per annum, the maximum value now being about 1,200° F., a temperature at which austenitic steels must be used. Below this a gap in the range exists, the maximum temperature feasible for ferritic steels being about 1,000° F. Operational pressures have risen to very high figures, especially when reheat is introduced; two commercial examples are 1,150 and 2,850 lb. per sq. in., while experimental plant uses up to 5,000 lb. per sq. in. Average boiler capacities have risen to between 450,000 and 900,000 lb. per hr., with some boilers generating 2,400,000 lb. per hr. Boiler efficiencies of 90 per cent are reported and availability is nearly 100 per cent. Boiler systems are largely orthodox, of the natural circulation drum type, but forced circulation monotube boilers are used to an increasing extent, particularly on the Continent of Europe. Design of boilers is also being influenced by the necessity for burning inferior coals with their more acute flue cleaning and ash disposal problems. One new method of cleaning the convection heating surfaces on load is to pour small steel balls over the tubes, and collect them in the ash hopper, where they are removed from the ash and cleaned.

Steam boilers appear to be in their heyday, possibly at about the stage of development of the reciprocating engine in the year 1900. No doubt bigger and better boilers are yet to come; but, to quote the general report, "it seems that developments in the field of atomic energy will outdate endeavours towards a further improvement in existing methods of power generation". Steam generation by nuclear reactor heat is the problem of the immediate future. The temperatures available are unfortunately low, 500° F. with water-cooled, possibly 750° F. with sodium-cooled fast breeder reactors. It is suggested that compound plants where superheating is accomplished by oil firing may be evolved.

Many other aspects of power generation are treated by one or more papers. Developments in the use of solar energy—never of great concern in the temperate zone—have progressed to some extent; but direct use of the sun's heat is still inconvenient and usually uneconomic. Even in India the preference of an oriental population for preparing their meals in the evening has reduced the sale of solar cookers. Heat pumps and fuel cells, the latter of great academic interest, are discussed in British papers, while complete sections are devoted to statistical compilation of data, purification of industrial effluents, and the technical and economic aspects of international co-operation.

The tremendous field covered at the Conference must be apparent from the number of papers presented by thirty-five countries. It is inevitable that somewhere the field must be bounded and that all the field may not be covered in the detail some would wish. For example, the application of power to transport, the developments of gas turbines and diesel and free-piston engines are only briefly considered. It is also disappointing that more attention was not given to the reminder of the president, Sir Harold Hartley, who said in his address: "Food is the most urgent need of the world to-day and I would ask you if we are devoting enough thought to the place of power in agriculture as compared with the emphasis we place on industry. . . .".

Generally, the tone of the Conference was optimistic, in spite of the shadow cast by falling fuel resources: the tone seems to be one of certainty that more and more power will be needed, combined with an equal certainty that a wider search for power reserves, coupled with a more effective use of known resources, and development of nuclear reactors, will provide that power. Finally, a word in praise must be said for the general reports summing up the proceedings of each section. These are admirably translated into French, German and English, and are remarkable for their concise and balanced interpretation of the mass of technical data presented. They are worthy of an international conference, which presents a remarkably clear picture of present-day practice and of the directions in which scientific research in power production is leading.

F. D. Robinson

ANIMAL REPRODUCTION

THIRD INTERNATIONAL CONGRESS IN CAMBRIDGE

The Third International Congress on Animal Reproduction, attended by more than five hundred representatives of no fewer than fifty different countries, was held in Cambridge during June 25–30. The proceedings were conducted in three sections, devoted to physiology, pathology and artificial insemination, respectively. About one hundred and fifty papers were presented, many of which were concerned with the practical aspects of animal-breeding, clinical problems, and technical advances in the methods of semen storage and artificial insemination. A noteworthy feature of the Congress, however, was the relatively high proportion of papers of more general scientific interest, dealing with the physiology of mammalian gametes and the early stages of embryonic development. The growing impact of two fundamental sciences in particular, namely, biophysics and biochemistry, on research in the field of animal reproduction, was specially evident from the nature of the Congress exhibits and demonstrations, many of which were provided by the scientific staffs of the Agricultural Research Council Unit of Reproductive Physiology and Biochemistry and other departments in the University of Cambridge.

A large number of original contributions dealt with semen physiology, bearing witness to the impressive advances in this field, which continues to expand in several directions. One of these concerns sperm morphology and motility; here the advent and perfection of powerful aids to research, such as electron and phase-contrast microscopy, photography in ultra-violet light, the application of fluorescent dyes, and a steady improvement in staining methods which permit the differentiation between live and dead spermatozoa have all helped to open up new possibilities towards the elucidation of the finer structure of spermatozoa. As a result of these studies, much has been learned in recent years about the fibrillar structure of the sperm-tail in relation to sperm motility, and the properties of the acrosome in relation to the 'cold shock' and other phenomena associated with senescence changes in spermatozoa. A second line along which research on spermatozoa has been rapidly developing relates to the survival of sperm cells at very low temperatures. Much of this research was inspired by the observation, made a few years ago, that better sperm survival can be achieved when semen is frozen in the presence of glycerol. The same approach has now been extended to the tissues of the gonads themselves. In addition to several communications on the practical application of glycerol in low-temperature storage of bull semen, two papers dealt with the broader physiological aspects of cellular damage resulting from freezing and with the principles underlying the ability of gametes and grafted gonadal tissues to survive in the frozen state. Yet another line along which progress in sperm physiology is being vigorously pursued is the biochemistry of semen. This was quite obvious from the large number of contributions on such problems as the incorporation of radioactive elements into the male gamete, the relation of respiration and fructolysis to sperm motility, the function of seminal hyaluronidase, and the role of mineral constituents in semen, particularly that of potassium ions which, judging from no less than three independent studies, play an important, hitherto largely disregarded, function in eliciting sperm movements.

One of the outstanding problems in reproductive physiology concerns the mechanism which enables the spermatozoa to traverse the female reproductive tract before reaching the site of fertilization, and in this connexion much work has been carried out in recent years on the metabolic processes associated with sperm movements. An important aspect of that research is the elaboration of methods for measuring sperm motility. Several valuable methods have been evolved in recent years; but there is still room for new objective and quantitative procedures. At least one more such technique was reported upon at the Congress, involving the use of a photo-electric cell for registering the movements of single spermatozoa. Strong evidence, however, is steadily accumulating which indicates that apart from motility inherent in the sperm cells, there are other factors which facilitate sperm transport in the female reproductive tract. There is much to show that spermatozoa do not depend entirely upon their own motility but are, in addition, propelled, as it were, by the concomitant contractions of the uterus. These uterine movements, judging from papers presented at the Congress, are dependent on the co-ordinated action of the neurohypophysis and hypothalamus. Another phenomenon frequently discussed during the Congress was the so-called sperm-capacitation, which appears to depend on certain peculiar, but as yet poorly understood, changes taking place in spermatozoa before they reach the site of fertilization, and enhancing the fertilizing capacity of the sperm cells.

Whereas the advanced stages of gestation have long been the target of choice for physiological research, data on the mammalian egg and the pre-implantation or near-implantation phases of mammalian pregnancy continued to be rather scarce until recently. However, now that methods for the transfer of mammalian eggs from a donor to a recipient have been greatly improved upon, it is possible to apply these techniques to the study of fertility and the development of normal and abnormal ova in the female reproductive tract. Several speakers dealt at some length with the manifold aspects of the technique of egg transplantation, chiefly in the sheep and the rabbit. Research in this field seems to concentrate largely on perfecting the existing means for preservation of mammalian eggs *in vitro*, and the elaboration of new techniques which would dispense with the need for laparotomy during the transfer of eggs. Results of fruitful research on the physiology of the mammalian egg were presented to the Congress in several communications, some of which dealt with the biochemical relationship between the early embryo and the uterine environment, whereas others described measurements of oxygen uptake by rabbit ova at different stages of development. Varied aspects of reproductive physiology covered by speakers included also attempts at determining the content of oxygen in the Fallopian tubes of the rabbit, and new findings on certain rheological and spectrophotometric properties of secretions collected from the female reproductive tract.

A large group of papers presented at the Congress dealt with the nutritional and hormonal aspects of animal reproduction. Several authors pointed out that the two principal functions of the male and female gonad, namely, the gametogenic and endocrine activity, are by no means equally sensitive to a given nutritional deficiency, and that in many instances, particularly where certain vitamins, proteins and minerals are concerned, the hormonal function of the gonads is affected earlier than gametogenesis. Much useful information on the role of nutrition and hormones in reproduction has been forthcoming from studies of monozygous twins. Two new chemical methods of tackling the problem of malnutrition in reproduction were communicated: one based on the analysis of semen collected from twin bulls, for the assessment of nutritional factors which control the secretory activity of male accessory organs; the other involving the analysis of the mineral content of hair samples taken from the poll region of cattle to serve as an indicator test for an early diagnosis of certain mineral deficiencies.

Among clinical problems fully discussed at the Congress, two received particular attention, judging from numerous communications, namely, the deleterious effect of certain infections (brucellosis, *Vibrio foetus*, *Trichomonas foetus*) on animal reproduction, and the occurrence of genital malformations as a cause of infertility.

T. MANN

THE PHYSICS OF SEMICONDUCTOR SURFACES

SURFACE physics has not usually been thought of as a particularly exact science. The experimental difficulties in obtaining meaningful measurements under well-controlled chemical conditions, and the theoretical difficulties of proceeding beyond a mere thermodynamical description to an atomistic, quantum-mechanical one, have alike tended to keep surface physics on the by-ways of science. It is, nevertheless, a field which is of growing importance, in physical science, in biological science and in technology. A measure of the progress recently gained may be gathered from the scope of a conference on the "Physics of Semiconductor Surfaces", held in Philadelphia last June. The conference, which was sponsored by the Office of Naval Research, Lincoln Laboratories, and the University of Pennsylvania, included representatives from Canada, France, Germany, Great Britain and the Netherlands, as well as the United States. Although much of the conference was devoted to the surfaces of silicon and germanium, there were contributions from chemists in the fields of oxidation and catalysis. The papers presented at this conference are to be published in book form in the near future by the University of Pennsylvania Press. In the meantime, a brief review of the conference, and a few comments on one or two of the papers—picked almost at random—will be given in this short account.

Two things have helped to promote progress in surface physics during the past ten years. One is the development of techniques for carrying out experiments in ultra-high vacuum. An atomically clean surface, kept in a vacuum of 10^{-10} mm. of mercury, should have a monolayer adsorption time of several hours—long enough to perform detailed measurements on it. The other stimulus—and the one more immediately responsible for the promotion of the Philadelphia conference—has come from the invention of the transistor and, with it, the availability of germanium and silicon in a state of very high purity. This means that one can now carry out experiments on a surface system in which it is possible to change the electrochemical potentials of holes and electrons at will by known amounts. It also means that, because the surface space-charge region extends relatively far into the semiconductor, the several contributions to the overall variation of electrostatic potential across the interface may each be determined quantitatively. The ability to distinguish the different parts of the surface dipole has hitherto been lacking in the analysis of solid–gas surface systems, although there is a rough analogue in electrochemistry, in the measurement of zeta potentials. The material presented at the conference affords a good illustration of these developments.

Many of the papers dealt with surfaces of germanium and silicon, as prepared by etching and maintaining in some gaseous environment. Here the physicist can make detailed measurements on the positions of electronic energy-levels associated with the surface, and of transition probabilities between these levels and the interior of the semiconductor. The physicist distinguishes between 'fast' and 'slow' states. The 'fast' states, characterized by relaxation times of less than a microsecond, must be associated with the actual germanium or silicon surface; the 'slow' states have relaxation times of the order of a second or longer and, in the present state of knowledge, are imagined to be associated with the oxide layer. Several papers gave quantitative information on the distribution of the 'fast' states in the forbidden energy gap, and on the capture cross-sections for these states. The most valuable experimental tools here are the effects of applying a high electric field in a direction normal to the surface, and of illuminating it. Other papers dealt with the 'slow' states and the probable connexion between these states and ($1/f$) noise.

All these experiments suffer from the drawback that the chemical constitution of the surface region is almost completely unknown, and largely uncontrollable. Many workers have therefore tackled the problem of carrying out similar measurements on an atomically clean surface, and then allowing various impurities to be deposited upon it, so that the effect of each one may be studied. P. Handler reviewed the experimental results obtained by the Farnsworth technique of ion bombardment and annealing in ultra-high vacuum. The most outstanding conclusion here is the unexpectedly high surface conductivity found after the surface has been prepared in this way. It was generally agreed that the Farnsworth surface is p-type, becoming less so as the surface is exposed to reasonable amounts of oxygen. There is quite good agreement between the findings of the various research teams working in this field. These facts, if they do indeed refer to the properties of an atomically clean surface, are of the highest importance, because this is the only case so far for which it has been possible to give anything approaching a respectable theoretical discussion. The theory of surface states was discussed by C. Herring, who directed attention to the Tamm and Shockley states associated with a perfect semiconductor–vacuum interface, and to the various kinds of level arising from surface impurities and imperfections.

Turning to matters of chemical interest, there was an excellent series of papers on the electronic aspects of catalysis. K. Hauffe discussed his work on the effects of the surface space-charge region on catalysis at semiconductor surfaces. G. M. Schwab presented a selection of experimental results, some of them obtained with germanium—which, he said, is not a very good catalyst, but illustrates the consequences of the theory quite nicely. The final session of the conference was devoted to surface oxidation, including a discussion of nucleation effects, by N. Cabrera, and several papers on the surface oxidation of germanium under various conditions.

The general level of the papers and discussions was exceptionally high, and most people seemed to feel that both the formal and the informal activities at the conference were profitable and stimulating. Surface physics is in a very exciting state of growth at the moment, and, if the purist views the current heavy emphasis on silicon and germanium with a somewhat jaundiced eye, he may take comfort in the expectation that the techniques and understanding developed with these materials will be of direct usefulness in the study of other surface systems.

C. G. B. GARRETT

OBITUARIES

Prof. E. J. Friedmann

PROF. ERNST JOSEF FRIEDMANN died in Cambridge on July 19 at the age of seventy-eight; he was working in his laboratory on the previous day. Born in Berlin and educated at the College Royal Français, he studied at the Universities of Freiburg im Breisgau, Berlin, Würzburg, Leipzig and Strasbourg, and took the degrees of Ph.D. in 1902 and M.D. in 1905 at Strasbourg. During 1905–7 he was a member of the staff of the Institute of Physiological Chemistry in the University of Strasbourg. There he worked under Prof. Franz Hofmeister, to whose influence he attributed much of the success of his career and in whose laboratory he acquired his characteristic meticulous care in all matters of practical technique in the highest tradition of the German school. In 1907 he went to Berlin as head of the Department of Physiological Chemistry at the First Medical Clinic of the Charité, with the title of professor in the Medical Faculty of the University. During the First World War, he directed (1915–18) the Bacteriological Laboratory of the German Army in Brussels. In 1930, he went to Moscow as professor of biochemistry but left after six weeks. He then went to Basle and worked at the Institute of Physiological Chemistry of the University.

In 1932 Friedmann came to Britain to work in the Department of Biochemistry in Cambridge with Sir Frederick Gowland Hopkins. Shortly afterwards his wife was taken seriously ill and died after a long illness, during which everyone was most impressed by his devotion to her. He remained in Cambridge not only because the political conditions in Germany made it impossible for him to return, but also because he had found a congenial atmosphere in Cambridge where Sir Frederick Gowland Hopkins had befriended him and encouraged him to continue to work in his Department. In 1941 he joined a research team engaged in work of national importance for the Agricultural Research Council. In 1946 he came to the Department of Radiotherapeutics of the University of Cambridge, where he worked until his death.

Friedmann's first paper was published in 1900 and he continued active research from then until the end of his life. Many of his papers are now classical, including two papers, "Über die Konstitution des Cystins" (*Bei. chem. Physiologie u. Pathologie*, 3, 1–46; 1902), and "Die Konstitution des Adrenalins", (*Bei. chem. Physiologie u. Pathologie*, 8, 95–120; 1906). He then wrote a series of twenty-five papers under the general title "Zur Kenntnis des Abbaues der Karbonsaure im Tierkörper" published between 1908 and 1914 in the *Beiträge zur chemischen Physiologie u. Pathologie*, which during this time became the *Biochemische Zeitschrift*. Among his other earlier papers, Dr. Friedmann regarded as the most important those dealing with the constitution of mercapturic acids, the synthesis of *iso*leucine, the synthesis of surinamine and the formation of ketone bodies.

In Cambridge he started to publish papers on the chemistry of œstrogenic substances. The first of these was a letter in *Nature* (135, 622; 1935). At the same time his interest in sulphydryl compounds first appeared. His book entitled "Sterols and Related Compounds" arose from three lectures which he had given at the Institute of Biochemistry in Cambridge and was published in 1937. These lectures and the book had a great influence.

It was characteristic that Friedmann always kept in touch with the most recent work and modern approach and methods, as exemplified by his studies of radioactive organic bromo-compounds published in collaboration with A. K. Solomon and N. T. Werthessen in 1939. At that comparatively early stage he had already perfected methods for labelling organic compounds with radioactive halogens and advocated their use in biological research. Since 1946 he has published an interesting series of papers on anti-mitotic agents, particularly of the quinone series, which as a rule were tested on tissue culture. These papers were mainly written in collaboration with Mrs. I. Simon Reuss and Dr. D. H. Marrian.

Most of us knew him only after he came to Cambridge; but we soon saw in him not only a great scientist but also a man of wide cultural background. Brought up in Berlin as the son of a wealthy banker during an era which was famous for its gracious living, he had a great appreciation of beautiful things. His main interests, outside his work, were books, antique furniture and Chinese art, and concerning these he had a tremendous fund of knowledge. He also liked to read detective stories when he felt too tired to work at night. Life had dealt him disappointments, but he never complained and never became embittered. His old-world courtesy was one of his most charming assets. He was always especially kind to younger workers, and never hesitated to spend a great deal of time discussing their work and helping them with their problems from his vast experience and enormous knowledge. He died in harness and, to judge by the vast amount of unpublished experimental data which he left, as active as ever. He leaves a host of friends who will cherish his memory.

J. S. MITCHELL

Mr. T. D. Bourdillon

THOMAS DUNCAN BOURDILLON met his death on July 29 while climbing in the Swiss Alps. He had established a world-wide reputation both for his skill as a mountaineer and his more specialized achievements in the art of rock climbing. Through the writings of others he became well known to the general public as a member of several Himalayan expeditions, of which the last was the successful one led by Sir John Hunt in 1953. His contribution to this success lay not only in his inclusion as one of the strongest members of the climbing party, but also in his preparatory researches and development work on the oxygen equipment used, which has been described in the *Proceedings of the Royal Society*, B, 143, and in the *Alpine Journal*, 59.

From Gresham's School, Holt, Bourdillon went up to Balliol College, Oxford, in 1942, and was in residence there until June 1944, at which time he joined the Army. From then until April 1948 he served in Greece and Egypt, and returned to Oxford in October 1948, where he read the honours course in physics and received his degree in June 1950. On coming down from Oxford he joined the Ministry of Supply and was appointed as an experimental officer to the Royal Aircraft Establishment, Westcott, where he worked on problems connected with rocket propulsion.

During 1951, 1952 and 1953, he was given leave of absence, to participate in the two preparatory Himalayan Expeditions which culminated in the successful one in 1953. Since that time he has been engaged fully on his rocket work and has made a notable contribution to our understanding of the phenomena of combustion of solid propellants. Although primarily a skilled experimental physicist, he possessed considerable practical engineering ability which stood him in good stead when acting as project officer responsible for the overall development of particular rocket motors. His work at Westcott portrays those innate characteristics which were so ably demonstrated in his mountaineering achievements, namely, scrupulous attention to detail, careful deduction and intellectual honesty.

No doubt Bourdillon will be remembered as a mountaineer first and foremost; but among his colleagues at Westcott there will remain the respect for a man of great personal integrity and a genuine modesty.

He leaves a widow, Jennifer, who shared fully his interests in mountaineering, and two young children.

J. E. P. Dunning

Mr. and Mrs. John Nicol

Mr. John Nicol, officer-in-charge of the Ibadan Sub-station of the West African Cocoa Research Institute, died from injuries received in the air disaster at Kano, Northern Nigeria, on June 24; his wife, Mrs. Bessie Nicol, was killed instantly. They were travelling on leave and to a re-union with their only child, Sheila, who is at school in Scotland.

The details of Nicol's complete career at present available to his colleagues in West Africa are meagre; but records reveal that he was born in 1911 and he graduated at the University of Aberdeen with a B.Sc. degree in forestry. After working for some years with the Department of Scientific and Industrial Research in the United Kingdom on the pests of stored products, he came out to the West African Cocoa Research Institute, Gold Coast, a few weeks after its inception in 1944. He was afterwards promoted to senior entomologist and was posted as officer-in-charge of the sub-station in Nigeria of the Institute in December 1954.

John Nicol's early work in West Africa was concerned with measures for the control of cacao capsids. Later, he became associated with trials concerned with the possibilities for controlling the spread of cacao swollen shoot virus by attack on the mealybug vectors with systemic insecticides.

As a founder-member of the staff, John Nicol had much to do with fostering the social life at Tafo, and with these activities, later extended to Ibadan, Bessie Nicol must be closely identified. The construction of the club, the tennis courts and the golf course (the latter being coupled with a malaria-control project) were all, in considerable measure, due to his enthusiasm.

'Nick', as he was widely known, was a talented photographer, his ability being recognized by election to the associateship of the Royal Photographic Society. Many of his photographs of cacao, its pests and its diseases have been published in technical papers by himself or his colleagues.

As officer-in-charge of the Ibadan Sub-station, John Nicol was faced with many difficulties. His gift for making friends and marshalling facts into convincing arguments enabled him to make considerable progress in establishing and equipping a new laboratory and staff accommodation. His untimely death is a severe blow to the progress of cacao research in Nigeria.

James Lamb

NEWS and VIEWS

Physical Chemistry in the University of Sydney: Prof. A. E. Alexander

Prof. A. E. Alexander has been appointed professor of physical chemistry in the University of Sydney. Prof. Alexander was educated in the Universities of Reading and Cambridge. He began research in Cambridge in association with Sir Eric Rideal and quickly became well known for his contributions to surface and colloid chemistry. During 1939 he worked with Prof. T. Teorell, of Upsala, with a Rockefeller travelling fellowship. On his return to Cambridge he became a Fellow of King's College and, in 1944, assistant director of research in the School of Colloid Science. Prof. Alexander went to Sydney in 1949 as the foundation professor and head of the School of Applied Chemistry in the New South Wales University of Technology, in which he is now dean of the Faculty of Science. He has taken a full part in the scientific life of Australia, having been president of the New South Wales Branch of the Royal Australian Chemical Institute, and of the Sydney University Chemical Society. He is a trustee of the Australian and New Zealand Association for the Advancement of Science, which selected him as the Liversidge Lecturer for 1954, and one of the two representatives in Australia of the Chemical Society of London. He has established excellent relations with the Commonwealth Scientific and Industrial Research Organization and Australian chemical industry. Prof. Alexander's many research papers and books on surface and colloidal science have brought him well-deserved international recognition. His present range of scientific interests—the pure physical chemistry of problems underlying various biological actions—will add welcome strength to the University of Sydney.

Electronics in Armament Research and Development: Mr. E. W. Chivers

Mr. E. W. Chivers, who has been appointed principal superintendent of the Electronics Division of the Armament Research and Development Establishment, graduated in physics (special) with honours in 1927 at Queen Mary College, London. After a short period of postgraduate research, he entered Government service in 1928 and went to the Research Department, Woolwich, where he was engaged on acoustical research in connexion with sound ranging. In 1931 he was transferred to the Searchlight Department at the Air Defence Experimental Establishment, Biggin Hill. His work there was concerned with physical problems associated with searchlights and their use, later extending to problems of searchlight design and automatic control. In 1940 he was transferred with the remainder of the Biggin Hill Establishment to Christchurch to join with the Army radar group which had been transferred from Bawdsey. There he became leader of the team responsible for the application of radar to the control of searchlights, the introduction of which into the Services made such a great improvement in searchlight operation. He continued in radar work when the Establishment (by then the Radar Research and Development Establishment) was transferred to Malvern, and was concerned with a number of Army radar projects throughout the War. In 1953, when the Radar Research and Development Establishment and the Telecommunication Research Establishment were combined as the Radar Research Establishment, he was promoted to deputy chief scientific officer and became head of the division responsible for ground radar for both the Army and the Royal Air Force. In 1954 he was appointed director of atomic weapons (development and production) at the Ministry of Supply Headquarters.

Reactor Conference at Harwell

The United Kingdom Atomic Energy Authority announces that a conference at Harwell will be held on November 30, at which its programme of research on advanced types of nuclear power reactor systems will be explained to representatives of British industry, and at which the salient features of the particular systems which have been chosen for investigation will be described. Accommodation will be available for about two hundred representatives from industry. Requests for further details and for reservations should be made to the Director (Industrial Collaboration Office), Atomic Energy Research Establishment, Harwell, Nr. Didcot, Berks, not later than August 31. The Authority intends that following this conference British firms wishing to do so may be kept informed of the general progress of work on these reactor systems. The information will be supplied at an annual conference on each system. Application for admission to this scheme should be made to the Industrial Collaboration Office at Harwell, from which further details may be obtained.

Medical School at the University College of Rhodesia and Nyasaland

The University College of Rhodesia and Nyasaland has appointed a planning committee to advise the College on the establishment of a medical school, and the committee will make a preliminary visit to the Federation of Rhodesia and Nyasaland next January. The committee's terms of reference are: "To advise the University College of Rhodesia and Nyasaland on the desirability and practicability of establishing a medical school as an integral part of the College; to prepare proposals for the training curriculum, postgraduate training, the research facilities, the buildings, equipment and staffing required, including those required for a suitable teaching hospital and other centres for clinical facilities; to prepare estimates of the capital and recurrent costs involved and a phased time-table for development; and to make any other proposals and suggestions for the development of medical education and research under the auspices of the College". The members of the committee are as follows: L. Farrer-Brown, director of the Nuffield Foundation (*chairman*); Prof. W. Melville Arnott, William Withering professor of Medicine, University of Birmingham; Prof. T. H. Davey, Middlemass Hunt professor of tropical hygiene, University of Liverpool; Prof. A. D. M. Greenfield, Dunville professor of physiology, The Queen's University of Belfast; Prof. P. B. Medawar, Jodrell professor of zoology, University College, London; Prof. R. Milnes Walker, professor of surgery, University of Bristol; and the Hon. Honor M. V. Smith, May reader in medicine, University of Oxford.

University Foundation of Brussels: Report for 1954–55

The thirty-fifth annual report of the University Foundation of Belgium, covering the year 1954–55 (pp. 153. Bruxelles: Fondation Universitaire), records that the Foundation made grants to 242 first-year students (of whom 45 were women), 561 to students in their second or subsequent years (105 women) and 971 grants were renewed (163 women). Of these grants, which totalled 5,843,000 francs, the great majority were at the Universities of Brussels (308), Ghent (331), Liège (269) or Louvain (653), the remainder being distributed among some fourteen other institutions, and all but thirty-six were for 3,000 francs. Students of medicine (469) received the largest number of grants, the next being engineering (253), philosophy and letters (242), science (241), commercial sciences, economics and finance (171) and law (165). Over the period 1930–55, 81 per cent of the grants were totally reimbursed. Some travel grants were awarded in 1954–55, and subsidies for scientific works and periodicals amounted to 1,984,000 francs, of which 1,559,500 francs was for periodicals. Subsidies to scientific or university associations amounted to 541,000 francs, and the report includes a list of institutions with which the Foundation has arranged the exchange of publications during the academic year and also a list of periodicals of which the Foundation has guaranteed a regular service to the scientific libraries of Belgium. In addition, statistics are included for the universities and high schools of Belgium. The number of students was 38,498, compared with 35,689 in 1953–54, and of these, 22,299 were pursuing courses in ancient humanities and 16,199 courses in modern humanities. Only 1,789 men and 646 women were taking science courses, 5,657 men and 1,152 women taking medicine or pharmacy, and 2,621 men and 20 women taking applied science, arts or manufactures.

Natural Resources, Food and Population in Inter-Tropical Africa

The International Geographical Union has published, under the title "National Resources, Food and Population in Inter-Tropical Africa", a report of a symposium held at Makerere College, Kampala, during September 10–17, 1955, with the financial support of the United Nations Educational Scientific and Cultural Organization (pp. 104. Bude: Geographical Publications, Ltd.; also Department of Geography, Makerere College, P.O. Box 262, Kampala, Uganda, 1956; 5*s*.). The president of the Union, Prof. L. Dudley Stamp, explains in a foreword that the symposium was designed to bring together workers in one of the major under-developed regions of the world and to concentrate on a study of the problems of the region. The report outlines the programme and gives the membership of the symposium, as well as summaries of the twenty-one papers read, but not of the discussions. These papers include a geographical appraisal of Buganda, by Prof.

S. J. K. Baker; Prof. L. D. Stamp's account of the World Land Use Survey in relation to intertropical Africa; land use surveys in the Sudan (Prof. J. H. G. Lebon); the physiography of south-central Uganda (J. W. Pallister); Kampala: planning background (H. Kendall); the division pattern of African agriculture in the Nyanza Province of Kenya (H. Fearn); the moisture resources of Nigeria and their utilization (Prof. B. J. Garnier); the strip fields of Southern Nigeria (W. B. Morgan); some aspects of food production in the Gold Coast (H. P. White); two types of agriculture in West Africa: their importance from the point of view of utilization of the soil (Prof. O. Ribeiro); the population of the Gold Coast (T. E. Hilton); population patterns and migrations in Sokoto Province, Northern Nigeria (R. M. Prothero); some aspects of irrigated agriculture in the Northern Province of the Sudan (Ahmed El-Sayed Osman); and the functional classification of settlements (Prof. M. Boesch). The symposium provided an invaluable opportunity for exchange of views and experiences of workers in contrasted parts of tropical Africa, and Prof. Stamp pays a warm tribute to the contribution which the work of Prof. S. J. K. Baker and his staff in the Department of Geography at Makerere College made to the success of the meeting.

Handbook on the International Exchange of Publications

THE second edition of the "Handbook on the International Exchange of Publications", edited and revised by Dr. Gisela von Busse, with the collaboration of Dr. H. Werhahn (pp. 5707. Paris: Unesco, 1956. 1,800 fr.; 36s.; 7 dollars), differs considerably from the arrangement and lay-out of the edition distributed in 1952. All addresses and references are now grouped in Part 2, which is in two sections, the first listing exchange offers of international organizations and the second outlining national exchange activities in eighty-four countries and thirty-seven territories. This section is arranged in the form of a directory and has been brought up to date as far as 1954 where the information was available. In both these sections entries are in English, French and Spanish, but Part 1 of the handbook is printed separately in English, French and Spanish. The first two chapters of this part describe the different forms of exchange and the way they are handled, including new sections on the publications of international organizations and on the exchange of the Organization for European Economic Co-operation. The third chapter, dealing with conventions and agreements for the exchange of publications, includes select lists of recent bilateral agreements for the exchange of official publications and of recent bilateral cultural agreements containing clauses referring to the distribution or exchange of publications. Like the fourth chapter, dealing with transport and customs, it essentially brings up to date the chapter in the first edition dealing with this subject. The lively demand for the first edition has shown that the handbook meets a real demand, and in its new form it should meet that demand even more effectively.

The Acquisition of Industrial Skills

EXPERIMENTS by W. D. Seymour on the acquisition of skills by operatives using capstan lathes showed that significantly better results were obtained with a part method of training only when the task contained elements which were perceptually stringent. Further experiments have now been devised to show whether such improved results arose from the use of the 'progressive part' method or whether equally good results would be achieved by merely isolating the perceptually stringent elements and training these before the whole task was attempted (*Occupational Psychol.*, 30, No. 2; April 1956). The learners were six boys and nine girls aged between 15½ and 18 years; all, except one, came from secondary modern schools. None had previous experience of the job chosen for the researches. They were separated at random into three groups, each of which was taught in a different way. One was shown the whole series of operations on a capstan lathe and then practised it as a whole until it could be carried out correctly in a given time. Another group, spending the same total time on learning and practising, did not tackle all the operations until it had practised first one and then a second particularly difficult operation, and could do each quickly and correctly in isolation. The third group, having the same time to learn, practised each operation separately, then combinations of some of the operations and finally the whole series. The first group was found to learn more slowly than the others; but there was no great difference in the time taken by the second and third groups. These results provide further evidence that the primary difficulty in acquiring speed skills in industrial tasks lies in the perceptual rather than the motor field.

Early Palæolithic Sites of Markkleeberg, near Leipzig

A PUBLICATION by the American Philosophical Society on "The Lower Palæolithic Site of Markkleeberg and other Comparable Localities near Leipzig" (*Trans. Amer. Phil. Soc.*, New Series, 45, Pt. 6 (1955); pp. 509–688; 2 dollars), by Rudolf Grahmann, is an account of the early Palæolithic sites of Markkleeberg that is of especial importance as the collections on which it is based were largely destroyed during the Second World War. One can no longer consider cultures as universal, even those occurring as early as Lower Palæolithic times. Already there were provinces where different cultures existed, and a different succession came about. The coup de poing culture, for example, occurs from South Africa to Western Europe, but scarcely exists east of the Rhine, where its place is taken by various cultures the tools of which were made from flakes instead of from cores. It is a commonplace that every generation likes to disprove the ideas of their forbears, and the Rhine frontier hypothesis has been recently criticized; but the present publication entirely backs it up. Only one coup de poing has been found among thousands of tools, and it was so poorly fashioned (judging by the illustration) as to be scarcely worthy of the name. All the tools found were made on flakes, and the industries are to be classed as flake-tool industries. Rudolf Grahmann comes to the conclusion that, geologically speaking, the industries that have been found date to the Mindel–Riss and to the Riss–Würm interglaciations. The earlier of these may well be the period of the famous Mauer jaw. Almost all the artefacts found are made from Baltic flint transported to the Leipzig region by the Mindel ice. Some of the material is grey and some of it black. The collections are classified, and a number of distinct types of tools and flakes distinguished. About half the publication is devoted to descriptions and to the illustrations, which are well drawn and give an excellent impression of the industries. The author is to be congratulated, and Dr. Hallam L. Movius, jun., who edited it, and the American Philosophical Society are to be thanked for the production of a very important publication which fills a gap in our knowledge of early Palæolithic cultures in the Leipzig region.

A Barking Crayfish

AN unusual example of a 'barking' crayfish has been reported from Newcastle, Australia (*Austral. Mus. Mag.*, 12, No. 2). Only one other example of the species (*Linuparus trigonus*) had previously been recognized around the Australian coastline; that specimen was also collected in seas adjoining the temperate eastern quarter of the continent and as recently as 1949. Both occurrences are surprise distributions of a crayfish which belongs to the Japanese seas. The strange noise made by the species has probably passed unnoticed until it was heard by Athol D'Ombrain as a harsh, grating noise. Its source was not located until some time after the death of the Newcastle specimen. Finally it was traced to the inner angles of the heavy basal joints of the stubby antennæ, immediately in front of the eyes. Here there are two smooth-lined cavities which enclose and bear upon a pair of highly polished bosses when the antennæ assemblage is thrown backwards over the head. Even after death a semblance of this friction-produced sound could readily be achieved by hand manipulation. The purpose of the 'barking' is not clear.

Zoological Nomenclature

THE International Commission on Zoological Nomenclature gives notice that as from December 26, 1956, it will start voting on the following cases involving the possible use of its plenary powers for the purposes specified against each entry. Full details are given in the *Bulletin of Zoological Nomenclature* (12, Pt. 3): (1) *Lepidurus* Leach, 1819, validation; *Triops* Schrank, 1803, determination of gender and designation of type species for (Cl. Crustacea, Order Decapoda); (2) Apodinae Hartert, 1897, (Cl. Aves), validation; (3) *volvulus* (emend. of *volvulas*) (*Filaria*), validation of, as from Leuckart, [1892] (Cl. Nematoda); (4) *Asaphus* Brongniart, 1822, validation of and designation of type species for; *cornigerus* Schlotheim, 1820 (*Trilobites*), suppression (Cl. Trilobita). Comments should be sent as soon as possible to Francis Hemming, Secretary to the Commission, 28 Park Village East, Regent's Park, London, N.W.1.

Cytogenetics and Breeding of Sugar-Cane

THE improvement of sugar-cane (*Saccharum officinarum*) by breeding and selection is of comparatively recent origin. Much work, however, is now going on in different tropical regions. T. S. Raghavan (*Proc. Indian Acad. Sci.*, 43, B, 2, 100; 1956) has pointed out that although the main aim in breeding work is to obtain high-yielding commercial cane, breeding for resistance to diseases is of great importance in some regions. Hybridization of different species of *Saccharum*, and sometimes of different related genera, has been necessary to obtain strains well suited to the needs of different regions. Where cane develops under favourable conditions, the noble (*S. officinarum*) and highly nobilized varieties have given good results as parents, while in less favourable areas *S. spontaneum* and *S. barberi* have given more satisfaction. At Coimbatore, *S. spontaneum*, and in Florida *S. robustum*, have proved of value in breeding programmes. Important intergeneric crosses are those with bamboo and *Sorghum*. Sugar-cane as a breeding material is fundamentally different from other commercial crops. It is a highly heterozygous polyploid complex with a large reserve of lethal genes which, especially in *S. officinarum*, are responsible for there being practically no survivals in the selfed progeny. It is only clonal propagation that has made it survive. Arising mainly out of its genetical impurity and high allopolyploidy, no prediction can be made as to the nature of the progeny to be expected in a cross. The high heterozygosity of the chromosomal material of both the parents renders odds against anticipating any desired combination. The occurrence of parthenogenesis and of chromosome elimination has raised new issues which are now recognized in the cytogenetic approach to practical problems. Lists of crosses and of parental and hybrid chromosome numbers are given.

Use of Silage in British Agriculture

FERMENTED green fodder has now come to be recognized as a valuable supplement to the traditional roots and hay for winter feeding of cattle. It also fits in admirably with the present-day intensification in Britain of grassland management based on increased use of fertilizer. It is therefore important that the facts concerning silage making and use should be brought thoroughly up to date and presented in a clear practical manner together with just enough of the theory to make the rules comprehensible. This task has been admirably carried out by a group of officers of the National Agricultural Advisory Service and published as a revision (the seventh) of Bulletin No. 37, "Silage", of the Ministry of Agriculture (pp. 58 + 1 plates. London: H.M.S.O., 1956. 3*s.* net). Silage, properly made, has a feeding value about twice that of roots and rather more than that of hay, reckoned on a starch-equivalent basis. It is readily eaten by cattle, and fortunately many of the operations of growing, cutting, carting and making lend themselves to mechanization, an aspect of the subject which rightly occupies an important place in the treatment. Grass is not the only crop suitable for silage making, though it is the most important; the use of arable crops, including by-products such as sugar-beet tops, is dealt with. The addition of extra carbohydrate as molasses to high-protein crops in order to secure a favourable fermentation is also explained. On the national level, any farming practice which can reduce the expensive imports of concentrated feeding stuffs into Britain deserves official encouragement. To put the facts before farmers is clearly a step in the right direction.

A Survey of Atomic Energy

THE spring issue of *Studies*, the Irish quarterly review, contains an interesting article entitled "Atomic Structure and Atomic Energy", by Prof. T. S. Wheeler, professor of chemistry in University College, Dublin, in which he gives an excellent summary of our present knowledge of the structure of the atom and the production of atomic energy. The component parts of the atom, isotopes, the relationship between matter and energy, nuclear fission, the uranium and plutonium bombs, nuclear reactors, and the British programme of nuclear power are all described briefly but adequately. The hydrogen bomb receives rather scanty treatment. So many technical terms are used throughout the article that one would have thought the term 'thermonuclear reaction' would have also been mentioned. Radioisotopes and their numerous uses are not mentioned. The article will be most useful to those who are fairly well acquainted with basic physics and chemistry, and will serve admirably as basic notes for lecturers on the subject of atomic energy. Quotations from recent utterances of the Pope on the terror of atomic destruction and on the wonderful results of the applications of atomic energy in the industrial, biological and medical spheres preface and conclude the article, respectively.

Production of Single Crystals of Germanium

The zone-melting technique employed for the production of metals of very high purity has been modified by D. C. Bennett and B. Sawyer (*Bell System Tech. J.*, 637 ; May 1956) for the production of single crystals of germanium of exceptional crystalline perfection and uniformity of composition. The apparatus as described can produce crystals up to 6 in. long in which the average variation of resistivity along the length can be controlled to ± 7 per cent, while the variation over the cross-section can be as low as ± 3 per cent. The crystals contained no grain boundaries or twins, and the etch-pit densities, used as a measure of the number of dislocations, average about 1,500/sq. cm., though much lower values than these have been obtained, the lowest as yet observed being 40 pits/sq. cm. The variation of composition as measured by the resistivity is principally due to variations of the volume of the liquid zone due to temperature fluctuations, variations in the rate of flow of inert gas and cracks in the unmelted charge. The temperature gradients at the melting and freezing surfaces are important, the former being 130 deg. C./cm. and the latter about 10 deg. C./cm. The rate of growth of the crystal—that is, the rate of traverse of the boat through the furnace—affects its quality, a rate of about an inch in three hours being reasonable where the best results are required.

National Museum of Canada : Report for 1953–54

The annual report for 1953–54 of the National Museum of Canada which has recently been published as Bulletin No. 136 of the Museum (pp. 122+16 plates. Ottawa: Queen's Printer, 1956; 1.50 dollars) prefaces an account of the general activities of the year with a restatement of its main functions. These are: "to collect and preserve Canadian anthropological and natural history material of scientific or economic interest; to carry out studies in connection with this material; and to provide and disseminate information regarding natural science and ethnology by means of exhibits, publications, lectures and photographs". The illustrated report fully justifies the claim of the Trustees that the Museum is carrying out the functions for which it was founded, for, in addition to the usual accounts of curatorial work, original papers by the staff on related subjects are published. A new venture was initiated when a bronze plaque was erected by the Museum at Hogsback, near Ottawa, to explain the geology of this interesting locality. This is the first attempt to mark a scientific site in Canada and could with advantage be followed in Great Britain.

Calendar Reform in India

The Calendar Reform Committee, which was set up some years ago by the Government of India, has reported on its work of examining the different calendars of India (pp. 280, published by the Council of Scientific and Industrial Research, Old Mill Road, New Delhi, 1955; n.p.). At the present moment, thirty calendars are in use in India, each of which differs from the others in various ways, including the methods of time reckoning. While these are the natural results of India's past political and cultural history, representing to some extent political divisions, now that India has attained independence uniformity in the calendar is desirable. The Gregorian calendar is followed by India, as it is in the greater part of the world; but many countries have found that, in spite of its virtues, it has its defects, and the present report gives the results of the Committee's recommendations, in addition to a large amount of useful information on various astronomical matters. In the unified national calendar, it is proposed that the Śaka era should be used, the year 1954–55 corresponding to 1876 Śaka, and a year would consist of 365 days with the usual arrangements for leap-years. The first month of the year would be Caitra, which would contain 30 days, or 31 in leap-years, and Caitra 1 would correspond to March 22 in the Gregorian calendar, or March 21 in a leap-year. The months following Caitra are Vaisākha, Jyaistha, Asādha, Śrāvana, Bhādra, Asvina, Kārtika, Agrahāyana, Pausa, Māgha, Phālguna; the first three would contain 31 days each, the next three in order 31, 31 and 30 days, and the next five 30 days each. The dates of the reformed Indian calendar would thus have a correspondence with the dates of the present Gregorian calendar, and, starting with Caitra, the months following in the order given above would correspond with April 21, May 22, June 22, July 23, August, 23, September 23, October 23, November 22, December 22, January 21 and February 20. In addition to recommendations for religious calendars, it is suggested that an "Indian Ephemeris and Nautical Almanac" should be compiled which, besides showing the positions of the heavenly bodies, should include the Indian calendar—both civil and religious—prepared according to the recommendations of the Committee.

The Night Sky in September

New moon occurs on Sept. 4d. 18h. 57m., U.T., and full moon on Sept. 20d. 03h. 19m. The following conjunctions with the Moon take place: Sept. 1d. 12h., Venus 1° N.; Sept. 6d. 17h., Mercury 0·8° N.; Sept. 10d. 07h., Saturn 2° N.; Sept. 19d. 14h., Mars 11° S. In addition to these conjunctions with the Moon, Venus is in conjunction with Pollux on Sept. 2d. 15h., Venus being 9·5° S. Mercury is too close to the Sun for observation. Venus rises at 1h. 15m., 1h. 30m. and 2h. 00m. on September 1, 15 and 30 respectively, and is a bright object with magnitude varying between −3·9 and −3·7, the visible portion of its illuminated disk increasing from 0·503 to 0·641; during this time its distance from the Earth increases from 57 to 86 million miles. Mars rises at 19h. 40m., 18h. 35m. and 17h. 25m. at the beginning, middle and end of the month, respectively, the corresponding times of setting in the morning being 6h. 10m., 4h. 50m. and 3h. 35m.; its stellar magnitude varies between −2·6 and −2·3 and its distance from the Earth is a minimum on September 7, being 35 million miles and increasing to 39 million miles by September 30. Mars is a little east of ψ Aquarii, and this opposition is particularly favourable for observers because it occurs near the perihelion of Mars. Jupiter is too close to the Sun for observation during the early part of the month; it rises at 4h. 10m. on September 30, almost two hours before the Sun, and is near σ Leonis. Saturn sets at 21h. 25m., 20h. 30m. and 19h. 35m. on September 1, 15 and 30, respectively, and is approaching β Scorpii during the month; its stellar magnitude is 0·7, and its distance during the middle of the month is about 960 million miles. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich (*D* and *R* refer to disappearance and reappearance, respectively): Sept. 13d. 20h. 28·8m., 29 Sgr. (*D*); Sept. 27d. 00h. 03·6., χ^1 Ori. (*R*); Sept. 30d. 02h. 39·5m., 60 Cnc. (*R*). The autumnal equinox occurs on Sept. 23d. 02h.

Announcements

THE following have been appointed to chairs in the newly established Medical School in the University of Western Australia: *Biochemistry*, Prof. J. W. H. Lugg, professor of biochemistry in the University of Malaya and formerly of the University of Melbourne; *Physiology*, Dr. W. J. Simmonds, of the Kanematsu Memorial Institute of Pathology, Sydney Hospital, and formerly lecturer in physiology in the University of Sydney; and *Pathology*, Dr. R. E. J. ten Seldam, reader in physiology in the University of Sydney and formerly director of pathology of the Roman Catholic Hospitals, Eindhoven.

IN view of the diversity of the programme, both geographically and scientifically, of the International Geophysical Year, 1957–58, the bureau of the special committee of the International Council of Scientific Unions decided to appoint a full-time officer to assist in the co-ordination of the operations in order to ensure that the Year achieves its fullest promise. Vice-Admiral Sir Archibald Day, hydrographer of the Royal Navy during 1950–55, has been selected for this post of co-ordinator of operations, and he will have his office in Brussels alongside that of the general secretary. Since his retirement, Sir Archibald, who is fifty-seven years old, has been on a hydrographic survey of Lake Nyasa, and the Ministry of Transport and Communications in the Federal Government of Rhodesia and Nyasaland has agreed to release him in order that he may take up his new post.

J. R. PUGH, assistant to the chief traction engineer of British Insulated Callender's Construction Co., Ltd., has been awarded the Sir Alexander Roger travelling scholarship for 1956 and will visit Germany, Austria, Sweden and France to study the design, erection and performance of high-voltage a.c. traction equipment. Since joining the Company in 1948 as a graduate apprentice from the University of Cambridge, Mr. Pugh has worked on the technical aspects of railway electrification schemes. This scholarship has been established by British Insulated Callender's Cables, Ltd., as a tribute to Sir Alexander Roger, its first honorary president.

THE British Oxygen Co., Ltd., has awarded fellowships for postgraduate research to C. M. George (Department of Chemistry, University of Bristol) and N. G. Parsonage (Inorganic Chemistry Laboratory, University of Oxford). The fellowships of the following have been renewed for a third year: B. F. Figgins (Queen Mary College, London), D. H. Kirkwood (Department of Metallurgy, University of Cambridge) and R. D. McCammon (Clarendon Laboratory, University of Oxford).

AN informal discussion on "Nucleic Acids and Nucleo-Proteins: Structure and Function" will be held under the auspices of the Colloid and Biophysics Committee of the Faraday Society during October 12–13 at the Manson Hall of the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1. About twenty papers will be read. The accommodation is limited, but those who would like to attend are invited to communicate with Dr. K. V. Shooter, Chester Beatty Research Institute, Fulham Road, London, S.W.3, from whom further information can be obtained.

THE Photobiology Group will hold a meeting in the Botany School, Downing Street, Cambridge, during September 28–29, under the chairmanship of Dr. M. H. Pirenne. The annual general meeting of the Group will be held on the second day. Non-members of the Group can participate on payment of a fee of 5*s*. Further information can be obtained from Dr. R. Hill, Biochemistry Department, Tennis Court Road, Cambridge.

THE ninety-ninth meeting of the Gesellschaft Deutscher Naturforscher und Ärzte will be held in Hamburg during September 23–26. On the first day, prior to the meeting proper, a discussion will be held on science and the general educational programme of German high schools. Further information on the whole meeting can be obtained from Dr. Weber, Sekretariat der Gesellschaft Deutscher Naturforscher und Ärzte, Hamburg-Harburg, Phönix-Gummiwerke A.G.

THE Hungarian Scientific Society for Measurement and Automation is organizing a conference, to be held in Budapest during October 1–4, at which the following eight topics will be discussed: general features of instrumentation, metrology and nomenclature; mechanical measurements; optical measurements; thermodynamics; communications measurements; physico-chemical measurements; nuclear radiation measurements; and mathematical instruments and machines. Most of the papers will be in Hungarian, but translations in English and German will be available in advance. Papers from abroad are invited; these should be not more than twenty minutes in reading time and should be in English, French, German or Russian. Shortened versions, of 500–800 words in length, must be sent before September 1. Further information can be obtained from the Secretariat, Hungarian Scientific Society for Measurement and Automation, Budapest V, Honvéd-u.22.1.3.

THE British Memorial Fund of Victoria, Australia, is offering a further four fellowships for 1957 to British subjects, less than thirty-five years old, with at least ten years of residence in the United Kingdom. Two of the fellowships are in natural history and chemical engineering, respectively, and two are open for any choice of study or research. Each is worth £A1,000 and tenable only in Victoria. Application forms, to be completed by September 15, and further information can be obtained from the Victorian Agent-General in London, Colonel the Hon. W. W. Leggatt, Victoria House, Melbourne Place, Strand, London, W.C.2.

SECOND INTERNATIONAL CONGRESS ON ACOUSTICS, CAMBRIDGE, MASSACHUSETTS

THE Second International Congress on Acoustics, sponsored by the International Commission on Acoustics, was combined with the regular summer meeting of the Acoustical Society of America and was held in Cambridge, Massachusetts, during July 17–23, with support from Unesco and the U.S. National Academy of Sciences, and with the Massachusetts Institute of Technology and Harvard University acting as hosts.

The opening ceremony consisted of a reception of participants by the sponsoring bodies. Later, as relaxations from the technical programme, there were a sight-seeing tour, a concert and a banquet. An exhibition of books and instruments dealing with acoustics was held at Harvard. Of interest even to non-technical members of the Congress was a symposium on musical and architectural acoustics held in the Sanders Theatre of the University, where W. C. Sabine made his first measurements of reverberation time in 1895. At this symposium Prof. V. O. Knudsen showed some relics of the famous cushions, which Sabine bought up from a church that was then being refurnished and which he compared in absorbing power with an open window. Other symposia covered the subjects of bio-acoustics and noise control, speech analysis and physical acoustics. In addition, about a score of technical sessions were held involving some four hundred authors of papers and covering between them all branches of the subject, both pure and applied.

It is impossible in a reasonable space to refer to all these; but an attempt will be made to indicate those aspects of the subject which seem to be enlisting the greatest attention and showing most significant advances.

What may be called 'visco-elasticity' or 'relaxation spectrometry', according to the interests of the experimenter, continues to be a fruitful subject both in sonics and ultrasonics. The variation of absorption of sound waves with frequency and—in the case of gases—of velocity of sound with frequency continues to provide the physical chemist with valuable data, which are proving of use also to the metallurgist, to the maker of plastics and—in respect of relaxation in vapours—to the aerodynamicist.

In this age of jet propulsion, measurements and calculations by physicists and engineers on the production of noise from a transonic or supersonic jet of gas emerging from a nozzle are numerous; so, too, are the considerations of the sounds in boundary layers and the propagation of sounds through the atmosphere, particularly when it is turbulent. In one paper mention was made of the sounds of underwater jets. Does this mean that the ship designer is returning to a mode of propulsion which he abandoned in 1885?[1].

Noise was, of course, apart from this special field, much discussed—in buildings, in traffic and in machinery—especially in relation to its psychological and physiological aspects.

The sessions dealing with speech and music showed a comparatively small number of research workers, many using such time as they can spare from more urgent acoustical work, and treading a rather pedestrian track of analysis and synthesis; but the number of people interested in this field seems to be increasing. The need here seems to be for more inspiration.

Authors of papers were invited to submit them for publication in the *Journal of the Acoustical Society* or in *Acustica*. The meeting was highly successful and attracted more than twelve hundred registered members, undoubtedly the largest number of students and exponents of this field of physics ever brought together. At the concluding session, it was announced that the Third International Congress would be held in Stuttgart in 1959.

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[1] See Barnaby, S. W., *Proc. Inst. Civ. Eng.*, **77**, 1 (1883).

COMPARATIVE MARINE BIOLOGY

CONFERENCE IN ROSCOFF

AT the International Congress of Zoology held in Copenhagen in 1953, members of the Zoology Section of the International Union of Biological Sciences proposed to the general assembly that a meeting should be held in 1956 to discuss the comparative biology of aquatic species throughout the area of their distribution. The plan was approved; the meeting, under the auspices of Unesco, and limited to the discussion of marine and brackish-water species, was held during June 27–July 4 at the Station Biologique, Roscoff, at the invitation of Prof. L. Fage, Prof. G. Teissier and Prof. P. Drach; the last was responsible for the organization. Prof. S. O. Hörstadius, president of the International Union of Biological Sciences, was present, together with biologists from fourteen countries.

The plan of the meeting was twofold. First, by means of papers and discussions to review various aspects of the problems involved in understanding the distribution of species—the disciplines and approaches of the general biologist, the ecologist, the physiologist and the geneticist are all essential and complementary in this field of work. Secondly, to initiate new co-operative efforts—the possibilities of exchange of workers, co-operative schemes of work on selected species, and standardization of techniques were to be considered.

The papers were divided into groups; under the general heading of "The Biological Cycles of Marine Organisms", the biology of *Ostrea edulis*, *Mytilus* sp., *Calanus finmarchicus*, *Carcinides moenas*, and *Nereis* sp. were considered in relation to their geographical range. Two papers dealt with algal distribution. Morphological variation and biometrical studies were introduced in a general paper by Prof. Teissier, and this was followed by communications dealing with intestine length in Clupeoid fishes, differences in widely separated populations of *Gobius minutus* and a general consideration of meristic characters of fishes in relation to temperature and water movements. The third group of papers dealt with the inter-relation of temperature and salinity with the distribution and metabolism of marine animals as well as the more general aspects of respiration, temperature adaptation and physiological variation.

Genetical constitution and distribution formed the subject of the fourth group. The general impression gained was that, although for some species much is known regarding the response to environmental stresses over the area of distribution, a great deal remains to be done before any general principles can be formulated. Progress in this direction will come only from a concerted attack by all available techniques on the biology of a few selected and representative species that are able to live throughout a wide latitudinal range or in a wide variety of environmental conditions. To this end, the conference resolved that the attention of appropriate bodies should be directed towards increasing the number of permanent positions in marine laboratories, and to the provision of technical personnel so as to permit a world-wide programme of continuous records of a physical, chemical and biological nature to be established. Collaboration with existing bodies devoted to marine science was recommended, and furtherance of international co-operation by the support of fellowships, travel, meetings and an information service was suggested.

The problems arising in the organization of co-operative research were discussed in two general papers and also by the conference sitting in committees. Divergent opinions were revealed. It was felt by some that for real progress some of the work should be in the hands of a limited number of specialists with security of tenure and at the same time freedom to move from place to place. Others felt that much could be done with the expansion of facilities for individual workers within the framework of existing institutions. Certainly the latter has more chance of immediate attainment. To this end a resolution was passed urging the importance of investigations of the biology of marine species throughout their geographical range; it was further recommended that institutes should be encouraged to set up programmes of continuous collection of basic information and that a means for its distribution should be established. The importance of publishing fauna and flora lists was emphasized; lists of common species, and if possible their breeding seasons and abundance, would be most valuable.

It was recommended that a small committee should be set up to further the objects and resolutions of the conference.

H. BARNES

BRITISH GELATINE AND GLUE RESEARCH ASSOCIATION

RESEARCH PANEL MEETING

THE twelfth meeting of the Research Panel of the British Gelatine and Glue Research Association was held on June 7, with Mr. S. G. Hudson (Richard Hodgson and Sons, Ltd.) in the chair. Two papers were presented, each by members of the staff of the Association, during the morning session, and both were followed by lively discussion. In the afternoon the Association's laboratories at 2*a* Dalmeny Avenue, London, N.7, were open for informal discussions.

The first paper, by Dr. A. Courts, on the collagen–gelatin transformation, described a series of fundamental investigations into the changes which occur during the pretreatment and extraction of collagenous material such as hide and ossein (demineralized bone). Both type and intensity of pretreatment influence the degree to which the extraction stage can be regarded as a 'melting out' of already preformed gelatin. In the normal industrial processes some further hydrolytic reactions are known to occur, especially during the later stages of extraction. One tool of which extensive use was made was the technique of Sanger[1], in which reaction between amino-groups and 1-fluoro-2 : 4-dinitro benzene gives, after hydrolysis and chromatographic separation, the number of α-amino-groups in a protein. Since these groups terminate polypeptide chains, the average chain-length can be obtained from this figure. Ossein, after treatment for periods of between two weeks and six months with a suspension of calcium hydroxide in water at 20° C., was found to reach rapidly the stage at which the average chain-length in the treated ossein could be related to that of the gelatins which could be obtained from it. The residue left after each extraction of gelatin by hot water had a chain-length which remained substantially constant. It may be presumed that all slightly shorter chains produced by hydrolysis went into solution as gelatin. The diphenylamine method of Anderson and Maclagan[2] was used to estimate mucoprotein at all stages of the process. The action of lime in removing this group of substances was clearly shown.

Dr. Courts also described the successful preparation of gelatin without the use of heat. Raw material which had received alkaline pretreatment was extracted by strong solutions of hydrogen bond-breaking agents, at room temperature. A substantial proportion of the material passed into solution as good-quality gelatin. This shows clearly that at late stages of pretreatment the raw material is primarily held together by hydrogen bonds.

The second paper, on the molecular weights of some gelatin fractions by the light-scattering method, was by Dr. A. Courts and Dr. G. Stainsby, and was read by the latter. He described briefly the technique used in measuring the light scattered by dilute gelatin solutions at 40° C., and also how the weight-average molecular weight (M_w) can be deduced from this. He then described the method[3] which has been developed to allow for the light scattered by the small quantities of suspended particles present in the solutions. These, which are of a non-gelatin nature, remained to some extent even in the most carefully purified solutions. After measuring the light scattered from the gelatin solution, a small addition of a solution of crystalline trypsin rapidly reduced the size of the gelatin molecules to a level at which they scattered only negligible amounts of light. The residual scatter at this stage was due to the solvent and to the suspended impurities. Measurement of its intensity enabled the scattering due to gelatin to be obtained, by subtraction, from the scattering figures for the original gelatin solution. Only by developing this technique was it possible to get reliable figures for gelatin weight-average molecular weights.

Two series of fractions, one of an alkali-processed gelatin (first extraction) and the other of an acid-processed gelatin (also first extraction), were examined by the method of light scattering for M_w, and by the Sanger end-group technique for C_n (the number-average chain-length). The results for the alkali-processed material are given in Table 1.

Table 1

Fraction	M_w	C_n
2	270,000	55,000
3	142,000	70,000
4	74,000	70,000
5	57,000	70,000

If the gelatin molecule consisted of a single polypeptide chain, it would be expected that M_w and C_n would only differ slightly, owing to imperfect fractionation. The very large differences observed may be interpreted as indicating that the gelatin molecules of higher molecular weight are composed of some half a dozen chains covalently linked in some way. It seems likely that these linkages have their origin in the collagen and are not produced in the conversion of collagen to gelatin.

Refractionation has been used to show that the extreme heterodispersivity needed to account for the results, if C was identical with M, is not the cause of the discrepancy. An examination of the F.D.N.B. reaction in the light-scattering cell has shown that the conditions used do not cause marked degradation while the reaction is in progress. There is, on the contrary, some indication of a cross-linking reaction. This would not interfere with the determination of the α-amino-groups.

Somewhat similar results to those with the alkali-processed gelatin were obtained with the acid-processed gelatin fractions. The situation was complicated by an indication that, at least for the lower molecular weights, the chains did not always terminate in an α-amino-group at one end.

A. G. Ward

[1] Sanger, F., *Biochem. J.*, **39**, 507 (1945).
[2] Anderson, A. J., and Maclagan, N. F., *Biochem. J.*, **56**, xxv (1954).
[3] Stainsby, G., *Nature*, **177**, 745 (1956).

INTERNATIONAL WHALING COMMISSION

EIGHTH ANNUAL MEETING

THE eighth annual meeting of the International Whaling Commission was held in London during July 16–20, all the seventeen contracting Governments, with the exception of Brazil, being represented. They were: Australia, Canada, Denmark, France, Great Britain, Iceland, Japan, Mexico, the Netherlands, New Zealand, Norway, Panama, South Africa, Sweden, the U.S.S.R. and the United States. Italy and Portugal were represented by observers, as were also the Food and Agriculture Organization of the United Nations, the International Council for the Exploration of the Sea and the International Association of Whaling Companies. Dr. G. J. Lienesch (Netherlands), chairman of the Commission, presided.

According to the figures compiled by the Bureau of International Whaling Statistics at Sandefjord, nineteen factory ships with 257 catchers were engaged during the 1955–56 Antarctic season, and the total catch by floating factories increased from 2,061,789 barrels to 2,134,012 barrels inclusive of sperm oil; there are six barrels to the ton, and the average price for whale oil is £70–80 per ton. The chief object of the Commission is to arrange a balance between killing- and replacement-rates of the whale populations, and to achieve this it sets limits upon the total catch. The limit takes into consideration the views of scientists upon the size of the stocks of whales and of the whalers on the economics of the industry, the scientific opinion being almost unanimously in favour of a substantial reduction in the catch on account of evidence that the stock is declining. The existing limit is 15,000 blue whale units, and the Commission recommended that the catch for future seasons should not exceed this amount, and it further recommended (with one dissentient) that the limit should be reduced during the coming 1956–57 season to 14,500 blue whale units.

Infractions of the whaling regulations during the past year were fewer than those of the previous year. At present every factory ship is required to have on board two inspectors who are generally of the same nationality as the flag of the ship. However, following the seventh meeting of the Commission in Moscow in 1955, the United States was asked to prepare a protocol for the amendment of the Convention so as to permit consideration of a scheme to appoint independent observers in addition to the national inspectors. All possible steps are now being taken to ensure that the protocol can be brought into force in time for the Commission to take action under its provisions at its ninth meeting, and it is hoped that the protocol will very soon be signed.

A statement of expenditure for the year ending May 31, 1956, amounting to £3,196, was approved by the Commission. For the current year due to end on May 31, 1957, the expenditure by the Commission is estimated at £2,935, and the contribution requested of each of the twelve contracting Governments remains at £150. £500 was set aside towards the cost of whale marking, which is the means of providing much of the essential scientific data on which the Commission's recommendations for the conservation of the whale stocks need to be based.

It was decided that a scientific sub-committee should again if necessary meet to consider certain scientific problems in anticipation of the next annual meeting, which will also be held in London, commencing on June 24, 1957.

THE B.B.C. AND ITS EXTERNAL SERVICES

A BOOKLET entitled "The B.B.C. and its External Services"*, describing the B.B.C.'s transmissions for listeners overseas, is of special interest at the present time in view of Sir John Glubb's recent convincing arguments that expenditure on the dissemination of ideas brings a higher dividend than expenditure on weapons. The booklet does not indicate what proportion of the B.B.C.'s income of £21 million from licence receipts (of which in 1955–56 the Government retained £2·75 million), £1 million from publications and £5·322 million from grants-in-aid was expended on external services; but these services in English and forty-three other languages are heard throughout the world, and occupy about eighty hours daily.

* The B.B.C. and its External Services. Pp. 32. (London: B.B.C. 1956.)

Thirty-nine high-power short-wave transmitters are used, of which two, for relay purposes, are operated at Tebrau, in Johore, by the B.B.C. Far Eastern Station. Medium-wave transmissions from Britain are largely confined to the radiation of those parts of the European Service broadcast to Western Europe throughout the evening on 224 m. Other long and medium wave-lengths are used when not required for the B.B.C.'s domestic services. Certain of the European Services are also broadcast by a high-power medium-wave transmitter at Norden in north-west Germany, with a medium-power relay in Berlin operating on the same wave-length, and are re-broadcast additionally over a very-high-frequency frequency-modulated transmitter in Berlin, where many suitable receivers are in general use.

To provide an effective signal in the area served by each programme, highly directional short-wave transmitting aerials are used, the appropriate aerial being selected from 177 aerials at the various transmitting-sites; but even this large number is insufficient to meet all propagation conditions. A continuous schedule of aerial conversion to different wave-lengths is required to ensure that programmes are radiated in the most easily receivable wave-bands, and this programme is designed to keep pace with the trend of solar activity. During the next four years the B.B.C. will make regular use of the higher-frequency bands for its external services, and wave-lengths in the 13-m. and 11-m. bands now serve large areas of South and South-East Asia, the latter band in particular providing transmission which escapes the severe interference affecting many of the external services programmes on the longer wave-lengths. Some of this interference is due to the overloading and unplanned operation of the bands allotted to short-wave broadcasting; but much of it is caused by deliberate interference (jamming) with certain language transmissions from the B.B.C. and from other countries. This jamming also affects the adjacent wave-lengths.

The Monitoring Service, which intercepts and reports foreign broadcasts, is an integral part of the External Broadcasting Organization. The B.B.C. has close ties with most of the forty-five broadcasting organizations in the British Commonwealth, and offices for B.B.C. representatives are maintained in Cairo, Delhi, New York, Ottawa, Paris, Sydney and Toronto.

THE SONIC GAS ANALYSER

By DR. A. E. MARTIN

Sir Howard Grubb, Parsons and Co., Ltd., Newcastle upon Tyne

ALTHOUGH efforts have frequently been made to develop a gas analyser depending on the variation of the velocity of sound with the nature of the gas, no practical instrument was produced until quite recently. The successful development of this gas analyser is due to the efforts of, among others, J. G. Dawes[1], J. H. D. Walton[2], L. E. Lawley[3], and D. Mounfield (Sir Howard Grubb, Parsons and Co., Ltd.).

The sonic gas analyser has certain advantages over some other types of instrument, the more important being: (1) no correction for variations in pressure is necessary since the velocity of sound is independent of pressure; (2) temperature compensation is easily arranged; (3) practically any mixture of gases can be dealt with; (4) the time lag can be made negligible; (5) the analysis unit is intrinsically safe and, since it can be placed at any distance from the measuring unit, can be used in refineries, coal mines and other places where an explosive atmosphere may be found; (6) it is possible to calculate to within a few per cent the sensitivity of the instrument and therefore actual calibration is unnecessary in many cases.

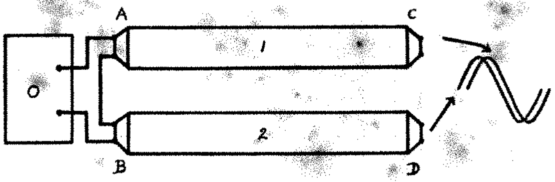


Fig. 1. Principle of the sonic gas analyser

Fig. 1 illustrates the principle of operation of the sonic gas analyser. A and B are sound transmitters, which for convenience may be deaf-aid magnetic earpieces, and these are actuated together by the oscillator O. Each transmitter is placed at one end of a tube and a similar earpiece is mounted at the other end of the tube to act as a microphone. If the distances A to C and B to D are equal, and both tubes contain the same gas, the time taken for sound to travel from A to C will be exactly the same as from B to D and the a.c. signals derived from the receivers C and D will be in phase. If now the gas in tube 2 is replaced by a heavier gas, for which the velocity of sound is lower, the signal received by D will lag behind that arriving at C by some angle θ, as indicated in Fig. 1. It is easy to see that

$$\theta = 2\pi f d \left(\frac{1}{V_2} - \frac{1}{V_1}\right) \tag{1}$$

where f is the frequency of the sound, d the distance from transmitter to receiver in either tube, and V_1 and V_2 the velocity of sound in tubes 1 and 2, respectively. By employing two tubes in this way temperature effects largely cancel out.

It is nowadays possible to measure θ by the application of electronic techniques, and in one particular instrument, for which $f = 3{,}000$ c./s. and $d = 30$ cm., full scale for a phase change of 20° is obtained.

To calculate the phase change to be expected for any given gas mixture, it is convenient to rewrite equation (1) by using the relation $V = \sqrt{\frac{\gamma RT}{M}}$, where γ is the ratio of the specific heats c_p/c_v, R the gas constant, T the absolute temperature and M the molecular weight. We then have:

$$\theta = \frac{2\pi f d}{\sqrt{RT}}\left(\sqrt{\frac{M_2}{\gamma_2}} - \sqrt{\frac{M_1}{\gamma_1}}\right) = 207\left(\sqrt{\frac{M_2}{\gamma_2}} - \sqrt{\frac{M_1}{\gamma_1}}\right)$$

in degrees for the values of f and d given above and for a temperature of 20° C. The variation of θ with temperature is approximately 1 part in 600 per 1° C. For most diatomic gases γ is close to 1·4 and then $\theta = 175°(\sqrt{M_2} - \sqrt{M_1})$. Thus for air ($M_2 = 28·95$) and nitrogen ($M_1 = 28$), $\theta = 15·6°$, which is nearly full scale on the standard instrument.

For 1 per cent by volume of an admixed gas or vapour in air the following simple relations can be derived:

$$\theta(\text{degrees}) = \frac{M}{6} - 3{\cdot}4\,\gamma \qquad (2)$$

$$\theta(\text{degrees}) = \frac{M}{6} - 6\left(1 - \frac{n}{10}\right) \qquad (3)$$

where M is the molecular weight, γ the ratio of specific heats and n the number of atoms per molecule of the 'impurity'.

Equation (2) is preferable for molecules containing only a few atoms, while (3) is more suitable for larger molecules. The values obtained for θ are in general accurate to a few per cent. [May 10

[1] Dawes, J. G., *J. Sci. Instr.*, **27**, 123 (1950).

[2] Walton, J. H. D., Brit. Pat. 727,891 (application date, 1951).

[3] Lawley, L. E., *Chem. and Indust.*, 200 (1954).

SLOW DECOMPOSITION OF EXPLOSIVE CRYSTALS

By Dr. F. P. BOWDEN, C.B.E., F.R.S., and J. McAUSLAN

Laboratory for the Physics and Chemistry of Surfaces, Department of Physical Chemistry, Cambridge

WHEN silver, lead, cadmium or other metallic azides are heated to a temperature below that necessary to cause detonation, they decompose comparatively slowly into metal and gaseous nitrogen. The kinetics of this decomposition, as determined from pressure/time curves, have been investigated by a number of workers[1]. A microscopic examination of the crystals during the process shows that they crack and split along crystallographic planes. The splitting can be violent, and it indicates that metal is formed and nitrogen liberated inside the crystal. There is evidence from some observations in the electron microscope (using a replica technique) that single crystals of lead or cadmium azide break up into small blocklets about 10^{-5} cm. across, and it has been suggested that reaction may occur preferentially at defects within the crystal[2]. The role of dislocations, impurity centres and crystallographic irregularities is not fully understood; but we may expect them to assist in the early stages of decomposition. Mitchell[3] has shown their importance in the decomposition of silver halides.

Sawkill[4], working in this Laboratory, has followed in the electron microscope the progressive decomposition of silver azide under the influence of the electron beam. At the same time, he used electron diffraction to determine the change in the atomic arrangement. The results show that the formation of crystalline silver is preceded by a migration of silver atoms into the azide lattice. The initial spacing of these silver atoms is wider than that of the normal silver lattice, but collapse occurs resulting in the formation of small single crystals of silver in the surface layer of the main azide crystal. In addition to this, and beneath it, a network of fine silver is observed which gives a ring pattern in electron diffraction and which may correspond to the liberation of silver on defects within the body of the crystal. Again the size of the units in this network is found to be about 10^{-5} cm. In these experiments the electron beam falling on the crystal induces chemical change. This can be due to the rise in temperature of the specimen or to the primary action of the high-energy electrons. There is evidence, in Sawkill's experiments, that the second factor is important.

A more direct attack on the mechanism of thermal decomposition has been rendered possible with the development by Oatley and his colleagues in the Engineering Laboratory at Cambridge[5] of a scanning electron microscope which can be used in reflexion or transmission. The electrons are focused to a narrow

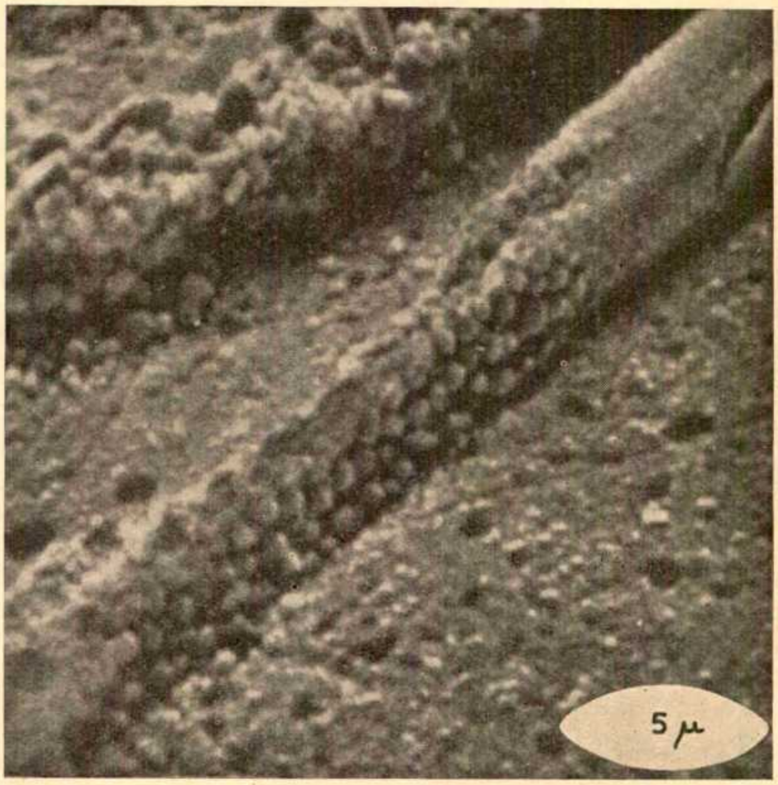
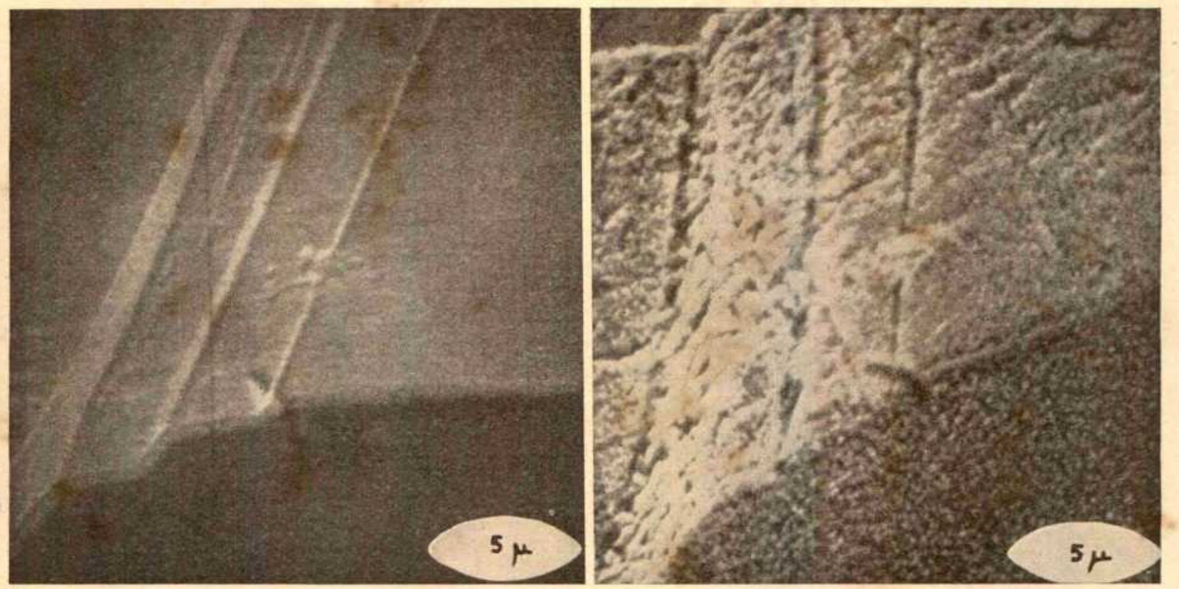


Fig. 1. Partly decomposed needle of silver azide of approximately 1μ cross-section. Decomposition has started from lower end, causing the needle to break up into blocks about 0·3μ across



(a) (b)

Fig. 2. (a) Area of plate crystal of silver azide, before heating. (b) Same area after heating. Note the randomly oriented 'pebbles' of 0·2μ diameter

beam which scans the specimen rapidly, and the specimen is not heated or damaged by the examination. With the helpful collaboration of Mr. C. W. Oatley and Mr. C. K. A. Smith, we are using this instrument (in reflexion) to study the thermal decomposition of silver azide and other explosive crystals.

Experiment. The crystals of silver azide are allowed to separate from ammoniacal solution on to a silver plate. This plate is mounted on a heating stage in the microscope so that the temperature can be raised to about 400° C. It is necessary to silver the larger crystals to prevent charging; but with the small crystals it is unnecessary. Both needles and plates of silver azide were prepared in this way, the needles varying from 1 to 10μ in diameter thick and the dimensions of the plates from 10μ × 10μ × 0·5μ up to 300μ × 300μ × 5μ. It is necessary to keep the temperature of the specimen below the melting point of silver azide (250° C.) but higher than 120° C. to ensure an appreciable rate of decomposition. The progressive changes in the crystal as it decomposes can then be conveniently followed in the microscope.

Disintegration of the crystal. A stage in the decomposition of a small needle-shaped crystal about 1μ thick is illustrated in Fig. 1. The left-hand end of this crystal is in better thermal contact with the hot plate than the other and decomposition has begun here and spread part way along it. It will be seen that the crystal has disintegrated into small units about 0·3μ diameter which have taken the shape of rounded 'pebbles'. The volume of these 'pebbles' is estimated to be about one-half that of the original crystal. If the change to silver were complete it should be about one-third, so that the decomposition may not yet be complete.

The decomposition of a part of a larger flat crystal is illustrated: Fig. 2a is a region before decom-

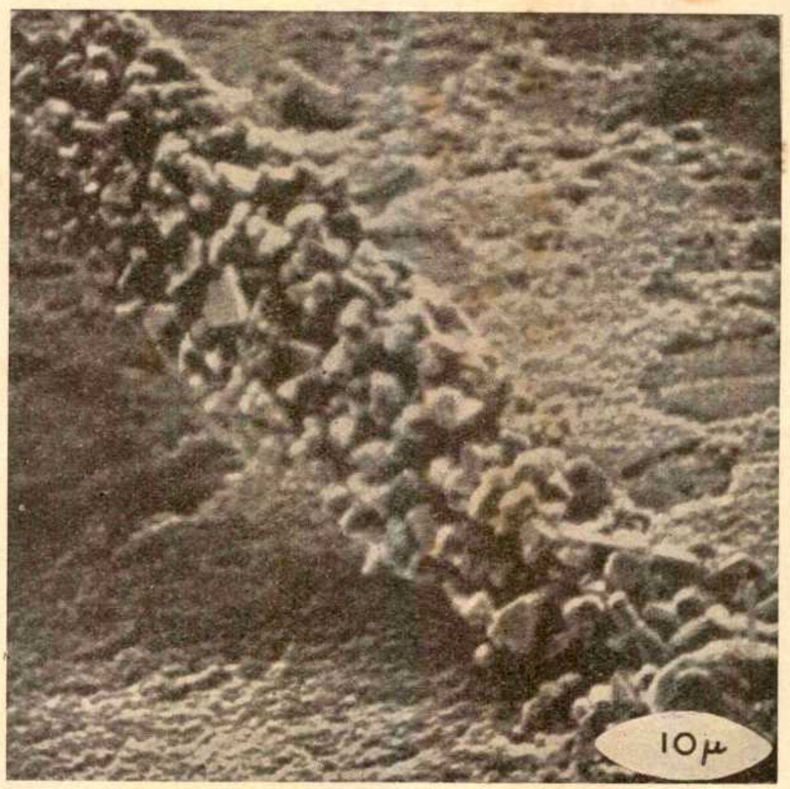


Fig. 3. Needle of silver azide which has broken up because of crystallographic phase change at 180° C. Note angular shape of fragments

position and (*b*) the same region after. Again it has decomposed into a number of 'pebbles' which are a fraction of a micron in diameter. The calculated volume of these is about one-third of the volume of the azide from which they are derived. This suggests that reaction is complete and the 'pebbles' are solid silver. It may be noted that the main body of the crystal has not contracted noticeably although it is being heated from the underside. It is a thin layer of the crystal adjacent to the surface which has decomposed first. This indicates that, in a large crystal, the volume adjacent to the free surface decomposes more easily, suggesting that free surfaces play an important part in the mechanism of decomposition.

The examination of a number of decomposing crystals show that this effect, the disintegration of the parent crystal into 'pebbles' about 1550–3000 A. in size, is general. The possibility that pebble size is determined by migration and aggregation of atomic silver (unrelated to the mechanism of disintegration of the parent crystal) cannot be excluded at this stage and further experiments at higher resolution are being made. The general behaviour, however, is consistent with the view that, in thermal decomposition, preferential reaction (with the formation of silver and the liberation of nitrogen) can occur on a fine network of dislocations which exist within the parent crystal. This would cause it to break up into units which continue to decompose until only silver remains. In any event, we may expect that the occurrence of reaction, and the liberation of silver and nitrogen within the crystal, will set up stresses which cause it to break along planes of weakness.

Polymorphic change. The decomposition of silver azide can be complicated by a crystallographic phase change which from X-ray studies is known to occur at about 180° C. (Sawkill, J., personal communication). If a crystal is heated to this temperature, the volume change accompanying the transition causes it to break up. Fig. 3 shows a crystal which has broken up in this way. The fragments are different in appearance from those of Figs. 1 and 2 in that they are angular in shape and generally hexagonal. Because of the poor thermal conductivity of the broken crystal, it was difficult to get further decomposition by heating, but some of these blocks finally decomposed to a product of size $0{\cdot}2\mu$ resembling the 'pebbles' in Figs. 1 and 2*b*.

These observations refer, of course, to the slow thermal decomposition of the azide; but parallel experiments on the fast burning and explosion of small crystals of various explosives are being made[6], using Courtney-Pratt's[7] high-speed ciné microscope camera. It is found that cracks develop in the crystal and run rapidly ahead of the advancing flame front, causing it to disintegrate into tiny flying undecomposed fragments which are burning on the surface.

It would seem therefore that, both in the slow and in the fast decomposition of these crystals, reaction does not occur only as a surface combustion. It can also occur within the crystal itself (probably as defects) and the parent crystal may break up into units which are only a few tenths of a micron in size. This break-up of the crystal will expose a large area of surface and will accelerate the reaction, so that account of it should be taken in any general study of the reaction kinetics of decomposing solids.

We thank Mr. Oatley and Mr. Smith for their active collaboration, I.C.I. (Nobel Division) for seconding one of us (J. McA.), and the Royal Society for a grant to the Laboratory.

[1] Jacobs, P. W. M., and Tompkins, F. C., reviewed in "Chemistry of the Solid State", by W. E. Garner (Butterworth Scientific Publications, 1955).

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FUNCTION OF CARBOTENOIDS IN CHLOROPHYLL-CONTAINING ORGANS

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WARBURG AND KRIPPAHL[1] showed that part of the energy necessary for the reduction of carbon dioxide in photosynthesis is derived from an enzymatic process in which a carotenoid participates beside nicotinamide and a heavy-metal ion. Recently Calvin, Stanier *et al.*[2] have suggested that carotenoids participate in photosynthesis; Calvin considers three possible alternative functions. It seems to us that our observations on carotenoids of the leaves, the unripe and ripe fruit of *Capsicum annuum* var. *lycopersiciforme rubrum* may be of some help in the elucidation of carotenoid function. Essentially similar results were obtained on *Solanum lycopersicum*, *Acer campestre*, *Aesculus hippocastanum*, *Spinacia oleracea*, etc.

The carotenoids were extracted with ether, saponified and divided between methanol and petrol-ether into epiphasic and hypophasic fractions by standard methods of carotenoid chemistry. The components of both fractions were separated by column chromatography. The concentrations of the resulting components were estimated with a Spekker photometer and identification was carried out by standard procedures (spectrum, mixed chromatogram, colour reaction with hydrochloric acid, analysis of furanoid derivatives, etc.).

The accompanying tables contain the results for leaves (Table 1), unripe (Table 2) and ripe (Table 3) fruits expressed in mgm./100 gm. fresh weight.

Table 1. CAROTENOIDS OF LEAVES

No.	Epiphasic pigments	mgm./100 gm.	No.	Hypophasic pigments	mgm./100 gm.
1	Mixture of unknown compounds	0·66	1	Foliaxanthin* (a hitherto unknown epoxyde)	5·66
2	Cryptoxanthin	0·23	2	Mixture of foliachrome* (a furanoid derivative of foliaxanthin and a *cis*-violaxanthin	0·82
3	Hitherto unknown isomer of cryptoxanthin	0·22	3	Mixture of another *cis*-violaxanthin and a *cis*-lutein	2·39
4	Mixture of β-carotene-mono-epoxyde (traces) and neo-β-carotene U	1·07	4	Mixture of violaxanthin* and another *cis*-lutein (traces)	8·27
5	β-Carotene*	7·92	5	Mixture of antheraxanthin (traces) and another *cis*-lutein	1·14
6	Unknown *cis*-isomer of β-carotene	0·40	6	Lutein* (Karrer's xanthophyll)	13·99
7	Neo-β-carotene B	0·32			
8	α-Carotene*	0·86			
	Total	11·68		Total	32·27

Table 2. CAROTENOIDS OF UNRIPE (CHLOROPHYLL-CONTAINING) FRUITS

No.	Epiphasic pigments	mgm./100 gm.	No.	Hypophasic pigments	mgm./100 gm.
1	Cryptoxanthin	0·027	1	Foliaxanthin	0·058
2	Hitherto unknown isomer of cryptoxanthin	0·010	2	Foliachrome	0·025
3	Unknown compound	0·006	3	Mixture of a *cis*-violaxanthin and a *cis*-lutein	0·049
4	Mutatochrome (?)	0·003	4	Mixture of another *cis*-violaxanthin and another *cis*-lutein	0·025
5	Mixture of β-carotene-mono-epoxyde (traces) and neo-β-carotene U	0·020	5	Mixture of violaxanthin and a *cis*-lutein	0·042
6	β-Carotene*	0·095	6	Mixture of antheraxanthin (traces) and lutein	0·031
7	Unknown *cis*-isomer of β-carotene	0·008	7	Lutein*	0·276
8	Neo-β-carotene B	0·005			
	Total	0·174		Total	0·506

Table 3. RIPE, RED, CHLOROPHYLL-FREE FRUITS

No.	Epiphasic pigments	mgm./100 gm.	No.	Hypophasic pigments	mgm./100 gm.
1	Cryptocapsine* (a hitherto unknown compound)	0·13	1	Mixture of various *cis*-isomers of both capsorubin and capsanthin	1·55
2	Cryptoxanthin*	1·10	2	Capsorubin†	1·46
3	Neo-cryptoxanthin B (?)	0·22	3	Mixture of unknown epoxydes	1·09
4	Mutatochrome (?)	0·04	4	Capsanthin†	9·60
5	Aurochrome (?)	0·26	5	Mutatoxanthin*	0·13
6	Neo-β-carotene U	0·26	6	Violaxanthin*	0·70
7	β-Carotene*	2·35	7	Mixture of *cis*-antheraxanthin and *cis*-zeaxanthin	0·35
8	Unknown *cis*-isomer of β-carotene	0·36	8	Another *cis*-zeaxanthin	0·67
9	Neo-β-carotene B	0·17	9	Antheraxanthin*	0·99
			10	Lutein-epoxyde	0·31
			11	Zeaxanthin*	1·75
	Total	4·89		Total	18·60

* Isolated in crystalline form.
† The accepted structural formula needs revision.

These observations indicate that the role of carotenoids in photosynthesis cannot be understood by considering a single carotenoid, but only by extending attention to all carotenoids and their relative changes during the life-cycle of the plant. Carotenoids serve oxygen transport and suffer transformation in consequence of this function. Primarily, carotenoids with β-ionon ring structure (β-carotene, zeaxanthin) are formed by the cells, and these are converted by the uptake of oxygen into the corresponding epoxydes (β-carotene-mono-epoxyde, antheraxanthin); after reduction they are either reconverted into the original compounds, or their α-isomers are formed (α-carotene, lutein).

Oxygen transport is conducted mainly by the system zeaxanthin → antheraxanthin → lutein, whereas the secondary system β-carotene → β-carotene-mono-epoxyde → α-carotene is only active when the primary system is unable to satisfy oxygen demand. In leaves containing chlorophyll, the transport of oxygen is operated at its maximum capacity and therefore the secondary system is also active. Consequently green leaves lack zeaxanthin, contain only traces of antheraxanthin and are rich in lutein. The participation of the secondary system is indicated by the presence of α-carotene, abundance of β-carotene and traces of β-carotene-mono-epoxyde.

In the unripe chlorophyll-containing fruit, the main system suffices for oxygen transport; therefore the secondary system is not functioning and consequently no α-carotene formed.

In the ripening fruit, after disappearance of chlorophyll, only zeaxanthin and cryptoxanthin take up oxygen and are transformed by it to epoxydes (violaxanthin, antheraxanthin, cryptoxanthin-mono-epoxyde). At this stage of ripening the epoxydes cease to deliver their oxygen and are transformed into polyenoxyketones (capsorubin, capsanthin, cryptocapsine). This explains the absence of lutein; at the same time, carotenoid synthesis exceeds the demand of oxygen transport and therefore zeaxanthin accumulates: the ripe fruit contains zeaxanthin but no lutein. The same process explains the absence of α-carotene in the ripe fruit: in the presence of abundant zeaxanthin, no oxygen is taken up by β-carotene and therefore no epoxyde and no α-carotene is formed.

Detailed results have been published[3] or are in the press[4]. The structure of the hitherto unknown pigments foliaxanthin, foliachrome, cryptocapsine and an isomer of cryptoxanthin will be submitted for publication in the near future.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

The Virogenic Stroma in Nuclear and Cytoplasmic Polyhedroses

It has been found recently[1] that in the larval fat body and midgut cells of Lepidoptera and in the midgut cells of Hymenoptera infected with nuclear polyhedroses proteinaceous virogenic stromata form *de novo* in the nuclear sap. These stromata become increasingly proteinaceous and Feulgen-positive as they grow and develop. Morphologically they are networks, and virus rods differentiate within vesicles in their cords. These begin as fine rodlets about 60 A. × 1200 A. in size and increase *in situ* to their final size of 280 A. × 2800 A. They are then set free from their vesicles into the pores of the net by disruption of the surrounding cord material and may ultimately reach the ring zone between the centrally placed virogenic mass and the nuclear membrane. The freed virus rods become enveloped by independently formed and still-growing capsule membranes, within which capsule protein is deposited. The encapsulated rods then become occluded within crystalline protein polyhedra, which arise and grow in the ring zone and later in the enlarged pores of the late-stage infected nucleus.

However, little is known as yet of the development of the numerous cytoplasmic polyhedroses of lepidopterous larvæ. The polyhedra in these diseases form in the cytoplasm of the midgut epithelial cells, and spherical virus bodies about 60 mμ diameter are found occluded within them. Virus bodies have also been found present in the material between the polyhedra[2-4]; but the very first stages of infection, prior to the considerable formation of polyhedra by which these diseases are detected, are unknown. In particular, no virogenic stromata comparable to those found in the nuclear polyhedroses have been described.

In January, I found that many of the half-grown processionary moth larvæ (*Thaumatopoea pityocampa*) infesting the maritime pines in and around Athens (Greece) were infected with a naturally occurring cytoplasmic polyhedrosis of the epithelial cells of the midgut. In this disease virogenic stromata analogous to those formed in the nuclear polyhedroses have been found (Fig. 1). They arise subapically in the infected cells. Each virogenic stroma is a definite structural entity and in damaged cells survives as a discrete body when the cytoplasm has been destroyed. The stromata have a micro-net structure. In the cords of the stromata virus bodies arise, at first particularly in the more superficial parts of the masses. The virus bodies are spherical and consist of an extremely dense centre, about 35 mμ diameter, and a less electron-dense cortex, about 80 mμ diameter. The appearance of the virus bodies on grids after dissolution of the polyhedral protein suggests that their dense centres are composed of several elongated granules. When the virus bodies have been formed the cord material around them disrupts and liberates them into the larger pores formed as a result of dissolution of the cords. The virogenic stromata grow considerably (up to 10μ × 2μ) before small polyhedra, less than $\frac{1}{2}\mu$ in diameter, form, distributed irregularly over their surfaces. The freed virus bodies become occluded in the polyhedra. Numerous colonies (stroma plus associated polyhedra) penetrate as far as 50μ towards the base of each cell. As the masses grow, large pores form well inside them and polyhedra arise and grow there, occluding the freed virus. As the masses and their associated polyhedra continue to grow, the numerous colonies begin to fuse, finally forming one large colony per cell. The stromata finally regress and remain as small remnants within the large masses of polyhedra.

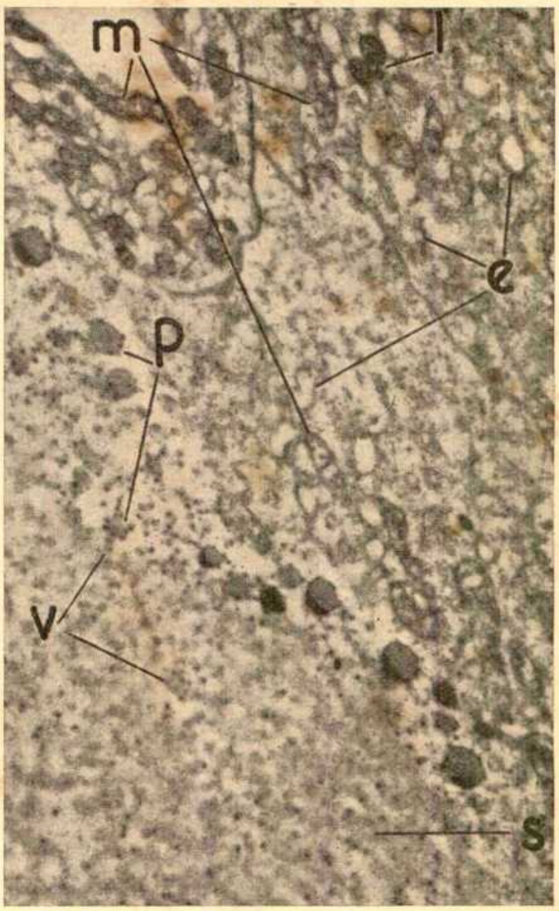

Fig 1. The section shows parts of two epithelial cells and one goblet cell (upper left-hand side). 'Normal' epithelial cell cytoplasm is present in the cell at the upper right-hand side. The cell at the left-hand side shows a moderately developed virogenic stroma. Its surface is sectioned obliquely in the upper part of the picture. *e*, endoplasmic reticulum; *m*, mitochondria; *l*, lipoid droplets; *s*, virogenic stroma; *v*, virus bodies; *p*, polyhedra. × 15,000. Electron micrograph taken by Miss S. Vernon-Smith

The cytoplasmic virogenic masses, unlike those of the nuclear polyhedroses, are protein and ribonucleic acid in composition and no deoxyribonucleic acid has ever been detected in them by Feulgen staining. The virogenic stromata possess neither mitochondria nor the endoplasmic reticulum of Porter[5] and Palade[6] and lack the ribonucleic acid small-granule component of Palade[7]. Where, however, fusion of the virogenic masses has occurred an odd mitochondrion or pigmented liposome is occasionally found surviving within the enlarged virogenic mass. As the stromata grow the endoplasmic reticulum, mitochondria and small-granule component immediately surrounding them disintegrate. Whether the disintegrated small granules are incorporated into the growing stromata is not yet clear. The stromata grow in the cytoplasmic matrix and may be considered as highly differentiated abnormal regions of the matrix initially induced by the viral materials absorbed by the healthy cell from the gut lumen. The virus bodies afterwards become differentiated from these stromata. The above observations indicated that, unlike the viruses of the nuclear polyhedroses which contain deoxyribonucleic acid only[8], those of the cytoplasmic polyhedroses would contain only ribonucleic acid. This was afterwards confirmed for the cytoplasmic polyhedrosis of *Sphinx populi*[9], in the polyhedra of which ribonucleic acid (0·9 per cent) was found but no deoxyribonucleic acid.

I am indebted to Dr. H. Hadjissarantos of the University of Athens for identifying the larvæ of *Thaumatopoea pityocampa*.

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Preservation of *Strigomonas oncopelti* in the Dried State

In view of the findings of Becquerel[1] concerning the resistance of a wide variety of protozoa and algae to drying, it is rather surprising that more extensive efforts have not been made to preserve these cells in the dried state as is so commonly done with other micro-organisms.

Daily and McGuire[2] have published some data on the preservation of algae in the dried state; but there appears to have been no similar work done with protozoa.

This communication is an account of one of several similar trials in which the trypanosomid flagellate, *Strigomonas oncopelti*, has been preserved by a method of drying previously investigated for the preservation of bacteria[3] (see particularly appendix). The organism was kindly supplied by Dr. B. A. Newton, of the Department of Biochemistry, University of Cambridge.

The cells dried were obtained from a culture which had been grown for three days at 25° C. in 100 ml. of 2 per cent glucose broth. The copious growth was centrifuged and the packed cells were resuspended in an equal volume of 20 per cent glucose. Four-drop volumes of the suspension were inoculated on to starch–peptone plugs which were then exposed to high vacuum to produce foams. The necks of the ampoules were lightly plugged with cotton-wool to reduce contamination risks. After 24 hr. on the manifold, the dried foams were sealed *in vacuo*. Some of the desiccates were stored at room temperature (*c.* 20° C.) and others were stored at 4° C.

Three ampoules from each storage temperature were opened after twelve months (the longest period so far tested), and 3 ml. of glucose broth was added to each ampoule. The ampoules were left at room temperature. All ampoules yielded heavy growths of the flagellates, turbidity appearing in those which had been stored at 4° C. in about 9 days and in those which had been stored at room temperature, some 3 days later.

It is not possible from these results to gauge the efficiency with which the organisms were preserved; but it seems of interest to record that a relatively complex micro-organism such as *Strigomonas oncopelti* has been recovered after storage in the dried state.

I am indebted to the Medical Research Council for a personal research grant.

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Isolation of a Heat-resistant Variant of Polio-virus

It has been shown[1] that when preparations of MEF_1 (type II) polio-virus (*P. hominis*) are exposed to heat at 50° C., there is a marked reduction in the rate of inactivation as the exposure time is increased (see Fig. 1). Bodian *et al.*[2] have suggested that such a phenomenon occurring during the inactivation of polio-virus with formaldehyde may be due to (1) protection of some virus particles by aggregation, or (2) the presence of inherently resistant particles, and concluded that there was no evidence to support the latter possibility. Since either of these possibilities may explain our results with heat as the inactivating agent, they formed the basis of further experiments.

The MEF_1 virus was a strain previously described[3], and all infectivity titrations were carried out in cultures of monkey kidney epithelial cells grown in the bovine amniotic fluid medium of Enders. Two methods were used for eliminating aggregates of virus particles, namely, filtration of infected tissue culture fluid through a Seitz *E.K.* pad or centrifugation at 10,000 rev./min. for 1 hr. The fluids so treated were exposed to heat at 50° C. and afterwards titrated as described by Stanley *et al.*[1].

Fig. 1 shows no significant differences between the inactivation curve of the control fluid and that of the fluid which had been filtered or ultracentrifuged. It therefore appeared that in this instance aggregation was of little importance.

Infected tissue culture fluid, cleared by centrifugation, was then heated at 50° C. for 40 min. and passaged undiluted. Degeneration of the tissue culture cells

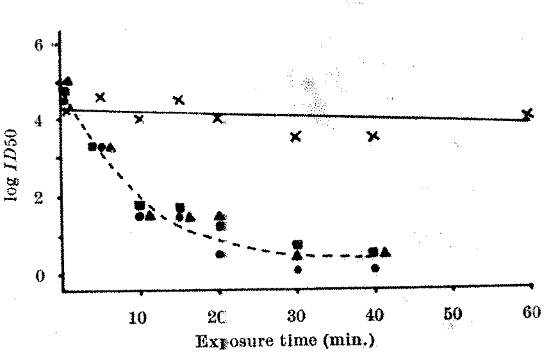

Fig. 1. Heat inactivation of *P. hominis* (50° C.). ×, Heat-resistant; ●, filtrate; ▲, infected tissue culture fluid cleared by centrifugation at 3,200 rev./min. for 20 min.; ■, ultracentrifuge supernatant

occurred after four days and the fluid was harvested, heated again for 40 min. at 50° C. and re-passaged. This process was repeated twice and a further heat inactivation curve obtained (see Fig. 1) using this material. It is apparent that the virus population comprising this passage differs markedly from the original preparation; and although it has now received four additional passages without further exposure to heat, there has been no reversion to the curve of the control material. Virus surviving exposure to heat at 50° C. for 24 hr. is now being examined.

It would thus appear that the inactivation curves originally obtained could be explained by the presence of a relatively small number of infective polio-virus particles inherently resistant to heat. This work will be reported in detail elsewhere.

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Unidentified Chick Growth Factors in Fermentation By-products

'DISTILLERS dried solubles' are commonly used in the United States as animal feed ingredients, particularly in rations for young stock. They contain considerable amounts of most of the B vitamins; but in addition there is strong evidence of the presence of unknown growth factors[1]. It appears that part of the growth response which is shown when the product is added to practical rations complete in all known vitamins may be due to inorganic factors[2]; but it is evident that there is also some organic factor of biological significance[3].

Corresponding products are at present available only on a limited scale in the United Kingdom. The production of dried solubles recovered from malt whisky distilleries in Scotland has permitted investigation of the growth factors which they may contain. Field trials with chicks and turkey poults indicated[4] that when groups were fed rations balanced for known components, the rations containing dried solubles permitted more rapid growth (up to about 10 per cent) and better food conversion (about 3 per cent improvement). Accordingly, we determined to carry out more closely controlled investigations using purified diets and chicks from the same hatchery.

Some difficulty was experienced in formulating a purified diet which would support normal growth; but satisfactory results have been obtained from a ration containing casein, gelatin, maize starch, sucrose and lard. Fibre was provided by the addition of distillers dried grains, and the vitamin- and amino-acid-levels were maintained by the addition of synthetic products. The vitamin content was supplemented in this way to twice the level recommended by the U.S. National Research Council[5].

The dried solubles have shown a tendency to hygroscopicity and two methods are at present used for overcoming this. In the first method the dried solubles are mixed with distillers dried grains to provide a 40/60 solubles–grains mixture which is effectively free flowing. In the second method the syrup derived from the evaporation of the spent wash is specially treated before drying. Both these products (solubles–grains mixture and 'treated dried solubles') were used in the present experiment.

Six groups each of 25 White Leghorn × Rhode Island Red male chicks were used, two groups to each treatment, and the treatments were randomized in an electric tier brooder. The three rations were balanced to take account of the dried grains provided in the solubles–grains mixtures and the B vitamins in both the dried solubles products. All the rations contained procaine penicillin at 4 gm. per lb. Growth was normal in all the groups and the details were as follows:

Experimental arrangements

Group 1 Control ration
Group 2 Control + 7½ per cent solubles–grains mixture
Group 3 Control + 3 per cent treated dried solubles

Results

	Group 1		Group 2		Group 3	
	Weight (gm.)	Cumulative gain (gm.)	Weight (gm.)	Cumulative gain (gm.)	Weight (gm.)	Cumulative gain (gm.)
Initial	34·8	—	35·1	—	36·6	—
7 days	72·4	37·6	78·4	43·3	78·9	42·3
14 days	134·8	100·0	150·3	115·2	149·9	113·3
21 days	231·6	196·8	251·8	216·7	249·7	213·1
27 days	315·1	280·3	339·0	303·9	343·5	306·9
Food consumption per group	25,265 (gm.)		26,255 (gm.)		27,385 (gm.)	
Food conversion efficiency (gm. food/gm. weight increase)	1·88		1·84		1·82	

Statistical analysis of the four-week weights revealed that the standard error between treatments was 6·65 gm. and the response in groups 2 and 3 is shown to be highly significant at the 5 per cent level. There is no significant difference between groups 2 and 3, and it therefore appears that the treatment has not in any way affected the growth-promoting property of the solubles.

A more extended investigation is now under way and the design of the experiment has been modified to allow of more detailed statistical analysis. This work, which will include investigation of other potential sources of the growth factor, will be reported in detail elsewhere, together with the results of the field trials.

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Chromatographic Separation of Digitalis Glycoside

SEVERAL of the constituents of *Digitalis purpurea* have been separated by paper partition chromatography, using ethylene glycol as the stationary phase and chloroform saturated with ethylene glycol as the mobile phase.

This system offers an advantage over the chloroform/formamide system used by Jensen[1] since the primary *A* and *B* glycosides as well as the secondary glycosides are separated before the solvent front reaches the bottom of the paper. Furthermore, any ethylene glycol left in the paper after drying will not react with the alkaline reagents, such as 3 : 5 dinitrobenzoate, commonly used to estimate the digitalis constituents, whereas formamide gives a marked reaction.

The toluene/propylene glycol system described by Zaffaroni[2] and used by Heftmann and Levant[3] for separating cardiac glycosides was tried but did not separate the digitalis constituents sufficiently for quantitative work.

In general, chloroform is preferable to toluene as the mobile phase for the separation of digitalis glycosides; propylene glycol and chloroform, however, are miscible and therefore unsuitable. On the other hand, ethylene glycol is relatively immiscible with chloroform and this combination has proved satisfactory. The method used is as follows.

Strips of Whatman No. 3 *MM* chromatograph paper 7·5 cm. × 55 cm. are passed through a 30 per cent v/v solution of ethylene glycol in methanol and blotted between folds of Whatman No. 1 paper. Solutions of the glycosides and aglycones in ethanol are applied to the starting line and the strips hung overnight in a chamber saturated with chloroform. Development is then commenced by allowing the mobile phase, chloroform saturated with ethylene glycol, to pass down the paper strips. There is a tendency for ethylene glycol to separate from the mobile phase in the trough and saturate the end of the paper, thus considerably slowing the rate of development. This may be prevented by placing a fold of dry Whatman No. 3 *MM* paper over this end of the strip before placing in the trough.

In the developed chromatograms each of the constituents occupies a small compact area with little tailing even when loads of 0·5 mgm. are chromatographed. Approximate R_F values are as follows:

Desacetyldigilanid *B*	0·05	Gitoxin	0·80
Desacetyldigilanid *A*	0·20	Digitoxigenin	0·90
Gitoxigenin	0·55	Digitoxin	0·95

Satisfactory quantitative recovery of several of the constituents has been obtained from the developed chromatograms, after removal of the ethylene glycol by heating for two days in a current of air at a temperature of 30° C. The glycosides present in alcoholic extracts of powdered digitalis leaves have also been separated and estimated.

The same solvent system has been used in preliminary experiments for separating mixtures of coumarin and related compounds, prior to testing for root growth inhibition. The degree of separation was of the same order as that obtained with systems containing butanol, acetic acid and water[4]. Chromatograms containing butanol and acetic acid in the mobile phase, after drying at room temperature for five hours, retained sufficient of the organic solvents to suppress completely root growth in cress seedlings. On the other hand, the amount of ethylene glycol remaining in chloroform/glycol chromatograms, similarly dried, did not cause significant inhibition of root growth.

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Tumour-inhibiting Properties of Potassium Iodide Solution containing Potassium Iodate

F. B. OBERHAUSER *et al.*[1] have recently published results of experiments in which they tried to influence the growth of a rat sarcoma by oral treatment of the animals with solutions of potassium iodate in potassium iodide.

The surprising results obtained by these authors seemed to justify a repetition of the experiments using another strain of rats and a sarcoma obtained from another source.

We used male Wistar rats aged 3–3½ months and an average weight of 200 gm. These were implanted with 5–10 mm.^{3} samples of rats' Jensen sarcoma subcutaneously in the back. (We owe this tumour to Prof. Lettré from the Cancer Research Institute of the University of Heidelberg.) One hundred animals used in these preliminary experiments were divided into three equal groups. The animals of the first group were implanted with the tumour only, whereas those of the second group were treated only with the solution used by Oberhauser *et al.* by stomach tube. The animals of the third group were treated with 0·2 ml. of this solution three times daily for 20 days preceding the tumour implantation. Those of the fourth group received the same treatment 10 days before and 10 days after the tumour implantation. Finally, the fifth group were treated with 0·2 ml. of the solution for 20 days after the implantation.

The results can be summarized as follows. All animals of the first group, with the exception of two which died from a wound infection on the third and fourth day respectively, died within about 30 days. The majority of the animals in group 2 died from diffuse hæmorrhagic gastritis. In these, numerous erosions of the gastric mucous membrane were found and in some cases the stomach was filled with blood. Some animals died from bronchopneumonia. On the thirty-fifth day of the treatment only six survived; these too had lost much weight and were apathetic and without appetite. Most animals of group 3 died before the implantation of tumours, partly from hæmorrhagic gastritis and partly from bronchopneumonia, others from unknown reasons (some of the dead animals had been mutilated by their litter mates). Those animals which survived the pretreatment died from their tumours after an average of 30 days. The experiments of groups 4 and 5 had an analogous result.

The rats used in our experiments can therefore be said to have sustained great damage when treated with the solution described by Oberhauser *et al.* in the way and in the same quantity used by these authors, causing the death of the majority of the animals. Those animals which survived the treatment died from their sarcomas. No inhibition of tumour growth was observed with this treatment. The high mortality of the treated animals rendered it useless to continue these experiments on the basis of the dosage applied by Oberhauser *et al.*

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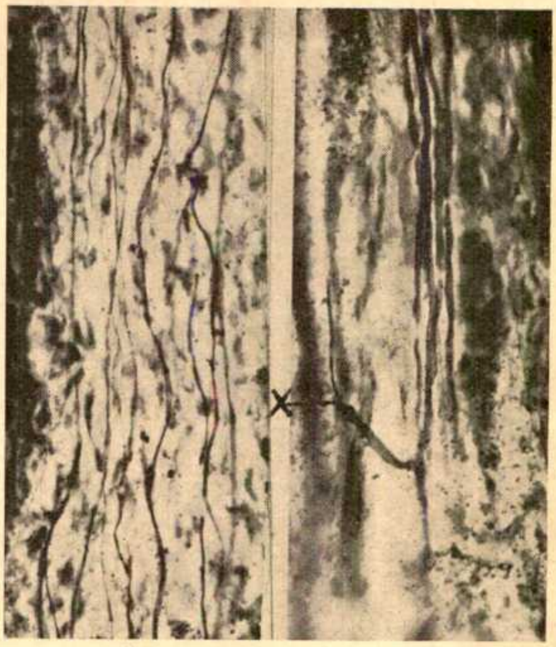
Innervation of the Continuously Growing Incisor

To my knowledge, the development of the innervation of the teeth has not yet been systematically investigated. There have been sporadic remarks; for example, Holland[1] writes: "As far as nerve tissue is concerned, it is believed that there is no direct connection or hookup with the parent sensory nerve ganglion until the tooth erupts and until root formation is nearly completed". Different authors, for example, Powers[2], in her studies of tooth innervation, has given illustrations of the rat-pulp for myelinated fibres but only from the molar teeth and illustrations of the periodontal nerve supply from the continuously growing incisor of the same species. In several animals (dog, calf, pig) I have found that in the earlier stages of the tooth development, for example, the period before the root begins to grow, there are in the pulp only unmyelinated (presumably vegetative) fibres. Later the myelinated sensory fibres appear. The pulp of the continuously growing incisor of the rat shows a similar situation. There are only unmyelinated fibres differing in size and branching. These are mainly in the neighbourhood of the vessels (see Fig. 1) and do not reach the odontoblastic layer.

Assuming that this tooth—the most important in the rat—must have an abundant nerve supply, I studied the continuously growing incisor by several methods but with the same result. Here are occasionally fibres in the incisor which resemble in their size myelinated nerve fibres, as shown in Fig. 2; only by close observation they reveal themselves as consisting of two or more, sometimes twisted, fibres. Conceding the possibility of there being nevertheless myelinated fibres in the incisor pulp, they must be very rare. With the same technique as used by Romanes[3], many myelinated fibres (Fig. 2) regularly showed in the molar-pulps.

In my opinion, this phenomenon can be explained as follows. The continuously growing incisor of the rat (and perhaps other rodents) behaves as an ordinary developing tooth before root formation, so far as innervation is concerned. The fact that the labial side of this tooth is covered with enamel up to the basal end means virtually that this tooth consists only of a crown-tube. Both the developing ordinary tooth of the higher mammals and the continuously growing incisor are lacking in a sensory nerve supply. The difference is only that in the former case this is transitory and in the latter it is the permanent physiological status. Common for both is the fact that the tooth itself is in a developing state. The physiological foundation of this type of innervation is, in my opinion, as follows: the continuously growing incisor is wearing out by the physiological abrasion. The pulp-cavity or pulp-tube is by this abrasion slowly closed by irregular dentine production which is different from the so-called secondary dentine of the molars and resembles a degenerative calcification. The former often has an irregular structure with many holes in it. Despite this, a pathological process, for example, inflammation, very seldom occurs in the incisor of the rat. This fact may be connected with the above-mentioned absence or scarcity of the sensory nerve supply.



(1) (2)

Fig. 1. From the pulp of the continuously growing incisor of the rat. Unmyelinated nerve fibres. Silver staining (ref. 3). (× 500)

Fig. 2. From the pulp-horn of the rat molar (same animal as in Fig. 1). Myelinated nerve fibres; at *X* the nerve fibre loses its myelin sheet. Silver staining (ref. 3). (× 500)

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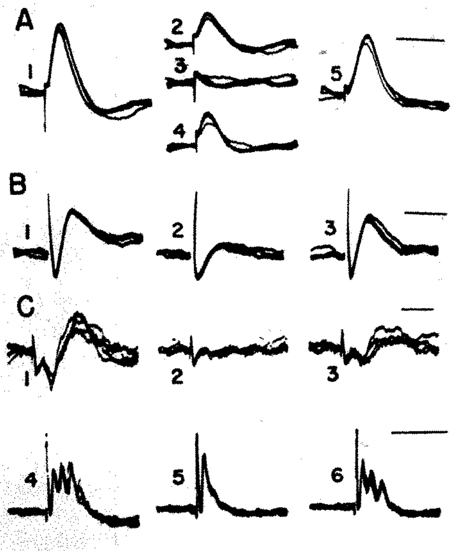
Inexcitability of Cortical Dendrites to Electric Stimuli

A PROMINENT component of the electrical activity of the cerebral cortex is the surface negative potential lasting about 15 m.sec. It is evoked synaptically by stimulation of various corticipetal pathways (for example, the callosal fibres or optic radiations), antidromically on stimulating the corticifugal pyramidal axons, or by stimuli directly applied to the cortex. This long-lasting surface negative potential has been ascribed, on good experimental grounds, to electrogenic activity in the apical dendrites of pyramidal cells[1].

Intravenous injection of *d*-tubocurarine (0·5–3 mgm./kgm. cat weight) into the succinylcholine-paralysed preparation diminishes and temporarily eliminates within 0·5–2 min. the dendritic potential previously evoked by any of the above modes of its production[2]. The disappearance and return of the antidromically evoked dendritic response evoked by stimulating the pyramids (C_{1-3}) parallels the disappearance and return of the late components of a volley descending in the tract after stimulating the cortex (C_{4-5}), which are of synaptic origin[3]. This and other evidence[2] indicates that in all modes of their activation the apical dendrites are excited by synaptic pathways, and therefore that their response is a post-synaptic potential[4]. However, when the dendritic activity to stimulation of the cortex (Fig. 1,*A*) or of structures 0·8–1·0 mm. below the cortical surface (*B*) is eliminated, the soma of the cells are still responsive to electrical stimulation. This is shown by the persistence of the first spike descending in the pyramidal tract (C_5), or of the surface positive spike to subsurface cortical stimulation (B_2). The cells then are also capable of antidromic invasion (C_2), as shown by the remaining positive spike of the records, whereas the apical dendrites are not accessible to invasion. These observations therefore lead to the conclusion that the apical dendrites are not themselves excited by applied electrical stimuli or by local circuit current. Similar evidence (unpublished) has been obtained for the dendrites of the cerebellar cortex.

Inexcitability to electrical stimuli is the condition prevalent in the electric organ of various fishes, and in the synaptically excitable membrane of the muscle end-plate and of the eel electroplaque[5]. In correlation with other observations, these findings have led to the suggestion[6] that the post-junctional membrane which is involved in synaptic action is always unresponsive to electrical stimuli. The present finding thus provides further experimental support for that suggestion, which has important consequences for the functioning of the central nervous system. The bearing of electrical inexcitability of the post-synaptic membrane on the nature of synaptic transmission, and on the classification and analysis of various forms of electrogenic activity, is discussed elsewhere[6].



Abolition of dendritic responses to electrical stimuli by *d*-tubocurarine chloride. Dose used in all experiments was 3 mgm./kgm. cat weight, intravenous.

(*A*) Stimulating and recording electrodes about 2 mm. apart on cortex. Four consecutive records superimposed in each set. Time, 20 msec. The normal surface negative response (1) was diminished 50 sec. after injection (2) and extinguished 20 sec. later (3). Recovery after 3 and 20 min. is shown in 4 and 5.

(*B*) Stimulating electrodes 0·8 mm. below cortical surface, recording electrodes on the latter. Three consecutive records superimposed in each set. Time, 20 m.sec. The positive spike, probably of cells, is followed by the negative dendritic potential (1). The latter disappeared 45 sec. after injection (2), with marked recovery 45 sec. later (3).

(*C*) Stimulating electrodes in pyramidal tract, recording on surface in 1–3. Electrode functions reversed in 4–6. Five consecutive superimposed records in each set. Times, 10 m.sec. The antidromically evoked cortical response is composed of two positive-spike components and a dendritic potential (1). Only the first spike component remained 2 min. after injection (2). Recovery after 20 min. in 3. The orthodromically evoked pyramidal response (4) was simplified, losing its synaptically excited components 2 min. after injection (5). Recovery after 20 min. in 6

This investigation was aided by grants from the Muscular Dystrophy Association, United Cerebral Palsy Fund, National Science Foundation and Donner Research Foundation.

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Seasonal Variations of Noradrenaline and Adrenaline Concentrations in Rat Tissues

VARIATIONS of catecholamine concentration in tissues from normal male Wistar rats were observed in the course of experiments covering a twelve-month period; further estimations were afterwards carried out to confirm these variations. Adrenaline and noradrenaline were estimated fluorimetrically in heart, kidneys, liver, diaphragm, leg muscles, brain and spleen using a modification[1] of the method of Weil-Malherbe and Bone[2]. The results comprise between 24 and 74 individual estimations on each tissue extending over periods of up to 25 months.

Noradrenaline and adrenaline concentrations and the percentage of adrenaline in a mixture of these amines (the 'adrenaline percentage') usually showed two maxima and two minima in a year, often of very unequal size. Except for brain, their times and the approximate extent of variation in the first year are outlined below; the changes in liver are shown graphically in Fig. 1. *Noradrenaline.* $2\frac{1}{2}$- to $4\frac{1}{2}$-fold variation of the means obtained in different months; maximal concentrations in winter (November–January), with usually another maximum in summer (May–July). Minimal in spring (March–May) and late summer (August–September). *Adrenaline.* Two- to five-fold variations; maximal in July with a usually smaller maximum in winter (November–January); minimal in spring (March–May), and again in late summer (August–October). *Adrenaline percentage.* $1\frac{1}{2}$- to 3-fold variations; maximal in July and again in March; minimal in autumn–winter (October–January) and in early summer (April–June). The catecholamine concentrations already published[1,3] were obtained during the months September–November.

To obtain the most reliable estimates of significance, analyses from several consecutive months in both

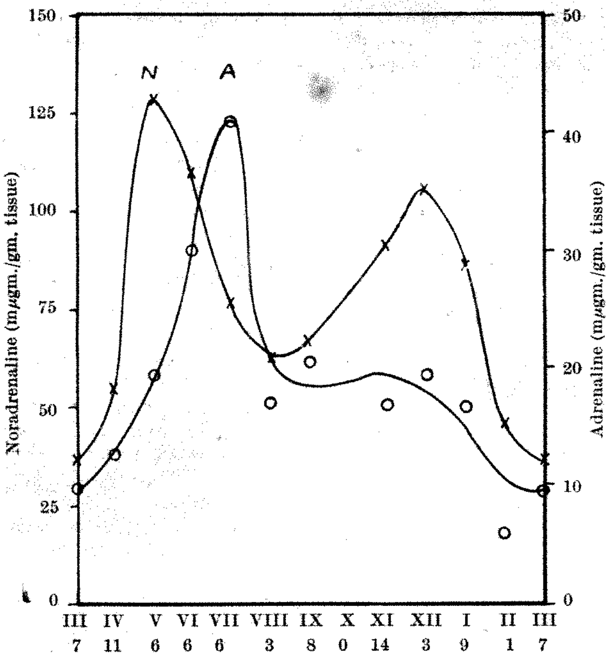

Fig. 1. Mean concentrations of noradrenaline (N) and adrenaline (A) in liver in different months, designated by Roman numerals. (Arabic numerals = numbers of estimations)

years were combined; there was at least one significant maximum and minimum ($P < 0\cdot01$) of noradrenaline concentration in each tissue and, except for spleen ($P < 0\cdot02$), of the 'adrenaline percentage'. There were significant or probably significant ($P < 0\cdot05$) variations of adrenaline concentration in each tissue. The variations of noradrenaline concentration in heart, liver, leg muscles and spleen, and of the 'adrenaline percentage' in heart, were significantly or probably significantly diphasic. Lack of significance in some cases was probably due to lack of estimates at times of probable maxima or minima.

There is little evidence of seasonal variation in brain; this might be due to a smaller number of estimates in this tissue although the estimates in spleen, of similar number, show significant changes. In brain the 'adrenaline percentage' varied notably less than in other tissues.

The means of estimates obtained in the second year were often considerably different from those of the first year; they not only confirmed but also exaggerated some of the changes originally observed. The seasonal changes are significant in spite of often larger standard errors incurred by combining estimates from several months and in two different years. The necessity of simultaneous control experiments is obvious; the changes of catecholamine concentrations outlined above are very much larger than those produced by, for example, insulin hypoglycæmia as determined by simultaneous analyses of untreated and treated rats[3,4].

Experiments with bilaterally demedullated rats indicate that the variations are not dependent on the adrenal medulla; they cannot be due to seasonal differences of environmental temperature or diet, nor solely to differences of light nor to interconversion of the two amines. They might have been caused in part by differences observed in the weight of tissues expressed as percentages of body-weight; seasonal metabolic changes, for example, of thyroid activity[5,6] or adrenocortical secretion[4], might without medullary secretion account for changes of weight and of the adrenaline and noradrenaline contents of tissues.

Recent experiments have shown that other catechol compounds which are extracted and estimated by the method are present to some extent in rat tissues; further experiments are required to determine the extent to which they contribute to the observed variations.

This work was supported by a grant from the Medical Research Council.

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Measurement of Denaturation of Fish Protein

IT is well known that frozen fish alter in character during storage at sub-zero temperatures, becoming progressively tougher to eat, and exuding much fluid or 'drip' on thawing. The change proceeds more slowly the lower the temperature. There is a real need for an accurate objective method of measuring this deterioration, from the point of view of product control and also as a tool for systematic research on methods of freezing and storage. Most of the observed phenomena have been attributed to changes in the proteins of the flesh[1], and these changes have therefore been examined by a number of workers with the object of providing a successful method.

The proteins of cold-stored frozen fish become progressively less soluble in dilute salt solution. Dyer, French and Snow[2] showed that more than 90 per cent of the total proteins of fresh fish muscle could be brought into solution by suitable treatment, and worked out the optimum conditions for extraction. The percentage of soluble protein progressively decreased when the fish were cold-stored, and later experiments[3] showed a correlation between soluble protein and taste-panel rating (degree of toughness). However, further work[4] revealed that the scatter of values in individual fresh fish was too great for the measurement of considerable differences in denaturation. This fact reduced the value of the method, and has since led to its disuse in some laboratories, and to the investigation of other properties instead, for example, viscosity[5].

It seemed likely to us that if great variations were encountered in such a fundamental property as solubility, they would probably occur in others, too. We have therefore investigated these variations, having regard to the anatomy of the musculature and the biological factors affecting the living fish, in the hope that such information might point the way to a more reliable technique.

In the experiments to be described, flesh from cod (*Gadus callarias*) was chopped finely with scissors, macerated with 5 per cent sodium chloride at 0° C., and then centrifuged to separate soluble from insoluble proteins, which were determined as nitrogen.

The first finding of interest was a linear relationship between soluble protein and length of fish. In one experiment, for example, 92·2 per cent of the total flesh protein from a 10-in. fish was soluble in salt solution, while only 60·8 per cent was soluble in similar tissue from a 38-in. fish.

Fillets are made up of about fifty segments of muscle tissue proper (myotomes), each separated from adjacent ones by tough fibrous septa (myocommata). After some practice, it was found possible to dissect out the myocommata reasonably free from muscle tissue, and their solubility in salt solution was found to be very low—in one case as low as 20·8 per cent. It was obvious, therefore, that the presence of such tissue must depress the figure for extractable protein in whole chopped fillets, and since the myocommata were observed to be thicker in larger fish, it seemed likely that their presence was responsible for the length–solubility relationship noted above.

Tissue in different parts of a single fillet, with and without myocommata, was accordingly investigated. A fillet was divided into pieces each containing seven myotomes, and it was found that, in a 34-in. cod, the percentage of soluble protein diminished progressively from 75·6 at the anterior end to 67·8 at the tail. When the myotomes were dissected out free from myocommata, however, in the other fillet of the same fish, the corresponding values were 89·8 and 66·5 per cent, showing that the absence of myocommata resulted in a much higher solubility at the anterior end. There was no significant difference between dissected myotomes and whole tissue at the tail end because the myocommata there were too close together to be removed effectively. The important point was that even myotomes dissected free from myocommata differed in solubility in different parts of the fish. It was decided, therefore, as a routine to dissect out only two or three of the widest myotomes for investigation from each fish (near myotome No. 12 counting from the anterior end). When this was done, the soluble proteins of fish 16·5, 20 and 25 in. long were found to be respectively 97·4, 97·1 and 97·8 per cent of the total. In another experiment, values from fish 10, 24·5 and 38 in. long were 95·6, 96·1 and 91·9 per cent respectively. The lower values in very large cod were afterwards confirmed, but it can be seen that the relationship between solubility and body-length was mostly due to the presence of varying amounts of myocommata, and that the variations caused by differences in length were therefore almost completely eliminated by the dissection technique.

The effectiveness of this technique as applied to medium-sized cod was then investigated more fully, and when twenty-four samples of dissected myotomes from cod ranging from 20 to 31 in. long, caught in October 1955, were extracted with salt; they were found to yield on the average 95·7 per cent soluble protein, with a standard deviation of only 0·97 (extreme values 93·7–97·2). This was most satisfactory, but when the technique was applied to a similar batch of fish caught in January 1956, the average value had dropped to 87·5 per cent with standard deviation of 5·69 (extreme values 72·4–97·2), showing that a further influence was operative. Now cod in January are in a semi-starved condition, and the lower values compared with the October ones can probably be explained by the fish preferentially utilizing soluble protein for energy purposes or for building up gonads. The greater scatter of results, on the same hypothesis, can be attributed to the different degrees of starvation in different fish. By March, the average value had risen again to 93·1 per cent ± 3·69 (extreme values 82·3–96·2). We are continuing to investigate these points, as well as the possible effect of maturity. Although the low values for extractable protein in the largest cod are still unexplained, and, together with the seasonal variation, introduce difficulties in achieving a completely satisfactory method for comparing fresh and frozen fish, the new technique represents a very considerable advance.

It has already been applied in the following way. Fillets from seven medium-sized cod caught in the summer were frozen at widely differing cooling-rates, then stored at − 14° C. for about one hundred days. The soluble protein in the dissected myotomes was then determined, and showed that the amount of denaturation was considerably influenced by the rate of freezing. The pattern of results was strikingly reproduced in a similar batch of fish caught later, showing that differentiation between fish exhibiting small differences in denaturation was now possible.

A full account of the completed work will be published elsewhere.

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Detection of a Presumptive Keto-steroid in the Ovaries and Blood of the Laying Hen

There is a considerable body of information on the occurrence of œstrogens and androgens in avian species. Much of the relevant literature has been reviewed by Sturkie[1], Lorenz[2] and Burrows[3]. In the absence of chemical or spectrophotometric evidence for the nature of the natural avian gonadal hormones, we have attempted to detect steroid œstrogens in extracts of the ovaries and blood of laying hens.

Ovaries were removed from laying hens immediately on killing and the large yellow ova were removed from their follicles and discarded. The residual ovaries were disintegrated in methanol in a Waring blendor with approximately twice their volume of methanol. The mixture was dialysed in 'Cellophane' dialysis tubing against methanol for 48 hr.[4]. The dialysate was diluted with water to 60 per cent (v/v) methanol and extracted with four successive portions of dichloromethane. The dichloromethane was removed at the suction pump. The residue was chromatographed on filter paper (Whatman No. 1) by the use of a ligroin–absolute methanol system at 34 ± 1° C.[5].

Examination of the paper revealed prominent spots which reacted positively to 2,4-dinitrophenylhydrazine, and which had an R_F value slightly less than that realized for pure œstrone under similar conditions. The spots were eluted from a number of papers with

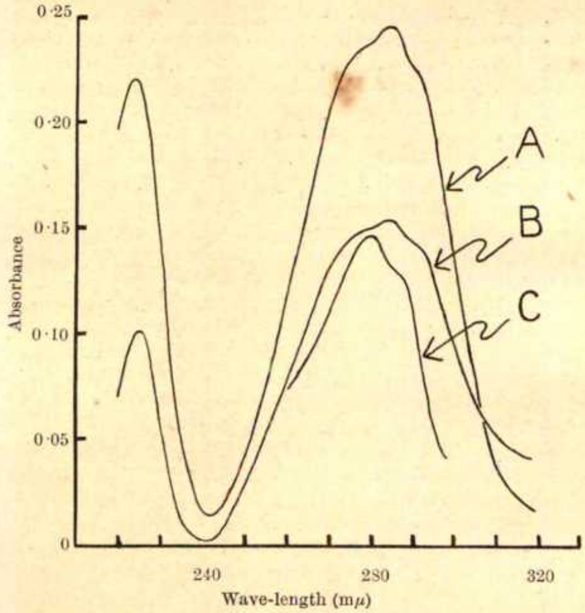

Fig. 1. Ultra-violet absorption of presumptive keto-steroids isolated chromatographically from ovaries (curve *A*) from blood (curve *B*) of laying pullets. Curve *C* was obtained from œstrone treated in the same way

dichloromethane–methanol (1 : 1 v/v). The eluted material was chromatographed repeatedly in the same system. The ultra-violet absorption spectrum of the eluate was recorded on a spectrometer (Warren 'Spectracord') after each run. After four such purifications the spot yielded material with the absorption spectrum shown in Fig. 1, curve *A*. The absorption peak at 283 mμ was close to, but distinct from, that obtained for pure œstrone (280 mμ) under the same conditions, and the absorption curve also indicated the presence of a 'shoulder' similar to, but different from, that shown by the steroid œstrogens (curve *C*). Finally, the Kober reaction was applied to the purified material according to the directions of Brown[6], the colour being observed in the Warren 'Spectracord'. The reaction was negative.

The same substance has been detected in the blood of laying hens. Whole blood was drawn into an equal volume of methanol, and a volume of water equal to that of the blood was then added. The mixture was dialysed against 60 per cent v/v methanol for 48 hr., and the dialysate was further examined as described above in connexion with ovarian extracts. A considerable number of papers, corresponding in all to about 2 l. of blood drawn from laying hens, was run. The areas on these papers that corresponded to the R_F values of the œstriol, œstradiol and œstrone were cut out, eluted with methanol–dichloromethane (1 : 1 v/v) and rechromatographed. A spot positive to 2,4-dinitrophenylhydrazone was found in the region corresponding to the R_F of the natural œstrogens. The ultra-violet absorption of this curve is shown (curve *B* in Fig. 1). It displayed close correspondence in detail with the curve for the substance obtained from the ovarian extract, and gave a negative result in the Kober reaction.

We are at present engaged in studies on the occurrence of this substance in relation to the reproductive cycle of the fowl.

We are indebted to the National Research Council of Canada for a grant in aid of research that made this work possible. One of us (R. H. C.) also wishes to thank the Royal Society for a Nuffield Foundation Commonwealth Bursary which enabled this project to be initiated during a visit to the National Institute for Research in Dairying, Reading, in 1954. We are further deeply indebted to Prof. W. A. Maw and Prof. N. Nikolaiczuk for providing suitable birds, and wish also to thank Prof. R. D. H. Heard of McGill University, and Dr. R. M. Fraps of the United States Department of Agriculture, for their interest and encouragement.

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Extra Ocular Photoreceptors in the Land Leech, *Haemadipsa zeylanica agilis* (Moore) from Nainital, Almora (India)

THE special function of the segmental papillæ of the medicinal leech, *Hirudo medicinalis*, has long been in doubt. As far back as 1885, Whitman, in a study[1] describing the external morphology of the leech *Hirudo*, suggested serial homology of the segmental papillæ with the eyes. He supported this by the evidence that in sections of the segmental papillæ are found all the elements of the eye, except the pigment. Owing to the absence of a pigment cup holding the glassy cells, however, as is found in true visual organs, Whitman found it difficult definitely to regard the segmental papillæ as visual organs. The possibility that the segmental papillæ may be concerned with vision has also been suggested by me in my memoir on the Indian leech *Hirudinaria*[2].

A morphological study of the land leech *Haemadipsa zeylanica agilis* (Moore), obtained from the Nainital area, has revealed a closer structural resemblance between the segmental papillæ and the eyes than was hitherto described for other species. A section of the body-wall displays structures, each in the region of the segmental annuli, consisting of a single

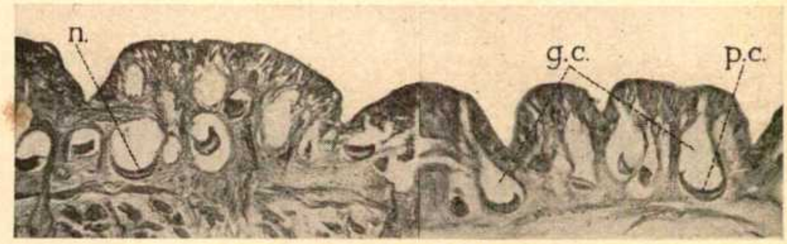

Fig. 1. Photomicrograp of a section through the body wall of the leech *Haemadipsa zeylanica*: *g.c.*, glassy cells; *n.*, nucleus; *p.c.*, pigment cup

glassy flask-shaped cell at the base of which is a layer of pigment with a nucleus embedded in it (Fig. 1).

The presence of the glassy cells together with the pigmented layer facing outwards is significant, and seems to point to a visual function for the papillæ, at least in so far as this species is concerned. It also supports Whitman's assertion that the eyes and the segmental papillæ were, originally, morphological as well as physiological equivalents.

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Antigens and Mating Types in *Escherichia coli*

Evidence has been offered by one of us[1] for the existence of properties correlated with sex compatibility in *Escherichia coli*. According to these data, sex-incompatible ($F-$) strains have a lower acid agglutination point and a far greater stability of broth-cultures as compared with $F+$ strains of corresponding phenotype. These and other related properties of cell surface and the $F+$ state are transmitted infectively from $F+$ to $F-$ strains at the same time. A search for an antigenic equivalent of such properties was but an obvious implication of these findings.

Some strains of *Escherichia coli K* 12 employed in previous researches were used for preparing immune sera by inoculating rabbits intravenously. Two phenotypes were chosen, one of which is defined by biotin and methionine deficiency and resistance to the bacteriophage T_1, and the other by threonine, leucine and thiamine deficiency and inability to ferment lactose, maltose, galactose, arabinose, xylose and mannitol. The $F-$ and the $F+$ variants of each phenotype were used.

Both *O* and *K* antigens were prepared from each strain, aiming at providing evidence for the somatic or the capsular nature of the antigenic structure, if any, correlated with sex compatibility. The *O* antigen was prepared by heating young broth-cultures at 100° C. for 2½ hr. The thermolabile *K* antigen was prepared by suspending in saline smooth opaque colonies freshly grown on nutrient agar supplemented with 1 per cent glucose. Rabbits were injected at 4-day intervals and sera collected when test-bleedings revealed an agglutinating titre of about 1 : 1,000.

Fresh suspensions in saline of the four strains, that is, the two mating types of the two phenotypes, were used for the agglutination reactions. For this purpose cultures were used at the logarithmic growth stage under conditions which were optimal for both recombination and *F* infection.

The results of the agglutination reactions showed that: (1) anti-*O* sera give no appreciable agglutination with any strain unless the cells are boiled for 2½ hr.; (2) anti-*K* sera differentiate $F-$ from $F+$ untreated cells of the same phenotype in that they agglutinate $F-$ much more rapidly and in larger clumps than they do $F+$; (3) the phenotype and the *F* state of the antigen used for injecting rabbits do not affect appreciably the type of antibody produced, but the anti-*K* sera have a higher titre than the anti-*O* ones; (4) controls, either in the absence of immune sera or with normal serum from untreated rabbits, are fully negative; (5) the Kauffmann serum *O26 B6* (kindly supplied by Dr. A. Buogo) gives, with the same antigens, a reaction identical with that of our anti-*K* sera.

These observations seem to indicate that the antigenic difference, if any, between $F+$ and $F-$ cells of the same phenotype is to be understood as a difference in surface antigens, which is in good agreement with our previous results. Possibly, $F+$ cells are deprived of, or $F-$ cells are more abundantly provided with, a capsular antigen which seems to be of the thermolabile *B* type.

On the basis of these preliminary results, wider researches have been undertaken in order to: (*a*) analyse, qualitatively and quantitatively, the antigenic structure of *Escherichia coli* strains belonging to different mating types; (*b*) ascertain the effect of adsorbed antibodies on the kinetics of recombination and *F* infection.

Moreover, it is apparent that if *F* infection is substantiated, at least partially, by transformation of antigenic properties, these researches might also reinforce the interpretation of the well-known phenomenon of paragglutination[2].

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5-Hydroxytryptamine in Scorpion Venom

In the course of an investigation of the toxic factors in the venom of *Leiurus quinquestriatus* (H. and E., 1829), one of the constituents of the venom has been found to be 5-hydroxytryptamine.

The venom was obtained by electrical stimulation of the telson[1], and was dried *in vacuo* and dissolved in water when required. The 5-hydroxytryptamine was identified by paper chromatography, developing with three different solvent systems and using the colour reactions with *p*-dimethylaminobenzaldehyde or diazotized *p*-nitroaniline, or the fluorescence produced after treatment with potassium dichromate and formalin (cf. Erspamer[2]).

Comparison of the areas of the spots with those from known concentrations of 5-hydroxytryptamine suggested concentrations of 3–4 μgm. 5-hydroxytryptamine base/mgm. dry venom. Assays of the crude venom on the rat uterus preparation or (with less precision) on guinea pig ileum confirmed these concentrations, and the activity of the venom on these preparations could be completely antagonized by dihydroergotamine. Assays of eluates of 5-hydroxytryptamine from chromatograms of the venom gave rather lower values, 1–2 μgm./mgm. venom; but eluates from other areas of the chromatogram did not show any activity on these preparations.

These concentrations of 5-hydroxytryptamine are even higher than those reported in wasp venom[3], and may contribute to the pain resulting from a sting. It is of interest that Mohammed and El Karemi[4] have claimed that a combination of dihydroergotamine and atropine, both capable of antagonizing

5-hydroxytryptamine, can protect mice from several lethal doses of venom. It seems unlikely, however, that 5-hydroxytryptamine, in these concentrations, can be a factor in the systemic toxicity of the venom, and extraction of the venom by 95 per cent (v/v) acetone, so that the 5-hydroxytryptamine is removed, does not appear to affect the toxicity of the residue.

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Shell Disease in Portuguese Oysters

Since the discovery in 1949 [1] of shell disease among Brittany oysters relaid in Britain, detailed observations of its occurrence have been made. It is now established among native oysters, particularly in some of the warm shallow creeks in Essex[2]; but there is no previous record of its occurrence in *Gryphaea* as distinct from *Ostrea*.

In 1953, two naturally occurring Portuguese oysters, *Gryphaea angulata*, from the River Crouch were found to be lightly infected; but no further evidence that the disease attacked this species of oyster was obtained until September 1955 when Portuguese oysters from West Mersea, Essex, were found to be infected and in some cases to have died, as a result of the disease. 7·1 per cent showed evidence of attack compared with 9·0 per cent of the native *Ostrea edulis* on the same ground. 14 per cent of the infected Portuguese oysters and 22 per cent of the infected native oysters were in the last stages of the disease. The Portuguese oysters had been relaid from a variety of sources so that it was not possible to discover where the infection originated.

Symptoms are the same in both types of oyster: an initial appearance of opaque white clear-centred spots on the inside of the shell was followed by their coalescence and subsequent appearance of greenish-brown patches. When the area of the muscle is reached, there is interference with the closing mechanism, resulting in death.

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Etiology of Atherosclerosis

A recent observation has been made which may have an important bearing on current views regarding the etiology of atherosclerosis. It has been observed that alimentary lipæmia, induced by a normal fat-containing meal (for example, a mixed grill), is inhibitory to the spontaneous *in vitro* fibrinolytic mechanism of blood which is active at *p*H 7·4 after dilution of the plasma[1]. The mean values in twenty normal subjects for the percentage of clot lysed in 24 hr. before, and 3½–4 hr. after, a fat-containing meal are as follow:

	Fasting	After fatty meal
Per cent lysis in 24 hr.	79 per cent	24 per cent

This observation may provide a bridge between the dietary[2] and mural thrombus incorporation[3] theories of the etiology of atherosclerosis. The sequence of events suggested is that a high food fat intake leads to a continuing inhibition of the fibrinolytic system of the blood and so to persistence of mural thrombi and their incorporation into the vessel wall.

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Inhibition of *Venturia* spp. by Analogues of Host Metabolites

The significance of host metabolites in the host relations of *Venturia inaequalis* and *V. pirina*, the causal fungi of apple and pear scab respectively, has already been reported[1]. Further studies have shown that, of the main components of the mixtures of plant phenols in the apple and pear, compounds of the chlorogenic acid type, that is, depsides, probably play an important part. They are toxic to the pathogens at low concentrations, but do exhibit some phytotoxicity when injected *in vivo*.

In a search for a compound of this type, which would be more toxic to the pathogens than chlorogenic acid but less damaging to the host species, we have examined, first in culture, a series of structural analogues. The fungi were grown on filter-paper cylinders standing in filter-sterilized liquid media, and growth and sporulation were recorded[2]. Growth was visually assessed in categories, category 2 being arbitrarily assigned to a normal amount (not type) of growth. Sporulation was estimated by a turbidimetric method in which the readings were directly proportional to the numbers of conidia produced by the cultures.

An example of the reactions of *V. inaequalis* to the compounds studied is given in Table 1, the result of each treatment being expressed as the mean of six replicates. The basal culture medium contained

Table 1. Inhibition of Growth and Sporulation of *V. inaequalis*

Addition	Sporulation	Growth category	Notes
—	0·349	2	
Chlorogenic acid	0·187	2	Abnormal growth
Caffeic acid	0·178	2	Abnormal growth
Ferulic acid	0·332	2	
Protocatechuic acid	0·207	2	
p-Coumaric acid	0·220	2	
o-Coumaric acid	<0·001	1	Abnormal growth
Cinnamic acid	0·000	0	Inoculum ungerminated
Quinic acid	0·352	2	

glucose, an enzymic digest of casein, and inorganic salts; the final concentration of each added compound was $M/100$ and the initial pH was 5·6 in all cases.

Cinnamic acid was the most inhibitory compound and was unique in preventing germination of the inoculum. Introduction of a hydroxyl group in the *ortho* position, that is, *o*-coumaric acid, permits germination, but growth is abnormal and inhibited, and sporulation is strongly inhibited. Hydroxyl groups in any position in the benzene ring with the exception of a single hydroxyl group in the *para* position, that is, *p*-coumaric acid, cause abnormal growth, and even with the latter compound sporulation was slightly reduced. Ferulic acid, where the *meta* hydroxyl group is masked, also gives normal growth, while methylene dioxycinnamic acid, in another test, was more toxic than *o*-coumaric acid. Protocatechuic acid, which does not possess the —CH=CH.COOH grouping, permits normal growth but induces slight inhibition of sporulation. In contrast, it may be noted that protocatechuic acid is highly toxic to *Colletotrichum circinans*[3]. Quinic acid, a component of chlorogenic acid, had no effect either on growth or sporulation. Similar results have been obtained with *V. pirina in vitro*.

In view of the outstanding toxicity of cinnamic acid and its potential value as a protective fungicide and a chemotherapeutant, its activity in the latter role was studied *in vivo*. Shoots of Cox's Orange Pippin, raised under artificial light in a heated greenhouse, were inoculated with *V. inaequalis*, and, twenty-four hours later, all but the control shoots were injected with a 0·2 per cent solution of sodium cinnamate[1]. Only slight interveinal chlorosis and growth inhibition resulted despite an intake of about 100 mgm. per shoot tip. Thirteen days after inoculation a high degree of inhibition of *V. inaequalis* was observed in the sodium cinnamate treatment. A chromatographic examination of leaves above the injection point indicated the persistence of the cinnamate.

Further studies of this aspect of host–parasite relations, and of the chemotherapeutic value of compounds allied to host metabolites, are being continued and will be reported in full elsewhere.

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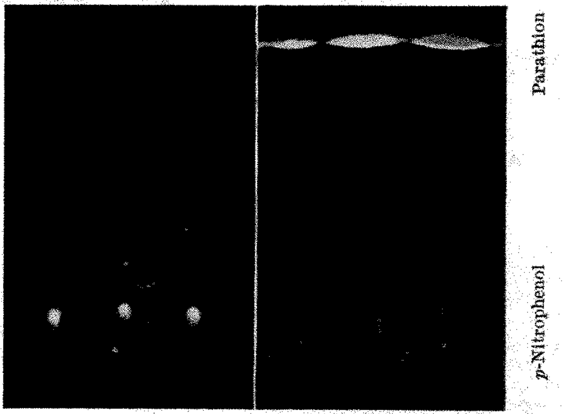
Isolation and Identification of Parathion in Biological Material

Numerous methods have hitherto been proposed for the isolation of parathion from biological material and for its identification. Most of these methods, have, however, defects which cannot be overlooked, resulting in either a small yield of poison (for example, steam distillation) or a highly impure extract (for example, isolation with the Stas–Otto method). Among the identification methods, the Averell and Norris[1] reaction has proved aspecific, while ultra-violet spectrophotometry and paper chromatography are highly disturbed by the impurities present in the extracts.



(a) (b)

Fig. 1. Chromatograms of parathion and p-nitrophenol using ultra-violet lamp of wave-length (a) 3600 A. and (b) 2537 A.

In trying to eliminate these inconveniences, I have devised a new system of isolation and identification which has given satisfactory results.

A preliminary extraction is made using the Fretwurst and Naeve[2] method: 10 gm. of the organ under examination are homogenized in a mortar with quartz, then diluted with 20 c.c. of distilled water, 20 c.c. of ethyl alcohol, and 50 c.c. of trichloroacetic acid at 20 per cent. After repeated shakings for 30 min. a portion of the mixture is centrifuged for 15 min. The supernatant liquid is filtered, the alcohol is evaporated and the aqueous acid solution is then filtered through a column of acid alumina prepared according to the method of Kuhn and Wieland[3]. No visible rings form; but parathion is completely adsorbed, while many impurities remain in the aqueous solution. The parathion is then eluted from the desiccated alumina with ethyl ether. The ether is filtered and evaporated with a weak air current. The residue is dissolved in benzene or alcohol and placed directly on the starting line of an *SS*2043*b* paper (28 cm. × 25 cm.) for chromatography. Simultaneously, test spots of parathion and p-nitrophenol are also placed on the paper. Development is carried out with the ascending method using as solvent 5 per cent ethyl ether in water-saturated petroleum ether. The paper is saturated in the vapour of the water phase of the solvent overnight. The run takes place in 2–3 hr. at a temperature of 20° C. The spots of the parathion and of its breakdown product, p-nitrophenol, are detected by two ultra-violet lamps, one at 3600 A. and the other at 2537 A. (Mineralight *SL* 2537), and photocopied according to Markham and Smith[4]. With the 3600-A. lamp the p-nitrophenol absorbs strongly, while the parathion absorbs weakly. Instead, with the 2537-A. lamp the parathion absorbs strongly: even 0·5 gamma of the substance is easily identifiable. The parathion has an R_F value of 0·98 and p-nitrophenol has one of 0·30. With this solvent we avoid the inconvenience of the partial transformation of the parathion in p-nitrophenol which is observed with alkaline solvents[5-7] or the necessity of working in 'reversed phase'[8].

A control to ensure the nature of the spots may be done by cutting strips from the chromatogram and examining them in ultra-violet with an adapter for the Beckman spectrophotometer model *DU*[9], first at wave-length 3200 A. (maximum for *p*-nitrophenol) and then at wave-length 2780 A. (maximum for parathion). With the first examination we obtain maximum absorption in the location of the parathion spot; the contrary occurs, on the other hand, when the examination is made with wave-length 2780 A. Sometimes the impurities still present in the extract alter the form of the spot, which becomes considerably flatter or wider: notwithstanding, the R_F value is not substantially modified, and, furthermore, the examination with the two ultra-violet ray lamps and an eventual successive transformation of the parathion into *p*-nitrophenol by ammonia vapour equally allow identification.

I am grateful to Dr. R. M. de Leo for his co-operation. Further details will be published elsewhere.

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Ascorbic Acid Content in Fruits of *Myrciaria glomerata* Berg.

The fruit of the Brazilian plant *Myrciaria glomerata* Berg. has proved to be very rich in ascorbic acid. The ascorbic acid content was determined in the extract obtained by running the fruits (as a whole or in parts) in a blender for 2 min.; a 0·4 per cent oxalic acid solution was used for preventing oxidation during the extraction period and subsequent determination; ascorbic acid was assayed by the 2 : 6-dichlorophenol–indophenol method according to the technique described by Leme and Malavolta[1].

A marked difference in vitamin C content was observed in fruits from trees exposed to full sunlight when compared to those from shaded trees.

Tree No.	Mgm. ascorbic acid/100 gm. Full sunlight	Shaded
1	2,417	717·3
2	2,389	838·6
3	2,322	560·8

Assays made with fruits at different stages of maturity gave the following results:

State of maturity	Mgm. ascorbic acid/100 gm.
Green fruits	2,716
Fully developed fruits	2,391
Ripe fruits	2 417

Green fruits had thus a higher vitamin C content than either partially or completely ripe fruits; the difference between the last two types was not statistically significant.

Different parts of the fruit that were assayed separately had the following ascorbic acid content:

Part of the fruit	Mgm. ascorbic acid/100 gm.
Peel	2,482
Pulp (without seeds)	3,018

It is fortunate that the edible portion of the fruit, namely, the pulp, is richer than the peel.

The results herein reported show that the fruits of *Myrciaria glomerata* have the highest vitamin C content found among edible fruits of the family Myrtaceae; they are also among the fruits richest in this vitamin, being surpassed only by the hips of wild roses and by fruits of *Malpighia* spp.

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Development of the Long Forms of Bacteria

Numerous methods of inducing long forms in aerobic and anaerobic bacteria have now been described[1,2]. One of the standard techniques of maintaining these forms is to grow the organisms beneath an agar block, that is, under microaerophilic conditions.

During the course of large numbers of experiments with shake cultures in quill tubes (3 mm. internal diameter), the medium being covered with various substances, the development of long forms has been readily observed. An account of this work is being prepared for publication.

Utilizing poor media (agar containing 2 per cent nutrient broth) it was observed that, with twenty different aerobic species (all catalase-positive) examined, a series of disks appeared below the meniscus at various depths up to 12 mm. (that is, to the depth of normal oxygen penetration). This phenomenon did not occur in this medium with catalase-negative organisms. When these disks are sectioned, long forms and typical *L*-bodies can always be seen (Figs. 1 and 2), sometimes for up to six weeks after incubation. The fact that sunlight increases the depths of the disks[3] suggested that the formation of hydrogen peroxide is the probable factor involved. If hydrogen peroxide is placed at the surface prior to incubation the disks appear at a very much lower level, whereas with catalase on top, growth occurs on the surface of the medium and no disks develop

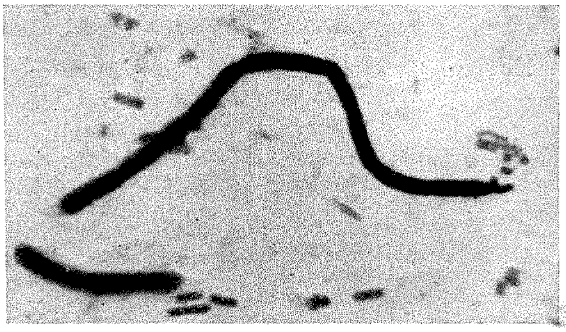

Fig. 1. *B. anthracis* showing normal and long forms (× 1,400)

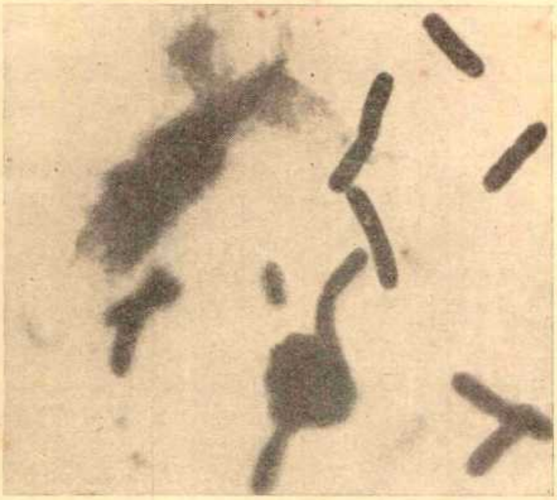

Fig. 2. *Cl. welchii* showing long forms and an *L*-body. (× 1,400)

(Fig. 3). The same effect is observed with aerobes in columns of nutrient agar topped with hydrogen peroxide (Fig. 4). Similar cultures (in poor media) incubated anaerobically for as long as a week do not develop disks until exposed to an atmosphere containing oxygen. This is strong evidence that the prime factor in the production of long forms is the presence of oxygen leading to hydrogen peroxide formation, and not necessarily a poor medium.

Hydrogen peroxide placed at the surface of shake cultures of anaerobes in nutrient agar produces increasing zones of inhibition according to the concentration of hydrogen peroxide used. The normal zone of inhibition is abolished if catalase is placed at the surface[4]. Again, at the surface of the column of growth of the anaerobes where the production of hydrogen peroxide is most active long forms can be readily observed.

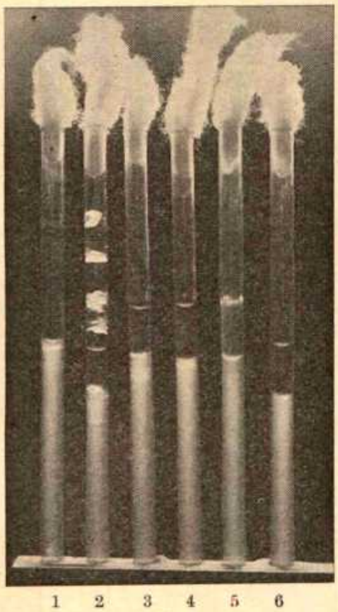

Fig. 3. The effect of hydrogen peroxide and catalase on the growth of *B. proteus* in poor media. Tube 1 exposed to air; tubes 2, 3 and 4 covered with hydrogen peroxide at 10^{-2}, 10^{-3} and 10^{-4} respectively; tube 5 covered with catalase; tube 6 negative control. (× ½)

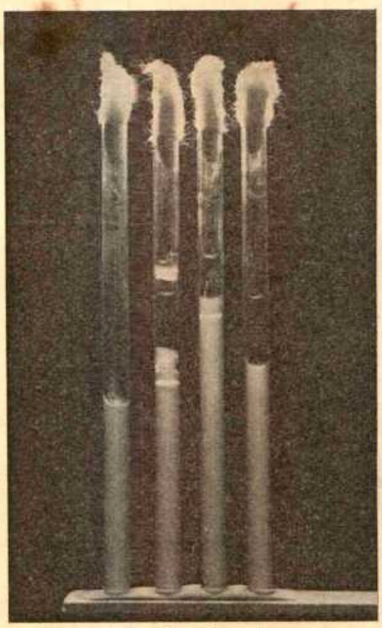

Fig. 4. The effect of hydrogen peroxide on shake cultures of *B. anthracis* in nutrient agar Tube 1 exposed to air; tubes 2 and 3 covered with hydrogen peroxide at 10^{-3} and 10^{-4} respectively; tube 4 negative control. (× ⅓)

It therefore seems altogether probable that these forms are produced by most bacteria when they are exposed to oxygen and either are deficient in catalase or are incapable of synthesizing this enzyme from the environment in which they find themselves. The fact that the strict anaerobes which are catalase-negative actively produce hydrogen peroxide[5] at the surface of the column of growth is also in keeping with this mode of *L*-formation.

It is more than likely that this formation of long forms occurs naturally when there is competition among organisms possessed of divers catalase content when growing on limited nutritive material in the presence of oxygen.

The fact that most viable organisms will either swell up or produce long forms in the presence of penicillin aerobically indicates that probably one of the main actions of this substance is to make the organisms more sensitive to hydrogen peroxide or to interfere with the synthesis of catalase from the medium.

It has also been observed that endospore formation of aerobic spore-formers occurs most readily just above the disks in these tubes in the presence of oxygen and this is again probably a direct effect of hydrogen peroxide on the cell. This is in keeping with the observations of Bayne-Jones and Petrilli[6] and Knaysi[7].

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April 14.

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Effect of Temperature on the Spontaneous Activity from the Isolated Ganglia of the Slug, Cockroach and Crayfish

Most biological reactions respond to an increase in temperature by an increase of rate, and decrease their rate if the temperature is lowered. However, two preparations, that of the elasmobranch ampullæ of Lorenzini described by Sand[1] and by Hensel[2]; and that of mammalian peripheral nerve described by Bernhard and Granit[3], show an anomalous transient response to temperature.

In these, when the temperature is increased the preparations show a transient decrease in rate of spontaneous activity, whereas if the temperature is decreased, the activity shows a transient increase. The final rate of activity shows the normal temperature effect: it is faster at higher temperatures.

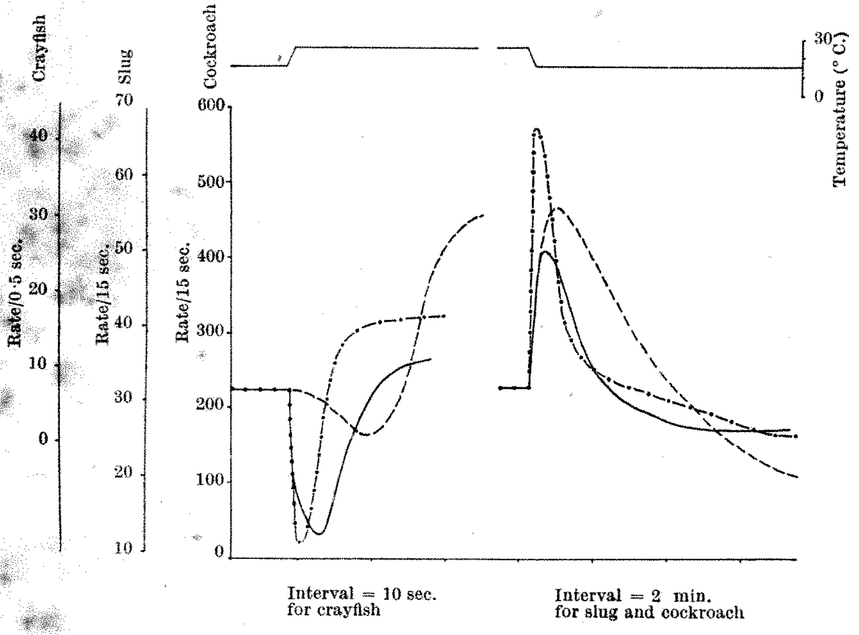

Fig. 1. Effect of change of temperature on the spontaneous electrical activity from the pedal ganglion of the slug ———, the abdominal ganglia of the cockroach —●—●—●, and the abdominal ganglia of the crayfish — — —

We have found three other preparations that show a similar anomalous transient response to temperature. These are the isolated pedal ganglion of the slug, the isolated thoracic and abdominal ganglia of the cockroach, and the isolated thoracic and abdominal ganglia of the crayfish. All three of these show spontaneous activity the rate of which is affected by temperature and temperature change. These effects are shown in Fig. 1. In all three an increase in temperature is followed by a transient decrease in spontaneous activity, whereas decreasing the temperature is followed by a transient increase in activity. This is true both for the rate of activity of single units and also for the number of units that become active. The effect is most clearly seen in the slug, where it takes approximately three to four minutes before the normal temperature effect is seen; it is most transient in the crayfish, where it lasts for about fifteen seconds after the temperature change.

Full details concerning the sensitivity of these preparations to temperature change will be published elsewhere.

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Effect of Spore Coalescence on the Early Development of *Gracilaria verrucosa* (Hudson) Papenfuss.

Carpospores and tetraspores of *G. verrucosa* have been grown on microscope slides in running, natural sea water under constant illumination. After the initial attachment to the slide, divisions occur which correspond, in general, with the observations of Killian[1]. These produce, in 40–45 days, a dome of cells which may be 30–35μ high and 120μ in diameter. In the majority of isolated sporelings there is a great reduction in activity at this stage; but in some cases development of the shoot begins, in circumstances described below. The peripheral growth of closely adjacent spores leads to their meeting and coalescing into irregularly shaped 'rafts'. In these rafts individual sporelings cannot be recognized after a time unless their positions have been mapped at earlier stages. On all slides shoots have been first observed arising from rafts of this kind. Isolated sporelings, on the other hand, rarely show any change from the 40-day condition after several months, by which time coalesced sporelings of the same age have produced shoots several millimetres long. Shoots are not produced by all sporelings in a raft, and, when an extensive raft produces numerous shoots, these are well spaced out and seldom arise from adjacent sporelings. Furthermore, it will be seen from Fig. 1 that the larger rafts tend to bear proportionately longer shoots. On the slide concerned, the longest (1·8 mm.) occurred on a raft of about five sporelings. Larger rafts on the same slide bore more than one shoot, but none was longer. The largest raft, containing about fifty sporelings, bore ten shoots averaging 0·61 mm. in length, the longest measuring 1·6 mm. A ratio of five sporelings to each shoot seems usual in the larger rafts; but the frequency of the small shoots produced on isolated sporelings is much lower than 1 in 5.

Thus it seems that a shoot beginning development on a raft is able to obtain nutriment or growth stimulants not merely from its parent sporeling disk but also from the surrounding tissue. In fact, coalesced sporelings behave less as independent individuals than as a single organism. The observations suggest parallels with the organization of the apex of a higher plant, but this analogy obviously cannot be pressed far at present. Both carpospores and tetraspores show this behaviour. This is more surprising in the latter, which presumably include both male and female spores, than in groups of genetically identical carpospores.

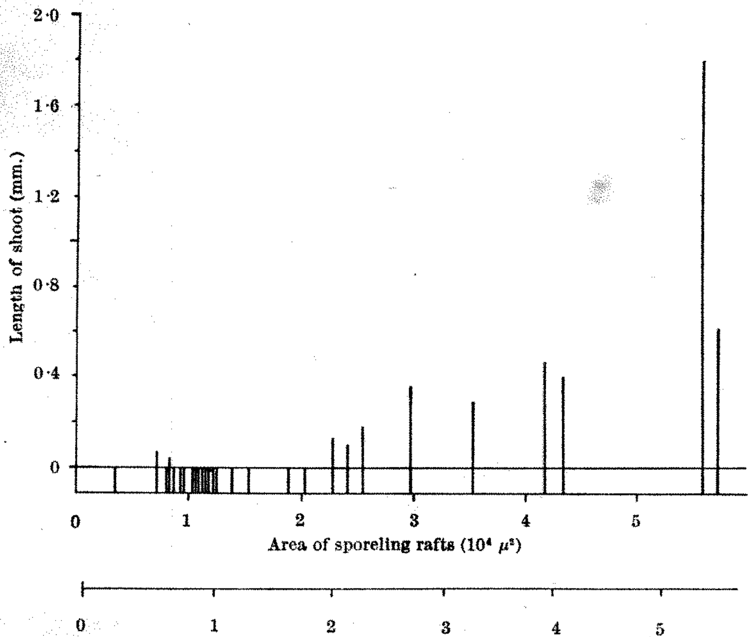

Fig. 1. Relationship between length of shoots of *Gracilaria verrucosa* and area of sporeling disks or coalesced rafts of disks bearing them after 80 days growth from carpospores. Lengths shown by lines above datum. Lines below this represent only the position of a single sporeling or raft. Areas of rafts are roughly proportional to the number of sporelings they contain. All sporelings or rafts bearing a single shoot or none are included. Larger areas bear proportionately longer shoots

Though it is possible that experimental conditions may be responsible, in part, for the results obtained, it is significant that sporeling rafts of the same kind, bearing mature fronds, have been observed on the shore. Speedier initiation and accelerated early growth of shoots would be of obvious ecological advantage to the plant. Its usual habitats are liable to frequent covering by sand; and the faster the early development of the shoot, the greater is the chance of its projecting above the sand surface, should the base become covered.

Rafts bearing several shoots appear very similar to Chemin's figures for *Grateloupia filicina*, *Lomentaria clavellosa* and *L. rosea*[2], and these may have arisen in the same way, though Chemin considered it more probable (in *L. clavellosa*, at least) that shoots developed from the expanded base of an original shoot. This is not the case in the present study.

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Systematics of the Marine-Bug

Physiological barriers prevent most insect taxa adopting a marine life; but the bug *Aepophilus bonnairei* has surmounted some of these and lives abundantly at the lowest *Fucus* zone of rocky shores in south-west Britain. The better to understand the adaptive trends followed, a sound systematic basis is needed. The bug is placed in a monotypic family: but (1) in Gerroidea next to Mesoveliidae[1]; (2) adjacent to Cryptostemmidae[2]; (3) between the bedbugs and Anthocoridae[3], or (4) in Saldoidea but as a branch distinct from saldids and Leptopodidae[4]. Pruthi[5] showed the male genitalia of *Aepophilus* and some saldids to be almost identical and suggested that on this single character the marine-bug did not warrant separation from Saldidae; not a single writer has accepted this view, but it is now shown to be correct.

The female genitalia of *Aepophilus*, *Salda* and *Saldula* are not distinguishable *inter se*; they show a greater development of the third valvifer than is found elsewhere in Heteroptera; a second valvifer sclerotized as two distinct plates; identical first and second valvulæ and associated rami; secondarily incomplete separation of the first valvifers from tergum VIII. The egg guide is formed by separate first valvulæ above and a median membrane, marked by four longitudinal rows of little tubercles, below.

The head of *Aepophilus* has three pairs of dorsal trichobothria, a broad and large labium and a labrum with an almost non-existent first segment and lengthened third. The pretarsi are devoid of arolia or analogous structures: male and female genitalia, head, thoracic sclerites, tarsi and pretarsus and abdominal structure—there is a single dorsal abdominal gland in larvæ opening in front of tergum IV—all indicate that the marine-bug is a saldid, and confirmation comes from the male 'strigil'. In Saldidae this comprises a set of modified setæ on the third latero-tergite and a granulose plate on the second[6]; in *Aepophilus* there is an identical granulose plate, but the specialized setæ are lost. The acquisition of a general setal cover, loss of black pigmentation, reduction of fore-wings and loss of hind-wings are, together, evidence of such extreme modification that perhaps tribal status is deserved: such is now proposed as Aepophilini Puton *stat. nov.*, within Saldinæ.

It has been shown that some Saldidae (*Saldula* spp.) are adapted to survive regular tidal submergence on mud-flats[7]: many *Pentacora* spp. are estuarine, while two imperfectly known genera, *Orthophrys* on the Atlantic coat of Morocco and *Omania* on the Red Sea coast of Sinai, have been captured in rock crevices well below high water. In the last two there is loss of overlap of the fore-wings, reduction or loss of the hind-wings and reduction of the scutellum; but evidently *Aepophilus* has gone much the farthest along the way to complete adaptation to a submarine existence. The taxonomic distribution of the genera mentioned, and others, is such that we may conclude that many saldid genera are exhibiting parallel trends towards a partial or more nearly complete aquatic life.

An obvious specialization of *Aepophilus* is the presence of bubble-retaining areas on the pronotum, hemelytra and sternal region, but no plastron has been detected. The red coloration is paralleled by that of *Aepopsis robinii*, a carabid living in similar situations and often collected with *Aepophilus*[8]; this too has evolved from a group of predominantly black insects. In addition to the structural modifications, there are behavioural ones; for example, the bugs become immobile when suddenly submerged. Some simple experiments have demonstrated the value of the modifications: the marine-bug can survive at least 23½ hr. in still sea water, at least 49 hr. in running sea water; bugs kept in still sea water for 18 hr. were active immediately on release, those kept in boiled sea water for a similar period took about 30 min. to resume activity. Further work is in progress.

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Transmission of Infra-red Light in Turbid and Clear Sugar Solutions

A well-filtered coloured sugar solution (in water) has an extinction-curve falling with increasing wave-length of light from near ultra-violet to red. Using as reference a clear, colourless sugar solution of the same concentration as the sample, it is possible to extend the observations in the range of near infrared without interference from the strong absorption bands of water at about 980 and 1,175 mμ. The extinction of the coloured sample will then show a continuous decrease with increasing wave-length up to a range of 1,000–1,100 mμ, where a flat minimum occurs. At still longer wave-lengths, the extinction rises again. The minimum extinction is very low compared with the optical density for visible light.

The same coloured solution, containing suspended particles (producing turbidity), shows the same behaviour, but naturally has a higher light attenuation than the filtered one at every wave-length. For solutions in the concentration-range common in sugar factories, the difference in optical density between unfiltered and clear-filtered solution is practically the same in the range 500–1,500 mμ.

Thus the presence of turbid matter can be indicated even in very dark solutions (for example, thick juices in sugar-beet factories and refinery liquors) simply by measurement of the transmission for light of about 1,050 mμ in a continuously flowing by-pass stream of the sample.

Unlike the procedure necessary for commonly accepted methods with the same purpose, the 'infrared method' does not involve any special preparation of the sample.

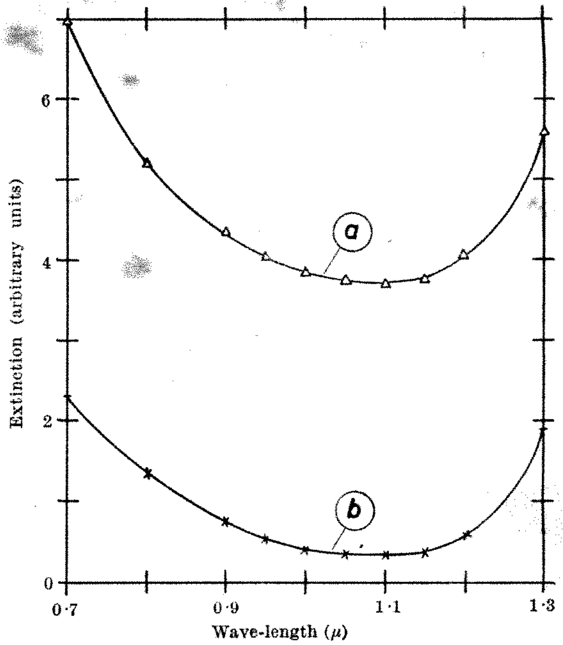

Fig. 1(*a*). Unfiltered sample of thick juice of sugar beet; (*b*) clear-filtered sample of the same juice

The phenomenon is exemplified in Fig. 1, showing a detail of typical extinction curves for one turbid and one clear-filtered sample of the same thick juice of sugar beet. The extinction value at 1,050 mμ for the filtered sample is in this case about 1/100 of the value at 463 mμ.

A full report will be published elsewhere. I wish to thank Mr. R. Lepik for valuable assistance in the investigation.

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Setting of Gypsum Plaster

The initial thickening of slurries of hemi-hydrate type gypsum plasters has been considered by many workers to be due to a colloidal mechanism, whereas the further hardening and final setting have always been attributed to a crystallization process. Recent work supporting the colloidal theory is that of Fischer[1], while still later Becherer and Fiedler[2] have attributed the initial thickening of plaster slurries to the action of capillary forces causing a packing together of hemi-hydrate particles.

Work I have carried out on several commercial plasters has shown that crystalline dihydrate appears in measurable quantity before the initial set. It seems likely that the initial thickening of a plaster slurry is due to the formation of this small amount of dihydrate crystals, and therefore the complete setting process, both initial and final, is one of crystallization.

Samples of gauged plaster were removed from the mixing bowl at various times before the initial set, which was determined as described in the Standards Association of Australia Interim Specification No. 317[3]. These were washed with ethyl alcohol and then three times with water-free diethyl ether on a suction filter. After the last ether washing, the suction was continued for a few minutes to evaporate all ether, and the plaster was then in a dry powdered state. The washing with solvents took no longer than three minutes for each plaster sample. These samples were then examined by differential thermal analysis, automatic thermo-gravimetric analysis and X-ray analysis. Each of the three methods of analysis showed small amounts of dihydrate present in each plaster at the initial set. The presence of a dihydrate pattern in X-ray photographs at the initial set indicated that the dihydrate was in a crystalline form. A typical plaster which had an initial setting time of 33 min. showed no dihydrate present 13 min. after mixing, about 4 per cent dihydrate 25 min. after mixing, and 8 per cent dihydrate at the initial set.

It has been claimed by previous workers, for example, Neville[4], that hydration of hemi-hydrate does not occur before the initial set because of the very small rise of temperature during the initial setting period. Neville attributed this, in part, to the heat of wetting; but a gradual rise of 1 deg. C. which I have observed up to the initial setting stage represents about 8 per cent of the total temperature rise and I attribute it to the hydration of hemi-hydrate. The amount of hydration is consistent with the amount of gypsum observed at the initial set.

Where samples were taken prior to the initial set, amounts of dihydrate less than 2 per cent were detected by differential thermal and automatic thermo-gravimetric methods but not by the X-ray film technique. Percentages of dihydrate present in the gauged plasters were determined by the automatic thermo-gravimetric method.

A more detailed description of this work is to be published at a later date.

I wish to thank Mr. E. H. Waters and Dr. W. F. Cole (who also took the X-ray photographs) for helpful criticism during the work, which was undertaken as part of the programme of this Division.

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Oriented Overgrowth of Paraffin Wax Crystals on Spherulites of Polyethylene

IN spite of the absence of polar groups in the paraffin molecule, oriented overgrowth of the crystals of paraffin wax can be readily obtained not only on ionic substrates such as sodium chloride and lithium chloride and on substrates with polar groups such as chloranil and anthraquinone but also on crystals of aromatic hydrocarbons; for example, anthracene and phenanthrene[1]. R. B. Richards[2] even obtained oriented overgrowth of paraffin wax crystals on the surface of strips of cold-drawn polyethylene.

We have found that the same overgrowth can be observed on spherulites of polyethylene. An example of the phenomenon is demonstrated in Fig. 1, which shows paraffin wax crystals grown in radiating array on the surface of a film of polyethylene crystallized by heating to about 170° and cooling slowly down to room temperature. The crystals of the paraffin wax (melting point 56°–58°) can be grown from a solution in petrol ether or benzene by evaporating the solvent.

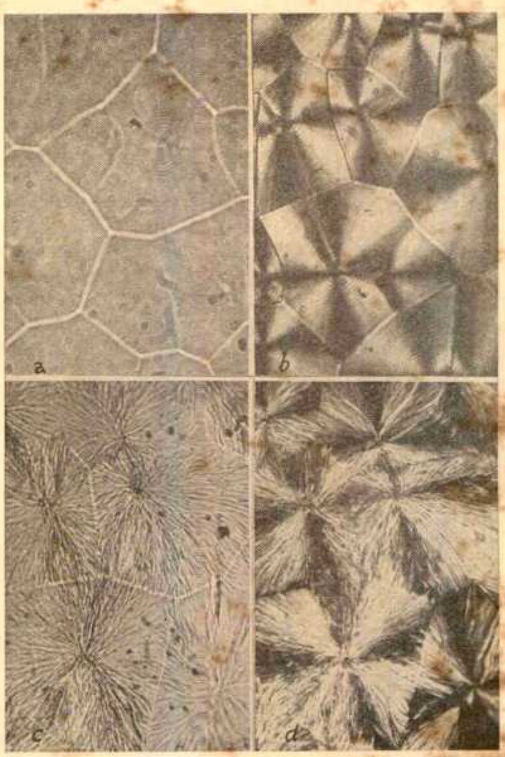

Fig. 1. Spherulites in a film of polyethylene. (*a*) Unpolarized light; (*b*) crossed nicols. Oriented overgrowth of paraffin wax crystals on spherulites. (*c*) Unpolarized light; (*d*) crossed nicols

The radiating array of the paraffin wax crystals on the spherulites of polyethylene is of special interest in view of a number of investigations of the structure of polymer spherulites (refs. 2–3 and others quoted in them) which led to the important conclusion that the molecules are tangentially orientated within the spherulites. This conclusion is largely based on birefringence evidence, and furthermore has been confirmed by X-ray diffraction. Bunn[5] has shown that the crystal structure of polyethylene is very closely similar to that of paraffin wax. Hence the paraffin wax/polyethylene system is, as Richards has pointed out, ideal for the occurrence of oriented overgrowth.

In strips of cold-drawn polyethylene on which oriented overgrowth was observed by Richards, sections of the polymer molecules in the crystalline regions are oriented approximately parallel to the direction of drawing. Paraffin wax crystals are flat plates with the paraffin molecules perpendicular or, in some cases, at an angle, to the plane of the plates. The oriented wax crystals appearing under the microscope as short needles are standing on edge with the plane of the crystals approximately perpendicular to the direction of drawing, that is, with the paraffin molecules parallel to the polyethylene molecules.

Thus in view of the position of the paraffin molecules in the paraffin wax crystals and the radiating array of these crystals on the spherulites of polyethylene, the overgrowth observed on these spherulites is in accordance with the conclusion that the molecules of polyethylene are tangentially arrayed in the spherulites.

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Use of Pectin in Gel Electrophoresis

ELECTROPHORESIS of protein mixtures in agar gels has been described by Gordon *et al.*[1]. It has been developed by Grabar and Williams and used in their immuno-electrophoretic method[2]. The latter, thanks to the specificity and sensitivity of immunochemical reactions, permits the detection of the presence even of the smallest amounts of components in a protein mixture and permits defining them by their electrophoretic mobilities. The agar gels can be dried and stained[3], as in paper electrophoresis. However, the use of agar has one disadvantage: the samples are usually introduced in the gel, mixed with melted agar, thus being heated to 40°–45° C. Thus there is a constant danger of denaturing certain more sensitive protein components. A possible interaction of agar with some of the substances analysed cannot be excluded. Finally, it was of interest to find a gel from which the electrophoretically separated components could be extracted and estimated quantitatively.

Among a number of different substances yielding gels which have been examined by us, pectin seems to present certain advantages over agar. It can be gelled enzymatically at room temperature by pectinmethyl-esterase in the presence of Ca^{++}, the separation of proteins carried out electrophoretically, then either stained or cut out and the proteins released enzymatically by hydrolysis of the gel with pectinase. None of these steps affects the proteins. The latter can be estimated by one of the usual methods (biuret, protein nitrogen, etc.). The use of pectin furthermore has the advantage that the gel is prepared at room temperature and that the gelification can be more easily controlled. We found that the concentration of the pectin gel which gives very satisfactory results is 0·2–0·34 per cent, against that of 1·5–2 per cent of the agar. Thus electrophoresis takes place in 99·8 and 99·66 per cent buffer respectively, a condition approaching that of free electrophoresis.

Our method for preparing the gel is as follows. Immediately before use, to 15 ml. of a 2 per cent pectin-stock solution are added: 10 ml. of 0·65 *M* calcium chloride, 1 ml. 0·1 per cent commercial pectin esterase and 24 ml. double-distilled water, carefully mixed and finally diluted with an equal volume of veronal buffer *p*H 8·2 and ionic strength 0·60. The final ionic strength of the solution is 0·03. In recent runs we found that the mixture of borate and veronal buffers, as described by Consden and Powell[4], also gives very good separations.

The pectin–enzyme mixture is poured over a 13×18 cm. Eastman Kodak cover-glass, surrounded by a 0·5-cm. high wall made of heavy-duty aluminium foil. At both ends of the plates, filter paper strips (Whatman No. 1) are placed. The troughs in the middle of the plate, in which the serum samples are placed, are made in a manner similar to those of agar, except that we use as moulds small iron bars (approximately $10 \times 5 \times 2$ mm.), which after the gelation are removed by a small, but powerful, magnet. The empty trough fills in a short time with buffer and to this buffer 0·1 ml. of the sample to be analysed is added, thus yielding a final dilution 1 : 10 (the volume of the trough is about 1 ml.). The plate is then placed on an electrophoresis apparatus, the filter paper immersed in the buffer chambers in the usual way, and the current, 170–200 volts giving 18 m.amp., switched on. After 4–5 hr. the run is completed, filter paper strips removed, the gel is fixed by leaving it for 30 min. in a mixture of alcohol–acetic acid (250 ml. of 40 per cent v/v ethyl alcohol + 3 ml. glacial acetic acid) and finally stained in amidoschwarz for 6 hr. After this period, the excess of dye is washed out of the plate with 60 per cent alcohol–acetic acid mixture (250 ml. alcohol + 3 ml. glacial acetic acid) until the plate is well differentiated. A typical result of such a run with normal human serum is given in Fig. 1.

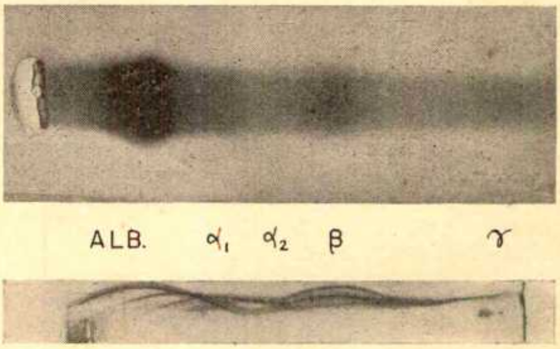

Fig. 1

Our present work consists of the quantitative estimation of these electrophoretically separated proteins, and the application of pectin gels to immuno-electrophoretic analysis (Fig. 1).

This work was supported by a grant from the U.S. Army Contract *DA*-49-007-*MD*-447.

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Coal Extracts as Promoters of Dropwise Condensation of Steam

When a very thin layer of a hydrophobic material is deposited upon a steam condenser tube, 'dropwise' rather than the more usual 'filmwise' condensation of the steam occurs ; and, owing to the elimination of the poorly conducting water film, the rate of heat transfer and therefore the rate of condensation is considerably increased. The capacity of a steam condenser of given size treated in this manner would be much greater than that of an uncoated condenser.

It has been found that when coals are extracted with certain organic solvents, an appreciable fraction of the coal substance is dissolved[1], and that the extract, after removal of the solvent, exhibits marked hydrophobic properties[2]. Promoters of dropwise condensation so far developed either have too limited a life in practice or contaminate the steam. It was thought possible that coal extracts might supply alternative materials for condenser-tube treatment which would prevent filmwise condensation over extended periods of use.

It is possible to obtain many kinds of extracts from different coals or carbonized coals by the use of a wide range of organic solvents. In the work described in this communication the results obtained with only two of the many that were tested are reported. These extracts were : (i) that obtained by the exhaustive Soxhlet extraction of a low-rank, free-burning coal with methyl-cyclohexanone (Sextone *B*), and (ii) that obtained by the exhaustive Soxhlet extraction of a shock-carbonized coking coal with chloroform.

The extracts were applied to $\frac{5}{8}$-in. outside diameter cupro-nickel condenser tubes as 1 per cent solutions in Sextone *B*. The method of application varied, either painting, dipping or electrophoretic deposition being used ; after applying the coatings, the tubes were drained and then baked at about 240° C. for 30 min.

These treated tubes were then placed in a single-tube test condenser condensing up to 200 lb. steam/hr./sq. ft. condensing surface and assessed by visual observation of the mode of condensation and also by measurements of the overall heat transfer. Fig. 1 shows an untreated tube on which the steam condensed as a film and Fig. 2 a treated tube upon which the steam condensed in the form of drops ; the overall heat transfer with the latter was 55 per cent higher than with the former (at a water velocity of 13 ft./sec.).

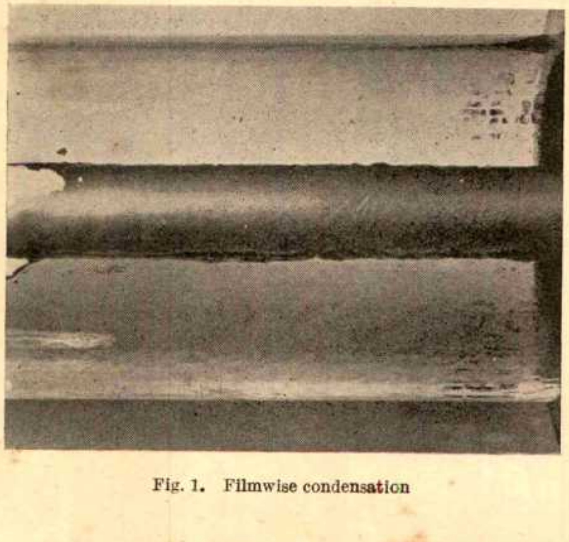

Fig. 1. Filmwise condensation

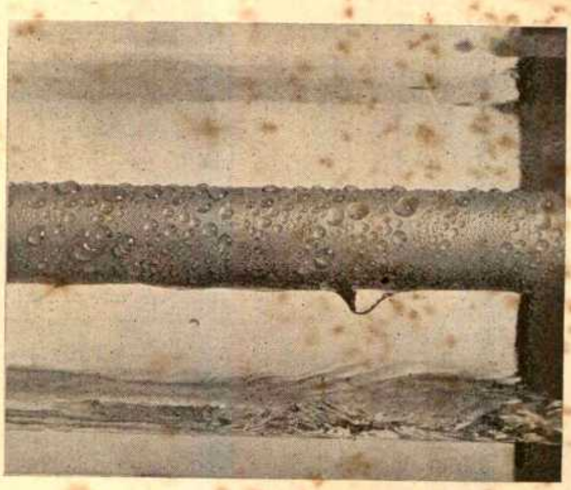

Fig. 2. Dropwise condensation

Tests have shown that the endurance of these promoters is markedly better than that of many other promoters that have been tried. Further tests are in progress.

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Critical Temperature for Phase Separation of the Solid Solutions of Rare Gases

The rare gases argon and krypton form a solid solution at 77° K. that shows a positive deviation from Raoult's law[1]. At this temperature, the tendency toward phase separation may be estimated from the value of the energy of mixing parameter w_{AB}/kT of about 1·3. This value was estimated by the use of the crude treatment of regular solutions[2] on data taken in an apparatus not primarily designed for the task.

We have now made refined measurements in an accurately thermostated copper block fitted with a capsule-type platinum-resistance thermometer, and connected to a sensitive manometer. The measurements have been made on mixtures of krypton and xenon, because for this system the region of interest lies in the temperatures immediately above the boiling point of nitrogen. The total pressure at six temperatures was determined as a function of mole fraction, and the results at each temperature were fitted to the quasi-chemical theory of regular solutions[3]. The w_{AB} values so obtained were a linear function of temperature, and extended roughly to the critical value of the temperature, which was thereby estimated to be 90·2 ± 2·0° K.

For the krypton–xenon system, w_{AB}/kT has the value 1·3 according to the crude theory at about 113° K. If we assume that the mixtures obey a law of corresponding states, the data for the argon–krypton system indicate that the critical temperature of this solution would be 62° K.

A further analysis of these and other data will appear elsewhere.

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Interferometric Spectroscopy in the Far Infra-red

Resolving power in the far infra-red region of the spectrum is limited in dispersion spectrometers by the small amounts of power available for measurement. The procedures for isolating unwanted orders with grating instruments and for discrimination against stray light not only reduce further the available power but also require elaborate instruments. We find an attractive alternative for this spectral region in interferometric spectroscopy, and this communication gives some pertinent experimental results.

Fig. 1 shows the response of a thermal detector to the resultant intensity from two interfering beams when the optical path-difference between them is changed. The reflexion interferometer used was 7·5 cm. in diameter and the maximum path-difference between beams was 7 mm. The spectral information contained in one half of Fig. 1 is displayed explicitly by its Fourier transform in Fig. 2. This transform was obtained by numerical analysis using a high-speed digital computer. The particular spectrum is of the radiation from a globar radiation source after reflexion from two cæsium bromide crystal surfaces and modified by the pure rotation absorption spectrum of water vapour. For comparison, a representation of the calculated rotation spectrum of the water molecule is given alongside.

The resolution shown here was arbitrarily restricted by the numerical analysis and does not represent the limit imposed by the maximum path-difference between beams. Since only reflecting elements are used in the optical system of the interferometer, the interferogram is symmetrical about the point of zero path-difference. This permits its representation by a Fourier integral containing only cosine terms.

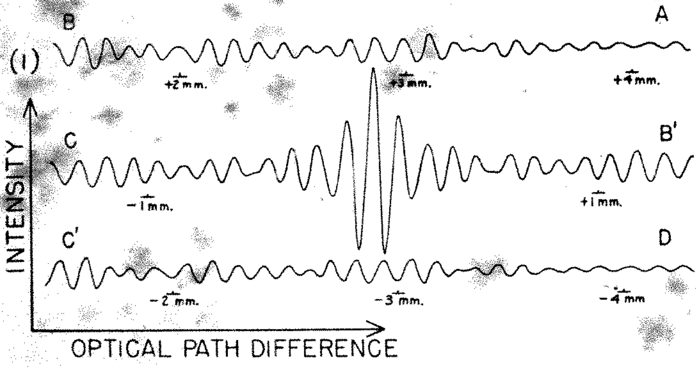

Fig. 1. Curve *ABB'CC'D*. Resultant intensity of two interfering beams as path-difference changes continuously

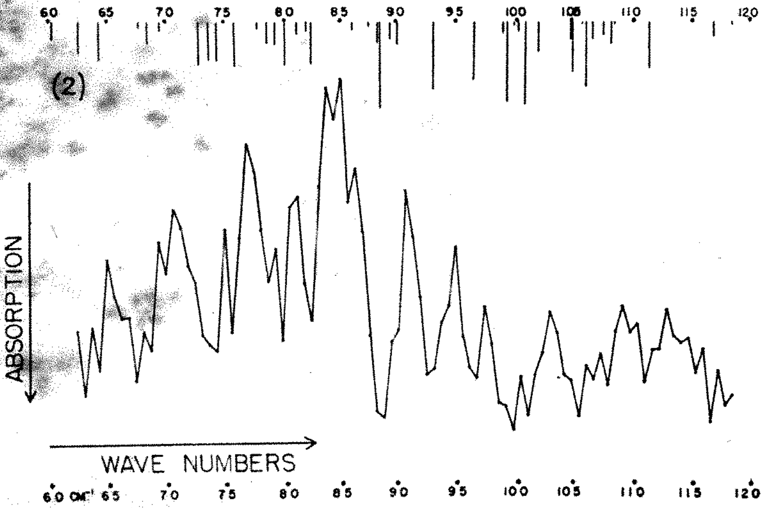

Fig. 2. Far infra-red reflexion spectrum of two cæsium bromide crystal faces modified by absorption spectrum of residual water vapour, with calculated water spectrum represented above

An additional significance of these results, for a region of the electromagnetic spectrum which has not been extensively studied, lies in the fact that the interferometer is readily adaptable to large construction to obtain greater light-grasp and resolving power.

A larger instrument with aperture 30 cm. has been made for study of atmospheric transmission in the submillimetre wave region.

We would like to thank various members, and Mr. G. M. Benson in particular, of the International Business Machines Corporation, Scientific Computation Laboratory, Endicott, New York, for their collaboration in applying digital methods to this problem. This investigation was sponsored by Air Force Contract AF18(600)-1307.

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G. A. Vanasse

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and
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Maryland.
March 12.

Semiconductors with Chalcopyrite Structure

It was recently reported[1] that certain compounds crystallizing with a triply substituted diamond lattice of the chalcopyrite type are semiconductors. We would report here optically determined energy gaps for a further four such compounds. These, together with the previously reported values for copper indium selenide and copper iron sulphide, are shown in Table 1.

Table 1

Material	Optical gap (eV.)	Material	Optical gap (eV.)
$CuInS_2$	1·2	$AgInTe_2$	0·96
$AgInSe_2$	1·18	$CuInTe_2$	0·95
$CuInSe_2$	0·92	$CuFeS_2$	0·53

The copper iron sulphide was of mineral origin; all other materials were synthesized directly from the constituents in sealed evacuated silica tubes. A more detailed account of the work is being given elsewhere[2].

I. G. Austin
C. H. L. Goodman
A. E. Pengelly

Research Laboratories,
The General Electric Co., Ltd.,
Wembley.
April 26.

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[1] Goodman, C. H. L., and Douglas, R. W., *Physica*, **20**, 1107 (1954).

[2] Austin, I. G., Goodman, C. H. L., and Pengelly, A. E., *J. Electrochem Soc.* (to be published).

Effects of Trace Elements on Embrittlement of Steels

In the course of investigations to assess the factors controlling the embrittlement of steels, a wide variety of steels of commercial origin has been studied. It was found that the Charpy impact transition ranges of all the steels were raised—although to varying extents—if the steels were exposed at 450° C. for lengthy periods. In many instances the transition range still remained below room temperature after exposure at 450° C., and the steels were not, therefore, brittle at room temperature. Nevertheless, it was apparent that an embrittlement mechanism was operating at 450° C. in all the steels.

It has long been suspected that trace elements play an important part in the embrittlement of steels, and steels of high purity have therefore recently been studied. Although the programmes planned are still far from complete, the results already obtained are of sufficient interest to justify reporting.

A commercial 3 per cent nickel–chromium steel of the *BS.En* 23 type, when oil-quenched as ⅝-in. diameter bar from 840° C. followed by tempering at 625° C. and water-quenching, had a Charpy *V*-notch impact transition range extending from −35° to 150° C. After reheating the hardened and tempered steel at 450° C. for 168 hr. and water quenching, the impact transition range extended from 230° to 20° C.

A steel of the same nominal composition, carbon 0·30 per cent, nickel 3·0 per cent and chromium 0·75 per cent, was prepared from carbonyl iron powder and other pure raw materials in powder form by compacting, sintering *in vacuo* and forging to ⅝-in. diameter bar. The Charpy *V*-notch impact transition range of this steel, after oil-quenching from 840° C. and tempering at 650° C. followed by water-quenching, was − 60° to − 200° C. This range was unaffected by exposure for 1,000 hr. at 450° C.

Another steel of the same nominal composition was prepared, using similar raw materials, by melting and casting *in vacuo*. The 22-lb. ingot produced was forged and rolled to ⅝-in. diameter bar. After oil-quenching from 840° C. and tempering at 650° C. and water-quenching, the impact transition range was again − 60° to − 200° C., and the range was unaffected by exposure for 1,000 hr. at 450° C. and water-quenching.

Now it is known that steels can be made, with impact properties which are unaffected by exposure at 450° C., it should be possible to assess the effects of each of the trace elements normally present in commercial materials by studying high-purity steels to which these trace elements have been added in controlled amounts.

K. Balajiva
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D. K. Worn

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April 16.

Extension of Field of Application of Relaxation Methods of Computation

The availability of suitable computing machines makes it possible to consider the solution of sets of non-linear partial differential equations by the progressive reduction of residual errors over networks of points. The example below makes clear the process envisaged. I am not aware of any previous discussion of this process in such a general context.

The theory of turbulent gas jets[1] provides a simple example in which the field equations can be written as follows:

$$U\,\frac{\partial U}{\partial x} + V\,\frac{\partial U}{\partial r} + \frac{C^2x^2}{r}\,\frac{\partial}{\partial r}\left\{r\left(\frac{\partial U}{\partial r}\right)^2\right\} = 0 \qquad (1)$$

$$\frac{\partial U}{\partial x} + \frac{1}{r}\,\frac{\partial}{\partial r}\left\{rV\right\} = 0 \qquad (2)$$

In this case there are two dependent variables U, V; two independent variables x, r; and a constant C. The first step is to divide the region of interest into a network of points and take values of U and V at these points. The next step is to calculate the left-hand sides of the two equations at the points of the network and consider these residuals. Adjustments ΔU and ΔV must now be made to the initial values U_0 and V_0 to reduce the residuals to zero. To facilitate this work, $U_0 + \Delta U$ and $V_0 + \Delta V$ are substituted in the equations and only linear terms in ΔU, ΔV retained. Thus equations 1 and 2 become:

$$U_0\,\frac{\partial U_0}{\partial x} + V_0\,\frac{\partial U_0}{\partial r} + \frac{C^2x^2}{r}\,\frac{\partial}{\partial r}\left\{r\left(\frac{\partial U_0}{\partial r}\right)^2\right\} + \Delta V\,\frac{\partial U_0}{\partial r}$$
$$+ \Delta U\,\frac{\partial U_0}{\partial x} + U_0\,\frac{\partial \Delta U}{\partial x} + \left\{V_0 + \frac{2C^2x^2}{r}\,\frac{\partial}{\partial r}\left(r\,\frac{\partial U_0}{\partial r}\right)\right\}\frac{\partial \Delta U}{\partial r}$$
$$+ 2C^2x^2\,\frac{\partial U_0}{\partial r}\,\frac{\partial^2 \Delta U}{\partial r^2} = 0 \qquad (3)$$

$$\frac{\partial U_0}{\partial x} + \frac{1}{r}\frac{\partial}{\partial r}(rV_0) + \frac{\partial \Delta U}{\partial x} + \frac{1}{r}\frac{\partial}{\partial r}(r\Delta V) = 0 \qquad (4)$$

By treating U_0 and V_0 as known functions of x and r, the left-hand sides of equations (3) and (4) can be reduced to zero by familiar relaxation methods. At suitable stages in the work, where the residuals would be recalculated in linear problems, the adjustments ΔU and ΔV are incorporated into the values U_0 and V_0.

The prospect of finding solutions to any set of equations that arises is inviting. The arithmetic is likely to be formidable, but this is a matter of balancing the cost against the value of the result. The real difficulty is likely to be in selecting in each case a statement of the equations and a sequence of operations so that the procedure converges to the solution.

B. E. KNIGHT

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[1] "Modern Developments in Fluid Dynamics", edited by Goldstein, 595 (Oxf. Univ. Press, 1943).

MR. KNIGHT's letter inquires into the possibility of using computing machines to solve non-linear partial differential equations by the relaxation method. His suggestions imply two quite separate proposals: first, that non-linear equations can be solved by systematic relaxation; secondly, that the numerical processes involved can be programmed as a set of instructions to an electronic computer.

On the first question, reference can be made to accounts[1] already published of the application of relaxation methods to solve non-linear problems. To obtain the solutions described in those papers, it was essential that the relaxation method was employed in conjunction with very considerable human judgment, experience and imagination; these qualities cannot be taught to a computer. The systematic unimaginative relaxation process indicated by Mr. Knight could be performed by a computer; for several linear equations it would undoubtedly converge to the wanted solutions, though the time taken might be out of all proportion to the results achieved. But for non-linear equations there is no reason for hoping that the successive systematic relaxation of individual residuals to zero will converge, whether the calculations be performed by an electronic computer or otherwise. Indeed, it is almost certain that convergence could only occur as a fluke following a happy but accidental choice of the first guess to the values of the wanted quantities. The relaxational solution of non-linear equations demands, in my experience, human initiative.

It may, however, be of interest to record some recent experiments, which I have carried out in conjunction with Messrs. Ferranti, using one of their computers to solve linear partial differential equations by the relaxation method. In such work it is sufficient, but not practical, merely to programme the computer systematically to reduce residuals to zero point by point, for the time consumed in such a technique would be quite uneconomic. Indeed the computer must be capable of performing some of the devices which have previously been thought to be only in the capacity of the human operator. We have had most encouraging results in this investigation; the experiments are proceeding, and we hope to describe them elsewhere at a later date.

D. N. DE G. ALLEN

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[1] Green, J. R., and Southwell, R. V., *Phil. Trans. R.S.C.*, **1**, 137 (1944). Allen, D. N. de G., and Southwell, R. V., *Phil. Trans. R.S.A.*, **242**, 379 (1950). Allen, D. N. de G., and Southwell, R. V., *Quart. J. Math. and App. Math.*, **8**, 129 (1955).

Determination of the Oxide Film Thickness on Tin

IN carrying out research in these laboratories on the corrosion of tin in anaerobic fruit acids, information was required on the thickness of the natural oxide film on tin. Since there appeared to be no published information about the thickness of tin oxide films, it was necessary to measure it; and for this purpose electrometric reduction has been found suitable. This method[1,2] is generally considered to be applicable only to metals more electronegative than hydrogen; but it succeeds for tin because of its high hydrogen overpotential. At room temperature the oxide film on tin probably consists of stannous oxide[3,4], and we have calculated our results on this basis.

The surface on which the oxide was measured was the flat end face of a cylinder 1 cm. diameter, made from Analytical Reagent tin. A mirror finish was obtained on this by polishing with emery papers, and finally with 'Silvo'. Any oxide film present was removed either by dipping in dilute hydrochloric acid, or electrolytic reduction. After washing with water and alcohol, the specimen was allowed to stand in dry air for the required period. The cylinder was then coated with cellulose lacquer, so as to leave only the polished end exposed, and placed in one limb of an *H*-cell apparatus, the other limb of which contained a platinum anode, and the electrolyte, 0·01 *N* potassium chloride. The two limbs of the apparatus, which was originally designed for polarization studies, were separated by a porosity 4 sintered-glass diaphragm. The apparatus was evacuated, and 'white spot' nitrogen admitted. Nitrogen was then bubbled for 2 hr. through the apparatus to de-oxygenate the electrolyte, and the apparatus again evacuated and nitrogen admitted. The electrolyte was forced by nitrogen pressure through the sintered disk into the limb containing the tin specimen. The oxide film was then reduced by cathodic polarization at a current density of 6 μamp./cm.^{2}, though a variation in this current density by a factor of four had little effect on the results. During the reduction, the potential of the tin was measured at frequent intervals against a silver–silver chloride electrode.

Typical potential-time curves are shown in Fig. 1. A well-defined plateau is obtained, corresponding to the reduction of the oxide film. The transition to the process of hydrogen evolution is sharp and the inflexion point at which the reduction is complete can be easily determined. Curve 1 was obtained after the tin had stood in air for 1 hr. The quantity of electricity required to reduce the stannous oxide formed in 1 hr. corresponds to a film thickness of 14–15 A., calculated on the apparent surface area, taking the density of the film as 6·3, the bulk density of stannous oxide. Curve 2 is typical of a surface that has been standing in air for 19 hr., and the oxide thickness after this period is 18–20 A.

Some tin surfaces were prepared by electropolishing in a solution of 100 ml. glacial acetic acid and 4 ml. 60 per cent perchloric acid at 0·2 amp./cm.^{2} for 2 min. Although a good bright polish was obtained, the surfaces were found to be covered with a film of unknown composition of the order of 1000 A. thick, which was not reduced at a constant potential, and which was not easily soluble in acids.

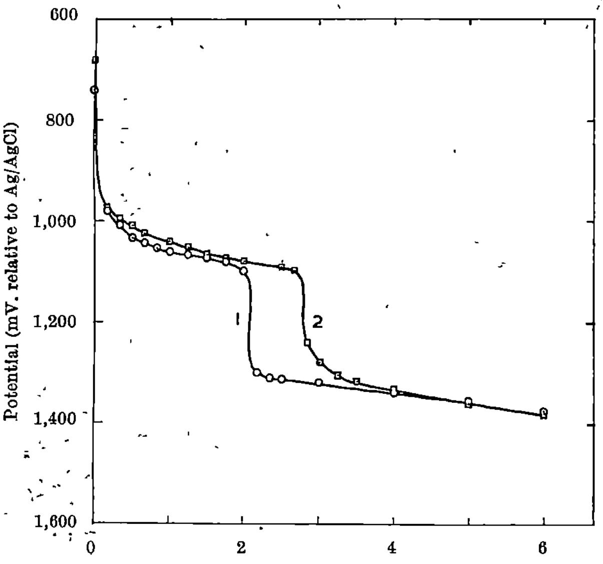

Fig. 1. Potential–time curves for the reduction of the oxide on tin (1), ○—○—, 1 hr exposure to air; oxide thickness, 15 A. (2), ⊡—⊡—, 19 hr. exposure to air; oxide thickness, 20 A

The method is also applicable to the determination of the oxide film thickness on tinplate.

F. W. SALT
J. G. N. THOMAS

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Swansea.
April 11.

[1] Evans, U. R., "Metallic Corrosion, Passivity and Protection", 63 (Arnold, London, 1946).

[2] Allen, J. A., *Trans. Farad. Soc.*, **48**, 273 (1952).

[3] Yang, L., *Discuss. Farad. Soc.*, **1**, 196 (1947).

[4] Hart, R. K., *Proc. Phys Soc.*, B, **65**, 955 (1952).

Gravity Bases in Central Africa

IN the course of a two-month gravity survey of the Western Rift Valley of Africa, several stations of the Duclaux–Martin[1] African base network were re-occupied in order to calibrate the meter used. The results indicate a linear relation between the corrected readings of the present survey and the Duclaux–Martin gravity values to a high degree of precision.

Table 1

Station	Latitude*	Longitude*	Elevation*	Gravity (m.gal.)			Deviation (m.gal.)	
				(1) Sutton	(2) Duclaux–Martin	(3) Herrinck	$\Delta g_1=(1)-(2)$	$\Delta g_2=(1)-(3)$
Kamembe Airport	02° 27·7′ S.	28° 54·3′ E	1,588 m.	977,587·91	977,588·04	977,587·88	− 0·13	0·03
Fizi, Post Office	04° 18·1′ S.	28° 56·7′	1,230	712·34	712·33		0·01	
Kampala, Palace Hotel	00° 19′ N	32° 34′	1,191	722·91	722·71		0·20	
Entebbe, Geol Dept.	00° 03·2′ N.	32° 28·7′	1,146	726·94	726·83		0·11	
Kamanyola, Hotel Vinck	02° 46·4′ S.	28° 59·7′	880	726·93	727·22		− 0·29	
Entebbe Airport	00° 03′ N.	32° 27′	1,146	728·58	728·40		0·18	
Usumbura Airport	03° 23·8′ S.	29° 22·1′	800	734·95	734·94	734·83	0·01	0·12
Uvira I.R.S A.C.	03° 24·3′ S	29° 08·5′	785	740·59	740·39		0·20	
Irumu Airport	01° 28′ N.	29° 52′	915	775·76	775·98	776·57	− 0·22	− 0·81
Stanleyville Airport	00° 30·8′ N.	25° 09·8′	440	883·34	883·42	883·71	− 0·08	− 0·37
Stanleyville Hospital	00° 30·7′ N.	25° 10·0′	437	883·73	883·75		− 0·02	
Binza, Service Météo.	04° 22·1′ S.	15° 15·3′	450	918·37	918·40	918·14	− 0·03	0·23
Leopoldville Airport	04° 19·3′ S.	15° 20·4′	295	955·63	955·59		0·04	
Goma Airport	01° 40′ S.	29° 14′	1,530	599·97		599·42		0·55
Albertville Airport	05° 55′ S	29° 12′	780	848·95		848·70		0·25
Lisala Airport	02° 09′ N.	21° 30′	495	851·24		851·20		0·04
Coquilhatville Airport	00° 02′ S.	18° 16′	350	904·61		904·68		− 0·07

* Co-ordinates and altitudes taken from references cited

During the months of December 1955 and January 1956, 392 gravity stations were occupied with Worden gravity meter *XP-O* in the Belgian Congo, Ruanda Urundi, Uganda and Tanganyika Territory in an attempt to delineate better the gravity anomaly associated with the Western Rift Valley. Among the stations reoccupied were thirteen Duclaux–Martin stations and nine stations occupied by Herrinck[2] for the Service de Météorologie et de Geophysique of the Belgian Congo. (Five of the above stations had been occupied by both the previous surveys; hence that is, seventeen separate stations are discussed here.) The Herrinck stations are part of a secondary base network of Congo airports using Duclaux–Martin values as a standard.

Meter readings were corrected using only two assumptions: (1) no reading error; (2) linear drift between control points. No special correction has been applied for the luni-solar tide. However, this effect, with a maximum deviation from the mean of about 0·15 milligal., was usually removed in the process of correcting for the drift. The corrected readings were then compared with the thirteen Duclaux–Martin gravity values, and a least square linear calibration equation was obtained. The resultant gravity values are given in Table 1 along with values obtained by Duclaux–Martin and Herrinck. Deviations are also listed. The standard deviation $m = \sum_{i=1}^{n} \Delta g_i^2/(n-1)^{1/2}$ between the Duclaux–Martin values and those calculated from the regression equation is $m = 0{\cdot}15$ milligal. with a maximum deviation of 0·29 milligal. at Kamanyola. Agreement with the Herrinck network, with the exception of the Irumu station, is also quite good.

The range of gravity values covered by the Duclaux–Martin reoccupations was 977,588–977,956 milligal. In this range of values there is an indication of non-linearity between the results of Duclaux–Martin and independent African survey by Harding[3] 1)). The results of this survey indicate that on-linearity is probably due to error in the ding values.

Further results from this survey will be published at a later date.

GEORGE H. SUTTON

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Scientifique en Afrique Centrale,
Centre de Recherche du Kivu,
Lwiro (Bukavu), Congo Belge.

March 26.

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[1] Duclaux, F., Martin, J., Blot, C., and Remiot, R , "Établissement d'un Reseau Général de Stations Gravimétriques en Afrique, à Madagascar, à La Réunion et à l'Ile Maurice" (Office de la Recherche Scientifique et Technique Outre-Mer, Paris. 1954).

[2] Herrinck, P., *Nature*, **172** 258 (1953).

[3] Woollard, G., Harding, N., Muckenfuss, C., Bonini, W., and Black, W , Woods Hole Oceano. Inst., Tech. Rep 52–59, July 1952 (unpublished manuscript).

Effect of Rainstorms upon the Cotton Jassid in the Sudan Gezira

Empoasca lybica de Berg., a pest of cotton in the Sudan Gezira Scheme, invades the seedling crop early in September, the infestation normally reaching its maximum intensity in the last half of November. Hanna[1] records that peak populations of this insect are affected by rainstorms of 10 mm. and more in July and August as well as by dust storms in September. Field observations by Cowland and Hanna[2] suggest that populations upon cotton are also affected by rainstorms in September. Rainstorms, probably because of the mud which splashes on to the lower leaves, reduce the number of jassids infesting the cotton. Those findings which concerned the direct effect of rainstorms upon jassids at nine sites in the northern part of the Sudan Gezira were not reported by Hanna[1] in his published paper on rainfall and jassid numbers.

The late rains of September–October 1955 furnished three occasions on which to investigate the effects of rainstorms directly upon jassids infesting standing cotton.

A rainstorm of 10·6 mm. occurred during the afternoon of September 25, 1955, at the Gezira Research Farm. That morning, because of the hot humid weather associated with an approaching storm, counts of jassids in an observation plot (laid out for another purpose) had to be abandoned after two subplots had been examined. Next day, counts on remaining subplots were completed. The mean number of jassid nymphs per plant in the six subplots of the experiment are shown in Table 1.

On September 26 there were in all cases fewer jassids on the plants than on September 21, although from the incomplete count on September 25 the mean population per plant had increased during the previous four days. The figures from subplot II clearly show how the increase of population is followed by fall in numbers after the rainstorm on September 25.

Table 1. MEAN NUMBERS OF JASSIDS PER PLANT

Date of count	Subplot					
	I	II	III	IV	V	VI
21.9.55	0·37	0·18	0·29	0·16	0·26	0·16
25.9.55	0·61	0·43	These subplots abandoned			
26.9.55	—	0·14	0·18	0·03	0·17	0·12

Table 2. CHANGES OF JASSID POPULATIONS ASSOCIATED WITH A RAINSTORM IN THE NORTHERN GEZIRA

Zone	Replicates	Jassids/100 leaves			Rainfall (weekly periods)	
		Sept. 23	Sept. 30	Oct. 8	Sept. 23 to Sept. 30	Sept. 30 to Oct. 8
Within storm area	13	19·6	8·8	17·2	20 mm	Nil
Beyond storm area	12	9·9	23·4	36·5	Trace	Nil

Counts were made on October 2 and 4 of the number of jassid nymphs per 100 leaves at random in each subplot of a five-feddan field (about 5·2 acres). The field was divided longitudinally into three equal strips and each strip contained 20 subplots. During the afternoon of October 3, 9·3 mm. of rain fell upon this field at the Gezira Research Farm.

There were thus sixty pairs of 'before and after' rain counts of jassids in the same subplots. The mean decrease of population of 20·0 to 12·8 jassids per subplot was significant at 1 per cent level. There was, however, no significant difference between the twenty pairs of counts in the middle strip, although the pairs of counts in the subplots along the east and west edges of the field were significantly different at 1 and 0·1 per cent levels respectively.

A particularly striking example of the check of jassid numbers associated with a rainstorm in a roughly triangular area of about 300 square miles in the northern Gezira occurred on September 26, 1955. Within that area rain-gauges registered between 16 and 29 mm. of rain; outside the area gauges showed a 'trace' to 5 mm.; this was the last storm of the season in that area. Table 2 shows the relevant jassid count per 100 leaves.

Between the 'before and after' rain counts inside the storm area, the observed mean fall of population is significant at 1 per cent level, while beyond the storm zone the increase of population in the same period, September 23–30, is significant at the 1 per cent level. Inside the storm area, all counts on September 30 were less than the corresponding count on September 23; but outside the storm zone the exact reverse was true.

A map showing the locality of the sampling areas and rain gauges has been deposited at the British Museum (Natural History), South Kensington.

While the checks to breeding associated with rainstorms tend to delay the build-up of jassid population on cotton, observation at the end of November, the time of peak populations, showed no marked differences in the number of insects on the cotton within and beyond the storm area of September 26.

We wish to thank the Chief of the Research Division and the General Manager of the Sudan Gezira Board for permission to publish this communication.

ALAN GOODMAN

Gezira Research Farm,
Wad Medani.

A. M. TOMS

Sudan Gezira Board Headquarters,
Barakat, Sudan.

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[1] Hanna, D , *Bull. Ent. Res.*, **41** (2), 339 (1950).

[2] Cowland, J. W., and Hanna, A D., Ann. Rep Res. Div. Min. Agric. Sudan Govt , 1948/49, p 106 (1951).

FORTHCOMING EVENTS

Wednesday, August 29—Wednesday, September 5

British Association for the Advancement of Science (at Sheffield).—Annual Meeting.

Wednesday, August 29

At 8.15 p.m.—Sir Raymond Priestley: "Twentieth Century Man Against Antarctica" (Presidential Address).

Thursday, August 30

At 10 a.m.—Sir George Thomson, F.R.S.: "Physics and Technology" (Presidential Address, Section A).

At 10 a.m.—Sir Charles Goodeve, F.R.S.: "Steelmaking since Bessemer" (Presidential Address, Section B)

At 10 a.m.—Dr. W. H. Thorpe, F.R.S: "The Implications of the Study of Animal Behaviour" (Presidential Address, Section D).

At 10 a.m.—Mr. A. C. Hartley: "Oil and Industry" (Presidential Address, Section G).

At 10 a.m.—Dr. H. Godwin, F.R.S.: "Quaternary History and the British Flora" (Presidential Address, Sections K, K*).

At 10 a.m.—Sir Christopher Cox: "The Impact of British Education on the Indigenous Peoples of Oversea Territories" (Presidential Address, Section L).

At 10 a.m.—Mr. G. V. Jacks: "The Influence of Man on Soil Fertility" (Presidential Address, Section M).

At 11.15 a.m.—Mr. M. V. Laurie: "Current Trends in Forest Research in Britain" (Chairman's Address, Section K*).

At 11.30 a.m.—Prof. J. Drever: "Psychology and the Humanists" (Presidential Address, Section J).

At 2.30 p.m.—Dr. F. J. North: "Local Societies in the Community of To-day" (Presidential Address, Section X).

At 7.30 p.m.—Sir Raymond Priestley: "Antarctic Adventure".

Friday, August 31

At 10 a.m.—Prof. A. Austin Miller: "The Use and Misuse of Climatic Resources" (Presidential Address, Section E).

At 10 a.m.—Prof. Gilbert Walker: "Prices as an Instrument of Transport Policy" (Presidential Address, Section F).

At 10 a.m.—Dr. A. E. Mourant: "Blood Groups and Human Evolution" (Presidential Address, Section H).

At 8 p.m.—Prof. F. G. Young, F.R.S.: "The Growth of Biochemistry".

Sunday, September 2

At 11 a.m.—(in Sheffield Cathedral).—Religious Service. Preacher: the Rt. Rev. the Lord Bishop of Sheffield.

Monday, September 3

At 10 a.m.—Dr. T. Robertson: "The Presentation of Geological Information in Maps" (Presidential Address, Section C).

At 10 a.m.—Prof. D. Whitteridge, F.R.S.: "The Machinery of Posture" (Presidential Address, Section I).

At 8 p.m.—Prof. Sydney Chapman, F.R.S.: "The International Geophysical Year".

Tuesday, September 4

At 7.30 p.m.—Sir John Cockcroft, F.R.S.: "The Future Development of Atomic Energy".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Research Student in the Department of Botany—The Registrar, The University, Hull (September 1).

Glaciologist (with an appropriate university degree) in the Antarctic Division of the Department of External Affairs, Canberra, for duties with the 1957 expedition to Mawson, Australian Antarctic Territory—The Senior External Affairs Representative, Australia House, Strand, London, W.C.2 (September 8).

Physicist, Basic grade (with or without experience), for work on X-rays, gamma-rays, radioisotopes and some electronics—The Administrator and Secretary, University College Hospital, Gower Street, London, W.C.1 (September 8).

Assistant Experimental Officer (with a pass degree or at least general certificate of education (advanced level), and preferably experience or training in horticulture) in the Irrigation Section—The Secretary, National Vegetable Research Station, Wellesbourne, Warwick (September 10).

Assistant Lecturer (Organic Chemistry)—Dr. L. N. Owen, Chemistry Department, Imperial College of Science and Technology, London, S.W.7 (September 10).

Physicist or Physical Chemist (with good honours degree and wide research experience, and preferably experience in modern analytical techniques, particularly infra-red spectroscopy and gas/liquid chromatography), for fundamental work connected with the kinetics of carbonization of coal—The National Coal Board, Coal Research Establishment, Stoke Orchard, near Cheltenham, Gloucestershire, quoting SS/370 (September 10).

First Assistant (Senior Lecturer grade) (medically qualified with experience in physiological research) in the Research Department of Anæsthetics—The Secretary, Faculty of Anæsthetists, Royal College of Surgeons, Lincoln's Inn Fields, London, W.C.2 (September 12).

Agricultural Economist (with a degree in agriculture or economics together with experience in the field of agricultural economics, preferably on farm management inquiries or production cost investigations) in the Federal Ministry of Agriculture, Federation of Rhodesia and Nyasaland—The Secretary, Rhodesia House, 429 Strand, London, W.C.2 (September 15).

Physicist (with a first- or second-class honours degree in physics, an interest in electronics and a liking for experimental work, and also willing to develop interests in classical and biological physics) with the Air Ministry at Farnborough, Hants, for research on problems connected with applications of physics to aviation medicine—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.190/6A (September 15).

Senior Lecturer in Agricultural Chemistry—The Secretary of University Court, The University, Glasgow (September 15).

Research Assistants (2): one in inorganic chemistry and one physico-organic chemistry—The Secretary, The University, Exeter (September 17).

Chair of Mechanical Engineering at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia September 29).

Engineer (with an honours degree or equivalent in physics or electrical engineering and experience in the design and construction of electronic apparatus) in charge of Nuclear Equipment in the Department of Physics—Dr F. B. Kipping, University Chemical Laboratory, Lensfield Road, Cambridge (October 1).

Senior and Junior Research Fellows (with a first- or second-class honours degree in an appropriate subject and able to show evidence of a very high standard of ability in research) at Government Scientific Establishments for research into subjects of importance to H.M. Government—The Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting S.4567/56 (October 31).

Director of the Western Australian Museum—The Hon Mr. Justice Wolff, President, Museum and Art Gallery of Western Australia, c/o The Supreme Court, Perth, Western Australia (November 30).

Agronomist; Plant Breeder; Entomologist; Plant Physiologist; Plant Pathologist/Virologist; and a Statistician Agronomist, with the West African Cocoa Research Institute—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.197/200/021.

Experimental Officer/Assistant Experimental Officer (Chemist or Chemical Engineer, with H.S.C. (science), H.N.C. in chemistry or chemical engineering, or equivalent qualifications), to assist in the scaling of laboratory syntheses to pilot plant scale—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting 1234/34.

Geologist (Geophysics) (with a good honours degree in applied geophysics with geology or physics as subsidiary subjects or a good honours degree in geology with postgraduate training and experience in applied geophysics) with the Federation of Nigeria, to conduct geophysical surveys, chiefly in connexion with ground-water but also with the engineering geology of damn-sites foundations, etc.—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.105/14/03.

Graduate (preferably in agriculture) to take charge of recording at Cockle Park Experimental Station—The Registrar, King's College, Newcastle-upon-Tyne.

Graduate (with an honours degree in physics, metallurgy or electrical engineering, and some research experience) in the South Wales Laboratories of the British Iron and Steel Research Association Swansea, to develop new processes for continuously applying protective coatings to steel strip at high speeds—The Personnel Officer, B.I.S.R.A., 11 Park Lane, London, W.1, quoting "M.W.C.I.".

Lecturer (with an honours degree in geology) in Economic Geology in the Mining Department—The Secretary, Royal Technical College, Glasgow.

Master to teach Physics—The Headmaster, Christ's Hospital, Horsham.

Mathematical Physicists and Mathematicians, Principal Scientific Officer, Senior Scientific Officer or Scientific Officer grade (with a first- or second-class honours degree in mathematics or physics), to work in one of the following fields: astrophysics, atmospheric diffusion, atomic physics, statistics or stochastic theory, statistical mechanics, reactor physics, fluid mechanics, solid mechanics or general applied mechanics, numerical analysis involving the use of large digital computers—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting Ref. B.1019/34.

Principal/Senior Scientific Officer (with a first- or second-class honours degree in chemistry, some research experience, and a sound knowledge of modern analytical techniques as applied to radioactive substances), to work in a team engaged on fundamental research work on radioactive materials (Ref. C.154/34); and a Scientific Officer (with a first- or second-class honours degree in physical or inorganic chemistry and experience in applied research), to carry out applied research in the field of inorganic chemistry in a range of interesting new materials (Ref. 123[illegible]/34)—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting appropriate Ref. No.

Senior Biochemist to the Colchester Group Hospitals—The Group Secretary, Colchester H.M.C., 14 Pope's Lane, Colchester, Essex.

Technician for biochemical and histological research work in the **Rheumatism Research Unit**, Royal National Hospital for Rheumatic Diseases, Bath—The Secretary, Bath Hospital Management Committee, Manor Hospital, Combe Park, Bath.

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(*not included in the monthly Books Supplement*)

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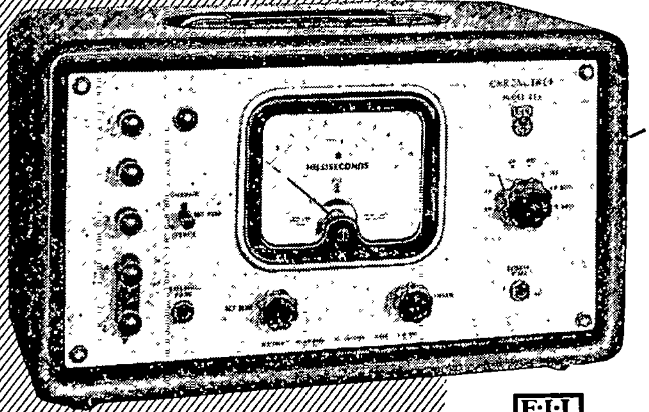

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ANTARCTICA

SIR RAYMOND PRIESTLEY is the first president of the British Association with personal experience of Antarctica, and very fitting it is that he should be president just before the start of the International Geophysical Year of 1957–58, which has so large an antarctic component. Sir Raymond is truly an elder statesman in antarctic affairs, in that he served as geologist both with Scott and with Shackleton before the First World War, and then proceeded to a notable career in university administration. After Cambridge, Melbourne and Birmingham, happy is it that he should recently have returned, on formal retirement, to leadership of the Falkland Islands Dependencies Scientific Bureau and now to the presidency of the British Association; his presidential address—"Twentieth Century Man against Antarctica"—is printed on p. 463 of this issue of *Nature*.

In the address Sir Raymond sketches in brief the history of Antarctica since 1900. Yet even in this necessarily greatly condensed story, from time to time there peeps through some of the old sparkle and humour which did so much for the morale of those strange ice-cave dwellers of Cape Adare forty-five years ago. Of that remarkable winter story Sir Raymond's modesty now tells us nothing. Like many others, historians delight in the small errors of fact and stress in their colleagues' work, and Sir Raymond will not expect to escape. But the elder statesman's power of panorama is here in full. Of special worth is his incidental comparison of Scott and Shackleton. Would that his friends could persuade him to write a comparative biography of those two great men, for Sir Raymond alone has the scientific knowledge and literary skill, and he served them both. Indeed the pre-1914 antarctic scene is portrayed, though briefly, with a vigour and a percipience perhaps not elsewhere equalled.

That pre-1914 period in Antarctica was the age of achievement despite inadequate techniques—and how inadequate they were was not clear for another decade or two. But the scientific output per unit of effort and money was undoubtedly of a higher order than ever later achieved. The inter-war years on and around the southern continent were decades of rapid advance, when technique at last had ceased to be a limiting factor, and the environment was sufficiently conquered for scientific achievement no longer to be hampered by excessive personal discomfort. In describing this period, Sir Raymond perhaps gives less than their proper due to the vigour, enthusiasm and extent of the Discovery Investigations. Likewise perhaps he remarks too little upon the achievement of the International Whaling Commission, which for all its shortcomings has in fact worked, and has saved alike the whaling industry and the southern whales—at least so far.

The era since the Second World War is more difficult for the historian, and more especially for the scientific historian who, as president of the British Association, knows well that any words of his will set up ripples which may have an influence far beyond his immediate audience and the scientific world. Sir Raymond has, rightly in this presidential address, almost succeeded in avoiding the political problems of Antarctica to-day. The fact of his success must not, however, be allowed to mislead or to act as a soporific to the nation. Sir Raymond does not hesitate to touch lightly upon strategic facts in these days when Suez and Panama are so vulnerable, and the one around-the-world sea route is the southern ocean washing the shores of Antarctica. One wonders if those who work in Foreign Ministries and State Departments would agree that "the fresh resurgence of interest" in connexion with the spectacular activities of the coming International Geophysical Year in Antarctica "has science for its main drive" as Sir Raymond suggests? Perhaps it was true for a short period; but can it still be presumed to be so? Once the national politicians—and let their countries here be nameless—saw the convenience of the scientific cloak, and once a few of the scientists had appreciated the quality of the wicket for extracting national money, the main-spring of antarctic endeavour—so some with knowledge will affirm—became brutally political.

Sir Raymond dilates upon the startling and wonderful scientific efforts which will be made, the myriads of radio-sondes, the rockets and the satellites, the glaciology and the seismology. But with all this he perhaps fails even then to provide a sufficient realization of the real operational magnitude of the many-nationed antarctic endeavours of the next few years. He refers to the £100,000,000 which, it has been estimated, will be spent on this work; but in fact the total cost of the United States effort alone might well exceed that figure. Few members of the British Association will have read the published terms of reference for the United States new antarctic organization, answerable direct to the Operations Co-ordination Board. Science, we can agree, stimulated the "fresh resurgence" in Antarctica; but surely it becomes progressively more difficult to sustain the thesis that the "main drive" is now anything but competitive power politics.

Since in his address Sir Raymond Priestley goes some little way towards assessing the relative achievements of the various nations concerned, it is apposite perhaps to make a comparison. Sir Raymond rightly stresses the British technological failing before the First World War. At that time we failed to perceive the virtues and necessities of dog transport, and the consequences are well known: the Norwegians achieved while we failed. Now again we thrive in the sciences, but once more fail in transport technique in comparison with our rivals in this power-political era. It is an astonishing fact that of the five mutually recognizing sovereign powers in Antarctica (Great

Britain, Australia, New Zealand, Norway and France), not one possesses an icebreaker, without which full manœuvrability around the continental coasts is impossible. Yet Argentina and the United States and the U.S.S.R. are already well provided in this respect. As in the days of Scott and Amundsen, it is to the nation which has the technical benefit of superior transport that goes the prize, whether it be the conquest of the pole, or the long-term foothold in Antarctica. Our science is adequate, our technique of support is not.

The president of the British Association has provided us with an admirable historical background and some little prophecy; but he has rightly felt it out of context to draw the moral beyond the world of science. Yet it is sadly true that, while the scientists admirably co-operate in the excitements of the International Geophysical Year, the nations themselves are fighting in Antarctica a 'cold war' in which material resources are of paramount importance. Whatever may be the outcome of this 'cold war', it seems certain that by the end of the International Geophysical Year scientific knowledge of Antarctica will have made immense strides forward.

GALENUS EXPLICATUS

Galen on Anatomical Procedures

Translation of the surviving books with Introduction and Notes. By Prof. Charles Singer. (Publications of the Wellcome Historical Medical Museum, No. 7.) Pp. xxvi+289. (London: Oxford University Press, 1956. Published for the Wellcome Historical Medical Museum.) 37*s*. 6*d*. net.

THE translation of a work such as this is far from being an uneventful exercise. A knowledge of the language is by no means sufficient, nor does a sympathetic concern in the writer and his work tide the translator over many of his difficulties. It is above all necessary to have a profound knowledge of the subject and of the personality of the author, and it may even be requisite to check his technique and experiments in the laboratory. The diction followed by a worker in the second century A.D. can be very difficult to modernize in another language, largely owing to the lack of an agreed technical vocabulary, and it may be inscrutable unless you have before you a replica of the objective evidence which influenced the original author.

No one knows the difficulties of the task and how to overcome them better than Prof. Singer himself, and the present work has been designed and completed with that knowledge and experience in view. He rightly has a very high opinion of the merits of Galen as an anatomist and physiologist. There is, he says, no comparable work in ancient literature; it established a point of view which was not exceeded for 1,450 years, and it started Vesalius on his triumphant career. A problem which has attracted considerable attention is whether Galen transferred to man anatomical features derived from the dissection of lower animals. In Book 6, Chapter 1 he mentions the types he preferred to dissect as being most like man, but does not admit ignorance of human anatomy. On this question Singer allows that Galen's text "in general is a description of the soft parts of the ape imposed on the skeleton of man". He adds, however: "had Galen any knowledge by dissection of the structure of the human body? I have thought much on this topic, and have several times changed my views, but now think that he had such knowledge. . . . Does Galen ever betray that he has a knowledge of human anatomy reached by direct contact with the object? I now think the answer should be 'Yes'." No further can we get in this ancient and prolonged controversy until fresh contemporary evidence is forthcoming. Moreover, as Singer points out, Galen was heir to five hundred years of physiological research, and yet when he died experimental science too fell dead. "How was it that all this hoarded physiological wisdom of antiquity came to this sudden dramatic end?"

Galen's work on anatomical methods consists of fifteen books, of which only a fragment of the Greek text of Book 9 on the brain has survived. The whole of Books 10–15 lack the Greek originals, and are not included in Singer's monograph; but an Arabic translation of the complete work is now available. It is therefore possible, and certainly desirable, that an English translation and commentary of the Arabic version of the missing Greek Books 9–15 should be undertaken, even though they have played no part in the history of anatomy. An admirable German translation by Max Simon was published in 1906. We must not forget that Galen's value to us is partly his references to the work of his predecessors, much of which would otherwise have remained entirely unknown. On the other hand, he quotes "Hippocrates" thirteen times in the present treatise, and Brasavola's Brobdingnagian index to Galen's Works, which weighs 9 lb. and piles up some 107,000 entries, includes three folio pages of references to the "Hippocratic" corpus, although there is no evidence that Hippocrates himself ever wrote a word of it. Many will be surprised to learn the extent of Galen's knowledge of anatomy and physiology and how accurate it was for his time. He was the last to practise anatomy for many centuries.

Reference to some of the topics known to and studied by Galen may be taken as a cross-section of his morphological activities. The fable that in the crocodile the upper and not the lower jaw is the movable one can be traced back to Herodotus (fifth century, B.C.). It was accepted by Aristotle, Galen, Leonardo, Vesalius, Rondelet, Columbus and Robert Boyle. Oliver Goldsmith claimed in 1772 that it could be established by experiment, and even in 1809 Descourtilz held that the lower jaw could be fixed, and the rest of the entire head moved upwards on the occipital condyle.

Galen did not attempt to dissect small animals, such as insects, but confined himself to vertebrates of all types. His lynx, about which Prof. Singer has some doubts, might well have been *Felis caracal*, which was readily available in number and of a convenient size for examination in the laboratory. These comparative studies led Galen to formulate a teleological explanation of natural phenomena. Hence he says that you can predict the structure of an animal on seeing it for the first time—a possibility exploited by Cuvier in our own era. Galen does not regard the substance of the heart as typical muscle, but that its specific activities accord with the peculiarities of its structure. Pulsation is an intrinsic faculty of the heart and does not proceed from the nerves. The anatomy of the heart and its valves is well described. Nerves can be either sensory or motor and may even be distinguished structurally—a histological truth which could not have been known to Galen. He is interested in the occurrence of an os cordis, and claims to possess a very large specimen of it extracted from the heart of an elephant, where, however, the bone does not normally occur.

Galen must rank as an important experimental physiologist. The statement rife at the time that the arteries do not contain blood he dismisses as "impudent nonsense" worthy of the "comic writers". He then proceeds to demonstrate the falsity of it by observation. His experiments on the physiology of the respiratory movements and on the function of the spinal cord are truly remarkable. On the debit side, however, we have two disastrous errors to record. He believed in the existence of perforations in the ventricular septum of the heart, through which blood could pass direct from the right ventricle into the left, and he assumed that the veins originated in the liver, from which it follows that the flow of the blood in them must be peripheral.

The notes appended to Prof. Singer's volume are the result of unwearied critical research not only in determining the modern equivalents of the muscles, nerves and blood vessels which Galen describes in remarkable detail, but particularly in clarifying and stabilizing the text. Such work is indispensable and beyond praise. Only those of us who have stumbled through Galen's anatomy, dictionary in hand and confusion in mind, can realize how much Prof. Singer has done to lighten the labours of our more fortunate successors.

There is a good index but no bibliography.

F. J. Cole

AN INTRODUCTION TO ASTRONOMY

Introduction to Astronomy

By Dr. Cecilia Payne-Gaposchkin. Pp. x+508. (London: Eyre and Spottiswoode (Publishers), Ltd., 1956.) 50*s*. net.

In the United States much more instruction is given in astronomy than in Great Britain. There it is included in general science courses, and many arts students take short courses of one or two terms in astronomy. Astronomy, which is the oldest of the sciences, is well adapted for teaching as a cultural subject; the history of the development of concepts in astronomy from the early ages to the present time forms a fascinating subject, while the modern investigations into the nature and structure of the universe and the attempts to learn about its beginnings, its evolution and its future have an inherent appeal to the human mind.

Though this introduction to astronomy has been written primarily as an introductory text for American students, it is well adapted for the general reader. The cultural aspect of astronomy has been kept in the forefront of the author's mind and the associations of astronomy with the fields of language, literature and history have been emphasized; little background either in mathematics or physics is required of the reader.

About half the book is devoted to the solar system and half to the stars and stellar systems. The author of a text-book always has to face the problem of the extent to which current ideas, which are still in a state of flux, are to be dealt with. This book gives a well-balanced account of modern views, and the author has pointed out that some of them may require modification or may prove to be quite incorrect. The chapter on variable stars, in which field the author herself has done much work, is perhaps too detailed for an introduction to the subject.

A few errors have been noticed. The statement about Augustus Caesar having taken one day from February to add to August is not correct and should be omitted in any future edition. The number of days in each month have remained as they were fixed by Julius Caesar. Halley spelt his Christian name Edmond, not Edmund as given on p. 145. Greenwich Civil Time, a term used in the United States, is not an acceptable alternative to Greenwich Mean Time; in the summer-months in the United Kingdom the (Greenwich) civil time differs by an hour from Greenwich mean time. Some of the statements about Venus on p. 185 require modification. Venus does not reflect sunlight without changing its colour; Venus is yellower than the Sun. Its light is not white; it is yellower than the light reflected by the Earth. The statement on p. 208 that the spectrum of Jupiter shows some striking features that are common to a greater or less extent to all the major planets, followed by the statement that the dark bands have been identified as molecular spectra of methane and ammonia, is rather misleading, inasmuch as the spectra of Uranus and Neptune contain no bands due to ammonia.

The book is particularly well illustrated with photographs, and there are many text-figures. The series of planetary photographs, taken at the Lowell Observatory, is most valuable; many of the photographs of stars and galaxies were taken with the 200-in. telescope.

H. Spencer Jones

PHYSIOLOGY OF THE MINERAL MINUTIÆ

Trace Elements in Human and Animal Nutrition

By E. J. Underwood. Pp. xi+429. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1956.) 9.50 dollars.

It is appropriate that the first book on the nutritional aspects of the trace elements should have been written by an Australian, for some of the most important work on the subject has been done in that country. This is partly the result of the 'challenge', in the sense used by Toynbee in his "Study of History", provided by the diseases of stock on certain Australian pastures, and the response of the scientific workers can only be described as having been an outstandingly successful one. This is not for a moment to suggest that Australia has had a monopoly in trace-element research. Little of the work on iodine, fluorine, molybdenum or manganese has been done there, and the pioneers like Chatin, Raulin, Bertrand, Hart and Ramage were not Australians (a number of them were French); but the work of Bennetts, Underwood and Marston on copper and cobalt has had such enormous economic repercussions that it is impossible not to be impressed by its importance.

In writing this book the author has considered iron, copper, cobalt molybdenum, nickel, zinc, manganese, iodine, fluorine and selenium in some detail, and dealt briefly with aluminium, arsenic, barium, strontium, boron, bromine, silicon and vanadium. His interpretation of the word 'nutrition' has been a very wide one. The chapter on iron, for example, contains the following headings: historical background; the total iron content of the body and its distribution; iron in blood; the forms and amounts of iron in tissues and secretions; absorption; excretion; iron deficiency; requirements for iron; sources of iron in foods and dietaries: references.

It will be seen from this that the physiology of the trace elements would have been a more descriptive title for the book, and people interested in any aspects of the subject would do well to consult it. The whole animal kingdom is really covered, including to some extent the marine invertebrates; but priority has been given to the higher animals including man, and this general approach explains the scanty amount of space devoted to boron, which is only necessary, so far as is known, for plants.

It is a little difficult to pick out the treatment of any one of the elements for special comment, for each of them to which a chapter is devoted is handled in much the same way. Excesses are discussed as well as deficiencies; toxic fluorosis, for example, is accorded full measure.

The last chapter is concerned with the soil–plant–animal relationships of the trace elements. More might have been made of this, for it is just these relationships which make the trace elements so important to human welfare and formed the rationale for the symposium on the subject which was held in the Vatican in 1955.

Judging by the number of times the author has made reference to some of my own somewhat pedestrian publications, the bibliography must be a very complete one. There are omissions, however, here and there. A little more might have been made of fœtal nutrition, for example. There is no record of that curious little creature *Archidoris britannica*, which crawls about the floor of the sea with considerable deposits of calcium and strontium fluoride inside it. If arsenic is worth a mention, it is difficult to see why mercury and lead were not accorded a place; and where is the section on chromium, which seems to be part of the permanent structure of the erythrocyte, whatever its function there may be? But these are trifles, mentioned only to be forgotten. The book is a good one, worth reading from cover to cover; and there is a good author and subject index.

R. A. McCance

CONTROL OF PITUITARY FUNCTION

Neural Control of the Pituitary Gland

By Prof. G. W. Harris. (Monographs of the Physiological Society, No. 3.) Pp. ix+298. (London: Edward Arnold (Publishers), Ltd., 1955.) 30*s*. net.

THE place taken by the hypothalamus in current biological discussion is in striking contrast to its size. This minute region of the brain also remains a happy hunting ground for experimentalists concerned to find in it neural 'centres' for almost every visceral function of the body. Those with which it has already been endowed are more numerous than are its recognizable groups of nuclei; and it is scarcely surprising that some of the latter have had to be invested with the control of very different functions.

Prof. Harris's book, "Neural Control of the Pituitary Gland", is a review of the relationship of this part of the brain to the two main divisions of the pituitary gland. The relationship of the neurohypophysis to the hypothalamus is dealt with in the latter and shorter part of the book. This begins with a brief account of the anatomy of the two structures concerned, and its final chapter focuses on the nature and site of formation of the posterior pituitary hormones, the bias of Prof. Harris's conclusion being that they are elaborated in the neurohypophysis itself. The considerable volume of recent work which has led to the view that the posterior lobe hormones are produced by the nuclei supraopticus and paraventricularis, and that they are transported down the supraopticohypophysial tract into the neurohypophysis, is dealt with in only three pages. The implication of Prof. Harris's cautious reference to this "attractive hypothesis" is that it still remains to be established.

Such reserve does not stamp his treatment of the control of the adenohypophysis. The analysis of this problem begins with the general proposition that the central nervous system "is largely responsible for correlating endocrine activity with that of the other systems of the body, and with the varying requirements of the organism due to environmental change". This statement introduces the further generalization that, with the exception of the neurohypophysis and adrenal medulla, there is no clear evidence that any of the endocrine organs, for example, the thyroid, ovaries and testis, have a secretomotor innervation. The view then emerges that the central nervous system regulates the endocrine organs indirectly by way of a control which the hypothalamus exercises over the anterior pituitary. The latter is effected by means of some undefined chemical substance(s) that is transmitted through the hypophysial-portal vessels, the integrity of which Prof. Harris believes to be essential for normal anterior pituitary function. The "chemotransmitter" then stimulates the pituitary to produce its various trophic hormones, the level of output of which is held in normal balance by a series of interactions with the hormones the secretion of which they stimulate.

The simplicity of this hypothesis is in such striking contrast to the complexity of the pituitary's influence in the body, and with the problems that are implied by the concept of a neural control of the endocrine system, that Prof. Harris's views deepen rather than lighten the mystery that surrounds the physiology of the hypothalamus. Among the many things which the critical reader new to the field needs to be, but is not, told is just what validity can be attached to statements about the precise localization of function in the hypothalamus, when methods of electrical stimulation as well as techniques of making hypothalamic lesions are usually overwhelmingly crude in relation to the size of the neuronal complexes concerned. It is because of this discrepancy that it so often proves impossible to reconcile statements that are made about the exact localization of some presumed hypothalamic functions. A second general point which overshadows this field of experiment is the possibility that many of the responses that are regarded as specific to the hypothalamus, or to some connexion between the hypothalamus and the anterior pituitary, are, in fact, responses which occur as part of a general complex of change that can be initiated by lesions or disturbances which bear no specific relation to either structure. Here it is the essential absence of controls, or of experiments that are carefully designed to test specific hypotheses, which prevents the student from coming to grips with the problems of the hypothalamus. Prof. Harris might have been better advised, therefore, if he had left the problem with the statement, which appears at the start of the general discussion to this section of the book, that the "information as to the details of the mechanism involved is scanty", instead of proceeding to speculations about the number of chemotransmitters that might be involved (when not even a single one has yet been identified), and about the functional differentiation of individual portal vessels in relation to different areas of the anterior pituitary (when it is not yet known that the number, let alone the precise disposition, of the portal vessels in a given species is constant). But if Prof. Harris does not tell us on what "good grounds" he bases this speculation, equally he does not refer properly to experiments that have conclusively shown that whatever influence the hypothalamus exercises over the functions of the anterior pituitary, the pituitary-portal vessels are neither a sufficient nor a necessary explanation of this presumed "control".

Theorizing from slender fact is, of course, one of the ways new fields of biological knowledge develop. But, as in this case, there is always the risk that a single positive observation may emerge which completely undermines an edifice of speculation, and particularly one that has been erected because of an urge to explain the incomprehensible. Publication is these days not infrequently slow, and the danger of a scientific work being somewhat out of date was accentuated in the present case by the fact, noted in the preface, that the book was based on a series of lectures given a few years back.

S. Zuckerman

ARTIST VERSUS SCIENCE

Louis Agassiz Fuertes

Edited by Mary Fuertes Boynton. Pp. xviii+317+17 plates. (London and New York: Oxford University Press, 1956.) 45*s*. net.

To readers who are familiar with the paintings of Louis Agassiz Fuertes, especially those of us who are either painters, naturalists or ornithologists, this book holds much of absorbing interest. But as 'much will have more', it is probable that the need will be felt for additional illustrations to those few given in the book, excellent as they are; especially of those swift field studies and preliminary drawings which are always more intimate and spontaneous, more of the very essence of the artist, than the deliberately planned, finished works.

This book consists mainly of letters from "L.A.G." to his friends and business connexions, and of theirs to him, these being supported, where necessary, by biographical notes. Together they paint a fairly full portrait of the artist, who emerges as a charming, sociable, hard-working person, with a great fund of humour, and obviously beloved by all who knew him.

In a way he was lucky, in that his work was recognized and taken up when he was quite young. He was commissioned by no less an ornithologist than Elliot Coues to paint one hundred illustrations of birds for a book; but one wonders whether this early plunge was in fact good for "L.A.G.", for as an artist he was not mature, and then, as now, the influence of Audubon was a dominant one in American bird portraiture. Had he been granted a few more years of study, it is possible that he would have become aware of the Swedish painter of birds and animals, his contemporary Bruno Liljefors, with his very different æsthetic approach to the work. But, as this book reveals, poor Louis was either so inundated with work of a semi-scientific nature or was away on his travels in foreign parts in search of specimens, that he had no time for artistic experiments, and his style remained, in its essence, a linear one. Because of the dictates of his scientist-patrons his colour did not equal his draughtsmanship, and in spite of all the talk and furore about the effect of light on the plumage of birds, he was forced to present his subjects in a light which was acceptable to the scientist and not in that which emanates from the Sun.

The book is particularly interesting in its account of the hunting expeditions into which "L.A.G." entered with so much zest and excitement, and in which he suffered heat, cold, weariness and illness, meantime killing a prodigious number of birds; these, however, were not wasted, for, fulfilling the purpose for which they were intended, they eventually found their way into museums as mounted specimens or study skins. Interesting too are the letters describing his adventures in landscape painting, these paintings being the preliminary studies for the landscape backgrounds to the dioramas in the American Museum of Natural History.

'Ars longa, vita brevis'; especially was this so in the case of "L.A.G.", for his tragically sudden death occurred while he was still at the height of his powers.

C. F. Tunnicliffe

PRESTRESSED CONCRETE DESIGN

The Theory of Prestressed Concrete Design

Statically Determinate Structures. By Prof. Henry J. Cowan. Pp. xvii+264. (London: Macmillan and Co., Ltd.; New York: St. Martin's Press, Inc., 1956.) 36*s*. net.

The title of Prof. H. J. Cowan's book is rather misleading, since it concerns itself almost entirely with beams, with just 12½ pages devoted to pipes and tanks. It can scarcely be said to deal comprehensively with statically determinate structures in general. So far as statically determinate beams are concerned, the book has been written with great care and thoroughness, with numerous worked examples to illustrate points in the text when dealing with design, after a general approach through early chapters on fundamental principles, manufacture, and the properties of steel and concrete.

It is a debatable point whether prestressed concrete design should be carried out these days using working stresses and working loads, with subsequent checks on the load factor at cracking, and at failure. However, having accepted this principle, which permits constant values of Young's modulus for steel and for concrete at the design stage, and permits tension in the concrete, one can appreciate the methods used to get balanced designs for a number of different cases of increasing complexity, and the neat use of diagrams to indicate the range of practical solutions.

Subsequent chapters deal with the load factors against cracking and failure for a number of these, with the effects of cables of varying eccentricity, and with bond, shear and torsion.

In the case of shear, the common error regarding the distribution of shear stress in an 'I' section has unfortunately been perpetuated, but it does not affect the validity of the rest of the work of the chapter, which deals with points very often ignored in books on prestressed concrete design.

If one accepts that design of simply supported prestressed beams should be carried out using working loads and working stresses, the book is a useful and comprehensive text-book; if one believes that design should be based on failure at a definite excess loading, and checked for condition at working loads, it is of far less use. Nevertheless, the chapter on ultimate load still largely applies, as in fact does most of the book except for the work on balanced design, albeit not so conveniently as intended.

References are numerous and well related to the text, and the style of writing is clear and easy to follow. It is well worth a place on the bookshelf for those requiring a detailed study of a specialized structural field. J. W. H. King

AUTOMATION ECONOMICS

The Economic Consequences of Automation

By Dr. Paul Einzig. Pp. xi+226. (London: Martin Secker and Warburg, Ltd., 1956.) 21*s.* net.

THE word 'automation' has become the excuse for a spate of books, articles and speeches, some of which contribute little to the clarification of its meaning. Dr. Paul Einzig's book has all the appearances of having been hurriedly compiled to meet the market, for it quickly abandons the attempt to ascribe to the word any particular meaning and plunges into an exposition of the problems that beset our economy. In this context, automation is merely a synonym for any technical change in methods of manufacture leading to greater productivity, and little attempt is made, except in two chapters at the end which briefly list its advantages and disadvantages, to discuss in detail the specific effects of the introduction of automatic equipment on particular industries or occupations.

Dr. Einzig is more concerned with the general economic problems of inflation, the business cycle and the balance of payments, and the part played in them by any form of labour-saving capital investment; thus there is little in his views that will be new to a reader of the more popular financial journalists. He rightly sees technological change as only one of the possible causes of unemployment, which is itself unlikely so long as expansionist policies continue. The growth of large-scale mass-production industries, in his view, may have a stabilizing economic effect, because of the long periods during which their investment plans mature, although the scale of their production makes them more vulnerable in times of deflationary pressure.

To the better-known reasons for believing that the dangers of the business cycle have been overcome, albeit at the cost of some continuing inflation, Dr. Einzig adds a new one which arises directly out of rising production itself. This is based on the time-lag between the steps taken to increase production, whether by increased employment or overtime or increased capital investment, during which income is generated and the actual production of consumable goods. The effect of this 'pipeline lag' is to keep purchasing power ahead of the volume of goods available to consumers and so to maintain demand. In other words, an increase of capital investment will not, as some economists have feared, cause over-production—although automation (or any other method of raising output by capital investment) may tend to exaggerate deflation during deflationary periods and inflation during inflationary periods.

This argument seems to be in contradiction to Dr. Einzig's view that automation reduces the extent of inflation by raising the output of goods and, by reducing the need for labour in the industries affected, weakening the power of the trade unions to demand wage increases under conditions of "overfull employment".

What is lacking in this analysis is any examination of the problem of the radically different rates of technical advance made possible in the mass-production consumer-goods industries and in the capital-goods industries—a matter of special importance in a country such as Britain, in which the rate of personal consumption at home is going to be more and more dependent on the ability to export capital goods to pay for imported food and raw materials. How are investment and output in these industries to be kept in balance?

Dr. Einzig recognizes that Britain is more likely to suffer from too slow an adoption of new methods than otherwise; but he exaggerates the extent to which, so far, the trade unions have resisted change. In the case of the Amalgamated Engineering Union, he assumes that this is because it is Communist controlled, which it is not. On the other hand, he has some justification for fearing that the narrowing of differentials may be having a harmful effect on the recruitment of the more skilled workers who will be required in industry. He also underlines the inadequate remuneration at present received by research scientists and engineers; but this leads him to the conclusion that a large proportion of them, because of their dissatisfaction with their conditions, are inclined to become Communists or 'fellow-travellers' and that their claims for higher pay must be satisfied in order to secure their political loyalty. Unsupported assertions of this nature must undermine confidence in what purports to be a serious economic study. Austen Albu

SHEFFIELD

Sheffield and Its Region

A Scientific and Historical Survey. Edited by David L. Linton. Pp. xxv+334+11 plates. (Sheffield: British Association for the Advancement of Science, 1956.)*

THOSE attending the annual meeting of the British Association have learned that, in a county justly noted for generosity, the city of Sheffield has played no small part in making Yorkshire hospitality so well known. Before reaching the city, visitors received details of the impressive programme, the varied excursions and the detailed arrangements made for their comfort and convenience. They have also been presented with a copy of a superbly produced book, containing a scientific and historical survey of Sheffield and its region. The book was produced under the general editorship of Prof. D. Linton, of the Geography Department, University of Sheffield, and will give pleasure not only to the recipients but also to all those inhabitants of Sheffield on whose behalf the book has been written for the guidance of visitors from home and overseas.

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* After the meeting, copies of "Sheffield and Its Region" will be obtainable from A. B. Ward, 24 Chapel Walk, Sheffield. 30*s.*

The potential value of the book emerges from an introduction which has been written with discerning skill. In his introduction the editor shows how the geographical containment of the city has limited and is bound to limit its growth as a regional capital which might be used for the devolution of many of the functions of central government. Yet this city of half a million people, the growth of which has been hindered by the hills around, has great pride in its achievements. This, as is well known, is largely bound up with its steel and cutlery industries; these industries have given the city a community of interest which is probably unparalleled in any city of comparable size in Great Britain.

It is not surprising, therefore, that the story of Sheffield, described in this volume under so many headings, has its origins, in one way or another, either in its great metal-producing and metal-working industries or in the climatic variations which arise from its intricate geomorphological features. The latter are well described in sections prepared by Wilfrid Edwards and Prof. Linton himself. Climatic variations are explained by Dr. Alice Garrett, who, *inter alia*, shows how and why Sheffield must be regarded as one of the snowiest of the large cities of Great Britain.

A study of the Palæolithic, Neolithic and Bronze Ages of the region has been made by A. Leslie Armstrong, who, after describing a number of palæoliths which have been discovered, points out that the "master craftsmen" who made them possessed also "tools and perishable articles of bone, wood and leather". The distinctive feature of the Iron Age in the region is the hill-fort, sixteen of which have been recorded, and the location of which is surveyed by J. E. Bartlett and F. C. Preston; they also describe Roman occupation in the region, a point of special interest being that to-day one steelworks which produces vast quantities of steel is situated on the site of the Roman camp at Templeborough, which is known to have had its own furnaces for making iron.

The history of Sheffield from the age of settlement to more recent times is considered by three of the University's lecturers. One of the places to which visitors are attracted is the field at Dore on the outskirts of Sheffield where, in 829, King Ecgbert of Wessex, having planned to attack Northumbria, was met by King Eanred of Northumbria; Eanred is reputed to have paid homage to Ecgbert. As Mercia was in temporary eclipse to Wessex, some historians are prepared to recognize Ecgbert as the first king of all England; his name is perpetuated in a street at Dore.

One of the most interesting sections in the book is that devoted to the early industrial development of the region. This, by Prof. G. P. Jones, describes primitive forms of metal-working and how, by the late sixteenth century, there were already about a hundred collieries in the West Riding, South Yorkshire and Derbyshire; although most of these were very small, even in 1599 one was producing at the then not inconsiderable rate of 2,000 wainloads a day. Favourable conditions, including ready access to rich supplies of good-quality iron ore, abundance of water-power, and nearness of good materials for making grindstones, led to the continued expansion of cutlery-making and, in 1624, by Act of Parliament the cutlers were made a self-governing corporation; the "Company of Cutlers in Hallamshire" is one of Sheffield's greatest prides.

The second part of this magnificent book is given over to accounts of the economic development of Sheffield, the growth of its social institutions and the great contributions made by the city to the arts and sciences. A picture of Sheffield's Development Plan is painted by the enterprising City Engineer, Henry Foster.

Details of the Sheffield region to-day, including its agriculture, mining and quarrying, steel-making and engineering and lighter trades, and urban centres, are described in the third part of the book, while there are some interesting appendixes on natural history contributed by members of the Sorby Natural History Society. Of the quality of the book it is enough to say that it has been produced by the Oxford University Press and is worthy of that Press.

The story of Sheffield could not have been better presented. If there is an omission, it is that no one has been bold enough to assess the quality and character of the people to-day and of important social developments. Reference is made to the long-sighted efforts of the Bishop of Sheffield, who, more than ten years ago, saw that the parochial system of the Church had to be supplemented if religion were to mean anything in the lives of masses of people in big industrial communities. He founded his industrial mission which has served as a model for similar developments elsewhere. Mention might have been made of the city's extraordinary collection of societies concerned, in one way or another, with better administration and human relations inside industry. Modesty, presumably, explains why no testimonial is given to the devoted work by so many of the region's most influential men to the region's many voluntary organizations. Youth organizations, particularly, have benefited not only by financial support but also by continuing and active personal help. On the cultural side, reference might have been made to the city's weekly visits by the Hallé Orchestra, to its splendid professional repertory theatre which is largely administered by amateurs, and to the Little Theatre, where a distinguished warden has seen that the city does not lack performance of Greek plays.

The quality of the people arises from the character of the city and its industries. Sheffield is a man's city, and the men have been fashioned by centuries of dangerous work, much of it done at night when true fellowship is the more readily built up. The people are long-headed and cheerful. The latter characteristic may spring paradoxically from the grim character of the industrial quarter, since nowhere in Great Britain is there such a trek into the country by walkers and cyclists as pour from Sheffield into Derbyshire at the week-ends. People in Sheffield know that they are close to beautiful countryside; unlike the inhabitants of many similarly placed in other cities, people in Sheffield regularly renew their links with Nature to look down on their city, which a former Vice-Chancellor of the University has said "reminds him of Florence seen from the surrounding hills".

T. H. Hawkins

THE NEUTRINO

By Dr. FREDERICK REINES and Dr. CLYDE L. COWAN, jun.
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EACH new discovery of natural science broadens our knowledge and deepens our understanding of the physical universe ; but at times these advances raise new and even more fundamental questions than those which they answer. Such was the case with the discovery and investigation of the radioactive process termed 'beta decay'. In this process an atomic nucleus spontaneously emits either a negative or positive electron, and in so doing it becomes a different element with the same mass number but with a nuclear charge different from that of the parent element by one electronic charge. As might be expected, intensive investigation of this interesting alchemy of Nature has shed much light on problems concerning the atomic nucleus. A new question arose at the beginning, however, when it was found that accompanying beta decay there was an unaccountable loss of energy from the decaying nucleus[1], and that one could do nothing to the apparatus in which the decay occurred to trap this lost energy[2]. One possible explanation was that the conservation laws (upon which the entire structure of modern science is built) were not valid when applied to regions of subatomic dimensions. Another novel explanation, but one which would maintain the integrity of the conservation laws, was a proposal by Wolfgang Pauli in 1933 which hypothesized a new and fundamental particle[3] to account for the loss of energy from the nucleus. This particle would be emitted by the nucleus simultaneously with the electron, would carry with it no electric charge, but would carry the missing energy and momentum—escaping from the laboratory equipment without detection.

The concept of this ghostly particle was used by Enrico Fermi (who named it the 'neutrino') to build his quantitative theory of nuclear beta decay[4]. As is well known, the theory, with but little modification, has enjoyed increasing success in application to nuclear problems and has itself constituted one of the most convincing arguments in favour of the acceptance of Pauli's proposal. Many additional experimental tests have been devised, however, which have served to strengthen the neutrino hypothesis ; and also to provide information as to its properties. The very characteristic of the particle which makes the proposal plausible—its ability to carry off energy and momentum without detection—has limited these tests to the measurement of the observable details of the decay process itself : the energy spectra, momentum vectors and energy states associated with the emitted electron and with the recoiling daughter nucleus[5]. So, for example, an upper limit has been set on the rest mass of the neutrino equal to 1/500 of the rest mass of the electron by careful measurement of the beta-energy spectrum from tritium decay near its end point[6], and it is commonly assumed that the neutrino rest mass is identically zero.

While there is no theoretical reason for the expectation of a finite neutrino rest mass, there is some expectation for a small but finite neutrino magnetic moment of perhaps as much as 10^{-10} Bohr magneton based on a consideration of possible virtual states in which the neutrino may exist effectively dissociated into other particles[7]. An upper limit of $2 \times 10^{-}$ electron Bohr magneton has been set on the magnetic moment by calculations concerning the maximum assignable heat transfer to the Earth by neutrinos from the Sun[8]. We have recently obtained an improved upper limit of 10^{-9} electron Bohr magneton using a large scintillation detector near a fission reactor at the Savannah River Plant of the United States Atomic Energy Commission. The counting rate of single pulses in an energy range of 0·1–0·3 MeV. in 370 gallons of liquid scintillator was observed, and all changes due to reactor power changes were assigned to possible electron recoils in the liquid through magnetic moment interaction with neutrinos. It is hoped that this limit may be further improved by lowering the gamma-ray and neutron background at the detector.

The Pauli–Fermi theory not only requires the neutrino to carry energy and linear momentum from beta-decaying nuclei but also angular momentum, or 'spin'. The simplest of beta-decay processes, the decay of the free neutron[9], illustrates this :

$$n^0 \rightarrow p^+ + \beta^- + \nu_- \qquad (1)$$

As the neutron, proton and beta particle all carry half-integral spin, it is necessary to assign a spin quantum number of 1/2 to the neutrino to balance the angular momenta of equation (1), where any two of the three product particles must be oriented with spin vectors antiparallel. As all four of the particles in equation (1) are, therefore, fermions and should obey the Dirac relativistic wave equations for spin 1/2 particles, there are presumably antiparticles corresponding to each, of which as yet only the anti-electron (or positron) and the antiproton have been identified. The antiparticle corresponding to the neutrino in equation (1) may be obtained by rearrangement of the terms in the following manner :

$$p^+ \rightarrow n^0 + \beta^+ + \nu_+ \qquad (2)$$

This process is observed in positron decay of proton-rich radioactive nuclides where the proton and daughter neutron are both constituent nucleons. Further rearrangement results in the reaction :

$$\beta^- + p^+ \rightarrow n^0 + \nu_+ \qquad (3)$$

This is descriptive of the capture of an electron from one of the inner atomic shells by a nuclear proton and is equivalent to equation (2). The question of the identity of the neutrino, ν_+, appearing in equations (2) and (3) with the neutrino, ν_-, appearing in equation (1) thus arises. With no finite mass or magnetic moment yet measured for either of the neutrinos, one is under no compulsion to assume that they are not in fact identical. The rule of algebraic conservation of fermions, which states that fermions are produced or disappear in particle–antiparticle pairs, requires the ν_- of equation (1) to be named 'antineutrino', since it is emitted with a negative electron. The identity or non-identity of the neutrino, ν_+, and the antineutrino, ν_-, although of no observable significance in single beta decay, should be amenable to test by measurement of the decay constant for double beta decay of certain shielded isotopes. This process was studied theoretically by M. Goeppert-Mayer[10] for the case in which neutrinos are not identical with antineutrinos and by Furry[11] for the case in which the two neutrinos are identical, as proposed by Majorana[12]. Double beta decay is typified by the possible decay of neodymium-150:

$$^{150}\text{Nd} \rightarrow {}^{150}\text{Sm} + 2\beta^{-} + 2\nu_{-} \text{ (Dirac–Mayer)} \qquad (4a)$$

$$^{150}\text{Nd} \rightarrow {}^{150}\text{Sm} + 2\beta^{-} \text{ (Majorana–Furry)} \qquad (4b)$$

If the neutrino and antineutrino are identical, then the virtual emission of one neutrino and its immediate re-absorption by the nucleus are equivalent to the real emission of two neutrinos, and equation (4*b*) is applicable. This cancellation is not possible if the neutrino and antineutrino differ. The half-lives for processes such as equation (4) have been shown by Primakoff[13] and by Konopinski[14] to be quite different in the two cases, of the order 10^{19} years for equation (4*a*) and 10^{15} years for equation (4*b*), where 5·4 MeV. is available for the decay. Furthermore, a line spectrum for the total energy of the two beta particles is to be expected for the Majorana–Furry case (equation 4*b*).

That a decay period consistent with equation (4*b*) does not exist has been shown for a number of shielded isotopes[15], first by Kalkstein and Libby, then by Fireman and Schwartzer for tin-124; by Awschalom for calcium-48; and our associates and us for neodymium-150. In the neodymium-150 experiment, a lower limit of 4×10^{18} years (corresponding to one standard deviation in the background) was set on the mean life against Majorana–Furry decay. This limit is to be compared with a reasonable value on this hypothesis of $1 \cdot 3 \times 10^{15}$ years and one calculated for identical neutrinos (using most severe assumptions) to be 6×10^{17} years. The conclusion remains that the neutrino and antineutrino are distinct particles with an as yet undetected 'difference'. This conclusion is further supported by the negative results of an experiment recently reported by R. Davis[16] employing the reaction:

$$^{37}\text{Cl} + \nu_{+} \rightarrow {}^{37}\text{A} + \beta^{-} \qquad (5)$$

The chlorine target was supplied by 1,000 gallons of carbon tetrachloride placed near a large reactor, and the liquid was tested for the presence of argon-37. Fission fragments, being rich in neutrons, should emit only the antineutrino, ν_{-}.

While careful reasoning from experimental evidence gathered about all terms in the beta-decay process—except the neutrino—may support the inference that a neutrino exists, its reality can only be demonstrated conclusively by a direct observation of the neutrino itself. If the neutrino is a real particle carrying the missing energy and momentum from the site of a beta decay, then the discovery of these missing items at some other place would demonstrate its reality. Thus, if negative beta decays as in equation (1) could be associated at another location with the inverse reaction:

$$\nu_{-} + p^{+} \rightarrow \beta^{+} + {}^{0}n \qquad (6)$$

which is observed to occur at the predicted rate, the case would be closed. An expression for this reaction cross-section has been obtained by application of the principle of detailed balancing to equation (1), knowing the decay constant and electron energy spectrum for the beta decay of free neutrons:

$$\sigma = \left(\frac{G^2}{2r}\right)\left(\frac{\hbar}{mc}\right)^2\left(\frac{p}{mc}\right)^2 \frac{1}{(v/c)} \text{ (cm.}^2\text{)} \qquad (7)$$

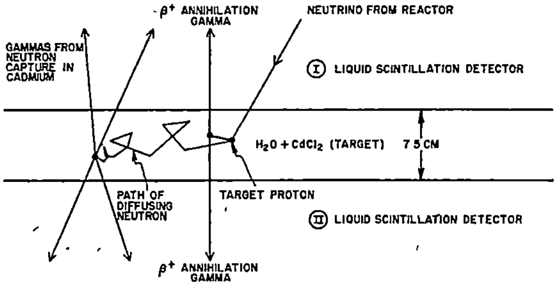
where σ is the cross-section in cm.^{2}; G^2 ($= 44 \times 10^{-24}$) is the dimensionless lumped beta-coupling constant based on neutron decay[9]; and p, m and v are the momentum, mass and speed of the emitted positron, respectively c is the speed of light, and $2\pi\hbar$ is Planck's constant, all in c.g.s. units. For neutrinos of 3-MeV. energy incident on free protons, this cross-section is 10^{-43} cm.^{2}. Explicit solution of equation (6) for the cross-section as a function of the neutrino energy yields:

$$\sigma = 1 \cdot 0 \times 10^{-44} \times (E - a) \sqrt{(E-a)^2 - 1} \text{ (cm.}^2\text{)} \qquad (8)$$

where $a + 1$ ($= 3 \cdot 53$) is the threshold for the reaction and E is the neutrino energy, both in units of $m_e c^2$. The threshold for a proton bound in a nucleus is higher by an amount equal to the energy difference between the target and daughter nuclei. It is interesting to note that the penetrability of matter is given by equation (8) to be infinite for neutrinos with low energies ($E < a + 1$) and is very large for neutrinos of only a few MeV., the mean free path for absorption being measured in the latter case in terms comparable to the radius of the universe.

Equation (6) may be employed in an experiment in which a large number of hydrogen atoms are provided as targets for an intense neutrino flux and are watched by a detector capable of recording the simultaneous production of a positron and a neutron. Such a direct experiment is made possible by the availability of high beta-decay rates of fission fragments in multi-megawatt reactors and advances in detection techniques through the use of liquid scintillators. An estimate of the neutrino flux available from large reactors shows that a few protons should undergo reaction (6) per hour in 50 litres of water placed near the reactor. The problem, then, is to observe these events with reasonable efficiency against the background of reactor neutrons and gamma-rays, natural radioactivity and cosmic rays. In an experiment conducted at the Hanford Plant of the Atomic Energy Commission by us[17] in 1953, an attempt was made in this direction. The target protons were supplied by 300 litres of liquid scintillator (toluene plus trace amounts of terphenyl, and alpha-naphtha-phenyloxayole in which cadmium propionate was dissolved). A delayed coincidence-rate of pairs of pulses, the first of each pair being assignable to the positron and the second to a neutron capture in cadmium, of 0·4 ± 0·2 counts per minute was observed, in agreement with the predicted rate, and with a large reduction in the backgrounds mentioned above. The signal-to-total-background ratio, however, was still very low (1/20), rendering further testing of the signal impractical and leaving the results tentative. On the basis of the Hanford experience it was felt that the detection problem was soluble in a definitive manner, and a second experiment was designed[18] with the view of further reduction of backgrounds and providing means for checking each term of equation (6) independently.

Fig. 1 is a schematic diagram of the detection scheme employed in this experiment. The sequence of events pictured is as follows: a neutrino from the decay of a fission fragment in a reactor causes a target proton to be changed into a neutron with the simultaneous emission of a positron. The positron is captured by an electron in the target water, emitting two 0·51-MeV. annihilation gamma-rays, which are detected simultaneously by counters I and II. The neutron moderates and diffuses for several micro-



β^+ ANNIHILATION GAMMA
NEUTRINO FROM REACTOR
GAMMAS FROM NEUTRON CAPTURE IN CADMIUM
Ⓘ LIQUID SCINTILLATION DETECTOR
$H_2O + CdCl_2$ (TARGET)
7·5 CM
PATH OF DIFFUSING NEUTRON
TARGET PROTON
Ⓘⓘ LIQUID SCINTILLATION DETECTOR
β^+ ANNIHILATION GAMMA

Fig. 1. Schematic diagram of neutrino detector

seconds and is finally captured by the cadmium giving a few gamma rays (totalling 9 MeV.), which are again detected by I and II. Thus we have a prompt coincidence followed in several microseconds by a second prompt coincidence, providing a very distinctive sequence of events.

The over-all size of the equipment was set by the number of events expected per hour per litre of water, and the detection efficiency one could hope to achieve. A primary factor in the design geometry and detection efficiency was the absorption of the positron annihilation radiation by the target water itself. Experimentation and calculations showed that an optimum water thickness was 7·5 cm. Since the over-all efficiency dictated a target volume of about 200 litres to yield several counts per hour, two target tanks were used, each measuring 1·9 m. × 1·3 m. × 0·07 m. The depth of the liquid scintillation detector (61 cm.) was such as to absorb the cadmium-capture gamma-rays with good efficiency and transmit the resultant light to the ends of the detector with minimal loss. The scintillating liquid (triethylbenzene, terphenyl and POPOP wave-length shifter) were viewed from the ends of each detector tank by 110 5-in. Dumont photomultiplier tubes, a number determined primarily by the amount of light emitted in a scintillation. The complete detector consisted of a 'club sandwich' arrangement employing two target tanks between three detector tanks, comprising two essentially independent triads which used the centre detector tank in common. The entire detector was encased in a lead–paraffin shield and located deep underground near one of the Savannah River Plant production reactors of the United States Atomic Energy Commission. Signals from the detectors were transmitted via coaxial cables to an electronics trailer located outside the reactor building. The pulses were analysed by pulse-height and time-coincidence circuits and, when acceptable, were recorded photographically as traces on triple-beam oscilloscopes. Fig. 2 is a record of an event in the bottom triad. The entire system was calibrated using a plutonium–beryllium neutron source and a dissolved copper-64 positron source in the target tanks; and standardized pulsers were used to check for stability of the electronics external to the detector itself. The response of the detector to cosmic ray μ-mesons was also employed as a check on its performance. After running for 1,371 hr., including both reactor-up and reactor-down time, it was observed[19] that:

(1) A signal dependent upon reactor-power, 2·88 ± 0·22 counts/hr. in agreement with the predicted[20] cross-section (6×10^{-44} cm.^{2}), was measured with a signal-to-reactor associated accidental background in excess of 20/1. The signal-to-reactor independent background ratio was 3/1.

(2) Dilution of the light water solution in the target tank with heavy water to yield a proton density of one-half normal caused the reactor signal to drop to one-half its former rate. The efficiency of neutron detection measured with the plutonium–beryllium source was unchanged.

(3) The first pulse of the pair was shown to be positron annihilation radiation by subjecting it to a number of tests: its spectrum agreed with the spectrum of positron annihilation radiation from copper-64 dissolved in the water, and it was absorbed in the expected manner by thin lead sheets inserted between the target tank and one detector.

(4) The second pulse of the pair was identified as due to the capture in cadmium of a neutron born simultaneously with the positron by virtue of its capture-time distribution as compared both with calculations and observations with a neutron source. The second pulse spectrum was consistent with that of cadmium-capture gamma-rays, and removal of the cadmium resulted in disappearance of the reactor signal.

(5) Reactor-associated radiations such as neutrons and gamma-rays were ruled out as the source of the signal by two kinds of experiment. In the first, a strong americium–beryllium neutron source was placed outside the detector shield and was not only found very inefficient in producing acceptable delayed coincidences but was also found to produce a first-pulse spectrum which was unlike the required signal in that it was monotonically decreasing with increasing energy. In the second experiment an additional shield, which provided an attenuation factor of at least 10 for reactor neutrons and gamma-rays, was observed to cause no change in the reactor signal outside the statistical fluctuations quoted in (1).

Completion of the term-by-term checks of equation (6) thus demonstrated that the free neutrino is observable in the near vicinity of a high-power fission reactor.

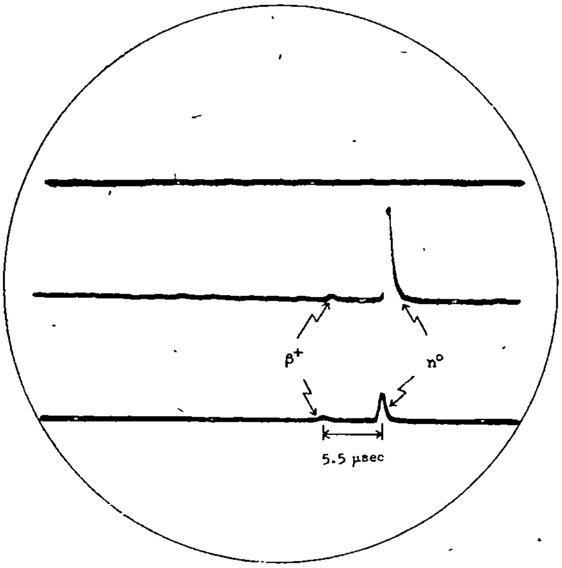


Fig. 2. A characteristic record. Each of the three oscilloscope traces shown corresponds to a detector tank. The event recorded occurred in the bottom triad. First seen in coincidence are the 'positron' annihilation gamma-ray pulses in each tank followed in 5·5 μsec. by the larger 'neutron' pulses. The amplification was chosen in this case to enable measurement of the neutron pulses. A second oscilloscope with higher amplification was operated in parallel to enable measurement of the positron pulses

The availability of neutrinos from reactors in sufficiently intense fluxes has opened a number of interesting possibilities. One arises from the use of heavy water to dilute the proton target as described above. This test was valid because the threshold for the neutrino interaction with the deuteron is higher by 2·2 MeV., the binding energy of the deuteron, than the threshold energy for equation (6), and the cross-section is for this reason an order of magnitude smaller; other considerations reduce it still further. The neutrino–deuteron interaction is itself, however, of interest, as two alternatives arise:

$$\nu_- + D \rightarrow \beta^+ + n + n \qquad (8a)$$

$$\nu_- + D \rightarrow \beta^+ + n_2 \qquad (8b)$$

where n_2 is the bound state of the bineutron[21], as yet unobserved. If reaction (8*a*) were observed to occur, then a careful measurement of its rate relative to the rate of reaction (6) and a knowledge of the fission neutrino spectrum should enable a direct determination of the ratio of the Fermi and Gamow–Teller coupling constants in beta decay. This follows from the fact that the coupling constant in equation (6) includes a mixture of both types, whereas in (8*a*) it is composed of the Gamow–Teller constant alone. If, on the other hand, equation (8*b*) were observed, not only would these considerations hold, but also the existence of a bound state of the bineutron, which would necessarily be a singlet state (antiparallel spins) because of the Pauli exclusion principle, would bear directly on the question of the dependence of nuclear forces on charge. This follows because the singlet state of the (n, p) system is known to be unbound. As the two neutrons in equation (8*a*) can possess only a few kilovolts of energy when produced by fission-fragment neutrinos, and as they leave the event in antiparallel spin states, the conditions seem favourable for the formation of bineutrons, even if the binding energy were only tens of kilovolts.

Since the proposal of the neutrino hypothesis by Pauli and its success in Fermi's theory of nuclear beta decay, the particle has been called upon to play similar parts in the observed decay of a number of different mesons[22]. The question arises as to the identity of these neutrino-like particles with the neutrino of nucleon decay. It is to be noted that in nuclear beta decay the initial and final nuclei both quite obviously interact strongly with nuclei. This is not the case in (π, μ) decay, where the emission of a 'neutrino' converts the interaction of the heavy particles with nuclei from strong to weak. Furthermore, despite the apparent equality of the nuclear beta-decay matrix elements with those associated with (μ, β) decay, both the initial and final products of the latter interact weakly with nuclei.

The neutrino is the smallest bit of material reality ever conceived of by man; the largest is the universe. To attempt to understand something of one in terms of the other is to attempt to span the dimension in which lie all manifestations of natural law. Yet even now, despite our shadowy knowledge of these limits, problems arise to try the imagination in such an attempt. If nuclear reactions played a part in a cataclysmic birth of the universe as we assume, what fraction of the primordial energy was quickly drained into the irreversible neutrino field? Are these neutrinos—untouched by anything from almost the beginning of time—trapped by the common gravitational field of the universe, and if so, what is their present density, their energy spectrum and angular distribution? Do neutrinos and antineutrinos exist in equal numbers? If the neutrino has zero rest mass, is it to be considered with 'matter' particles in discussing its gravitational potential, or with electromagnetic radiation? The problem of detecting these cosmic end-products of all nuclear energy generation processes and the measurement of their characteristics presents a great challenge to the physics of to-day.

The known properties of the neutrino are summarized below.

PROPERTIES OF THE NEUTRINO

Spin: $1/2\hbar$.
Mass: $< 1/500$ electron mass, if any.
Charge: 0.
Magnetic moment: $< 10^{-}$ Bohr magneton
Cross-section for reaction: $\nu_- + p^+ \rightarrow \beta^+ + n^0$ at 3 MeV. $= 10^{-43}$ cm.^{2}.
Neutrino ν_+ not identical with antineutrino ν_-

Our work and that of our associates reported in this paper were supported by the United States Atomic Energy Commission.

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[5] We do not attempt here to describe the many beautiful and difficult recoil experiments in which recoils of neutrino-emitting nuclei (∼ 8–200 eV.) have been measured. A summary can be found in an article by O. Kofoed-Hansen in Siegbahn's "Beta and Gamma-Ray Spectroscopy" (Interscience Publishers, Inc., New York, 1955).

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NUCLEAR COOLING

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IN various laboratories temperatures of the order of 1 millidegree above absolute zero have been reached by the magnetic cooling method using the isentropic demagnetization of an electron paramagnetic substance. The lowest temperature which may usefully be reached in this way is limited by the presence of interactions (dipole–dipole, exchange, etc.) between the electron spins. Soon after the first successful magnetic cooling experiments it was suggested[1,2] that by demagnetization of nuclear spins much lower temperatures might be reached at which the nuclear spins would become ordered.

The feasibility of nuclear demagnetization experiments was discussed in some detail in 1939 by Simon[3]. He pointed out that, in order to remove an appreciable part of the nuclear entropy, field and temperatures of the order of 50 k.gauss at 0·01° K. would be necessary.

The first step in a nuclear cooling experiment is to magnetize, that is polarize, the nuclear spins. Halban[4] directed attention in 1937 to the possible utility of oriented nuclear systems in the study of nuclear reactions, and Spiers[5] calculated the angular distribution of emissions to be expected from oriented radioactive nuclei. Since such experiments do not necessitate demagnetization, use could be made of atomic and molecular fields for orienting the nuclei. Various methods have been proposed and used experimentally; an account will be found in the review article by Ambler and Hudson published in 1955[6]. More recently, indium nuclei have been polarized using an external magnetic field by Dabbs, Roberts and Bernstein[7] (1955). From these diverse experiments information about the spins and parities of excited states of about a dozen nuclides have been obtained.

As a result of these successful applications, work on nuclear demagnetization at the Clarendon Laboratory has, since the pioneer experiment of Hatton and Rollin in 1949[8], been understandably relegated to second place. Those authors demagnetized a crystal of calcium fluoride from a field of 4,000 gauss at 1·2° K. to 500 gauss. The temperature of the fluorine nuclear spin system was deduced from the strength of a nuclear resonance signal, and was observed to fall to 0·17° K., rising to 1·2° K. with a relaxation time (spin–lattice) of 60 sec. In their experiment, however, the entropy removed from the nuclear spin system was extremely small (10^{-4} per cent) compared with the entropy content of the lattice, and so no appreciable cooling of the system as a whole could result. The same consideration also applies to the ingenious series of experiments described in 1951 by Pound, Purcell and Ramsey[9].

More recently, interest has been renewed in the problem, and we have made some progress towards the realization of our aim, which is to effect an appreciable reduction of entropy in a nuclear spin system by an external magnetic field, and so to obtain information about nuclear interactions in solids by measuring the temperature reached on subsequent demagnetization.

Nuclear cooling involves the following steps. The nuclear paramagnetic substance is magnetized in a large field and the heat of magnetization absorbed by a thermal sink at 0·01° K. or thereabouts. The field is then reduced to zero, when if the process occurs adiabatically the nuclear spins cool to a temperature determined by the initial temperature, the applied field and the nuclear interactions.

A heat sink at 0·01° K. can only be an electron paramagnetic material which has been previously demagnetized (from a few tens of k.gauss at about 1° K.) to practically zero field. It must necessarily be some way away from the nuclear specimen if the latter is to be magnetized. Daniels[10] has designed a water-cooled solenoid capable of producing fields adequate for nuclear demagnetization and so arranged that, 23 cm. away from the centre of the coil, the field is reduced to less than 0·1 per cent over a region large enough to accommodate the heat sink. This magnet was used in the experiments to be described.

In order for the heat of magnetization of the nuclei to be transferred to the heat sink in a reasonable time (say, less than half an hour), it is first of all necessary that the nuclear spin–lattice relaxation time be short enough. This is most easily achieved by using a metal, since it is known[8,11] that in metals this time is of the order of seconds at 1° K. and can be expected to be of the order of minutes at 0·01° K.

It is, however, essential, if a metal is used, to take precautions to prevent eddy-current heating of the specimen due to ripple fields and to the changing flux on demagnetization. The former can be avoided to a certain extent by using a very smooth d.c. source to energize the magnet and by placing a thick copper screen around the cryostat. The latter can only be avoided by subdividing the specimen into a large number of insulated segments. To indicate the importance of these precautions: the total heat of nuclear magnetization for a solid copper cylinder 1 cm. in diameter and 5 cm. long in a field of 30 k.gauss at 0·01° K. is of the order of 10^3 ergs, while the heat generated in the cylinder during the reduction of this field to zero in two minutes is about one hundred times this value.

Kurti[12] has discussed various types of heat link, and concluded that a copper link of reasonable dimensions would give adequate heat transfer. Copper is not only readily available as thin insulated wire but also has desirable nuclear properties (see, for example, ref. 3). It is therefore convenient to use copper both in the heat link and in the nuclear stage itself. The latter can then be made simply as an extension of the link.

Heat transfer from the link to the paramagnetic salt constituting the sink, and stray heat influxes to the specimen, have been the two major stumbling blocks in this research.

It is known[13,14] that the heat flow between copper fins and a pressed paramagnetic salt in contact over the macroscopic area A can be expressed by the equation:

$$\dot{Q} = \alpha A(T_1^3 - T_2^3) \qquad (1)$$

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* English Electric Research Fellow.

where T_1 and T_2 are the temperatures on the two boundary surfaces, and α is of the order of 10^3 ergs cm.$^{-2}$ deg.$^{-3}$ sec.$^{-1}$. Since we wished to transfer quantities of heat of the order of 1,000 ergs in a few minutes at about 0·01° K., it is clear that the area of contact must be several hundred square centimetres. Early attempts by Robinson to achieve such a heat transfer using powdered chrome potassium alum compressed about copper fins or wires failed. It was comparatively easy to achieve areas of contact of the order of 10–50 cm.^{2} which were adequate at temperatures above 0·1° K., but it was found mechanically impossible to increase this area greatly. Robinson[15] found, however, that if the alum were made into a slurry with a mixture of glycerol and water, it was possible to obtain the same degree of thermal contact as is represented by equation (1) *without* applying pressures. It is then feasible to make an assembly of a paramagnetic salt having a relatively complex fin or wire system embedded in it and thus to obtain a large area of contact. Using this technique, Kurti and Spohr have constructed a specimen and used it in the experiment now to be described. (This experiment constitutes part of a D.Phil. dissertation to be presented by D. A. Spohr to the University of Oxford.)

A photograph of the specimen and cradle is reproduced in Fig. 1, together with a schematic diagram of the essential features. The heat link connecting the top and bottom pills consists of 1,540 enamelled copper wires (40 S.W.G.) embedded uniformly at their top ends over the cross-section of a glycerol-chrome potassium alum slurry (of about 16 gm.) enclosed in a 'Perspex' container. The contact area between the metal and the slurry was calculated to be 400 cm.^{2}. At the lower ends the wires are folded over four times in a length of about 7 cm. to form the nuclear 'specimen', which thus contains approximately 0·75 gram atom of copper.

In this preliminary experiment, no heat switch was used between the stages. The contact resistance between the link and the paramagnetic salt, together with the expected spin–lattice relaxation time, made it possible to measure nuclear temperatures after demagnetization and before the nuclear system warmed again to the temperature of the heat sink, a process which took two to three minutes.

The assembly shown in the photograph was mounted inside a loosely suspended 'capsule' consisting of a double-walled brass tube, the top part of which contained 25 gm. of manganous ammonium sulphate, cooled by demagnetization at the same time as the chrome alum pill. The bottom part of the capsule surrounding the nuclear stage was kept in good thermal contact with the manganous salt by means of liquid helium and by thin copper wires running longitudinally between the brass walls. The purpose of the capsule was to reduce stray heat influxes into the system due to vibration, gas recondensation and conduction down the glass suspensions. Prior experiments with the capsule and with a specimen in which the folded-up nuclear stage was replaced with a pill of cerium magnesium nitrate (used as a magnetic thermometer) indicated that the heat influx to the bottom of the link was about 1 erg per min. The same experiments also showed that 10 min. after demagnetization of the heat sink, the lower end of the heat sink had reached 0·011° K. From the slope of the cooling curves and the known heat capacity of the cerium salt, it was possible to deduce that the heat transfer between the salts and the link was approximately that predicted by equation 1.

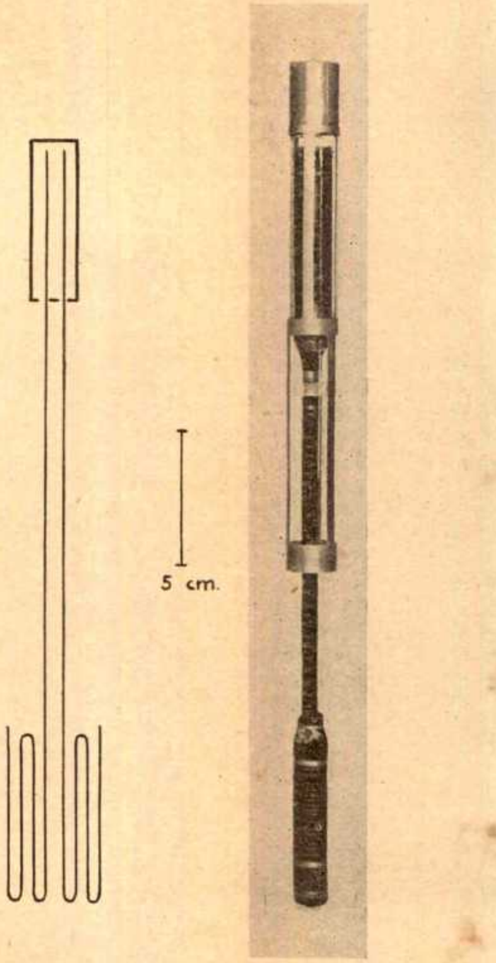

Fig. 1. Heat sink, heat link and nuclear specimen in cradle

The temperature of the nuclear spin system was obtained from ballistic measurements of its susceptibility, assuming that the latter obeyed Curie's law. The calibration of the system was calculated from the theoretical nuclear susceptibility of copper ($\chi = \frac{3 \cdot 74 \times 10^{-7}}{T}$ per gram atom) and from the sensitivity of the measuring circuit. This was determined by measurements at liquid-hydrogen temperature of a specimen of manganous ammonium sulphate of the same size as the nuclear stage. The sensitivity can be expressed by the equation :

$$\delta_N = 3 \cdot 4 \times 10^{-5}/T \text{ cm.} \qquad (2)$$

for a reversal of the primary field of 7·8 gauss.

Unfortunately, it was not also possible to calibrate the ballistic system in the conventional way by observing the galvanometer deflexion at various known temperatures above 0·01° K. This was partly because of the extremely small value of the nuclear susceptibility in this calibration range, and partly because *at these temperatures* the nuclear susceptibility is masked by a susceptibility probably arising from paramagnetic impurities in the copper wire (cf. ref. 16), and insulation. The interpretation of the ballistic measurements is also complicated by the proximity of a large mass of paramagnetic material in the heat sink and capsule. The effect of this and of the paramagnetic impurities on the measured susceptibility was determined by a control experiment in which the nuclear stage was located outside the influence of the primary field.

In the nuclear cooling experiment, the electronic stage (sink) was first cooled by demagnetization from approximately 1° K. and 20 k.gauss to about 0·01° K. The nuclear stage was then slowly magnetized in fields of up to 28 k.gauss. The resulting reduction of entropy for this field was about 1 per cent of the total nuclear entropy of 2·8 cal./deg./gram atom. The field was maintained at its full value for various times ranging from 5 to 20 min. and then reduced to zero at a rate of between one-half and one k.gauss per sec. Readings of the ballistic deflexion were taken at about 10-sec. intervals starting some 13 sec. after the field had reached zero.

Fig. 2 shows the deflexion δ_N obtained for a field reversal of 7·8 gauss as a function of the time after complete demagnetization. The corresponding values of T calculated by equation 2 are also indicated. The different curves correspond to different values of the initial field as given in Table 1. By extrapolating these curves back to zero time, an estimate of the magnetic temperature reached immediately after demagnetization can be obtained. It will be seen that, using the largest field, this is about 20×10^{-6} °K.

It has already been mentioned that paramagnetic impurities might contribute a susceptibility of the same order as that due to the nuclei. It is, nevertheless, unlikely that the large relative changes in susceptibility after demagnetization could be due to that cause. For such large deflexions to occur, the electron paramagnetic would have to behave very nearly ideally, and even then one would not expect any appreciable change in the entropy (that is, a further increase in deflexions) for values of H/T larger than about 50 k.gauss per deg. (The difference in heat of magnetization for a gram atom of a perfect electron paramagnetic between $H/T = 300$ and $H/T = 2{,}300$ kgm./deg. is 10^{-9} ergs at 0·012° K.) Fig. 2 shows, however, that progressively lower temperatures were reached for values of H/T of up to 2,300 k.gauss per deg.

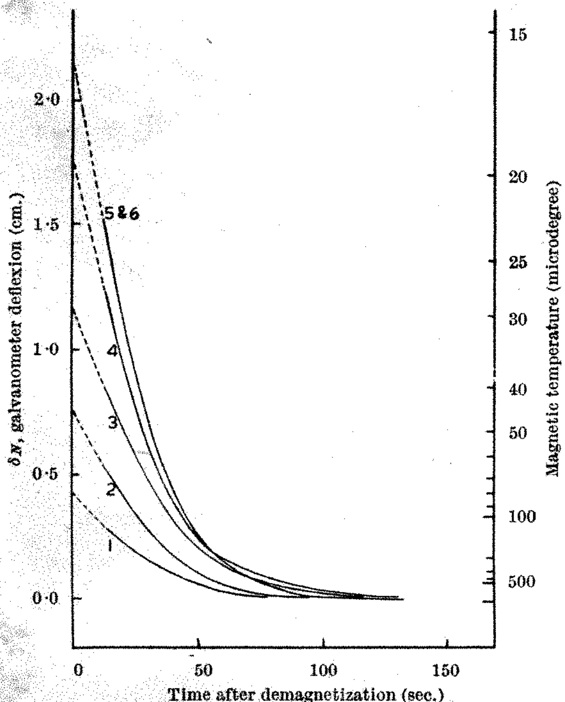

Fig. 2. Ballistic deflexion and temperature of nuclear stage after demagnetization

As it can be assumed that Curie's law is obeyed even at the lowest temperatures during this experiment, then one can estimate the magnitude of the temperature θ_N characterizing the nuclear interactions[8]. If T_i is the initial temperature, H_i the field before demagnetization, and T_f the temperature reached immediately upon demagnetization, then θ_N is given by:

$$\theta_N = T_f \frac{\mu H_i}{kT_i} \tag{3}$$

where μ is the nuclear moment. Assuming that $T_i = 0{\cdot}012°$ K., and using the dotted line extrapolations in Fig. 2 to estimate T_f, one obtains the values given in Table 1 for the different curves shown in Fig. 2.

Table 1

No of curve.	1	2	3	4	5	6	
Initial field	3·48	6·95	10·4	13·9	20·9	27·8	k.gauss
$\theta_N \times 10^6$	1·94	2·18	2·11	1·87	2·26	3·00	

It will be seen that the results are in rough agreement from run to run. The average value of θ_N, namely, $2{\cdot}3 \times 10^{-6}$ °K., may be compared with the calculated value for the temperature of the nuclear co-operative anomaly in copper (4×10^{-6} °K.) given by the theory of Fröhlich and Nabarro[17].

From the present experiment it is not possible to decide whether the conduction electrons and the lattice also participate in the cooling. The rate of warming up is compatible with both the estimated nuclear spin–lattice relaxation time and the heat transfer coefficient between the nuclear stage and the heat sink. There are two arguments in favour of the hypothesis that the electrons participate in the cooling process, and thus, that there is a thermal equilibrium established in the whole specimen (the lattice in any event has a negligible thermal capacity). One is that if the cooling and subsequent warming up were due to nuclear spins only, then δ_N (or $1/T$) would be a linear function of time by virtue of the dependence of the nuclear specific heat on $1/T^2$. As can be seen from Fig. 2, that is not so (at least at the higher temperatures) and the curves indicate a heat capacity increasing with temperature. Further, the mechanism which produces the co-operative anomaly considered by Fröhlich and Nabarro involves the participation of the electron spins. If that were not the case, the expected anomaly would occur at a much lower temperature ($\sim 10^{-7}$ °K.) in contradiction to the value estimated from these results.

These experiments have shown that by using nuclear demagnetization one can reach temperatures below those accessible with electron paramagnetics. They also furnish direct evidence of the interactions between nuclei in metals. We have therefore thought it worth while to describe these first exploratory experiments, which we hope in due course to improve by the use, for example, of a heat switch, and also to extend to materials other than copper. It should be emphasized that the importance of this type of experiment is not so much in the lowness of the temperature achieved, but rather in the information we may hope to gain about the behaviour of nuclear spins in solids and their interaction with their environment.

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BIOLOGICAL HAZARDS OF NUCLEAR AND OTHER RADIATIONS

By Dr. C. AUERBACH

THE dangers of ionizing radiation to human health have long been recognized by a small circle of experts. The early radiologists had to pay a tragic toll of death and disease for their ignorance of the cellular damage caused by radiation, and geneticists, foremost among them Muller, have for many years warned against the much less obvious, but in no way less real, danger to future generations. Only during the past year or two has a wide public become disturbed about the biological effects of ionizing radiation because of their connexion with nuclear fission. Fantastic over- and under-estimates of these effects have appeared in the popular press and have been used as ammunition in the war of opinions between those who oppose and those who support the continuation of atom and hydrogen bomb tests. The more sober and cautious statements of the biologists themselves tend to be regarded with suspicion as being biased by political convictions. It is therefore greatly to be welcomed that authoritative digests of scientific experience and opinion have been prepared and published independently in Great Britain and the United States*. The British report has been commissioned by the Government, the American one by the National Academy of Sciences. Both have been prepared by leading authorities in physics, medicine, genetics and allied fields, the British one by a committee appointed by the Medical Research Council, the American one by six separate committees dealing with the impact of radiation on genetics, pathology, meteorology, oceanography and fisheries, agriculture and food supplies, disposal and dispersal of radioactive wastes. The American report thus covers a very wide field, including such questions as the possible influence of atomic bomb tests on the weather or the use of isotopes in agricultural and oceanographic research, while the British report, after an introductory chapter on the nature of radiation and its action on living cells, is concerned only with the proved or possible effects on the individual, his immediate progeny, and future human populations.

Although only the British report indicates in its title that nuclear fission is not the sole source of ionizing radiation, it is clear from both reports that the present dangers arise much more from excessive use of X-rays than from bomb fall-out or from atomic energy establishments. Thus, ironically, the public anxiety about nuclear weapons has resulted in reports which emphasize long-neglected dangers in medical practices. In Britain, X-ray diagnosis, mainly of hip, lumbar spine, lower abdomen and pelvis, adds at least 22 per cent and possibly much more to the average amount of natural radiation (3 r.) which the gonads receive during the genetically important period from conception to thirty years. In the United States X-rays are estimated to add 3r. to a background radiation of 4·3r. Even allowing for the facts that this figure includes therapeutic as well as diagnostic X-rays and may represent a maximum compared with the British minimum, this amazingly high contribution of X-rays to the gonad dose of the average American reflects the excessive use of X-rays in that country. Both reports agree in considering the present level of ionizing radiation due to nuclear fission as negligibly small, and in estimating that this level would rise to about 1 per cent of the normal background radiation, if nuclear weapon testing should continue at the present rate. The formidable technical problems which even in the near future will be posed by the accumulation of radioactive waste are brought home by the forecast that in 1965 nuclear reactors in the United States will be producing somewhat more than 10 kgm. of fission products per day.

The hazards to the exposed individual himself are negligibly small when accidents or nuclear warfare are excluded. A shortened expectation of life through accumulated low doses of radiation, which is mentioned in the British report only as a hitherto unproved possibility, is suggested by American data on the comparative life-spans of radiologists and other physicians. Repeated exposure to doses which are individually harmless may increase the incidence of leukaemia, as shown by a follow-up of British patients who had received prolonged X-ray treatment for ankylosing spondylitis. The British report recommends, therefore, that no individual should receive more than 200 r. of total body radiation, spread over tens of years, and that the maximum weekly exposure, averaged over any period of thirteen consecutive weeks, should not exceed 0·3 r. Among fission products likely to be ingested only strontium-90, which is retained in the bone, may constitute a danger, but its present level is negligibly low.

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* Medical Research Council. The Hazards to Man of Nuclear and Applied Radiations. (Cmd. 9780.) Pp vii+128. (London: H.M. Stationery Office, 1956.) 5*s* 6*d*. net.
National Academy of Sciences—National Research Council. The Biological Effects of Atomic Radiation: a Report to the Public from a Study by the National Academy of Sciences. Pp. ii+40. The Biological Effects of Atomic Radiation: Summary Reports from a Study by the National Academy of Sciences. Pp. xiv+108. (Washington, D.C.: National Academy of Sciences—National Research Council, 1956.).

For a calculation of the genetically permissible dose, as distinguished from that which is harmless to the individual, new considerations become relevant. Not only is the genetical material by far the most radiosensitive part of the organism; the linear increase of mutation-rate with dose and the absence of a lower threshold make the exposure of many individuals to very small doses genetically as dangerous as that of a few individuals to large ones. There is, in fact, no innocuous dose from the genetical point of view, and the permissible dose-level has to be reached by a compromise between the immediate benefits of ionizing radiation and the damage to future generations. We still lack the data for an even moderately accurate quantitative estimate of the genetical effects of a given dose on human genes. Calculations use extrapolations from experiments on lower animals and include premises on which geneticists differ among themselves.

It is therefore encouraging to find a considerable measure of agreement between the conclusions of the British and American geneticists. Both estimate that the doubling dose, that is, the dose which would double the mutation-rate, lies most probably within the range from 30 r. to 80 r. In the final result, this dose would double the incidence of genetically caused defects; but for recessives this may take a very great number of generations. American geneticists estimate that the effect on the first generation of doubling the gonad dose would consist in an additional 200,000 cases of genetically caused tangible disabilities among 100 million births. In Great Britain, 200 more cases each of manic depressive insanity and schizophrenia and 1,500 of severe mental deficiency would be expected among the first generation of 20 million births. For hereditary traits which show continuous variation about the normal, an increased mutation-rate results in increased proportions of the extreme variants on either side of the mean; but if the trait has already been subjected to much selection towards one extreme, as is likely for human intelligence, it is mainly the minus variants which will be increased in number. The maximum dose which the British report considers tolerable from a genetical point of view is 50 r. to the gonads in excess of the natural radiation up to the age of thirty, and this should be received by not more than 1/50 of the total population. The American report recommends that records of the accumulated life-time exposure to radiation should be kept for every individual, that the average exposure of the population's reproductive cells to radiation above the natural background should be limited to 10 r. from conception to age thirty, and that individual persons should not receive a total accumulated gonad dose of more than 50 r. up to age thirty, and not more than 50 r. additional up to age forty.

In the manner of presentation the two documents differ fundamentally. The American report clearly aims at being intelligible to the general public. Full reports with technical details are being prepared and will be published at a later date. Although the various sections differ in the amount of technicalities they contain, they all state unambiguously the relevant facts, conclusions and recommendations. In particular the section on genetics is a model of popular exposition of a difficult and debatable problem. Where differences of opinion between scientists exist, these are stated; but instead of confusing the general reader with controversies, stress is laid on the points of agreement. To make quite sure that the main facts and conclusions reach the widest possible public, these are once more summarized in a brief "Report to the Public". The British report is written in a spirit of scientific humility and caution which may well leave the general reader with a feeling that it would be best not to bother much about a subject on which so little is known. There is nothing in the British report corresponding to the categorical American statements: "Any radiation is genetically undesirable", or "From the genetic point of view, they [the radiations] are all bad". Yet it is likely that the authors of the British report would agree with these statements. For the scientist, especially the geneticist, the report is highly interesting, just because it deals in great detail—partly in the form of thirteen appendixes—with the data, calculations and considerations on which the final conclusions are based. The intelligent and educated general reader who is willing to spend time and effort on understanding the report will no doubt learn very much from it; but it is to be feared that he will be in a minority, and that the general public, including our legislators, will prefer to get its information second-hand from newspaper digests which, based on a document of this nature, can scarcely fail to be one-sided or otherwise misleading, especially as the report gives little guidance for such a purpose. It seems highly desirable that a digest for the public be prepared as soon as possible by the authors of the report.

NEWS and VIEWS

Royal Botanic Gardens, Kew: Sir Edward Salisbury, C.B.E., F.R.S.

Sir Edward Salisbury, who has been director of the Royal Botanic Gardens, Kew, since 1943, is resigning from that post, having reached the age of seventy. To botanists, both in Britain and throughout the world, Sir Edward is well known, not only for his outstanding botanical work (especially on plant form, reproduction and ecology) but also for his splendid books, which include those for the specialist, those for the student and those for the layman. Through these books, Sir Edward has exerted a profound influence on the advancement of botany. For many years he has worked also for the advancement of science in general (but especially the biological sciences) through various societies of which he has been president or vice-president or secretary. For example, he was honorary secretary of the British Ecological Society during 1917–32 and its president in 1928. He has been president also of several other scientific societies.

Sir Edward Salisbury has been one of the pillars of the Royal Society for many years. During 1945–55 he was the biological secretary and was vice-president in 1943 and during 1948–55. In both these capacities his exceptional gift of organization has proved invaluable. This, together with the great advantage he had to offer as an adviser, has made him an outstanding vice-chairman of the Agricultural Improvement Council since 1944, a member of the Scientific Advisory Committee to the Cabinet during 1943–45, vice-president of the Royal Horticultural Society, honorary adviser to the Ministry of Labour, vice-chairman of the Committee on Colonial Agriculture and a member of the Agricultural Research Council. He is also a governor of several leading universities, agricultural and horticultural colleges and institutes. He was president of Section K (Botany) of the British Association in 1937.

All Sir Edward's earlier academic work was done in the University of London. This culminated in the Quain professorship of botany at University College from 1920 until he was appointed director of the Royal Botanic Gardens, Kew, in 1943. To such a man of many parts, honours in the form of honorary degrees and medals, too numerous to mention, came naturally. It is to be hoped that in spite of his resignation from Kew, the great services of Sir Edward to scientific advancement, exposition and training, through at least some of the many organizations which he has so actively and vigorously supported, will be available for a long time to come.

Dr. George Taylor

Dr. George Taylor, who succeeds Sir Edward Salisbury at Kew, is fifty-two years of age; he was born and educated in Scotland. From the George Herriot School, Edinburgh, he went to study at the University of Edinburgh, where he graduated with first-class honours in botany, and afterwards joined the staff of the British Museum (Natural History) in the Botanical Department, of which he became keeper in 1950 upon the retirement of Dr. J. Ramsbottom. Dr. Taylor has published extensively in the field of Phanerogamic taxonomy; but among his special botanical interests may be mentioned the Himalayan poppies, of which a former director of Kew, Sir David Prain, made a special study. Dr. Taylor published a monograph of the genus *Meconopsis* in 1934. He has also paid considerable attention to aquatic phanerogams, especially the Podostemaceae, that remarkable family of plants living on rocks in rushing water and exhibiting a wealth of morphological and ecological problems. He has taken a prominent part in various botanical expeditions, notably to Rhodesia in 1927, to the mountains of tropical East Africa in 1934, and to Tibet and Bhutan in 1938. He is also a keen and able horticulturist, which was recognized by the award to him this year of the Victoria Medal of Honour of the Royal Horticultural Society. Apart from his work at the British Museum, Dr. Taylor has had considerable administrative experience as botanical secretary of the Linnean Society since 1950, and as one of the general secretaries of the British Association since 1951. Dr. Taylor thus brings to his new duties a record of successful pursuit of three aspects intimately associated with his fresh responsibilities.

British Museum (Natural History): Keeper of Botany

The Principal Trustees of the British Museum have appointed Mr. James Edgar Dandy to succeed Dr. George Taylor as keeper of botany. Mr. Dandy was educated at Preston Grammar School and Downing College, Cambridge. He started his botanical career in the Herbarium at the Royal Botanic Gardens, Kew, where he came under the stimulating influence of Dr. John Hutchinson. In 1927 he was appointed assistant keeper in the British Museum (Natural History) and was placed in charge of the Monocotyledons and Gymnosperms. He is a recognized world authority on Monocotyledons; but his interests have not been confined to that group. He is engaged on monographic studies of the Magnoliaceae and several groups of the aquatic Monocotyledons (including the genus *Potamogeton* in collaboration with Dr. George Taylor). He has almost completed a Flora of Antigua and Bermuda and is compiling a list of the plants of the Anglo-Egyptian Sudan. Mr. Dandy has taken a prominent and decisive part in the legalistic realm of plant nomenclature, and is a member of a number of international committees dealing with this subject. So far, his published work has been confined to treatments of genera or families preliminary to more detailed monographic surveys; but, under his editorship, two very important works will shortly appear. These are the Catalogue of the Sloane Herbarium to be published by the Trustees of the British Museum, which contains the most extensive botanical collections of the seventeenth and eighteenth centuries, and a Check List of the British Flora to be sponsored jointly by the British Museum and the Botanical Society of the British Isles.

Nature Conservancy: Dr. E. B. Worthington

Dr. E. B. Worthington, who has recently completed his term of office as secretary-general of the Scientific Council for Africa South of the Sahara, has been appointed as deputy director-general (scientific) of the Nature Conservancy and will take up his duties on September 17. After graduating in zoology from the University of Cambridge, Dr. Worthington was Balfour Student there during 1930–33 and took part in, or was leader of, two expeditions to the great African lakes, making a number of contributions to ichthyology and hydrobiology. At that time, in collaboration with his wife, he wrote a general book on African inland waters. In 1934, while demonstrator in zoology at Cambridge, he became a scientist on Lord Hailey's African Survey and, on its completion in 1937, was appointed the first director of the Freshwater Biological Association, Windermere. For two years at the end of the Second World War, Dr. Worthington was an adviser to the Middle East Supply Centre, conducting a survey of scientific work in the Middle East countries, and then in 1946 he joined what afterwards became the Research Branch of H.M. Overseas Service; he spent some years in East Africa preparing a development plan for Uganda and organizing inter-territorial scientific services. On the formation of the Scientific Council for Africa South of the Sahara in 1950 he was appointed secretary-general, and has spent the past year in writing a book on the contribution of science to the development of Africa. Besides his many papers, Dr. Worthington, who is fifty-one years old, has written a number of books, mainly on African inland waters and fisheries. He thus brings to the Nature Conservancy a varied experience in biological research and in the application of science to the conservation and use of land and water.

Royal Agricultural Society of England Medal : Dr. G. D. H. Bell

THE Royal Agricultural Society's Medal "for research work of outstanding merit carried out in the United Kingdom which has proved, or is likely to prove, of benefit to agriculture" has been awarded to Dr. G. D. H. Bell, director of the Plant Breeding Institute, Cambridge. Bell's success as a plant breeder is not unrelated to his wide knowledge of plant husbandry and his ability to anticipate agricultural developments. In 1943, at the time when autumn-sown cereal crops were gaining favour, he introduced his two-row winter-hardy Pioneer barley, a variety that represented a new departure in malting barleys. Then came the six-row winter type Prefect of reasonably good malting quality. Prefect was followed by Proctor, a barley that combines to a very considerable extent malting quality and responsiveness to intensive cultural treatment. This variety, coming at the time it did, offered at least a partial solution to the mounting conflict between the brewer who looks for malting quality, and the farmer who wants yield and is aware of the potentialities of some modern varieties under liberal manuring. The next of Bell's barleys, Provost, perhaps carries this reconciliation a stage further, for here we have a variety which in malting tests has given a higher average extract than Proctor. Another of his products is the Minerva Maple pea.

While these new varieties represent the more tangible expressions of Bell's contribution to British agriculture, his work on breeding techniques, particularly his investigations in the Triticinae involving the study of interspecific and intergeneric hybrids, their disease reactions and the cytology and fertility of F_1 hybrids and derived amphidiploids, has materially added to the store of information fundamental to future progress. Incidentally, it is work of this kind that emphasizes the futility of attempting to draw a line separating the 'pure' and 'applied' sides of science; indeed, progress demands that research goes hand-in-hand with the application of available knowledge. Dr. Bell has made numerous contributions to the literature of plant breeding, and he is well known to the agricultural reader for his able articles entitled "Crops and Plant Breeding" that are a feature of the *Journal of the Royal Agricultural Society.*

Woods Hole Oceanographic Institution

REAR-ADMIRAL EDWARD H. SMITH has retired from the directorship of the Woods Hole Oceanographic Institution, having reached the age-limit, and has been succeeded by Dr. Columbus O'D. Iselin, senior oceanographer in the Institution and associate professor of physical oceanography in Harvard University. During his six years as director, Admiral Smith has expanded both the shore and ship laboratories and equipment of the Institution and broadened its interests. It was largely due to his efforts that the research vessel *Crawford* was acquired recently for studying the formation of hurricanes (see *Nature,* August 18, p. 349, and July 28, p. 181). His successor, Dr. Iselin, has been with the Institution since its inception in 1930. A former student of Dr. H. B. Bigelow, he started his oceanographical career on an expedition to Labrador in his own schooner *Chance* in 1926. In 1931 he took command of the research vessel *Atlantis* on her first cruise in the North Atlantic after the ship was built in Denmark. Dr. Iselin served as director of the Institution during the Second World War and resigned in 1950 to devote more time to scientific studies. For his work for the United States Navy on the application of science to undersea warfare, he was awarded in 1948 the Legion of Merit. In 1951 he received the Agassiz Medal of the U.S. National Academy of Science.

The Functions of the Press Council

THE broadsheet, "Performance of the Press", recently issued by Political and Economic Planning (22, No. 397; pp. 20; 2*s.* 6*d.*), considers three aspects: current criticisms of the Press; the Press Council and its objects; and the functions of the Council. In considering the first, P E P does not specifically consider the reporting of science, but notes that the tastes and attitudes of readers govern the nature of the Press at least as firmly as the Press moulds the opinions of the public. After reviewing the work of the Press Council during the three years of its existence, P E P points out that the purposes of the Council, as envisaged by the Royal Commission and adopted in the Council's objects, cover three different functions: as an institute; as a trade association; and as a tribunal. It seems clear that the present basis of the Press Council is too narrow to allow it to carry out the institutional aspects of its work satisfactorily. Its aspects as a trade association include such matters as newsprint, recruitment and training, labour relations, and productivity, some of which are already dealt with by other means, and it appears that most members of the Council consider that the Council should not concern itself with these affairs. P E P notes particularly the importance of the training of journalists, suggesting that the whole subject of education, recruitment and training of journalists deserves a study by itself. The Press Council has, however, concentrated its attention on its function as a tribunal, dealing with points of conduct in a quasi-judicial capacity. It has provided a possibility of appeal both for the public and for journalists themselves and must have made many people think twice before leaving the way open for criticism. Nevertheless, P E P considers that the Council may never develop into the kind of body envisaged in the broadsheet or by the Royal Commission unless it extends its activities, and that the next stage should be to strengthen and develop the Council to enable it to carry out all its professed objects effectively.

Duck Stamps

FOLLOWING the great droughts of the early 1930's when farmers in the 'dust bowl' of the United States were panic-stricken and in poverty, the number of waterfowl reached the lowest recorded point in American history. Soon after, the Biological Survey was set up and Government funds were set aside for the purchase and restoration of submarginal and other lands for wild life, with special emphasis on migratory waterfowl. These funds were insufficient for the national need, and the Duck Stamp Act, formally known as the Migratory Bird Hunting Stamp Act, came into being. Its purpose was to supplement and support the Migratory Bird Conservation Act by providing funds for the acquisition of areas for use as migratory-bird sanctuaries, refuges and breeding grounds, for developing and administering such areas, for the protection of certain migratory birds, and for the enforcement of the Migratory Bird Treaty Act. Since 1940 there has been little in the way of congressional appropriations specifically for the acquisition and development of lands for migratory birds, and the Duck Stamp receipts have taken on added importance. From 1935 until 1953, some 8,500,000 dollars of Duck Stamp funds were used for refuge development, and slightly more than 10 million dollars for operational maintenance. A description of the scheme and of some of the refuges which have been purchased are described in Circular 37 of the Fish and Wildlife Service of the United States Department of the Interior.

Elephants and Electric Fences

CONFLICTING views about the deterrent effects of electric fences on elephants are described in a recent issue of *Oryx* (3, No. 5; August 1956). J. A. Hislop has had unfortunate experiences with three fences in Malaya over a period of seven years and, although one fence remained undamaged for about two years, it was then breached in a number of places and was never again effective. Describing his experiences in Malaya before the War, E. O. Shebbeare found that electric fences were quite effective if they were adequately constructed and regularly patrolled. A. H. Fetherstonhaugh, who, until recently, was chief game warden of the Federation of Malaya, states that electric fences were most useful in protecting rubber estates from wild animals; elephants were difficult to deal with because of their size and sagacity but, provided they had sufficient range and adequate fodder and that electric fences were not erected across a major migration route, the fences were quite effective in preventing their passage through restricted territories.

Citrus Research

THE contemporary *Bulletin of the Research Council of Israel* (Sect. D, Botany, 5, No. 2–3; 1956) is devoted to the Fourth International Congress of Mediterranean Citriculture, held in Israel during May 1956. Among the topics discussed, and here set out in detail, were the anatomy and histology of healthy and xyloporosis-affected Palestine sweet-lime rootstocks budded to Shamouti sweet orange; rootstock–scion influences in the morphology and anatomy of the bud union of Shamouti orange; orange leaf transpiration under orchard conditions; *mal secco* of citrus in Israel and neighbouring countries; the effect of different factors on the ascorbic acid content in citrus fruits—the relationship between species and variety and the ascorbic acid content of the juice; an investigation into the process of flower and fruit abscission of the Shamouti orange; studies on the viability of citrus seeds and certain properties of their coats; toxic influences of sodium and sulphate ions on citrus seedlings.

Handbook on the Use of Chemical Weedkillers

DURING the past ten years advances in the use of chemicals for the control of weeds have been so rapid that the subject has become bewildering to the non-specialist. Successful crop production, however, now depends on the intelligent use of these chemicals, and the Recommendations Committee of the British Weed Control Council has done a most useful work in bringing out "Weed Control Handbook 1956" edited by the staff of the Agricultural Research Council Unit for Experimental Agronomy (pp. 130; British Weed Control Council, Cecil Chambers, 86 Strand, London, W.C.2; 1956; 5*s*.). Though intended primarily for the 'adviser', it is full of valuable information for the farmer, research worker or student. After classifying the weedkillers commonly used in Great Britain, Part 1 of the booklet sets out the agricultural and horticultural crops on which they may be safely used and the weeds that may be controlled by each type of chemical. The special problems connected with forest nurseries, lawns, roadside verges and woody weeds are also dealt with. Part 2 provides practical instruction on such matters as spraying procedure, the calculation of application-rates and the decontamination of the sprayer. It also contains chapters on the legal aspects of spraying and on promising new chemicals, and gives the list of approved herbicides for 1955–56 under the Crop Protection Products Approval Scheme. Tables make reference to crop or weed simple and rapid, and a clear distinction is made in the text between firm and tentative recommendations. The Committee hopes to issue a new edition of the handbook every year.

Morgan Crucible Co., Ltd., London (1856–1956)

THE Morgan Crucible Co., Ltd., of Battersea, London, which celebrates its centenary this year, has published in connexion therewith a short history of the firm, written by Richard Bennett (pp. 67+3 plates). As the chairman of the Company, Mr. P. Lindsay, points out in the prologue, Mr. Bennett does not attempt to give a detailed history of its development or to trace all the varied influences that have shaped the growth of a firm in which the tradition of family service has always been strong. The book gives a very readable account of the growth of the firm, and both the text itself and the admirably chosen illustrations relate that growth to the general pattern of industrial activity of the period. There is much in these pages that could well be used as the text for a discourse on initiative and enterprise and welfare in industry.

Grating and Quartz-Prism Polychromators

THE main article in the May issue of the *Hilger Journal* (2, No. 4; 1956) is devoted to a description of two large self-contained polychromators, the first a 3-m. grating instrument which has now been used in industry for several years, and the second a quartz-prism instrument which is announced for the first time. They serve different purposes and are not substitutes for each other. The grating polychromator is the instrument to use for analyses of highly complex alloys, and the quartz polychromator for the analysis of a wide range of alloys with different base metals. Both have four components: a source unit; discharge stand; the polychromator itself, which consists of the dispersing system and the assembly of exit slits and multipliers; and an electronic console which houses circuits for controlling the analysis and interpreting the results. The 3-m. radius concave grating in the grating instrument is ruled by Siegbahn and can be supplied to provide a dispersion of 6 A./mm. or 12 A./mm. in the first-order spectrum. The spectrum range is from about 1940 A. in the ultra-violet to about 8000 A. in the near infra-red, and the instrument takes four minutes to perform a spectrochemical analysis of a substance, printing the result on a strip of paper. The condensing system in the new prism polychromator includes a quartz biprism, and consequently the spectrometer produces two identical spectra which are separated by a long rectangular prism aluminized on two adjacent surfaces and sent to different focal surfaces where they are received by an assembly of exit slits. The quartz polychromator requires no adjustment for temperature and can accommodate thirty-six channels; but the electronic console is built in units so that the polychromator can be built up from a minimum of twelve channels by the addition of units of six.

Units and Systems of Weights and Measures in the United States

THE subject of weights and measures is of wide interest, and many requests for information on both the customary and metric systems of weights and measures are received by the United States National Bureau of Standards from teachers, students and the general public. To serve this need, the Bureau has prepared Circular 570, "Units and Systems of Weights and Measures: Their Origin, Development and Present Status", by Lewis V. Judson (pp. 29. Washington, D.C.: Government Printing Office, 1956; 25 cents), which brings together in a convenient form much of the information that was previously available in separate mimeographed leaflets. The essential differences between the British and United States systems are clearly explained. The origin and early history of units and standards are discussed; with regard to the metric system it is mentioned that, though the use of the system was legalized in the United States by Act of Congress of 1866, it was not obligatory, and at present the Bureau neither advocates nor opposes its compulsory adoption. To satisfy the considerable interest shown in the maintenance and preservation of the United States national standards of length and mass at the Bureau, a special door, fully protected by an alarm system, was installed during 1955 so that during working hours the vault in which the standards are kept can be viewed by those interested. At other times the steel outer doors are locked. The circular concludes with ready-reference conversion tables dealing with lengths, areas, capacities and weights. For scientific workers and industrialists requiring more extensive information, the Bureau has published "Units of Weights and Measures" (Miscellaneous Publication 214).

Catalogue of Optical Glasses

OPTICAL glass has been made at the Smethwick (Birmingham) glassworks of Chance Brothers, Ltd., since 1848, though since 1948 the main production has been concentrated at the war-time 'shadow factory' at St. Helens, Lancashire, formerly used by Umbroc, Ltd. Some melts are still made at the Umbroc Works by the 'classical process'—that is, each pot of glass is cooled slowly to produce as many large lumps as possible for subsequent moulding into slabs; but another method now employed to an increasing extent for the production of colour filter glass in sheet form or of raw material for the production of lens blanks is to roll the molten glass into sheets $\frac{1}{4}$–$\frac{3}{4}$ in. thick. The classical process is also used at the Smethwick works for certain glass types; but, in addition, platinum pots of 12–16 l. capacity are used for melting rare-earth and other special glasses. Full details of the physical properties of the various glass types produced, together with available sizes and batch reproducibilities, are listed in Catalogue O.S.16, which has recently been issued. The glass types are arranged in groups and described as 'crowns' or 'flints' with a generally accepted, but arbitrary, division at $V = 55$ (V represents the reciprocal dispersive power or constringence) for indices (n_d) of refraction in air for the sodium-D line below 1·6, and at $V = 50$ for higher indices. Nine spectral lines are used for determining the optical properties, and routine measurements of the refractive index and dispersions of each production melt are made with a Hilger–Chance precision refractometer.

South Australian Museum, Adelaide: Report for 1954–55

THE annual report of the South Australian Museum for 1954–55 (pp. 11. Adelaide: Government Printer, 1956) records the retirement of the entomologist, Mr. H. Womersley, and his appointment as honorary acarologist. Dr. E. T. Giles has been appointed entomologist, and he reports that a considerable amount of re-organization has been undertaken since his arrival. The apparatus and equipment have been rearranged and the library reclassified to give a more logical sequence. Mr. H. Womersley was in charge of a scientific expedition to New Guinea, where collections of mites, largely consisting of new discoveries, were made and brought back to the Museum. Mr. William A. Cassidy, a Fulbright research student from the University of New Mexico, has spent a considerable time studying the numerous meteorites in the collections of the Museum.

Ciba Foundation, London: Report for 1955

THE annual report for 1955 of the Ciba Foundation for the promotion of International Co-operation in Medical and Chemical Research (pp. 43; from the Foundation, London; 1956) gives details of the five discussion meetings and the four sessions of the quarterly clinical forum held during the year, as well as particulars of the seven international conferences, the proceedings of four of which have been published in book form. The three on ageing in transient tissues, on bone structure and metabolism, and on paper electrophoresis, respectively, were due for publication. Five scientific film sessions were also held during the year, and the seventh annual lecture was given in Stockholm by Prof. H. Olivercrona on "Hypophysectomy in Diabetes". Accommodation was provided at the Foundation for nearly eight hundred visitors from thirty countries who came to London in connexion with their scientific work. Six British medical graduates were granted short-term bursaries for work in France, and the first seven international awards were made for papers descriptive of research relevant to the problems of ageing, a field in which the Foundation is attempting to encourage long-term research by younger workers. Besides particulars of publications of the Foundation, the report includes some notes on the library, which was ready for visitors early in June, and lists of holdings and of periodicals received.

Grants for Education in Plastics Technology

THE Trustees of the Plastics Industry Education Fund have recently announced their plans for the support of education in plastics technology during 1956–57, among which are a number of new projects. In addition to the grants for the seven students at the Borough Polytechnic, London, who last September started a full-time course for two years leading to the diploma of the Plastics Institute, a further £1,000 has been allotted for grants to students living in the London area who wish to take up this course next September. The Birmingham College of Technology is being offered £1,000 to start a 'sandwich' course in plastics technology which will last four years, with the students spending alternately six months at the College and then six months in industry. It is intended that the students should be recruited from school and not be released from industry in order to attend the College. £175 has been granted to Mr. S. H. Heath, a lecturer in plastics technology at the Birmingham College, to enable him to visit firms in Europe for three months and study and report on recent developments in new materials and polymerization processes. Funds have been provided for a research studentship in plastics technology, worth £300 a year for two years, at the Acton Technical College, London. A grant of £500 for the purchase of equipment for teaching plastics technology has been made to the Cardiff College of Technology and Commerce, where a course leading to the diploma of the Plastics Institute was started last September and where it is hoped to establish shortly a course for the associateship. There will again be available from the Fund a sum of £1,000 for training grants to young men or women working in the plastics industry to study full-time for a degree in science or engineering, and this year applications will be considered also for assistance to take a full-time course in industrial design.

Magnetic Resonance: Symposium at Bangor

A SYMPOSIUM on magnetic resonance, arranged by the Liverpool and North Wales Branch of the Institute of Physics, will be held in the University College of North Wales, Bangor, during September 26–27. Lectures will be given by the following: Dr. B. Bleaney (Clarendon Laboratory, Oxford), free atom resonance; Dr. J. G. Powles (Queen Mary College, London), spin echo techniques; Dr. R. E. Richards (Department of Physical Chemistry, Oxford), magnets; and Prof. E. R. Andrew (University College, Bangor), nuclear magnetic resonance work and other research at Bangor. At the symposium consideration will be given to the formation of a group to provide future occasional meetings. Further information can be obtained from Prof. E. R. Andrew, Physics Department, University College of North Wales, Bangor, Caernarvonshire.

Announcements

A. S. P. DA SILVA has been appointed by the Brazilian Ministry of Agriculture to be chief of the Experimental Station at Pelotas.

DR. J. B. M. COPPOCK, director of the British Baking Industries Research Association, Chorleywood, Herts, and Dr. C. R. Jones, of the Research Association of British Flour Millers, Old London Road, St. Albans, Herts, have been appointed corresponding editors for Great Britain of *Cereal Science Today*, the new journal of the American Association of Cereal Chemists. They would be glad to receive news of events or developments of potential interest to readers of the new journal.

THE Oliver Memorial Fund is offering an award of £50 to a British subject for original work or services in connexion with the research, organization or donor aspect of blood transfusion. Applications or information on possible candidates for the award should be sent before September 30 to the Honorary Treasurer of the Fund, c/o National Provincial Bank, Ltd., Holborn Circus, London, E.C.1.

THE Chemical Society is offering grants from its Research Fund for the assistance of research in all branches of chemistry. About £700 a year is available for this purpose, the income being derived from a donation of the Worshipful Company of Goldsmiths, from the Perkin Memorial Fund, and from other sources. Applications for grants should be submitted not later than November 15 to the General Secretary of the Chemical Society at Burlington House, Piccadilly, London, W.1.

THE Committee on Statistics of the University of Chicago is offering a number of post-doctoral awards for study in statistics by persons whose primary field is not statistics but one of the physical, biological, or social sciences to which statistics can be applied. The awards are for the academic year 1957–58 and are worth 3,600–5,000 dollars. Application should be made before February 15, 1957, to the Committee on Statistics, Eckhart Hall, University of Chicago, Chicago 37, Ill.

THE British Society of Rheology will hold a conference on "Extrusion and Rolling Processes" during September 27–28 in the Stephenson Hall of the University of Sheffield. Six papers will be read, covering various aspects of the rheology of metals and of plastics. Further information can be obtained from the Honorary Secretary of the Society at 52 Tavistock Road, Edgware, Middlesex.

THE Iron and Steel Engineers Group of the Iron and Steel Institute will hold a meeting in South Wales during October 4–5. During the mornings, papers will be read in the Grand Pavilion, Porthcawl. In the afternoons, visits will be made to the Margam Works (blast furnaces, coke ovens and sinter plant) and the Abbey Works (open-hearth steel plant and wide strip mills), respectively, of the Steel Company of Wales, Ltd. Application forms, to be completed by September 10, and further information can be obtained from the Secretary of the Institute at 4 Grosvenor Gardens, London, S.W.1.

THE third British Weed Control Conference, organized by the British Weed Control Council, will be held in the Norbreck Hydro, Blackpool, during November 6–8. There will be two general discussions on the first day: one on whether weedkillers are being developed and used for ensuring efficient food production, and the other on wild oats. The subsequent days will be devoted to the reading of research reports. Further information can be obtained from W. A. Williams, British Weed Control Council, Cecil Chambers, 86 Strand, London, W.C.2.

THREE awards have recently been made from the Mental Health Research Fund, as follows: a grant of £200 to Dr. James A. Hislop, of the Department of Human Ecology and University Health Service, Cambridge, for investigation of the length of stay of patients admitted to Fulbourn Hospital from the Isle of Ely during the past hundred years; a Leverhulme grant of £1,000 a year for two years to the University of Leeds towards the cost of a senior research fellowship awarded to Dr. Max Hamilton, senior lecturer in the Department of Psychiatry, for work on the treatment of paranoid disorders by electro-convulsive therapy and insulin shock; and a travelling fellowship of £1,150 to Dr. R. E. Hullin, lecturer in the Department of Biochemistry, University of Leeds, to spend a year in the Department of Physiological Chemistry, University of Pennsylvania, investigating new biochemical methods which may be applied to the study of the blood in manic-depressive psychoses and endogenous depression.

THE ROLE OF SCIENTISTS IN WORLD AFFAIRS

IN August last year the World Association of Parliamentarians for World Government organized an international conference of scientists to consider the dangers to world peace due to the development of nuclear weapons. At this conference three commissions were formed to discuss respectively the destructive potentials of nuclear weapons and the possible consequences of their testing in peace and massive use in war; the technical problems of the supervision and control of the production and use of nuclear weapons in order to enforce their prohibition; and the responsibility of scientists for the direction of their work, the uses to which it is put, and the public knowledge of its implications. A brief report of this conference was published in *Nature* (176, 289; 1955).

At its conference this year, the Association set aside one day for a discussion of the work of these three commissions. Opening the discussion, Dr. J. Bronowski reported that the commissions had been reconstituted as independent bodies of scientists, as it was considered that any conclusions reached would then command more respect than they would if they were associated with a political organization, however eminent it be. Recognition of the commissions by established scientific bodies is being sought, and has already been obtained from the Atomic Scientists' Association. It is intended that eventually, by consultation among interested scientists, agreed statements shall be drawn up and published.

Passing on to consider in more detail the work of the third commission, that on the responsibility of scientists, of which he is the secretary, Dr. Bronowski reported that an interesting exchange of opinions had taken place, but that the members of the commission had not yet got to the stage of drawing up an agreed statement; so at present he could only outline some of his own views. He recalled how the sight of the devastation at Nagasaki had convinced him that it is the duty of scientists to work to bring about a universal understanding of the implications, both for good and for evil, of the development of atomic energy. They have this responsibility not only because of their specialized knowledge but also because they have learned to approach problems in a scientific way. They know full well that the most subtle theory is useless if it cannot stand up in a world of hard facts. It is useless, for example, to talk eloquently about raising living standards throughout the world if there is not even the possibility of making available the energy necessary to do it, as indeed there was not until the first atomic pile was successfully operated in 1942. Thus it is particularly important in political discussions to learn what is practicable and what is not, and to act accordingly. The scientist knows also that the end never justifies the means, or rather that the end cannot be distinguished from the means. The results can never be altered to fit the theory. This professional integrity of the scientist is needed also by those who have to tackle problems concerning the affairs of men.

Reporting on the activities of the second commission, that on the international control of atomic energy, Dr. P. E. Hodgson, its secretary, said that an account of its discussions at the 1955 conference, together with a survey of the main problems to be studied, had been published in the *Atomic Scientists' Journal* (5, 209; 1956). He went on to survey the main developments in the field of international control during the past year. On one hand there have been several encouraging examples of international co-operation on atomic energy, such as the Geneva Conference in 1955 on the Peaceful Uses of Atomic Energy, the European Organization for Nuclear Research (C.E.R.N.), and Euratom; but, on the other hand, the power and efficiency of nuclear weapons have steadily increased. It is now possible for any one of the major atomic Powers to inflict on another, without warning, severe and widespread damage of the most lasting kind. But such a blow would not prevent an equally devastating retaliation. This situation is gradually hardening due to the development of intercontinental rockets, against which there is even less defence possible than against high-altitude aeroplanes. Thus international control is becoming steadily more difficult, though even now it would not be impossible if wide powers of inspection were given to a control agency. Any plan for international control would, however, always have to take into account the possibility of hidden stocks of fissile material that could not be detected by any physical means. The most effective and practicable preliminary steps towards international control are the cessation of tests of nuclear weapons and of long-range rockets.

The work of the first commission is being temporarily suspended in view of the establishment of a United Nations commission with similar terms of reference. It will reconvene to study the report of the United Nations commission when this is published.

In the ensuing discussion, Prof. A. Haddow pointed out that the scientist has no mandate to decide the future of the world. His main duty is to publicize the details of his work, and to educate the public to an understanding of their implications. Then, as a citizen, he takes part in the political debate to decide the applications of scientific knowledge that shall be made. The growing number of contacts between scientists and politicians are greatly facilitating the diffusion of the new knowledge. Finally, he considered that there is a very strong case, on scientific, humane, medical and political grounds, to cease tests of nuclear weapons.

Prof. B. G. Whitmore brought out clearly that the *inter*national control of nuclear weapons is not possible as the nations are organized at present, owing to the possibility of hidden stocks of fissile material. But it may be possible to organize the nations into one body so that a *supra*national control becomes practicable. This was supported by Prof. R. W. Ditchburn, who urged scientists to play their part in the creation of a strong interwoven network of international co-operation.

In his concluding remarks, Dr. Bronowski underlined once more the dual nature of the task of the scientist: to assist in keeping and building peace, on one hand, and in raising living standards on the other. It is in these two key roles that the scientist has a great responsibility to the rest of human society.

P. E. HODGSON

THE WEATHER IN THE ANTARCTIC

IN the recently published Meteorological Office Geophysical Memoir No. 94*, Mr. H. H. Lamb reports on his work as meteorologist aboard the whale factory ship *Balaena* during the antarctic summer of 1946–47. The *Balaena* carried aircraft for spotting whales, and Mr. Lamb's task, so far as immediate operations were concerned, was to forecast weather and swell for the aircraft and the small whale-catching vessels. Broadcast observations were collected to compile once daily a synoptic map of much of the southern hemisphere, which was used in conjunction with local observation for the forecast work. No observations were received from other whaling vessels, and observations south of Australia, South Africa and South America were very scanty. Though meteorological observations have, of course, been taken in antarctic waters by numerous expeditions, it is believed Mr. Lamb operated the first weather-forecast service there.

It was found that knowledge of the structure and movements of pressure systems, air masses and fronts gained in the northern hemisphere was, after experience of the effects associated with the pack ice and topography of the Antarctic Continent had been gained, perfectly applicable in the Antarctic. Although the nearest reporting station was sometimes two thousand miles away, the forecasting work was very successful. Special attention in the forecasting work was paid to the sub-tropical anticyclones, as their positions and intensities largely determined the movements of the main warm-air steering currents of depressions. Care, too, had to be taken to maintain on the charts all fronts which might affect the ships.

The general weather over the Antarctic Ocean was very disturbed, with one depression soon following another and the only sunshine occurring in a break of a few hours in the clouds every three or four days. As the cloud system of one depression moved away, the next could always be seen approaching. For a short period the ship was less than a hundred miles from the Antarctic Continent, and in off-shore winds the sky was sometimes quite clear. In spite of the great amount of cloud and the fact that there was rain or snow on 122 of the 131 days spent in the Antarctic, the precipitation measured was only 43·6 mm. water, equivalent to an annual precipitation of 4 in. a year—a desert value. The value is not to be taken very exactly owing to the difficulty of giving only just enough heating current to the rain-gauge to melt the snow and no more, and also to loss of catch by the disturbance to airflow caused by the ship. Cumulo-nimbus clouds were frequent, and inversions only occurred occasionally.

The mean pressure south of 50° S. was only 982 mb., and the maximum only 1013·4 mb. These values are much lower than over corresponding areas of the northern hemisphere and suggest that there is unequal sharing of air between the hemispheres. Mr. Lamb, using all the available information, gives in the memoir a mean pressure map of the southern hemisphere. This has a weak anticyclonic area over the Antarctic Continent (pressure about 1,000 mb. reduced to mean sea-level), a ring of depressions off the edge of the pack-ice of central pressures about 980 mb., and then a steady rise to the sub-tropical high-pressure belt in 30° S. Daily weather maps show that the south polar anticyclones cannot be regarded as permanent and that the general situation over the Antarctic Continent is sometimes cyclonic.

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* Air Ministry. Meteorological Office Geophysical Memoirs No. 94: Meteorological Results of the *Balaena* Expedition, 1946–47. (M.O. 584*b*.) By H. H. Lamb. Pp. 68+5 plates. (London: H.M.S.O., 1956.) 8*s*. 6*d*. net.

CONSERVATION OF FISHERIES

A CONFERENCE on fisheries conservation was held in Rome during April 18–May 10, 1955, and was attended by delegates from forty-five countries. The conference was convened by the United Nations Organization in order to assist the International Law Commission in preparing draft articles on basic aspects of international law on fisheries, and a report was presented to the Commission in June 1955. The papers read at the conference have now been published*. They include important general contributions on fisheries resources and regulation by M. Graham, M. B. Schaefer, G. Belloc, W. C. Herrington, J. L. Krask, G. L. Kesteven and S. J. Holt, as well as summaries of actual international conservation problems such as the North Sea fisheries (C. E. Lucas), the Pacific halibut (H. A. Dunlop) and the Fraser River salmon (L. A. Royal). That it should be possible to control and conserve such diverse fishes indicates how much scientific knowledge has advanced in recent years.

Mr. Graham stresses that T. H. Huxley's dictum—let the fisherman be free—should be followed unless there is evidence that fishing activities are seriously influencing the yield of a fishery. He points out that among the effects of over-fishing one must distinguish a decline in total yield from a decline in catch per unit effort or a decline in average size of fish. The latter two effects may not be a sufficient reason for regulating a fishery, although from economic causes (lack of recruitment of boys to the industry, no market for small fish) they may limit it. Dr. Schaefer expounds the whole theory of fishing and the equilibrium catch; and although he mentions the maximum economic catch, it is apparent that he regards the production of the maximum sustainable yield as the main object of conservation. This thesis underlies most North American fishery regulation; but the maximum yield does not seem to have been obtained yet from the Pacific halibut. From Dr. Schaefer's own contribution on the tropical tunas, it would seem that high catches of yellowfin tuna near the limit of sustainable yield during 1948–51 resulted in an economic regulation of the fishery to a lower level in later years. In the North Sea all three effects of over-fishing have been experienced, and the recent international agreement on mesh sizes goes only part of the way to solve the problem.

Other interesting papers deal with the influence of the environment (J. E. Tait), the behaviour of fishes in relation to the environment (M. Fujinaga, J.

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* Papers presented at the International Technical Conference on the Conservation of the Living Resources of the Sea, Rome, April 18 to May 10, 1955. (United Nations Publication, 1956. II.B.1.) Pp. xii+371. (London: H.M.S.O.; New York: United Nations, 1956.) 22*s*. 6*d*. net, 3 dollars; 13 Swiss fr.

Furnestin, R. Muzinič, A. J. C. Jensen, R. Kandler, T. A. Kow, G. Ranson, G. Rollefsen and W. F. Royce), the productivity of the sea and the possibility of acclimatizing certain species in parts of the world outside their present range (L. Zenkevich). Some contributions from the Italian, Japanese and Korean delegations are frankly political and seem out of place in a scientific report. However, they illustrate how important marine-produced proteins may be in the national diet of many countries. To some extent this importance may explain the apparent disregard of the conference report at the meetings of the International Law Commission in May and June this year. It is to be hoped that the reported draft articles on fisheries law, particularly that allowing a State to take unilateral action to regulate fisheries outside normal territorial waters, are being carefully scrutinized by the United Nations General Assembly.

A. J. SOUTHWARD

GRANTS FOR DEVELOPMENT AND WELFARE IN THE BRITISH COLONIES

THE schemes made under the Colonial Development and Welfare Acts, covering the period April 1, 1955–March 31, 1956, which are detailed in the latest return*, bring the total commitments for development and welfare schemes under the Acts to £147,681,582, and for research schemes to £14,750,061, of which £27,909,965 and £1,889,486, respectively, are for the year in question. Of this last sum, £819,495 is for agriculture, £332,701 for medicine, £281,182 for social science, £139,281 for locust control, £64,279 for insecticides, £51,620 for products research, £19,241 for economics research, £10,880 for tsetse and trypanosomiasis, £3,510 for fisheries and £14,000 for research fellowships.

Of the actual research schemes, £362,000 is for the Regional Research Centre for Agricultural Research in the Caribbean area, while a supplementary £113,567 goes to the Institute for Social and Economic Research in the West Indies over the period 1956–60. £59,905 is capital expenditure for establishing the Fundamental and Applied Nutrition Units at the University College of the West Indies and £42,570 for the establishment and maintenance during 1955–58 of a Fundamental Nutrition Research Unit there. £25,300 is provided for soil and land-use survey in British Guiana, £21,960 for the maintenance of the Rockefeller Foundation Regional Virus Research Laboratory, Trinidad, and £9,740 for establishing seismic recording stations in the West Indies. In South-East Asia £27,946 is for filariasis research at the Institute for Medical Research, Kuala Lumpur, £19,100 for research in the Federation of Malaya on virus and other diseases transmissible from animals to man, and £13,904 for the appointment of a plant pathologist investigating diseases of manilla hemp in North Borneo.

In West Africa £43,100 is for an agricultural improvement scheme in Gambia and a similar sum for the West African Building Research Institute, £20,000 for the preparation of a social, political and economic history of the Benin, and £11,000 for extending the work of the Termite Research Unit to West Africa. In East Africa £82,329 is for the East African Institute of Social Research, Makerere College, Uganda, during 1956–60, £38,100 for the East African Virus Research Institute, £34,000 for the preparation of a Flora of East Africa; £32,770 goes to the Rhodes–Livingstone Institute, £30,914 to the East African Agriculture and Forestry Research Organization, £22,596 to the East African Veterinary Research Organization, £19,215 for the Desert Locust Survey and £16,619 for economic research at Makerere College. £15,000 was contributed towards the activities of the Commission for Technical Co-operation in Africa South of the Sahara and the Scientific Council for Africa South of the Sahara (a further £30,000 being provided from development and welfare schemes), while grants for general research schemes included £60,350 for research on animal physiology under tropical conditions at the Hannah Dairy Research Institute; £50,200 for the Anti-Locust Research Centre during 1956–57 and a supplementary £40,100 during 1955–56; £40,586 for trachoma research in Jordan; £36,300 for the Colonial Pesticides Research Unit, Porton, during 1956–60, and £18,160 for the Termites Research Unit during 1956–60.

Among the major development and welfare schemes of particular scientific interest are the following: £103,600 for the construction of a new chemistry laboratory in East Africa and a further £107,000 for the construction of Nairobi Technical College; £1,653,370 for the intensification of African agricultural development; £350,000 for survey of the Rufiji River, Tanganyika; £328,875 for the construction of trade schools and a technical institute in Tanganyika, and £451,890 for water development and irrigation in Tanganyika. £1,050,000 is for the construction of permanent buildings for the University College of Rhodesia and Nyasaland, and £48,000 for the development of meteorological services for Central Africa. Of the contribution of £1,748,756 to the development plan for the Northern Region of Nigeria during 1955–56, £274,628 is for agriculture, £117,514 for technical education, £338,243 for medical services and health, £548,168 for rural water supplies, £39,395 for veterinary services, £35,861 for leprosy control and £26,771 for forestry. £1,312,500 has been provided for the development of rural water supplies in the Eastern Region of Nigeria, £536,250 for developing medical and health services; and of £1,204,840 for the development plan of the Western Region of Nigeria during 1955–56, £245,210 is for agriculture, £548,810 for medical services and health, £92,010 for technical education, £43,070 for leprosy control, £33,270 for veterinary services, £24,570 for forestry, and £49,600 for rural water supplies. £115,530 is for the development of medical services and £149,278 for soil conservation in Basutoland, £83,724 for development of surface water supplies in Bechuanaland Protectorate, £113,185 for rural development and soil conservation in Swaziland; £82,000 for agriculture and forestry development in St. Helena; £510,000 for irrigation and domestic water supplies in Mauritius; £80,781 for the construction of a pathology building for the University of Hong Kong; £984,000 for the construction of permanent buildings for the University of Malaya; £50,000 for aerial survey in British Guiana; and £45,000 for construction of a chemical laboratory in Jamaica.

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* Colonial Development and Welfare Acts. Return of Schemes made under the Colonial Development and Welfare Acts by the Secretary of State for the Colonies, with the Concurrence of the Treasury, in the Period from 1st April, 1955, to 31st March, 1956. Pp. 38. (London: H.M.S.O., 1956.) 2s. 3*d.* net.

BRITISH ASSOCIATION MEETING AT SHEFFIELD

TWENTIETH-CENTURY MAN AGAINST ANTARCTICA*

ADDRESS BY SIR RAYMOND PRIESTLEY

President of the Association

THE British more than most peoples go in for paradoxes. It is therefore not atypical that the British Association should, once in a while, elect as its President a man who has been away from science for some forty years. After all, even in this technological age, the value and the advancement of science in a democracy both depend to a considerable extent upon a correct appreciation of the importance of science by the layman at large. There was an element of statesmanship in the man who coined the phrase "we must educate our Masters". We cannot afford to fumble over this vital question of education while we exist precariously in a competitive world. Especially is this so when at least one of our rivals is not yet committed to majority rule, but has her policy directed by men who have both the sense to mobilize the wealth of new knowledge technology is placing at man's disposal, and the power to compel the rank and file to use that know-how to the best advantage. So I shall make no apology this week as I wander from Section to Section as—shall we say—a touchstone of intelligibility.

As I stand here in my present predicament, I draw courage from two facts. The British Association is this year undertaking a serious study of how it can best discharge its particular responsibility in the circumstances of to-day, which are as different from those that prevailed when the Association was founded more than a century ago as chalk is from cheese. The Association's functions of integration and dissemination are expressed in its title and set out at greater length in its constitution. To-day they are more important than they ever were before, and the duties involved are much more difficult to perform. The world can no longer afford to wait until an annual convention for the announcement of major discoveries in science. A great apparatus of scientific periodicals has in any event removed the need. Yet the annual parade of science before the people should have its value. At that parade science must wear the abbreviated bathing-costume of the nineteen-fifties rather than the Victorian crinoline, so that the beauty, the challenge and the danger of the truth may be seen by all. This aim can only be achieved to the extent that the scientist can state his results in language that can be appreciated at least by the average educated citizen. An approach towards that ideal is one task that we have given to our Division for the Social and International Relations of Science.

A second task that must follow from this first is to attract endowment sufficient to make our means—adequate enough a hundred years ago when pounds were pounds—equal to the performance of a greater task in a more expensive world. To solve the latter problem we must do two things. We have to make our meetings sufficiently attractive so that our membership taxes the accommodation of the great cities in which we meet. At the same time we must convince industry that we have a task worth doing and are equal to that task. This should not be beyond our powers if we think our first problem through.

My second comfort to-night is the fact that I have chosen for my main theme a subject about which, if I know too little, the great majority of my listeners will, from direct experience at any rate, know less. Antarctica is remote. It has therefore still to a great extent the fascination of the unknown. It is vast. Its area is six million square miles; nearly as large as Europe and Australia together. The greater part of the continent's surface lies between 6,000 and 11,000 ft. above sea-level and is covered with ice several thousand feet thick. The oceans surrounding it teem with life as do no other waters in the world. For half a century whaling man has followed in the explorer's track to farm these seas. The continent these waters surround is practically devoid of life, and this is due primarily to the fact that, over most of it, there is no single month in the whole year in which the mean monthly temperature is above the freezing point of fresh water. This is a salient fact to remember. Low winter temperatures, no matter how severe, are not incompatible with the existence of highly organized life-forms. They are therefore not a serious obstacle to civilized man with his present knowledge. Maximum winter cold is one record the U.S.S.R. can justly claim, though only just, for Canada and the United States are not far behind. Yet in no country is scientific man more firmly installed or more at home than in these three.

The Pre-War Years

The story of the recent history of exploration in Antarctica is a fascinating one. Before 1900 the defences of the continent had been breached by a Norwegian seaman so keen to make a first landing that he pushed aside his superior officer and sprang thigh-deep into icy sea. A year or two later this same Norwegian adventurer, Carstens Borchgrevinck by name—a man of parts if not of punctilio—backed by an English publisher, Sir George Newnes, had spent the first winter on the antarctic continent at Cape Adare and made the first tentative push inland on the Ross Barrier—a trivial but a significant record. Much greater things were to follow soon.

The first fourteen years of the twentieth century have been named, not inappropriately, the heroic age of antarctic exploration. The tale is a fitting element in the surge of geographical discovery that was a feature of the peaceful Victorian and Edwardian reigns when major wars were rare and a steady approach towards an eventual Utopia—at any rate for the European ruling classes—was expected by most thoughtful men. This surge of antarctic discovery opened with a sharpening of international interest and in cordial co-operation. European scientific societies, under royal patronage—more common then than now—conferred politely about spheres of interest. Scientific leaders were chosen, or chose themselves; old tried equipment and methods—the Nansen sledge and cooker; men, dogs and arctic tents—were translated to a new field, and the twentieth-century antarctic race was in full swing.

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* Presidential address delivered at Sheffield on August 29 and appearing in the September issue of the *Advancement of Science*.

By 1904 the more accessible parts of the antarctic coastline had been the temporary homes—for one or two years—of European teams with a strong element of natural science. These first scientists were fortunate, as we now know, in the location of their headquarters. Biological and geological discovery went on apace, and we gained our first slight knowledge of the physical condition of antarctic ice and atmosphere. In the meantime sledge parties penetrated for many miles along the coast and made the first tentative journeys inland.

The Swedes, under Otto Nordenskjöld, were fortunate in their location and lucky in their bad luck. They lost ship and gear in the polar pack, but were consequently pioneers in living on the antarctic land. They survived with courage and cheerfulness through two difficult years, during which they collected evidence of several former antarctic floras and they afforded a good example of international co-operation by being rescued by an Argentine naval vessel.

Bruce and his Scots left behind them, in Argentine occupation, the first permanent antarctic weather station. This last achievement had results that were to be of some importance when the temper of the world had changed. French, German and Belgian expeditions contributed to this mass assault with notable but unspectacular results. From the international effort there were three important exceptions. Norway and the United States, both of whom had considerable polar experience, were looking towards the arctic at this time. Imperial Russia—as she then was—who, many years before, in Bellingshausen, had produced one outstanding antarctic explorer, had relapsed into her more usual rather introspective mood.

I have left the British effort until last, for while it was, geographically speaking, the most notable of all, it also leads naturally on to the second phase—the quest for the southern pole. This period was the heyday of the polite recognition of national spheres of interest, and in Antarctica we started with a long lead through the chance that James Ross had approached the continent in the season 1840–41 at the place where the land is most deeply breached by the sea. Scott effected a landing as far south as 78°, and no one by ship could do much better even to-day. Being of an energetic race—at any rate in all that appertains to physical exercise and sport—his men took to their legs and penetrated deeply into the continent. Employing archaic sledging methods inherited from the Franklin search in the Arctic, but gradually evolving an efficient sledging technique within these limitations, *Discovery* sledge parties set a pattern that accomplished a great deal but was eventually to cost us the pole and several valuable lives. They learned that scurvy was not a menace confined to arctic travel and long ocean commissions. On the southern journey the mere suggestion that his breakdown from scurvy was a cause of comparative failure produced in an extraordinary man an obsession which was to govern the rest of his life and give a name to Shackleton Base to-day. The curious chance that one of Scott's officers had served with Jackson in Franz Josef Land led to the employment of ponies as draught animals in Antarctica, with further diversion of the British mind from that real polar sledging treasure—the dog.

There followed in the next few years the polar quest. In 1908, Shackleton, to some extent in pursuit of self-respect, made the greatest leap forward towards either pole that any leader ever made. He traversed the Ross Barrier 300 miles from front to rear, and when the mountain ranges curved across his path, struck up the longest valley glacier in the world, and penetrated over the plateau in face of a galling head-wind and below zero temperatures to within ninety-seven sea miles of the pole. It is fair to say that when he turned back—a decision surprisingly discreet to one who knew the man—we knew exactly what the southern pole was likely to be like. The only surprise to Scott and Amundsen three years later was the fact that a ski-stick could be pushed its whole length into soft snow because of the absence of strong wind. Shackleton returned—but only just. Forty-eight hours of fine weather on the Beardmore glacier when the party was on starvation rations and looking for a depot was typical of 'Shackleton's luck' as we knew it in that wonderful year.

Of the Amundsen–Scott race I say little because there is no polar story so well known. Within a month two parties of five men stood at the South Pole. One did not return. The British lost the race and gave their lives because their methods were less than the best. We did most of the approach work to both poles and were beaten at the post because we did not fully understand the value of dogs as transport animals nor how to get the best out of those we used. Other factors contributed to the tragedy; but the stark fact is that, with sledging rations completely devoid of vitamin C, the margin of safety of any man-hauling party to the South Pole from any base on the rim of the continent is too small. Scott committed errors of organization for which he more than atoned by the manner of his death. He should not have changed his parties from two units of four men to one of three and one of five. By doing so he endangered the party going home, who had, without measuring or weighing apparatus, to take exactly three-quarters of the food from dozens of weekly bags. He handicapped his own party psychologically by crowding them in a tent meant for four men and disorganizing a very carefully thought-out routine. He made, in my opinion, a bad mistake in taking with him three officers and one long-service seaman. Seaman Evans was in a thought-tight compartment by himself and was naturally the first to break. The weather was unkind. Only recently an American scientist has pointed out that, of all the years of which a meteorological record has been kept, 1912 was the stormiest on record and the winter of 1912 set in unusually early. Nevertheless, scurvy was, I believe, the decisive factor. Under man-hauling conditions, four months is about as long as men hauling sledges can live on rations completely devoid of vitamin C. Once that period had elapsed, nervous and physical deterioration was bound to set in, sores to refuse to heal, and lassitude to supervene. Scott's southern party did not starve to death.

This about completes the tale of British antarctic exploration before the First World War, so far as positive achievement is concerned. But there are other things to record before we are finished with the pre-war years. Australia launched her first antarctic venture in 1911, and by 1914 Douglas Mawson had proved his status as polar leader, polar scientist and traveller, and had, incidentally, set a record of endurance that will never be surpassed. Losing one member of a three-man sledge party down a crevasse with most of their provisions, he saw another die of exhaustion at his side, and then, alone, staggered along for three weeks, to arrive at his base one day after his ship had left for home. In the autumn of 1913, I was with Prof. David at his Blue Mountain home when the news was flashed across in the first wireless communication ever sent from Antarctica to civilization without relay, in itself a significant milestone in antarctic history. Mawson, staying south a second year, more than doubled his results, which, with the time-lag characteristic of our antarctic scientific memoirs, are still coming hot from the Australian press to-day.

These years also saw the birth in the minds of William Bruce and Ernest Shackleton of a significant idea still unfulfilled—the Transantarctic plan, which belongs more properly to the years of war that were to bring the long Victorian–Edwardian age to its end and profoundly change the temper and outlook of mankind.

What were the dividends that accrued from this first twentieth-century wave, characterized as it was by a rather attractive blend of adventure, science, individual rivalry, and international good manners and good will ? There were quite a few, but from among them I should like to pin-point two. I was once a geologist, so I may be excused if I go to that field for my first example. The most intriguing feature of polar geological research has, unquestionably, been the evidence of past changes of climate so revealed. East Antarctica we saw, and see to-day, as a continental shield that had remained relatively stable through the ages with, piled upon it, horizontal sediments, which are a record of its denudation and the profound changes of level that have occurred as the aeons passed. West Antarctica we think of as a prolongation of Andean folds. Between the two lies the so-called Ross–Weddell Graben. We still cannot be certain, as we were certainly not in 1914, whether or not the severance is complete, though evidence from air survey makes it more probable that Antarctica is one continent than two.

On this continent, in 1914, we knew of *Archaeocyathus*, a common ancestor of sponges and corals, occurring in Cambrian limestone-stunted forms it is true, but still evidence of warmer seas. Coal seams seven feet thick of Permo-Carboniferous to Rhaetic Age were found in the Beacon sandstone that caps the horst that dominates Victoria Land. From the Priestley Glacier came part of a Rhaetic tree containing in its tissue a tiny winged spore. From the upper ranges of the Beardmore Glacier—collected by a disappointed and weakening party, carefully cached a few miles from where they died—came 40 lb. of priceless specimens, including *Glossopteris indica*, type fossil of the Permo-Carboniferous so widely spread in Australia and elsewhere. From the fold-ranges of West Antarctica, Nordenskjöld and Gunnar Anderson collected in succession Jurassic, Cretaceous and Tertiary floras culminating in *Fagus antarctica*, the southern beech. Stranger still, in all our wanderings, no single formation of undoubted glacial origin was found older than late Tertiary Age. This remains the classic problem of antarctic geology ; fit subject for discussion at British Association symposia—a problem that as a very ex-geologist I will not attempt to solve. Perhaps palæo-magnetism may yet provide the missing clue and Wegener be finally justified, or finally set aside.

Pre-First World War exploration paid handsome dividends in a more prosaic field. The Compagnie Argentina de Pesca has just celebrated a jubilee, its fiftieth year of whaling, which makes the first shore-based antarctic whaling station stem from Nordenskjöld and his Swedes. To some extent the name misleads, for to the credit of Norway must go most major technical improvements in whaling, from the basic small fast whale-catching vessel to the harpoon gun. Of the vicissitudes of whaling one gets some idea when it is realized that, in one's Victorian youth, whalebone for ladies' stays was a chief objective, while to-day whalebone is the least valuable portion of the whale, and it and the tail flukes are the only parts discarded. There are rumours to-day, however, that whalebone may come back into use as a raw material for artificial silk.

The First World War

In 1914 antarctic exploration was diminished rather than inhibited by the First World War. That War was not quite global in extent, and, in the first years at least, until unrestricted submarine warfare set in, some of the old polite conventions survived from the days when wars were the affair, in the main, of gentlemen and professional soldiers. Shackleton left for the south in pursuit of his Trans-Antarctic quest after having offered ships and men to the Admiralty and having been told to go ahead. As I have said, his first expedition was a great success—in its way unique. Yet Shackleton never showed himself a greater leader than when he brought crew and shore party safely through this second, completely unsuccessful expedition without the loss of a single man. Crushed in the ice of the Weddell Sea, the *Endurance* was lost with most of her records and practically all her specimens.

The boat voyage from Elephant Island to South Georgia was an epic seldom surpassed in the history of navigation. Shackleton, the sailor, made little of it. Shackleton, no mountaineer, dramatized the scramble across the South Georgia ranges overmuch. Shackleton, the undefeatable, made four attempts in tiny ships to rescue his marooned companions and at last succeeded. Then Shackleton, the versatile, donned army uniform and became a clothing and equipment expert in Murmansk. I served both with Shackleton and Scott and very briefly met Amundsen in mid-career. I believe a colleague hit the nail when he wrote : "As a scientific leader give me Scott ; for swift and efficient polar travel, Amundsen ; but when things are hopeless and there seems no way out, get down on your knees and pray for Shackleton". Shackleton Base for a Trans-Antarctic Expedition is right.

The Inter-War Years

I must be forgiven if I have appeared to stress too much these early years, for in these I played a minor part. For the rest I must hasten, picking out only the salient features as I bring the, to me, fascinating story up to date.

As Europe and America recovered their poise, two trends, both important to antarctic exploration, can be recognized. America awoke to Antarctica and brought to her aid all the resources of modern mechanical science. Shackleton, Scott and Mawson had taken the first halting steps in this direction without success. In 1908 I had my first motor-car ride in McMurdo Sound near 78° S. latitude in an open, Arrol-Johnston car with air-cooled engine and with wheels. For ten miles we did thirty miles an hour on windswept sea ice and then met snow and stopped. Scott's first tractors had little better fate. Mawson's aeroplane crashed in Adelaide in 1911, but journeyed to Antarctica as an alleged air-propelled sledge—and stayed at or near headquarters when there. But in the thirties Byrd used tractors and aeroplanes with success and on the grand scale. He flew to the Pole and back, and in 1937 Ellsworth flew across the continent, landing several times on the way. These were major feats and pointed to a new era to come, in which radio, not an unmixed blessing, but an aid that, once available, could not be ignored, combined with many other mechanical and electrical aids to transform the antarctic scene.

Meanwhile, in West Antarctica, quite different developments of equal interest to the polar specialist were taking place. Even pre-1914 War polar exploration was not really dangerous compared with civilized life. But scurvy was, as I have shown, a major hazard, and winter sledging could be very uncomfortable indeed. I have left winter quarters for cold-weather sledging with a sleeping-bag weighing 12 lb. and returned with the same bag 28 lb. in weight. All the extra weight was frozen breath and sweat that had to be thawed out and warmed before I could sleep. In 1907–12 we were strictly geared to the polar quest. One gallon of oil had to last four men a week, or three men for ten days. Not a drop could be spared from its primary task of preparing hot meals. In 1926 or thereabouts a very remarkable generation of arctic explorers arose in Cambridge. They evolved an efficient technique of living on the land, and, on the sea in kayaks: they 'out-Eskimoed' the Eskimos. Gino Watkins and his colleagues did more than any other factor to rehabilitate British polar exploration in Scandinavian countries, where our reputation had rather slumped through Amundsen's easy and clear-cut victory in the polar quest. In 1934 these men transferred their attention to Antarctica as the British Graham Land Expedition under John Rymill. The menace of scurvy had gone (except under catastrophic circumstances) with the availability of vitamin C in tablet form and the rational use of what meat the Antarctic can provide—which, along the coast, is a great deal. Winter travel had been made comparatively comfortable by doubling the oil ration; a simple but fundamental change from which, however, the early man-hauling pole-seekers were inhibited by the nature of their task. From Rymill's generation, in direct descent, stem the early leaders of the Falkland Islands Dependencies Survey, that present British nursery of dog-sledging technique, admittedly unequalled, in this particular respect, in the antarctic world, though our cousins the Australians are hard on our heels.

The Second World War

In 1939 the Second World War broke out, and for some years the Antarctic was deserted as never before in this century. This War was truly global and total. All civilized conventions went by the board, and in the struggle for survival no holds were barred. German raiders used sub-Antarctic bases as supply depots and bolt-holes in their raids on Allied shipping and the whaling fleets. In 1938 the Reich had sent a catapult ship carrying two flying-boats to Antarctica to stake a claim and spy out the land. The subsequent raids underlined the rather sinister emergence of politics and national ambition as motives in the antarctic exploration field. It was a variant on an old theme. Iceland and Greenland in the tenth century owed their exploration and settlement not least to the fact that Eric the Red and his turbulent fellow Vikings could not bring themselves to refrain from homicide. The difference, after all, is one of scale rather than of type. The raider *Kismet* sank nine ships totalling 57,000 tons, the *Pingouin* sank 136,000 tons of Allied shipping and captured a whaling fleet with 22,000 tons of oil.

In 1939–40, before her entry into the War, the United States staged a major expedition which had the distinction of embracing, for the first time, both East and West Antarctica, bases being established both at Little America and at Marguerite Bay in what we call Graham Land and the Americans Palmer Land, a clash of nomenclature that reflects a controversy a century old. In 1944–45, when the Allies' naval supremacy was re-established and the sea war over, a naval expedition under Commander Marr—who first went south as a sea-scout under Shackleton—was sent to West Antarctica, and the Falkland Islands garrison was strongly reinforced. Landings were made at Deception Island and Port Lockroy and the Melchior Islands. The Falkland Islands Dependencies Survey began to take shape.

A new factor in Antarctica had emerged; Argentina and Chile were looking to the south. Is it unreasonable to infer that, in these fateful years, with a bias towards totalitarianism themselves, they had decided—wrongly—who would win the war, and had determined, not unnaturally, to pick up what they could of the geographical loot that might be lying about when the British Commonwealth and Empire had been destroyed? Argentina, at least, had some claims to succession: though not to usurpation when the elimination of the present occupier did not in fact take place.

The 'Cold-War' Years

When we study the history of antarctic exploration from the end of the Second World War the pattern becomes more complex. There is plainly to be seen the reflexion of the great dilemma that confronts civilization in this era of rapid technological development in the circumstances of 'cold war'. As man's mastery of machines progresses and his movements become more rapid, the Earth, considered in terms of time taken to traverse it, shrinks. This fact makes international organization and international understanding more imperative year by year; an international outlook more essential to the survival of civilized man. At the same time, the course of recent events has encouraged an aggressive nationalism which is rapidly bringing about the dissolution of the old colonial empires and the emergence of new States, inexperienced and prickly, eager to assert their new-gained rights and to enlarge their realms.

This dichotomy is mirrored in the antarctic history of the past ten years. The year 1948, for example, saw the conception of the first truly international antarctic expedition. On the initiative of Norway, the Norwegian–Swedish–British Expedition of 1949–52 was launched with purely scientific objectives. Two years of first-class scientific work was done in amity by a truly international team who emerged from the experience with enhanced mutual respect and a record of work of unsurpassed value. The inland-ice of Queen Maud Land was investigated to a depth of 100 metres by platinum-resistance thermometers and a core taken down to 200 metres. Six hundred and fifty successful radio-sonde ascents were made up to a maximum of 72,000 ft. A seismic profile of the inland-ice was accomplished during a penetration inland of 390 miles. Aeroplanes of the Norwegian and Swedish air forces combined to extend a survey well begun by the expedition's weasel- and dog-sledging parties. Organization was efficient and the work done in comfort, as when my friend G. de Q. Robin lived for several months on the plateau in a caravan fitted up as seismic laboratory and living quarters combined, much as if he were on a vacation tour at home. Yet, even to-day, exploration is not without its risks. Three men lost their lives when their vehicle plunged into the sea over the coastal ice-cliff during a dense fog.

Such amity among the nations, however, remained the exception rather than the rule, for competition is more common than co-operation in the world to-day. In West Antarctica, Britain was faced with claims both by Argentina and Chile, not only to that sector of the continent, but to the off-lying islands and the Falkland Isles as well. By 1945 the South American neutrals had tabled claims to all land to the south of that continent. These claims were based partly on geographical propinquity, partly as successor states to Portugal and Spain—as inheritors of pretensions that stem from the Treaty of Tordesillas in 1494 and the Papal Bull upon which that treaty was based—partly, in the case of Argentina, on occupation for a number of years.

Twisting the lion's tail is to-day a safer occupation than it was a century ago. Yet Britain has reacted vigorously enough, through occupation and administration, upon a major scale. The Falkland Islands Dependencies Survey is a name that stands for an effort in antarctic activity that is, in its way, unique Since 1944 this activity has been maintained on a steadily increasing scale. To-day Britain has ten permanent bases in West Antarctica, with a magistrate and supporting team at each. From those on the mainland the old Watkins–Rymill tradition of dog-sledging has been maintained and improved, journeys totalling thousands of miles having been made.

The bases breed their own dogs and carry out continuous trials of equipment and rations. In fact, an experimental laboratory in methods of polar travel has been in existence there for a dozen years. A very complete meteorological record is kept at all stations for the benefit of the whaling industry, from which, until recently, the costs of occupation were mainly defrayed. At some stations an ionospheric and seismological programme is in full swing. Topographical and geological surveys are major objectives. This year a start has been made on an aerial survey of the whole region in dispute.

Side by side with the British bases, sometimes within a few hundred yards, stand those of Argentina and Chile, manned chiefly by Service personnel. Our Chancellery proposes—theirs refuse—arbitration through the International Court. Formal protests are bandied to and fro. Through it all, with very occasional exceptions when for the moment national fervour outruns good sense, the personnel of the expeditions interchange social visits and afford each other mutual help. Straying Argentine St. Bernards are returned by British scientists; anniversaries are celebrated in common; British invalids are cured by Argentine doctors and vice versa; Argentine beef and champagne prove acceptable exchanges for Scotch whisky and English beer.

What will come of this international rivalry it is impossible to predict world balance of power being so delicately poised. In 1948 the United States made a proposal to seven Governments for a limited kind of condominium control. From time to time one nation or another formally reserves its rights. The suggestion of United Nations control finds increasing favour in many quarters and has been mooted in the British Parliament. In the meantime, the situation is bound to have its effect on polar achievement in many ways, of which I may mention two.

It greatly increases the amount of money, man-power and energy expended upon the opening up of the southern continent. If, for example, the U.S.S.R., however pure her motives, gazes polewards, the United States must perforce take notice too. The strategic value of Antarctica, should world atomic war break out, with the consequent likelihood of the destruction of the Suez and Panama Canals, will stem from the fact that all inter-continental seaborne traffic, and much coastal traffic as well, must then proceed via the Cape of Good Hope and Cape Horn. In the circumstances, from this cause alone, concern with Antarctica, as a possible air or submarine base, is bound to be a preoccupation of any great Power.

Antarctic exploration and exploitation are bound, therefore, to become more and more an affair of Governments rather than, as in the past, of individual adventurers or scientific societies. At the same time, if the experience of the past ten years is any criterion, less and less scientific result will accrue per unit of energy and money expended. Foreign ministries, even more so defence ministries, are very remotely concerned with science for its own sake. This marked failure to work up and publish results is, indeed, the outstanding feature of the antarctic record since the Second World War. This is an aspect of modern antarctic exploration to which the British Association, as other science associations, might well give some heed.

I cannot, within the bounds of a single address, hope to deal with the work of all countries in Antarctica since the War. The Americans have planned and carried through operations almost on a war scale. Admiral Byrd goes south periodically with many ships and thousands of officers and men. In 1946, for example, planes from the deck of an aircraft-carrier, standing off the coast, reconnoitred some 800,000 square miles in a few weeks. Airborne magnetometers were used for the detection of islands completely hidden by land-ice. Icebreakers steamed in a matter of days half-way round Antarctica from the Ross to the Weddell Sea, and, incidentally, pulled out Finn Ronne's party, which had done a unique job of dog–air co-operation with the British under Butler along the Graham Land coast. This American party made history by overwintering two women at their base. In theory a further step in co-operation was achieved when an agreement was signed making photographs and specimens mutually available; but alas, things have not worked out so well in practice as was hoped. Returned antarctic explorers are as human as anyone else. One of the announced motives of the American exercise was the testing of men and equipment in case of the outbreak of 'hot' war.

The contributions of Australia, with the veteran Douglas Mawson as the main driving force, and of France, have been outstanding too. In Kerguelen, France has a sub-antarctic scientific outpost of first-class quality and is preparing airstrips there 3,000 metres and 2,000 metres long. An intriguing side-issue is the attempt to acclimatize "reindeer, mink, sheep, pigs, and ponies". From a base in Adélie Land the French have explored widely along the coast and some distance inland. Australia has permanent stations established at Macquarie Island and at Mawson on the mainland. A spokesman has recently defined her objective as the making of short forays at selected points on the antarctic continent, concentrating on specific scientific problems, which suggests that here, at any rate, the old scientific spirit is still alive.

Whaling

No account of twentieth-century man's relationship to Antarctica would be complete without some reference to the history of the whaling industry. Whatever may happen in the future, so far whales, elephant seals and fur seals are the only tangible assets antarctic exploration has produced.

The first shore-based venture in South Georgia in 1904 employed one catcher and took 195 whales. In 1954–55 nineteen factory ships, three shore stations and 254 whale catchers between them accounted for 37,654 whales and produced 372,956 tons of oil and nearly 80,000 tons of meat products. Until the present spate of Government activity set in, antarctic exploration had, through this single asset, paid for itself over and over again.

The whaling industry has not been without its vicissitudes. The price of oil has fluctuated from £8 10*s*. a ton to £170 a ton, though it is now fairly stable at £75. But operating costs increase steadily and to-day the margin of profit has become very small. The success of whaling, of course, even if prices are remunerative, must depend upon the maintenance of the stock of whales, and this has led to international regulation on a considerable scale. In the early days the industry was carried on from shore stations, all of which were, in those less complicated times, in the undisputed control of Britain. The industry was easily controlled by the issue of licences. In 1925 the situation was transformed by the invention of the floating factory, and the stern slipway followed soon. Up the latter the whales could be hauled by winches and flensed and rendered-down on board, thus doing away with the need for a shore base away from the home country. From now on an entirely different type of control was needed. The League of Nations in 1931 drew up a convention which established the principle of the international regulation of whaling on the high seas. In 1933 most companies agreed to voluntary limitation of catches. Whaling inspectors were appointed to accompany all ships in 1934–35. Complication was caused by the defection of Germany and Japan from the League just before the Second World War; but when the War was over, the International Commission was established in 1946. The catch is now limited to 15,000 blue whale units. Despite protective measures, the blue whale stock has greatly decreased, and there are to-day signs that the fin whale stock, now the mainstay of the industry, is on the decline.

The skill of the whalemen of Norway has been both the strength of, and a danger to, the whaling industry. Something in the nature of a Guild of Whalemen has developed with its accompaniment of a jealously-guarded monopoly of skill. The two chief trends of the half-century have been the improvement of the technique of whaling and the more efficient utilization of the body of the whale. In the former field Norwegians have been supreme, though recently useful innovations such as the electric harpoon—to replace the destructive harpoon-gun—and the echo whale-finder have originated in Britain. Other notable developments have been the use of helicopters for finding whales and the attachment to whale carcases of small wireless transmitters so that catchers fitted with direction-finding apparatus can home on them in any weather conditions. In utilization Britain has, perhaps, taken the lead. To-day almost every part of the whale is used. The main use of whale oil is, of course, the manufacture of margarine and soap; but it is also used as burning oil, for tempering steel, for leather dressing, and in lubricants. Experiments in the production of artificial wool from blubber are under way in Japan. Whale-meat meal is used for feeding cattle, pigs, poultry and silver foxes; small quantities of whalebone for the grooving of sliding doors, for collar studs and stiffeners, for cigarette cases and the backs of hairbrushes. Canned whale-meat is to-day, even in peace time, in some countries a common form of human food. In 1954, 30,000 tons of salted whale-meat was used as food for miners in Japan alone. In 1954–55 these by-products were worth nearly a million pounds.

Whaling springs from exploration; but it has, in its turn, had a profound influence upon exploration. Here again, there has been a curious mixture of effects. Whaling captains, by and large, are, not unnaturally, loth to give away the location of good hunting-grounds. From this natural reticence have sprung many of the contradictions and uncertainties of polar history in the past. This trait must have had its effect upon the controversies about priority of claim that have been so frequent and so bitter. Yet there have been from time to time enlightened owners and skippers who have contributed notably to the unveiling of the southern continent and the islands off its coast. From the nineteenth century Messrs. Enderby Bros., John Biscoe, and Weddell immediately spring to mind. Their names are rightly written large upon antarctic maps. In the present century the firm of Salvesen, Captain Larsen—who died while whaling in the Ross Sea—Lars Christiansen, and Mikhelsen, equally deserve to be remembered as explorers as well as whalers.

Another valuable contribution to the exploration of antarctic seas that springs directly from whaling is the oceanographical research carried out by the Royal Research Ships *Discovery I* and *II*, and now continued by the National Institute of Oceanography. This work was originally financed by the United Kingdom from whaling dues. The *Discovery*'s work is essentially a survey of the antarctic seas and their organic resources. These seas have an exceptional density of marine life, and oceanographical conditions are distributed in a simpler pattern than in most other oceans. For twelve years between the wars R.R.S. *Discovery* covered the southern charts with a complex network of courses, encircling the globe. The scientific results surpass even those of the *Challenger*. By 1938, eighty memoirs by fifty authors filled fourteen volumes. More than 4,000 whales had been marked. Her researches on the breeding and life-cycle, the distribution, migrations, and habits of the whale have been of major importance to the successive bodies responsible for the regulation of the industry. The oceanographic survey has revealed the broad structure and mechanics of the principal water masses and currents and certain basic features of the distribution of the ocean plankton.

The Antarctic To-day

So we come to the present day and to a fresh resurgence of interest which we can really claim has science for its main drive. Twice in the past, during 1882–83 and 1932–33, the scientists of the civilized world have planned an International Polar Year. To-day they plan again, but, as is fitting, on a vastly larger scale, the International Geophysical Year for 1957–58. Although it is intended to cover the whole Earth with chains of stations from pole to pole, the systematic exploration of the physical phenomena in and over Antarctica is a most striking component of the plan. A long-range practical objective has been described as a better understanding of climatic variation and the study of the nature of long-period climatic change. We are apt to forget how much the present pattern of our civilization depends upon the latent heat of ice. If the present ice-sheets of the world melted in a hurry, sea-level would rise somewhere about a hundred feet. This would, among other painful things, bring about the greatest slum clearance the world has ever known. The present long-term tendency to glacier retreat is, however, accompanied by a rise in sea-level of only four inches a century. The rise in the temperature of ocean water that accompanies this climatic change has important repercussions on the fishing industry, upon which the welfare and livelihood of tens of thousands of European families depend. Another question still a matter of controversy is whether continents move, and, if so, at what rate. A fuller knowledge of the ionosphere will help in improving wireless communications, which are now essential to our mode of life. Upper atmospheric studies are important in the future development of high-flying aircraft.

The immediate observations that will be made during 1957–58, chosen because it is a year of nearly sunspot maximum, are, however, concerned with the exact recording of physical phenomena which will appear to the layman as the purest of pure science. Yet Sir Edward Appleton has lately reminded us that history has taught us to regard pure science as the capital of scientific knowledge, capital that has yielded astonishing dividends from time to time.

The world is entering on its latest experiment in a big way. A mere enumeration of the subjects of study is evidence enough of the comprehensive nature of the programme. Meteorology, the study of aurora and airglow, geomagnetism, ionospherics, ozone, cosmic rays, glaciology, solar activity, variation in longitude and latitude, seismology and oceanography, are all embraced. I can even visualize a little geology being done on the side, though most of the people concerned may never handle antarctic rock. The total cost of the plan has been assessed at £100,000,000. No less than forty-five nations have pledged themselves to play their part. In and around Antarctica there will be more than forty stations, of which three will be, respectively, at the geographic pole, the geomagnetic pole, and the Pole of Inaccessibility*. These last will be supplied and maintained entirely by air.

The most spectacular element in the plan is the examination of the upper regions of the atmosphere. Man reaches farther towards space than he has ever done before. It is planned to employ man-made satellites, dispatched by means of three-stage rockets, to a height of 200 miles, there to girdle the Earth in an elliptical path which varies between 200 and 800 miles, in 90 minutes dead. The satellite is expected to stay up days or weeks, before it falls and is consumed, as are millions of the meteorites that enter the atmosphere every day. Large rockets will reach out—their tracks like slender fingers—to several hundred miles above the Earth, carrying heavy loads of recording apparatus. Rockoons, smaller rockets launched from balloons twenty-seven miles up, can carry a lesser load to a height of more than sixty miles. Small rockets may be dispatched from aircraft in flight.

Balloons will be launched trailing a variety of instruments, tracked throughout their course by observers, and eventually parachuting to earth. Automation, a cause of anxiety and unrest here at home, can be seen with more detachment as an essential element of the International Geophysical Year plan. Perhaps it is at its most dramatic in the so-called 'Grasshopper', a small recording device weighing 200 lb. which can be dropped from an aeroplane at any desired spot. As described to me, it automatically opens, rights itself on its six legs in true insect fashion and goes into action. 'It gathers weather information at predetermined intervals, transcribes it automatically into International Morse Code, and transmits it by radio at seventeen words a minute." It works for sixty days and records and transmits surface wind speed and direction, temperature, barometric pressure and humidity. To one who has toiled to and fro between hut and screen, this sounds to be a very desirable development indeed—a distinct advance towards *Utopia Antarctica* and not a matter for grousing at all, even if the substitute job is handyman or cook.

Already the International Geophysical Year has begun to work its transformation of the antarctic scene. Direct American flights from New Zealand to Antarctica have taken place. The Russians are in regular radio touch with Moscow, and plan a supply route direct from the U.S.S.R. by air. The continent is becoming studded with little towns. Icebreakers plough the antarctic seas with internal temperature kept at 75° F.: a fact that reminds me vividly of what I reckoned to be one of the hardships of American life. In this great effort Britain plans to play a worthy part. One major expedition, sponsored by the Royal Society, is already established near 76° S. in the Weddell Sea. The Falkland Island Dependencies Survey bases are being reinforced to help.

Dr. V. Fuchs's trans-Antarctic expedition is a horse of a rather different colour, though it will, as a side-issue, contribute to the plan. He intends to cross the antarctic continent from west to east. It has been said in criticism that the British have been so obsessed with the story of Shackleton and Scott that they cling unduly to outmoded ways. We have, it is true, suffered from too strict adherence to tradition in the past. There is an element of gambling in the present Trans-Antarctic plan. But Fuchs intends to take seismic soundings of the ice depth together with a continuous gravity traverse as he makes his way across. In addition to tractors and aircraft, he will have auxiliary dog transport to examine rock exposures he may meet along the unknown country he has to traverse. Of all the modern equipment, the small electronic device weighing less than one pound by which he can home on his moving column from distances up to twenty-five miles attracts me most. If he is fortunate he may come back with results that will, of their kind, be as valuable as anything his more sedentary competitors can possibly produce. And there is an element of adventure that, for any normal citizen, will definitely add to the fascination this particular venture exerts. Good luck to him. May he and his men so conduct themselves that, if they do fall short of complete success, they will, like Shackleton of *Endurance* fame, come out of the trial with reputation not diminished but enhanced.

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* The term was first used by Vilhjalmur Stefansson to indicate the point in the Arctic Ocean which was theoretically most difficult of access under the sledging conditions prevailing in his time. As applied to the antarctic continent, it must presumably mean the spot on the inland ice most remote from an attainable base.

The Future

When I left England with Shackleton in 1907, I travelled to Australia in six weeks by sea at a cost of £19 from a London where the four-wheeler horse-cab was still commonplace; where radio was in its infancy and a criminal could still hope to outpace the law by ocean travel. I lived in a world which was, by and large, convinced that mankind was unique and life confined to Earth. The expedition left New Zealand on New Year's Day, 1908, and for all its countrymen knew about what was happening in the next twelve months we might have taken off into space. The first tentative flights were being made in machines heavier than air.

To-day I return to England for the British Association meeting from Australia in the inside of three days at a cost of £300; to find Dr. Fuchs in constant touch with his colleagues in Antarctica; in a world in which a Harvard professor of astronomy has recently asserted in a London Sunday newspaper that life exists on a million worlds. His country proposes to launch an earth satellite as part of its International Geophysical Year programme. American airmen are flying hundreds of tons of stores from New Zealand to Antarctica as an ordinary Service transport operation.

Who can predict what may happen in a similar tale of years in the future? Antarctica may be colonized: man may have landed on the moon. On the other hand, it is as likely that, if man's passions get out of hand—and control of emotions is not a notable twentieth-century trait—the survivors of mankind may be plunged in a Dark Age such as has succeeded civilizations of the past at least nine times in the chequered history of mankind. Man is indeed at a crossroads to-day. We of the British Association may well ask ourselves what we can do to help the world to make the choice that will ensure the survival and further progress of humanity perhaps to the point when man is no longer earth-bound.

So far as the future of Antarctica is concerned, we still have too little to go upon for speculation to cut much ice. Now that atomic energy is available and atomic power is immediately ahead, the mere strategic threat of a monopoly of Antarctica by any one Power should by itself suffice to keep the interest of the nations alive. Great and valuable mineral deposits there must be in any continent of this size and kind, though nothing of significance has so far been found. Prospecting on the continental scale, let alone exploitation, will be so costly that, apart from a stroke of luck, it will require finance and organization at least on the national scale to ensure success. In 1951 the two hundred million pound Kitimat project was started in a completely undeveloped area in British Columbia and is just about to pay off. But this is based on cheap local power and will be used for processing aluminium ore brought 4,500 miles from Jamaica. In Antarctica something on this scale would be the least that would be required should large and valuable ore bodies be found. Airborne magnetometers and stereoscopic-camera mapping are already in use in antarctic surveying. Future exploitation lies with the co-ordinated use of airborne surveyors carrying out wide sweeps and of helicopter-borne ground parties equipped for high-speed core drilling and rock sampling. In Canada five geologists with two helicopters have prospected in one season some 67,000 square miles. Attention must needs be concentrated, as at present, on the relatively few exposed rock surfaces where mining could be carried out without difficulties arising from ice movements. Once the ore is located the whole enterprise could gradually go underground. Tunnel or adit entry might be followed by the construction of underground engine-rooms, hoisting gear and mineral dressing plants. Floating power-stations that could be withdrawn for maintenance during the 'closed' season might be a useful expedient in the initial stages; but land-based stations would be essential to any permanent settlement. Once a footing had been obtained, anything might happen in these days of technological man.

It has been suggested, for example, that the Antarctic might have a future use as a vermin-free store for the world's periodical food surpluses, where these might be preserved against the needs of future generations, since widespread crop failures might otherwise spell disaster to a world whose population seems destined to increase. Again, one of the main claims for atomic power is that it can be maintained for long periods in remote places with a minimum of attention and thus might be used for the development of the desert areas of the world, uninhabited to-day because they are too cold, too hot, or too dry. If atomic-powered icebreakers can be built, why not atomic-powered settlements on the antarctic mainland? The harnessing of the antarctic gales is another possible source of power. But everything will depend upon the discovery of a worth-while economic objective, and this is not at the moment in sight. The chances are that, for the remainder of this century, Antarctica will remain the scene of investigations in pure rather than applied science. But man may yet find a way to overcome the latent heat of ice and add a seventh habitable continent to the six he already has in thrall.

SUMMARIES OF ADDRESSES OF PRESIDENTS OF SECTIONS

PHYSICS AND TECHNOLOGY

IN his presidential address to Section A (Mathematics and Physics), Sir George Thomson stresses the need for more young people to be trained in physics and mathematics, since these branches of science are becoming increasingly important in technology. Advances are being made within existing technologies by using devices based on physics and on methods depending on mathematical, especially statistical, analysis, and fresh branches of technology are arising which depend on new scientific discoveries. In industry to-day there are both engineers and physicists, and the number of physicists is increasing exponentially. The value of the physicist to the industrialist lies in the fact that he is prepared to look at things from first principles, to try a variety of quite different modes of attack and to get the thing to work somehow, though the product he makes is likely to be scrappy and to go wrong. The engineer uses his background of experience of design to tidy this product up and to make something which can be used by the ordinary person.

In the early days, technology owed little to science—the smelting of metals, for example, was discovered before science existed. Physics, too, arose largely from curiosity—the study of odd phenomena like the reflexion of one's face in a pool or the attraction of rubbed amber for pieces of chaff. Nevertheless. there was always some interplay between technology and science, as witness the impetus given to the study of heat by the invention of the steam engine. But the real influence of physics on technology started with the advent of electricity. From Faraday came the dynamo; from Maxwell and Hertz radio; and from J. J. Thomson the television tube; and in many of our newer industries based on physical processes the physicist is still the one in charge. Technology thus owes a considerable debt to physics; but this debt has largely been repaid, for without the many machines and devices, such as the mechanical vacuum pump and the innumerable electronic components which technology has developed, progress in physics would have been impossible.

Four particular applications of physics are singled out by Sir George for discussion: the peaceful uses of nuclear energy; the electronic computer; the transistor; and the earth-satellite to be launched by the United States during 1957. First in importance in the peaceful applications of nuclear energy is the production of electricity. Nuclear energy, at present, can be applied only in the form of heat. The reactor, in which the chain reaction takes place by which the uranium or plutonium atoms are split with the release of enormous amounts of heat, is essentially a furnace the heat from which must be transformed by some conventional method into electricity. In the Calder Hall piles, for example, the heat is removed by carbon dioxide gas, transferred through heat exchangers to water and steam, and the steam goes into turbines which drive the dynamos generating the electricity to be fed into the national grid system. In accordance with the programme for the development of nuclear energy in Britain, it is expected that, by 1975, 40 per cent of the, by then, considerably increased generation of electricity in Great Britain will come from nuclear power, thus saving approximately 40 million tons of coal per annum. Only a small part of the cost of the new power will be represented by the uranium fuel, and it is considered that there need be no fears about the possible future shortage of fissile material, whether this be natural uranium or obtained from thorium in a breeder reactor. Sir George forecasts that in the not very distant future electrical energy will be derived directly from the thermonuclear reaction between deuterium nuclei (the basis of the hydrogen bomb), thus eliminating the inefficient heat engine which must occur in the uranium system.

The chief limitation to the wide application of nuclear power is the cumbrous, though essential, radiation shield. This may rule out the nuclear-powered motor-car and possibly also the nuclear-powered aeroplane, since for an Atlantic crossing the saving in weight of fuel through using nuclear power would be balanced by the added weight of the necessary biological shield.

Turning to the use of radioisotopes, Sir George cites two examples, one from medicine of the use of sodium-24 to determine the rate of flow of blood, and the other from engineering of the measure of wear of a bearing.

The electronic computer, because of its versatility and wide range of application in science, medicine and commerce, is considered by Sir George to be comparable in importance to nuclear energy. Its importance arises from, first, its power of discrimination, that is, its ability to influence itself by what itself has found, and second, its speed and the consequent large number of operations it can perform in a given time. The transistor is a device consisting of a minute slice of germanium or silicon, replacing in many cases the thermionic valve, with the added advantage of great reduction in size and probably cost of electronic equipment. It was the result of research in pure physics.

The proposed earth-satellite is regarded by Sir George as an admirable example of the interplay of physics and technology. Its immediate purpose is to make measurements outside the Earth's atmosphere; but it is hoped that it will lead to the overcoming of gravity so that men may travel to other planets. The spherical satellite, some 20 lb. in weight, will be launched by a three-stage rocket and move at a height of 300 miles around the Earth at a speed of nearly 18,000 miles per hour, where it should stay for several weeks sending out continuous messages of the measurements it is taking.

STEEL-MAKING SINCE BESSEMER

SIR CHARLES GOODEVE'S presidential address to Section B (Chemistry) discusses the chain of chemical development which was started by Bessemer, namely, the making of steel by pneumatic processes. The problem to-day is the same as that faced by Bessemer: the preferential deoxidation of the iron oxides in ore with the minimum of other elements, followed by the preferential oxidation under different conditions of the other elements in the impure metal. The usual deoxidizing element is carbon in the form of coke which reduces the ore in the blast furnace. It is not, however, possible to stop the process at the right place, and the pig iron is over-deoxidized and contains a large amount of carbon.

Before Bessemer, the oxidation was done in the puddling furnace which produced 'wrought' iron. Great skill was needed and the process was slow and arduous, requiring two or three hours to produce a quarter of a ton of metal. The open-hearth furnace, invented shortly after Bessemer's converter, operates similarly to the puddling furnace; but the chemical reaction is faster because the temperature is higher, and the evolution of carbon monoxide stirs the bath. A modern open-hearth furnace produces a ton of steel every three minutes.

Bessemer oxidized by blowing air through the metal. The speed of this process is limited only by the danger of blowing the iron out of the converter. A modern converter can make 8 tons of steel in 3 min. and is about a thousand times faster than a puddling furnace.

We now know that at steel-making temperatures a reasonable proportion of the colliding molecules have the required energy of activation to produce chemical change, and the rate of reaction is governed by the rate at which collisions between the right kind of molecules occur. This in turn depends on the rate of diffusion and rate of mixing.

Bessemer realized the importance of mixing; but the explanation of his failure to remove phosphorus was not known in his time. Sidney Gilchrist Thomas found the solution twenty years later: that while it is not possible to burn the phosphorus out of the iron, it can be drawn out under oxidizing conditions by means of a slag formed from strongly basic materials such as lime and magnesia.

In recent years much research has been done which explains quantitatively the complicated selectivity rates governing oxidation and deoxidation. Sir Charles then describes the theory of chemical potential and its application to the removal of phosphorus from iron in a basic converter.

Bessemer steel, however, contains two or three times as much nitrogen as open-hearth steel, and this spoils it for some purposes. The open-hearth also has the advantages that it can use steel scrap as well as pig iron, and it can use pig iron with a greater variety of composition. Hence it has steadily replaced the converter, which now produces less than 15 per cent of the world's steel. The decline of the converter process is now being arrested mainly through the development of large-scale production of oxygen, which can be used, diluted with air, steam, or carbon dioxide, for blowing converters. Oxygen removes most of the disadvantages from the Bessemer process. It reduces the nitrogen content of the steel and makes it possible to melt scrap.

Another pneumatic process has been developed in Austria for making steel by blowing a jet of oxygen down on to the surface of the metal. This impact stirs the metal sufficiently to set up vigorous chemical reaction. More interesting is the fact that the phosphorus comes out before, or along with, the carbon, showing departures from equilibrium conditions by factors of ten to one thousand. This is because the kinetics of the phosphorus reaction are much more favourable than those of the carbon reaction.

Sir Charles concludes by reviewing the future of pneumatic processes. Steel-making still depends on the production of the iron–carbon alloy, pig iron, which is not only off the direct route from ore to steel, but also is costly to make. Steel-makers for many generations have longed to develop a cheap process for converting ore directly to low-carbon steel. Several exist, but they have severe limitations.

The speed of Bessemer's process depends on the dispersion of bubbles of air in a liquid metal. Similar speed could be obtained by reversing the system and dispersing small drops of liquid ore in a hot reducing gas. The British Iron and Steel Research Association is now developing such a process under the name 'cyclosteel'. This is still in its very early stages: formidable technical obstacles stand in its way; but such a method of making steel from powdered ore and coal is extremely attractive.

THE PRESENTATION OF GEOLOGICAL INFORMATION IN MAPS

A GEOLOGICAL map, Dr. T. Robertson points out in his presidential address to Section C (Geology), is a combined lithological, stratigraphical and structural representation of what is known or deduced about the rocks in a region or area of the Earth's surface, the terms lithological, stratigraphical and structural being used in their very broadest sense. Such a map has two functions—one scientific, the other economic. In its primary or scientific aspect, the map is a record of research into the geological history of the region, telling as fully and as lucidly as its limitations permit the story of what has happened to the region during the continuous succession of geographies that it has experienced over a period amounting in some cases, where the pre-Cambrian rocks are known, to some thousands of millions of years. A land surface is generally, however, a destroyer of the Earth's historical documents, not a preserver of them, and few regions possess a continuous series of geographical records even for one set of rocks. It is nevertheless vital in research to bear in mind that, no matter how much of the record is now missing, the geological life-history of the region is one and indivisible, each geographical expression taking from and adding to our knowledge of those preceding it. In its economic aspect the geological map is a means of providing as many geological facts and deductions as can conveniently be given in codified form, with the hope that they will be useful to anyone who is in search of information for economic purposes.

The geological map is in essence a record of deductions from facts rather than a record of facts in themselves. The deductions are partly derived directly from the local evidence and partly indirectly, as by the application of reasoning or analogy based upon what is known, or what is thought, to have taken place elsewhere. It is in these processes, carried on throughout the progress of the survey, that the alternating inductive–deductive flux characteristic of scientific research is clearly shown, and the completed map becomes a record of the results of such research. No geological map, however, is a complete scientific study in itself, for it is a representation of a combined lithological and structural conception based upon the scientific judgment of the surveyor, and this conception cannot be fully explained within the limits set by cartographic means of expression. Hence arises the need for a written explanatory account. The result of the geological survey of an area is a complex of interwoven research items leading to theoretical and practical deductions which have application not only in that area but also throughout the whole range of the science.

The deductions that give rise to the actual texture of the map are affected by two important factors, namely, the type and degree of accuracy of the geological data used and the extent to which deductive processes have been applied to them. Consideration of these leads to the conclusion that the geologist must be his own cartographer, and a plea is entered for greater recognition of cartography as being an essential part of geological research, not a mere tool in the hand of the geologist.

SOME IMPLICATIONS OF THE STUDY OF ANIMAL BEHAVIOUR

IN his presidential address to Section D (Zoology), Dr. W. H. Thorpe remarks that it is instructive to consider in what way developments in the study of animal behaviour since Lloyd Morgan's day have affected our views of the animal, and what are their implications. For Lloyd Morgan achieved a general attitude towards animal behaviour and experiment thereon which is striking for its sanity and balance.

Lloyd Morgan assumed three levels of mind (regarding the instinctive as a level of mind and not only of bodily behaviour). He says: "Bottom level minds, if such there be, are percipient only, having sense awareness and no more. Middle level minds are perceptive and percipient, while top level minds are reflective, perceptive and percipient". These three levels he regarded as associated respectively with the sub-conscious, conscious and self-conscious; although we should hesitate now to use these terms.

The main theoretical innovations since Lloyd Morgan's time are undoubtedly those concerning appetitive behaviour, consummatory acts and releasers.

While the idea of a relatively rigid consummatory act is sound, and the separation between appetitive behaviour and consummatory act probably continues to be as useful as it ever was, recent researches have made it clear that the distinction is not hard and fast, so that the characteristic instances of flexible appetitive behaviour and rigid consummatory act can now better be regarded as the two ends of a series.

Thus recent experiments on the following-response of young birds such as moorhens and coots have shown that the active maintenance of a certain spatial relation to a chosen object turns out to be its own reward. Similarly, with the vocally imitative birds, the very act of imitating, the very fact of achieving the appetitive behaviour, seems itself to be the consummatory act.

Again, naturalists of fifty years ago were impressed by the complexity of the action patterns of instincts. But they had scarcely realized that the innate *perceptual* organization must be no less complex, and they had no idea of the sensitivity and fineness of adjustment characteristic of many organs of special sense, as now revealed by sensory physiologists and ethologists studying the orientation mechanisms of insects and birds.

Such discoveries have led to another modification, namely, the tendency to modify the concept of consummatory act by the concept of consummatory stimuli or situations. Besides 'seeking' to discharge its fixed action patterns and so relieve the instinctive 'tension' accumulating around the mechanism of the consummatory act, there is now evidence that some of the appetitive 'searching' is an attempt to find a key environmental situation. Perhaps there is also some real though very limited purposiveness in the search for a satisfying situation. Actions are not always brought to cessation by exhaustion of internal drives or by cessation of the eliciting stimulus. There are external situations which instead of, or in addition to, acting as releasers for the next phase of behaviour serve to bring the previous phase to a close. In this case they must be effective in stopping a piece of behaviour even when the original eliciting stimulus is still present. They are thus 'consummatory stimuli' or situations, and thus the 'goal' is not always the performance of an action: it may sometimes be the perception of an environmental situation.

Many such modern developments in ethology show a tendency to return to the Lloyd Morgan position at a newer level, consonant of course with the immense development in our understanding of the physiological basis of behaviour. For example, it seems inescapable that much modern work on animal behaviour implies that the vast majority of metazoan animals are perceptive. Moreover, in many highly organized perceptions, the perception of relations involved implies something more than this, which Lloyd Morgan would have taken to be self-consciousness; and a great deal of modern evidence for insight—learning, imitation, play, number sense and reminiscence—gives reasons for considering animals to be reflective in his sense. Modern developments in the study of the higher learning faculties of animals have also served to emphasize the necessity for getting back to the idea of a carefully thought-out combination of objective and subjective approach, exemplified by Lloyd Morgan. The best instruments can be misused, and it is possible to cut our throats with Occam's Razor and to disintegrate our animals with a blast from Lloyd Morgan's Canon. If we try too rigidly to be objective, we may fail to see important features of animal behaviour which become clear to us when we attempt to put ourselves in the animal's place; while to go to the other extreme and be too subjective is fatal. We must safeguard ourselves always with all the knowledge we have of the animal's nervous, sensory and behavioural capabilities and its endocrine equipment. A proper balance of subjective and objective is thus necessary both for a worthy ethology and a worthy psychology.

The result of this recent work on instinctive behaviour and the percipient learning abilities of animals is that some apparent lines of demarcation between man and animal nature have become blurred. Behaviour study seems to be reinforcing physiology in stressing the basic unity of the living system in more and more of its manifestations. Some of the fundamental thought-processes of animals seem far less dissimilar from ours than we once thought, and we now see that even the bees have a propositional 'language'.

Ethology has as yet little to say on the fundamental issue of the relationship between living and non-living states; but it does make an impressive contribution to the chorus of voices which are emphasizing the essential unity of living things and the similarity, in much that is fundamental, between animals and man. But while this is true, it would be a view of the utmost *naiveté* to assume that studies of animal behaviour imply any decrease in the stature of man. For it is sound scientific common sense to see that, if only because of the existence of science itself, man displays emergent qualities far transcending those of the organisms most closely related to him.

THE USE AND MISUSE OF CLIMATIC RESOURCES

PROF. A. AUSTIN MILLER, in his presidential address to Section E (Geography), emphasizes that the climate of a country is one of its natural resources and may be regarded as an annual income of rain, warmth, energy, etc., the conservation and expenditure of which should be systematically planned. The first step in such planning is a full and fair assessment of the available resources; but although voluminous climatic records are available, there are still extensive areas where they are inadequate. Moreover, the data are not always of the most useful kind; more information is needed on evaporation, river flow, actual insolation, soil temperatures and micro-climate, not normally included in the duties of meteorological observers. This emphasizes the need for team-work and co-operation between scientists in many fields—climatologists, geographers, hydrologists, engineers, agriculturists, pestologists, physicists, etc.

The total available revenue of climatic resources is reliable within broad limits over a full year; but the incidence varies diurnally, seasonally and, to some extent, capriciously with the weather. Studies of seasonal distribution and of variability are therefore indispensable, especially in regions of subsistence agriculture, where the population lives from hand to mouth. But the vulnerability of primitive agricultural systems is being reduced by scientific research. Knowledge of the nature and the degree of dependence of crops and stock on climate is rapidly improving in precision; with this knowledge and a full assessment of climate, it is possible to fit the crops to existing conditions and to attain higher yields, better quality, more efficient distribution and, above all, greater security. This applies throughout the world—not just to areas of backward and subsistence agriculture but even to the most advanced and intensive types of commercial horticulture. Much more widely than is generally recognized, supplemental irrigation is needed to obtain increased yields, especially of grass and vegetables.

In more advanced societies with industrial and urban characteristics, and greater technical resources, climatic planning involves: (1) redistribution in space, that is, transfer of water, power, etc.; (2) regulation of consumption in accordance with expectable climatic conditions, banking the surplus heat or rain of one season against the deficiency of the cold or dry season to come. Heat, derived initially from the Sun, is stored in the ground and in water bodies and can be extracted from them as required, magnified by the heat pump and used for domestic heating, refrigeration or even as a source of power. Water is stored in lakes or reservoirs at the surface or in water-bearing strata (aquefers) underground.

Despite an apparently generous rainfall, Britain (and many other industrialized countries) is in immediate danger of water shortage, mainly because of the rapidly growing demand for industrial purposes and the extension of piped supplies to an increasingly urbanized population. Water, from the mains, is now regarded as universally available; industry and settlement are no longer tied to natural supplies; on the contrary, the new industries and new towns, their sites selected for some other reason, demand and determine the water supply (piped). Four possibilities for remedying the resulting threatened shortage are being investigated: (1) extension of surface storage, together with means of checking evaporation losses, which are considerable in summer and enormous in hot climates; (2) transport by pipe-line from areas of surplus (the highland zone) to areas of deficiency and increasing demand (the lowland zone); (3) the re-charge of aquefers, such as the chalk under the London Basin, now being depleted by over-pumping; and (4) the re-use of effluents and other unpurified supplies for industrial and irrigation purposes for which potability is unnecessary.

The world map of power resources is undergoing a revolutionary change and some of the future supplies are climatically determined. Water-power, dependent on relief and climate, is already established; solar energy and wind-power are on the verge of entry into the list of geographical factors. But advances in the technique of transport of fluids (oil and water) by pipe-line and of power and heat (as electricity) by cable diminish the importance of the actual location of supplies and widen the geographical range of practicable utilization of climatic resources. Taken in conjunction with the new assessment of agricultural productivity and the discovery of new uses for hitherto neglected climatic assets, these developments hold out a whole new set of possibilities the potential effects of which are worthy of the close attention of geographers.

PRICE—AND COMPETITION—IN TRANSPORT AS AN INSTRUMENT OF POLICY

THE price of freight transport forms the subject of the presidential address by Prof. Gilbert Walker to Section F (Economics). Railway rates have so far been controlled by the close regulation of a supposed monopoly. For the future (as long, at least, as the Transport Act of 1953, now to be amended by the Transport (Disposal of Road Haulage Property) Bill, shall be effective) transport charges are to be determined by competition between carriers.

Price as an instrument for distributing scarce resources has much to recommend it. Its efficiency can be (and is in an appendix to the address) illustrated by the example of parking. Competition in transport, though active, is certainly not free. There is, by law, only the one carrier by rail.

Road hauliers are limited by law to successful applicants for a licence. The cost of transport does not necessarily reflect the amount of resources consumed by the respective services. The Transport Tribunal has recently heard the case of the British Transport Commission for a schedule of maximum charges to be applied subject to Clause 20 of the Transport Act of 1953. The Herbert Committee, reporting on electricity supply, has declared that the managers of nationalized industries should not take it upon themselves to furnish some facilities at less than cost if this is done at the expense of their better-paying customers. The small road hauliers cannot serve the public except on terms which pay, so what will happen to those traders and travellers who demand facilities which do not cover the direct costs of operation to the carrier affording them ?

The British Transport Commission is proposing to invest £1,200,000,000 in modernizing its plant. More is to be spent on the highways of Britain. There is no organization the duty of which it is to examine and compare the returns to these two quantities. No reduction in the price of carriage by road need be looked for from a programme of road improvement even although costs might be lower, unless the supply of vehicles plying for hire and reward can be increased. The conditions on which the licence to carry by road is being issued by the licensing authorities, first established for passengers by the Road Traffic Act of 1930 and by the Road and Rail Traffic Act 1933 for goods, is recommended as a subject requiring the most careful attention now that competition is to be relied upon as the instrument of policy.

OIL AND INDUSTRY

THE presidential address of Mr. A. C. Hartley to Section G (Engineering), entitled "Oil and Industry", traces the vital parts which civil, mechanical, electrical and other phases of the engineering profession have played in evolution of this industry since Drake drilled his first oil well in Pennsylvania in 1859 up to the present day. In oil exploration, the civil engineer is concerned with surveying, road-building, providing means of access, and subsistence, all contributory to geological and geophysical prospecting. In oil-well drilling, the mechanical engineer, and in oil production, the chemical engineer, both contribute substantially to modern methods of winning crude petroleum. Transportation both of crude oil and refined products again concerns mechanical (pipe-line) engineers, and Mr. Hartley stresses the great opportunities still open to them "to develop and improve plant and techniques and so enable the rapidly increasing quantities of oil required to be transported". Oil-loading in sea-going tankers is another phase of the petroleum engineers' activities, which, with a rise from pre-war 16,000 tons to present-day 32,000 tons capacity of tankers, has brought about not only re-designing of these oil-ships, but also construction of deep-sea jetties for accommodation of multiple tankers of heavy tonnage as well as cargo vessels ; the case of the Kuwait Oil Co., with its 4,200-ft. jetty out to sea, exemplifies present-day trends. Oil distribution concerns pipe-lines, road or rail tank cars, barges for coastwise traffic ; many of the specialized engineering professions are concerned in this.

Mr. Hartley includes some reasoned comments on the growth of the industry during the past sixty years ; discussing the present and future position of the oil industry, he considers that, while it is likely that atomic energy will be developed in Great Britain as rapidly as anywhere else in the world, by 1975 that energy will only be equivalent to about 40 million tons of coal. From this it is concluded that it is unlikely that atomic energy will contribute as high a percentage as hydro-electricity is now doing. Thus the petroleum industry has a long way to go to meet the steeply rising demands of oil consumers, anticipated to be about 70 per cent on last year's (1955) consumption making 1,200 million gallons in ten years time and increasing to at least 1,600 million gallons in 1975. World oil reserves are discussed, and we may expect "the ultimate recoverable quantities of oil in the ground to be sufficient to enable the increasing demands of world economy to be met until it moves into the age of atomic power". A section on 'oil in war' is a brief survey of what petroleum engineers and others accomplished during the Second World War to enable our Fighting Services to maintain superiority. The oil industry has still a vast effort to make and a long future before it, if only "to take over so much of the percentage now being filled by the coal and gas industries until nuclear power brings relief".

The vital part that oil has played in past years in the life of Britain is nothing less than transformation of the whole industrial life of the nation. When it is considered that 4½ million vehicles for carriage of passengers and goods in Britain alone depend on petrol or diesel oil; aeroplanes, naval and most merchant ships rely on it as fuel ; heavy industries require substantial quantities of oil fuel ; lubricating oil has to be provided from petroleum for 90 per cent of the world's requirements ; and, finally—the latest phase of production—hundreds of petroleum derivatives are now available to be used in manufacture of insecticides, detergents, plastics, rubber goods, paint and artificial silks, then beyond all question oil and industry to-day are inseparable and are likely to remain so for many years to come.

BLOOD GROUPS AND HUMAN EVOLUTION

DR. A. E. MOURANT, in his presidential address to Section H (Anthropology), states that, whereas in the past the study of human anatomical characters and, more recently, of blood groups, has been directed mainly towards the establishment of static classifications, we are to-day becoming more interested in the processes which have led to the development of the existing characters and of their distribution.

The external characters of the body were for a long time the only available basis for anthropological classification. They are mainly determined by heredity, but also in part by the external environment. Moreover, their genetics is complex and has been little studied. Each character appears to be controlled by a number of separate genes known as polygenes.

The blood groups are genetically much simpler and better understood : they are entirely under genetical control and unaffected by the environment of the individual. Nine genetically distinct blood-group systems are known, each comprising a number of genes, the frequencies of which vary from one community to another in a manner which permits a classification of those communities. Most of the existing information, however, refers solely to the *ABO* system. A number of other simple genetical systems are of anthropological interest, perhaps the most important being that which controls the varieties of adult hæmoglobin, including sickle-cell hæmoglobin.

Within any given area of sub-continental size, the gene-frequencies in most of the blood-group systems show an approach to uniformity, whereas those of the *ABO* system vary considerably between adjacent quite small areas, such as the counties of England. This suggests that the *ABO* groups have been subject to appreciable natural selection more recently than the others.

It is now known that certain diseases are commoner among persons of one blood group than of another, the most striking example being the greater tendency to duodenal ulcer among persons of group *O* than among those of other groups. Since these diseases are in part determined by the environment, we have here a possible mechanism of selection.

A better understood example of natural selection is that affecting normal hæmoglobin and sickle-cell hæmoglobin, controlled by a pair of allelomorphic genes. Homozygotes for the sickle-cell gene mostly die young of anæmia; but heterozygotes are less likely to die of subtertian malaria than are persons homozygous for the normal gene. Hence, under malarious conditions, selection gives rise to an equilibrium between the two genes.

By a study of characters subject to rapid selection, such as the hæmoglobins, of those not quite so rapidly selected, like the *ABO* groups, and of those blood groups which are yet more slowly selected, we may be able to trace relationships between human populations which have existed at varyingly remote times.

Even when allowance is made for the differing extent of our knowledge, there appears to be an increase in complexity in the blood groups as we go from the lower primates to the anthropoid apes, and a great increase as we go from the latter to man. We may perhaps suppose that the critical stage of evolution from ape to man took place in a limited area, and that the blood groups of the evolving race were relatively simple and adapted to the local environment. As man with his newly evolved mental powers gradually covered the Earth, so the blood groups and many other genetical characters have evolved along many different lines to meet the variety of new environments to which adaptation has been necessary.

We cannot doubt that human evolution is still going on, and its study on genetic lines has a great contribution to make to anthropology.

THE MACHINERY OF POSTURE

In his presidential address to Section I (Physiology), Prof. D. Whitteridge remarks that the very great developments in the design of servo-mechanisms during the Second World War have produced attempts to describe the activity of the nervous system in similar terms. These attempts have been resisted by those who hold that such descriptions are either valueless or already well known. One of the most attractive analogies is between head and eyes, and the gun-control platform on a battleship which may carry a telescope for observing enemy aircraft and has to be stabilized against roll and against change of course. If the telescope is stabilized against movement of the ship, the image of enemy aircraft will remain in the visual field and the observer can follow its comparatively slow movements.

It must be admitted at once that Sherrington knew as compensatory reflexes what we might describe as stabilizing reflexes or mechanisms with negative feedback. He emphasized the plasticity of the stretch reflexes of the muscles of the leg by which the weight of the pelvis can be supported in a variety of slightly different positions of the joints of the hind legs. He emphasized the sensitivity of the stretch reflex and the shortness of its latency. Nevertheless, the essential conditions for stability were not explicitly stated.

In the impressive and detailed work of Magnus on righting reflexes, we find much more stress on the presence or absence of these reflexes than on their exact performance. The persistence of righting reflexes after removal of the cerebellum is emphasized; but we have to go to the description of Dusser de Barenne to see how poorly they are then carried out, with tremors and irregular jerks.

The usual teaching is that, in the monkey and man, the labyrinthine mechanisms have become of little importance, and it has been suggested that they are inhibited by the precentral cortex. On the other hand, the reactions of normal human beings to sudden passive movement on the tilt table seem to be carried out by vestibular mechanisms and may have latencies shorter than those of cortical movements. After double labyrinthectomy, patients have 'jumbled vision' during walking or when they are wheeled over rough ground, because voluntary movement of the eyes is too slow to compensate for the passive movement experienced. During rotation of the head about the visual axis in man and the pigeon, the counter rotation of the eyes provides complete compensation; but after the movement is over, the eyes drift back. Clearly the vestibular reactions stabilize the eyes and provide a basis for the operation of fixation reflexes.

Finally, the role of the cerebellum as a stabilizing mechanism received new attention. After its removal, the latency of spinal reactions is unchanged; there are no data on the latency of rapid righting reactions, though they often show serious over-action. There is considerable evidence that the latency of cortical reactions is greatly increased, and correspondingly hopping and placing reactions are slowly and inadequately executed.

The suggestion of a series of stabilizing systems at different levels in the central nervous system cannot be extracted from the older literature, and has some usefulness in predicting and explaining the behaviour of intact organisms.

PSYCHOLOGY AND THE HUMANISTS

The claim that we can have a science of human behaviour has aroused misgivings because of the supposed implications of such a science for everyday life. In discussing these implications, Prof. J. Drever points out in his presidential address to Section J (Psychology), we must not be sidetracked by applications. Some of the latter have obviously questionable features. The refinement of technique in propaganda and advertising is not without danger, nor perhaps should we feel complacent about an educational system which sometimes seems to grade children like eggs or potatoes; but such developments are in the nature of by-products, and it is not with them that we are concerned.

Misgivings about the implications of psychology on the part of humanists and others concerned with values seem to depend upon two assumptions: (1) that science is an attempt to supersede ordinary thinking rather than supplement it; and (2) that in setting out to establish a science of human behaviour the psychologist is somehow claiming that human beings are predictable in the way that atoms or billiard balls are predictable. In point of fact, neither of these assumptions seems to be justified. The former is a result of over-simplification, and arises from a belief that in any situation there is always some one statement or theory which is 'really true', all others being partial or false. But even within science this does not hold.

The scientist describes as accurately as he can certain features of the world around him, and then devises systems or models through which the economy of inference replaces the laborious cataloguing of facts; that is to say, he invents a way of talking or thinking which is very useful for certain purposes, among them prediction and control. But this is not to say that he discovers what things 'really' are. My neighbour is really my neighbour just as he is really *Homo sapiens*, and really hydrocarbons, water, and some trace elements. The emergence of a science of behaviour does not seem to alter this situation in any important way, and it is a situation which has existed since science began.

The second assumption arises from the widely held view that science is mainly concerned with causes; but this is not the primary concern of science. The search for causes is a diagnostic enterprise carried on by the practical man—the medical practitioner, for example, or the engineer—rather than the physiologist or physicist. When we talk about the cause of anything we generally mean some particular item in its history without which it would have turned out differently. More especially it is an item which we can control or change, since every event has a multitude of causal ancestors. The reliable identification of this kind of item is clearly necessary for control over our environments, and science by clarifying the structure of events makes it much easier; but science itself need not talk about causes at all. All that we need assume when we embark upon a science of behaviour is that the object of our study makes some kind of sense, or in other words, is not merely random. This is an assumption which the humanist no doubt shares.

Perhaps the real reason for some of the contemporary uneasiness is that with the abdication of philosophy, which has become a specialism among specialisms, the ordinary man is tending to turn to the scientist, and perhaps particularly to the psychologist and psychiatrist, for answers to quite general questions. It may be that some are too ready to give him what he wants; but the real solution seems to lie in a bolder and more positive approach on the part of those who at present seem to have nothing to offer us between the rigours of logical analysis and a sort of nostalgic antiquarianism.

QUATERNARY HISTORY AND THE BRITISH FLORA

In his presidential address to Section K (Botany), Dr. H. Godwin points out that in so far as time is required for the processes by which plants and animals attain their distribution areas, so far the problems of biogeography must be historical problems.

Investigation of the Quaternary Period, and especially that part of it which includes the latest glaciation, the succeeding 'Late-glacial' period, and the Post-glacial period, has been applied with great effect to the study of plant geography in the British Isles. In the first place, it has enabled us to reconstruct former climates and geographical conditions during those phases of plant migration, expansion and reduction which gave rise to present ranges of area; and in the second place it has given us a chronological scale against which a great number of sub-fossil plant remains have been effectively dated, sometimes in years, sometimes by reference to a defined period of climate, vegetation, archæological culture or of geological events. Important techniques serving these purposes are pollen analysis and radiocarbon dating, the former serving at once to give a chronological scale and to provide direct evidence of the former range of certain plants. For the purposes of his address Dr. Godwin considers the data thus acquired for a few species only.

It has been strongly urged by many botanists that the rich collection of arctic-alpine plants now found in such mountain areas as Ben Lawers, Ben Bulben, Teesdale and Cwm Idwal are so localized because they were nunatak refugia during the glaciations. The dated records for such species as *Thalictrum alpinum, Dryas octopetala, Salix herbacea, Betula nana* and *Polemonium coeruleum* dispose effectively of this hypothesis, for they prove that these species were widely present in the lowlands of Britain in the Late-glacial period *after* the ice had vanished. Their restriction of range is a Post-glacial phenomenon associated, it may be guessed, with expansion of continuous deciduous forest, with increasing temperatures, with soil deterioration and with blanket-bog formation on high mountain areas. The records likewise prove the extinction during this period of certain plants present in the Late-glacial, so that their absence (as of *Betula nana* from Ireland) is due to extinction and not failure of migration to these shores.

Abundant evidence is forthcoming that a large part of the population of weeds and ruderal plants in Britain was naturally present also in the Late-glacial period, and that after suppression in the closed forest period they began re-expansion when prehistoric agriculture opened the woodland cover.

Likewise the records give evidence for the expansion of thermophilous plants (such as *Najas marina*) in the middle Post-glacial period, and retraction after the climatic optimum.

The methods of Quaternary research allow us to date the formation of the North Sea to a period about 8,000 years ago, and to prove that there was a long period of temperate climate and open vegetation before this, and during which dry-land immigration of plants and animals from the Continent of Europe was possible. Not only so, but the records strongly indicate that the bulk of the British flora was indeed present during this time, and that subsequent overseas immigration has been relatively unimportant until recent historic time.

Such studies as these give a new and firm basis for the study of biogeography of all those temperate regions affected by the Quaternary glaciations.

THE IMPACT OF BRITISH EDUCATION ON THE INDIGENOUS PEOPLES OF OVERSEA TERRITORIES

IN his address to Section L (Education), Sir Christopher Cox directs attention to the paradox by which, as British Colonial policy achieves its purpose and our direct responsibilities for the education of other peoples in different parts of the globe contract with the growth of self-government, the calls made upon Britain's educational resources visibly multiply. The Colonial relationship as it fades out may well be replaced by a continuing system of special intimacy in which more of us than ever before may find ourselves called upon to take some part. A wider understanding of our Colonial educational relationship therefore has its bearing on the effectiveness of the help we can give in this period of transition to the post-Colonial epoch.

Britain's official concern with 'Colonial educational policy' is of comparatively recent growth. In early days, in contrast with official policy in India, it was for the most part left to missionaries to introduce Western schooling to the indigenous Colonial peoples, unless exceptionally such factors as the predominance of a non-Christian world religion brought about early planning by a Colonial Government. But after the First World War the position was transformed. Focused first on Africa, and later on the Colonial territories as a whole, the Secretary of State's Advisory Committee on Education came into being, representing a wide range of professional experience in the United Kingdom, and from the start was designed to exercise a powerful influence upon policy. The Colonial Educational Service was established, and special training devised. Most famous of the Committee's many memoranda was its first—the White Paper of 1925 on Educational Policy in Tropical Africa. With access to the findings of anthropology and to the history of British education in India, its authors sought to spare the African peoples those deep-seated but wholly unintended distortions and injuries to which our lack of experience had contributed elsewhere. Keynotes were environmental adaptation and the grafting of Western schooling on to the indigenous stock.

But intentions and fulfilment are very different things. It is suggested that our effort to apply to African educational policy lessons learnt from experience in India came twenty or thirty years too late. Western schooling had already taken root and local reactions to it had begun to take shape. Once that has happened, the fundamental factor becomes less the policy of government than the attitude of the governed. "In the long run," in the words of a *Round Table* contributor, "Africa will take what it wants, digest it slowly, and assimilate what it does not spit out again." Selection there might have to be: but selection by Africans, in Africa—not for Africans, in Britain. The general position all over British Africa to-day, despite its many remaining backward areas, is increasingly one in which Africans have set their hearts upon a complete Western education as they believe it to be, while in West Africa educational progress has been identified with the post-War march towards self-government. It is these factors that determine the acceptability of what we have to offer to-day.

Against this background certain features of the Colonial educational scene to-day stand out. Demand altogether outstrips the capacity of the territories to meet it. The fact that their resources at present bear no comparison with those of an industrial country inexorably limits their educational development to a fraction of the comprehensive system reached by a modern State after centuries of growth; yet many of them are moving rapidly towards self-government. Sir Christopher refers to the resulting central educational dilemma, in which the rival claims of quality and quantity contend in a setting of exiguous resources and insatiable demand—a problem which, like that of the allocation of priorities between educational and economic investment, is being discussed in more detail at subsequent symposia. It is urged that, by and large, our duty is to introduce the Colonial peoples to the general pattern of the system that we know and believe in, and to indicate ways in which we ourselves think that system can be adapted to local necessities as well as local wishes; there are certain fields, most notably universities, secondary grammar schools and teacher training, in which what we have to offer must be really first-class if the health of these young educational systems is to be assured. Reference is made to the crucial importance of technical education and to the special requirements of girls' education and adult education.

In recent years educational growth and national emergence have progressively reduced the need for formal advice from the Secretary of State, but have multiplied occasions for contact, consultation and practical help. Of outstanding importance has been the assistance given in the field of university education by the Inter-University Council for Higher Education Overseas and by the University of London. Exceptional in their scale and complexity were the contacts culminating in the Cambridge Conference on African Education of 1952. But in general the demands upon Britain for help are probably now more numerous, varied and exacting than ever before—in the increased call for educational staff, in the flow of oversea students, in the two-way movement of mature professional visitors coming to Britain and of *ad hoc* missions or experts going out from it. Our contribution, whether here or overseas, will be the more effective if we are aware of the way in which we have been mixed up together and understand some of the factors involved in the working out of the Colonial educational relationship. The verdict of history on the Colonial educational work of Britain cannot yet be given; but the way in which we go about this in its closing stages will determine whether the educational links between many young countries and our own will be only those of history, or whether a new and active relationship of mutual benefit among partners will have emerged.

THE INFLUENCE OF MAN ON SOIL FERTILITY

MR. G. V. JACKS, in his presidential address to Section M (Agriculture), directs attention to the dominant influence of towns on the evolution of the soil under human occupation.

Man's first action on the soil is usually that of a shifting cultivator or nomad, at which stage he scarcely affects the existing balance of Nature. As population increases and the land fills up, he adopts settled agriculture, which upsets the biotic balance. The first stages of settled agriculture are inevitably soil-exhausting, and human societies tend to develop social systems which keep soil exhaustion under control. This was the reason for the rigid medieval three-field system of agriculture, and is also the reason for the present-day appearance of soil-conservation districts, with their communal rules for checking soil exhaustion, in many countries that have not yet reached the stage at which the positive influence of towns in creating soil fertility makes itself felt.

The growth of towns has a powerful influence on the evolution of the soil. Towns create far more wealth than agriculture can create, a rising standard of living and a greater demand for the produce of the soil. To begin with, this results in an accelerated exhaustion of the soil; but if the wealth of the towns increases, a stage is reached at which it pays farmers to increase output per acre and, therefore, to raise soil fertility. Every successful, mature civilization has enormously increased the fertility of the soil.

In Britain a gradual change-over from soil-exhausting to soil-conserving agriculture began with the enclosure of the 'common fields' and the rise of the wool-trade. Subsequent improvements in agriculture and soil fertility were brought about because the growing urban population was able and willing to pay for the food and clothing it needed. In North America the earlier rapid exhaustion of the soil has recently been succeeded by a substantial increase in soil fertility (measured by crop yields) as the wealth of American industry begins to flow back into the soil. In the U.S.S.R. the rapid expansion of industry is still starving the land, and no increase in yields is yet apparent. South Africa and Australia, with increasing industrialization, seem to have reached the turning point between soil exhaustion and soil conservation. Future development of industry in India might have a favourable influence on soil productivity, which is at a low level. Much of the rest of the tropics is still at the stage of shifting cultivation, though many Colonial countries have begun to practise settled agriculture and are suffering severe soil exhaustion as a consequence. Social systems are being evolved to check this exhaustion. It seems improbable, however, that the general level of tropical soil fertility can be raised without the backing of large, well-to-do urban populations.

Mr. Jacks ends by asking whether the world, a hundred years hence, will be able to feed the 6,000 million people who may then be living in it, and answers yes, provided most of them live in towns and produce enough wealth to pay for the food they require.

LOCAL SOCIETIES IN THE COMMUNITY OF TO-DAY

In his presidential address to Section X (Assembly of Corresponding Societies), Dr. F. J. North suggests that a meeting of delegates from corresponding societies is an appropriate occasion for considering the decline in membership to which the reports of local societies refer with increasing concern, and for asking whether the decline is temporary or indicative of a permanent trend, and what can be done to arrest it.

The history of local societies shows that they were a product of an age when conditions were very different from those which obtain to-day. It was an age of leisured amateurs with both time and means to follow cultural pursuits; an age when the 'fragmentation' of science had scarcely begun, so that an educated person could not only take an intelligent interest in almost any topic that might be considered at the meetings of a local society, but also play a useful part in contributing to discussions or engaging in original work.

The spread of education has provided a greater potential membership for local societies; but recruitment has been hindered for a variety of reasons. There has been a great increase in the number of cultural and professional organizations, and there are new claimants upon leisure time and increased facilities for enjoying it. All these were making themselves felt long before the cinema, sound broadcasting and television entered the field as formidable competitors.

With the view of assessing the relative importance of the circumstances affecting local societies, Dr. North reviews changes in the membership of the Cardiff Naturalists' Society (chosen because it is the one he knows best), indicating the causes to which the fluctuations are due and the effect of the foundation of a rival scientific society in the city. This survey leads to the conclusion that, while the community of to-day would be vastly poorer if local societies were crowded out of existence, the decline in their present strength and popularity is in large measure due to failure to move with the times.

Suggestions are offered concerning the ways in which adaptation to the new conditions will affect lecture programmes, the publication of transactions or proceedings, the co-ordination of the activities of societies by unions and federations, and will involve meeting counter-attractions like broadcasting and television by action designed to profit from the curiosity and interest their programmes create.

Whatever may be done to retain present interest, the future of local societies will depend upon the recruitment of members from among those who, now of school age, will be the adults of another decade. It is not only necessary to stop leakage, but even more necessary to take steps to ensure an adequate intake. With this object in view, advantage should be taken of the interest aroused among senior pupils by the service rendered to schools by museums; this is greater than many people suppose. In the National Museum of Wales, for example, a staff of fifteen, with the active support and guidance of the Director and the departmental staff, is solely concerned with school activities. Being organized by a museum, the service is able to emphasize the inspirational interest of the subjects dealt with, as well as provide assistance to those who are preparing for examinations. It is hoped in this way to create, during school-days, interests that will remain in after-life, and there is ample evidence that this hope is being fulfilled.

Many other museums engage in school services on varying scales but with similar objects in view, and local societies have much to gain by cultivating closer relations than may now exist with museums on one hand and schools on the other, with the view of tapping this reservoir of potential members.

MICRO-ORGANISMS FROM DECAYING SEAWEED

By PROF. E. G. PRINGSHEIM
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THERE are certain places where a peculiar assemblage of micro-organisms can regularly be found. Such are cow-droppings, which harbour the large bacteria *Caryophanon* and *Lineola*[1] and species of *Vitreoscilla*[2]. More varied are the contents of the rumen of ruminants and the cæcum of rodents[3] with their specialized populations of flagellates, yeast-like organisms, the giant bacterium *Oscillospira caviae*, and others. There are the slimy exudations of wounded tree-trunks, the habitats of the colourless chlorella-like *Prototheca* and other specially adapted small algae.

An interesting community of colourless organisms, apart from bacteria, can also generally be found on seaweed, particularly *Fucus*, when these are uprooted and partly exposed to the air. The thalli die, and the sea water covering the lower portions soon teems with bacteria, among which the following organisms are nearly always present.

Nitzschia putrida (Cohn) Benecke[4], perhaps the only colourless diatom, swarms gliding out of drops of the putrid fluid or bits of thallus, when these are put on the surface of sea-water – agar. By moving away from the centre of inoculation on to the sterile agar, the cells purify themselves and can easily be picked up and grown in bacteria-free culture on sea-water – agar enriched with peptone, yeast extract or the like.

At the same time, various amœbæ creep away from the inoculum, especially when the *Fucus* material has been kept in the laboratory for some time. They too purify themselves when gaining the sterile parts of the agar surface; but when thus freed from bacteria, they no longer multiply but encyst. As with fresh-water amœbæ, there is something as yet unknown lacking in their diet when bacteria are absent, and so far it cannot be provided in any other way.

An interesting organism, known for a long time from water in contact with decaying *Fucus*, is *Gyrodinium cohnii* (Seligo) Schiller. Küster[5], in an article entitled "Eine kultivierbare Peridinee", described how its cells, transferred to a *Fucus* decoction – agar plate, divided once or twice. This was, at that time, considered an appreciable performance, although Küster could not make the cells excyst and did not, therefore, obtain any further development. Purified with the help of the washing technique[6], *Gyrodinium cohnii* can be induced to multiply in a medium containing yeast digest (Pringsheim, 1955), sodium acetate and peptone in sea water and encysts only after heavy multiplication, the cysts germinating in fresh medium. This peridinian is devoid of photosynthetic pigments but, as a reserve, stores plenty of starch. Its nutrition is therefore comparable to that of *Polytoma* and *Polytomella*, colourless members of the Volvocales, and of *Chilomonas*, a colourless cryptomonad. The substances used by *Gyrodinium cohnii* to form starch will, I hope, be established by further investigations.

While the organisms so far mentioned live in very polluted water, *Oxyrrhis marina* Duj., a doubtful peridinian which lives on particulate food and is more animal- than plant-like, occurs only when there is not too much putrefiable material. It can be grown with small marine flagellates as its food. Replacement of zootrophy by osmotrophy has not yet been achieved.

There are in this community also some organisms which have been discovered only recently. A member of the Vitreoscillaceae[4], only one species of which had previously been extracted from a marine habitat, was observed several times in the putrid fluid between *Fucus vesiculosus* from Kiel Bay (Kieler Förde) on the Baltic, when these had been kept in a large dish half covered with sea water. It could be grown from filaments isolated with the capillary pipette and transferred to peptone – yeast extract – sea water – agar.

In some of the crude cultures of seaweeds in sea water, colourless, non-motile filaments of great length were detected. Colonies on agar were obtained by repeatedly washing relatively short lengths of trichomes and transferring them to the surface of peptone – sea water – plates, then streaking with a loop. The colonies were dense, brain-like, non-translucent and composed of one very long filament. This can be demonstrated by touching a colony with a wire-needle or capillary pipette, when a continuous thread of great length can be pulled off the agar.

This organism was *Leucothrix mucor* Oersted, described as early as 1844 under this name and recently grown in pure culture by Harold and Stanier[7], who clarified its history, relationship and biology. Its freeing of bacteria is greatly facilitated by the washing procedure before plating. The organism produces short lengths of cell-chains which glide along solid surfaces and serve as an efficient means of propagation. In this respect it resembles *Thiothrix*, to which it is apparently related, as Harold and Stanier have demonstrated. *Leucothrix* is very variable according to conditions. In rich nutrient solutions, the filaments become very long; in poor media they soon cease to grow, and their terminal portions are then transformed to beaded chains which break up into short lengths or hormogonia. The formation of a rosette by the propagative organs specially investigated by Harold and Stanier is characteristic.

Much more difficult to cultivate is *Ciliophrys*, a heliozoon-like creature with spherical cells beset with great numbers of extremely delicate radiating plasmatic strands. The species found between decaying *Fucus* material seems to be *Ciliophrys marina* Caullery 1909. It can produce a flagellum, with the help of which it swims rapidly through the water, changing to a spindly shape, generally with a roundish front and a conical posterior end which may be divided into several irregular, pointed cones. The conditions in which it ceases motility and resumes swimming are not yet clear. Cultivation was possible with the help of soil–water putrefaction cultures, but subculturing was not always successful.

There are also in this community a number of ciliates and flagellates, and some bacteria, which seem to be worth studying, so that biologists interested in this kind of work may find it worth while to watch the biotype in its various stages of development.

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THE QUESTION OF CORRELATION BETWEEN PHOTONS IN COHERENT LIGHT RAYS

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CONSIDERABLE interest has been aroused in this question, especially since the experiments of R. Hanbury Brown and R. Q. Twiss[1] showed a correlation, unexpected by many, between the current outputs from two photoelectric detectors viewing coherent light rays. On the other hand, A. Ádám, L. Jánossy and P. Varga[2] performed a similar experiment using "an amplifier with a resolving time of 2 μsec." and observed no such correlation.

In this laboratory we have been performing coincidence experiments[3] on photons emitted in cascade transitions from optical sources using apparatus of resolving time $2\tau = 10^{-8}$ sec. With this apparatus[4], which is now standard in nuclear physics, time delays can be inserted in either photomultiplier channel, and so a distinct answer to the question of time correlation can be obtained. Our apparatus has observed true coincidences in the above case of optical transitions in cascade. This is of prime importance, since our negative results with coherent light rays can have meaning only if the apparatus has been shown to be capable of, and efficient in, observing 'true' coincidences.

The experiment reported here was designed to duplicate so far as possible the optical arrangement of Brown and Twiss, up to and including the photomultipliers. It is in the electronic detection of coincidences between the outputs of the photomultipliers in which we differ from them. Furthermore, our apparatus compares pulses due to the detection of individual photons by the photomultipliers, rather than an integrated output due to large numbers of photons. We also feel that the Brown and Twiss experiment does not sufficiently reject the possibility that the correlation they observed in the 'photocathodes superimposed' position was due to rapid intensity fluctuations in the source. It seems probable that classical wave theory would predict correctly this case, since both photomultipliers would be observing the same part of the source, and since the fluctuating part of the photocurrent was observed. Furthermore, no correlation would be observed in the 'photocathodes not superimposed' position if their movable photomultiplier then viewed another region of the source, which was comparatively steady, or the intensity fluctuations of which were not correlated with the previous region. Although we do not feel competent to answer the question, it occurs to us that the radio telescope of Brown and Twiss could be working in a similar manner if the galactic source of radio noise was fluctuating in intensity with different regions fluctuating, for example, independently. It should here be emphasized that random coincidences are evaluated in our experiment by insertion of a time delay in one channel much greater than the resolving time of the apparatus. This means that such macroscopic intensity fluctuations in the source would not affect the results of our experiment.

The experimental arrangement is shown in Fig. 1. *S* is a high-pressure Hilger mercury arc. The image of the arc is focused by means of an *F*2 Zeiss Biotar lens *L* on to a small pinhole *H* of diameter 0·25 mm. The light is filtered by a Baird interference filter (λ4358 A.) and the appropriate Wratten filter, at *F*, so that essentially monochromatic light falls on the pinhole. It was found that a good lens free of aberrations is essential in order to get a uniform beam free of striations falling on the half-silvered mirror *M*. The light transmitted by the mirror is detected by a 1*P*21 photomultiplier P_1, and that reflected is detected by a similar photomultiplier P_2. The areas of the two photocathodes are limited by identical rectangular apertures A_1 and A_2, 4 mm. by 8 mm. Single photons detected by the photomultipliers give rise to voltage pulses which are shaped (5×10^{-9} sec. duration), and delayed by coaxial cables L_1 and L_2. They are mixed in the coincidence stage and an output pulse obtained if they are in time coincidence at the coincidence stage. In the diagrams, positive delay refers to P_1 pulses delayed with respect to P_2 pulses, and negative delay vice versa. The total coincidence rate *C* as a function of delay, and the counting rates C_1 and C_2 in each channel, were recorded. Throughout the experiments C_1 and C_2 remained sensibly constant.

The following set of experiments was carried out in order to test the equipment and to test for correlation between photons: (*a*) cable attenuation corrections; (*b*) coincidence rate as a function of

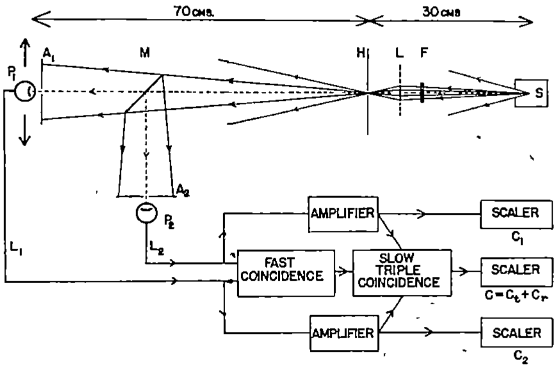

Fig. 1. Simplified diagram of apparatus

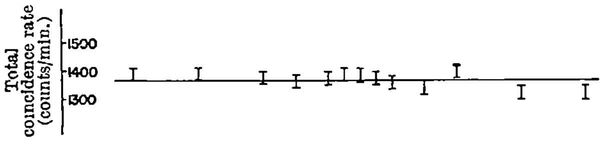

Fig. 2. Total coincidence rate versus delay, 'photocathodes superimposed'

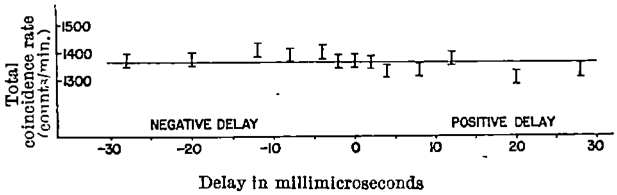

Fig. 3. Total coincidence rate versus delay, 'photocathodes not superimposed'

delay, 'photocathodes superimposed'; (*c*) coincidence rate as a function of delay, 'photocathodes not superimposed'; (*d*) coincidence rate as one of the photomultipliers scans the beam; (*e*) coincidence rate as intensity of the source varied; (*f*) prompt resolution curve for the coincidence apparatus. In all the experiments the apparatus was functioning stably and consistently.

The cable attenuation corrections were obtained with the photomultipliers observing independent sources, and in no case are they greater than several per cent. These have been applied to all the following results.

With P_1 and P_2 in the 'photocathodes superimposed' position, the total coincidence rate as a function of delay was recorded and the results of Fig. 2 obtained. It is noted that within the statistical error of a probable error of 1 per cent, there was no increase in coincidence counting rate at zero delay relative to long delays.

The 'photocathodes not superimposed' position was obtained by moving P_2 laterally a distance of 12 mm., which is equivalent to three times the slit width. The total coincidence rate as a function of delay was again recorded, and the results plotted in Fig. 3. Again there was no increase in coincidence counting rate at zero delay relative to long delays. It is readily apparent that the two sets of results presented in Figs. 2 and 3 are indistinguishable.

In order to ensure that the image position had not been missed, P_1 was moved in steps small compared to the slit width and the total coincidence rate recorded for zero delay. The flat curve of Fig. 4 was obtained. The beam was quite uniform as shown by the total side-channel count from P_1, which remained constant (variation less than 1 per cent) over the whole width of the beam. There is no increase in coincidence counting rate at the 'photocathodes superimposed' position.

A further check was carried out—the intensity of the light source was varied, and the coincidence rate at zero delay, and the side-channel rates, recorded.

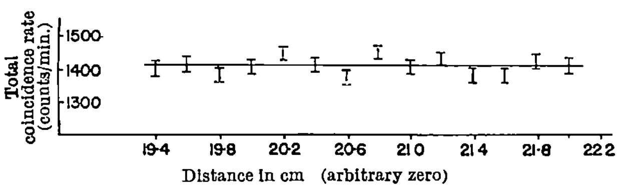

Fig. 4. Total coincidence rate at zero delay versus position. (Photomultiplier P_1 moving in steps across the image)

The coincidence rate C was proportional to the product C_1C_2 consistent with the coincidence rate being pure random[5] (random rate $C_r = 2\tau C_1C_2$).

Finally, to ensure that the apparatus was functioning properly, resolution curves (Fig. 5) were obtained before and after the previous experiments. Stilbene crystals were placed in front of the photomultipliers and a cobalt-60 source (1·17 and 1·33 MeV. gamma rays in cascade) used as a source of prompt radiation.

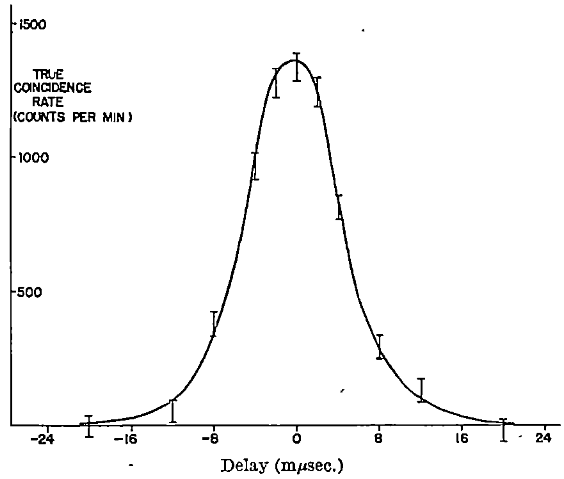

Fig. 5. Prompt resolution curve

From these experiments one can place an upper limit on the fraction of photons acting in an anomalous manner. The side-channel rates C_1 and C_2 were each $(5{\cdot}00 \pm 0{\cdot}05) \times 10^4$ counts per second. The coincidence rate was $24{\cdot}0 \pm 0{\cdot}4$ counts per second. Even if one goes to eight times the probable error there can be no more than three true coincidences per second. Since the 1*P*21 photomultipliers have a photoelectric efficiency of about 10 per cent at a wave-length of 4358 A., this means that the probability is less than 1 in 10^7 that more than 0·03 per cent of the photons detected are in true coincidence. (Ádám *et al.*[2] estimated that less than 0·6 per cent of the photons are in time coincidence allowing a deviation of three times the probable error. In our case, using three times the probable error, less than 0·01 per cent are in time coincidence.)

In conclusion, our experiments indicate that there is no correlation (less than 0·01 per cent) between photons in coherent light rays.

We are indebted to Dr. W. Wehlau, in the Astronomy Department at this University, who brought this controversial matter to our attention. Discussion with him on this and allied subjects has proved most valuable.

Note added in proof. It would appear to the authors, and also to Prof. Jánossy (private communication), that if such a correlation did exist, it would call for a major revision of some fundamental concepts in quantum mechanics. This was, of course, the reason why these experiments were performed.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Density and Expansivity of Solid Argon

A FULL knowledge of the thermodynamic properties of some simple solid, such as a solidified inert gas, is necessary for the satisfactory development of a rigorous lattice dynamics. When a simple inter-atomic potential containing two constants is applied to a given substance (see, for example, Barron and Domb[1], Henkel[2]), it is necessary to know at least the density and energy of sublimation at absolute zero so as to determine the constants. In order to verify the theory in detail, it is then necessary to measure three independent quantities such as C_p, α and $\varkappa_s$, where α is the volume expansivity and $\varkappa_s$ is the adiabatic compressibility.

For various reasons, argon is the most suitable substance for such a study; but until recently only one of the three coefficients, C_p, has been known accurately for the solid[3]. Last year, Stewart[4] determined the isothermal compressibility ($\varkappa_T$) at 65° and 77° K. and Barker and Dobbs[5], in this laboratory, determined $\varkappa_s$ over the same temperature-range by an ultrasonic method. We have now measured the density between 20° and 80° K., and have thus obtained values of α.

Up to 60° K. we have used the X-ray method of measuring the lattice parameter by taking Debye–Scherrer 'powder' photographs. Details of the experimental arrangement as applied to metallic specimens at low temperatures are given elsewhere[6]; in the present work, a polycrystalline specimen of argon was deposited from the vapour on an aluminium wire subjected to precise temperature control. Recrystallization became evident at about 60° K., so that the method became increasingly inaccurate; and above this temperature we have determined the bulk density of polycrystalline specimens by finding the volume of gas at N.T.P. required to fill with solid argon a glass bulb of about 3 c.c. maintained at a given temperature. All the solid specimens used were transparent and free from visible flaws. The argon was stated by the British Oxygen Co., Ltd., to be of at least 99·999 per cent purity.

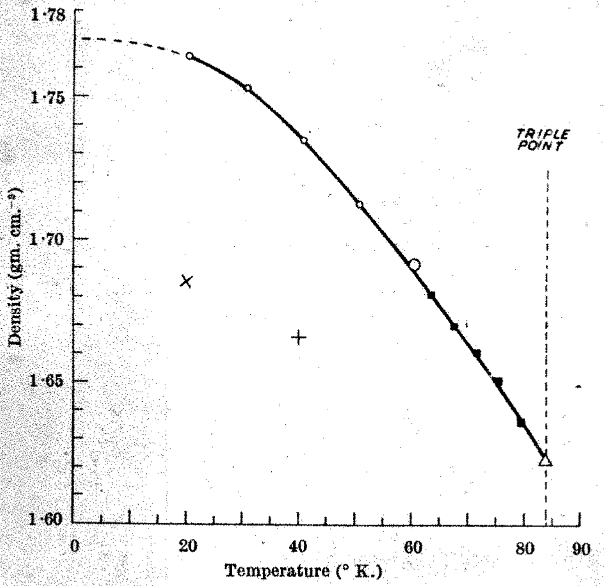

Fig. 1. Density of solid argon. Present results: ○, X-ray method. ■, bulk density method. Earlier results: △, Clusius and Weigand; ×, de Smedt and Keesom; +, Simon and von Simson

The results are shown in Fig. 1; it will be seen that the two methods give good agreement where they overlap, within our estimated accuracy of about 0·001 gm. cm.$^{-3}$. Our results differ appreciably from those of the X-ray measurements at single temperatures of de Smedt and Keesom[7] and Simon and von Simson[8], but agree with the value of the density at the melting point deduced by Clusius and Weigand[9] from observations of the melting curve and of the density of the liquid.

In the following table we summarize our results for the density (ρ), and give estimates at four temperatures of the expansivity and of the Grüneisen parameter $\gamma = \alpha V/\varkappa_s C_p$.

T (° K.)	20	40	60	80
ρ (gm. cm.$^{-3}$)	1·764	1·737	1·691	1·636
$\alpha \times 10^4$ (deg.$^{-1}$ C.)	4	12	15	18
γ	2·0	2·7	2·8	2·4

The values of α, much larger than suggested by the previous independent measurements at three temperatures, account for the large difference between the results of Stewart for $\varkappa_T$ and those of Barker and Dobbs for $\varkappa_s$, since the ratio $\varkappa_T/\varkappa_s = 1 + \alpha^2 TV/\varkappa_s C_p$ rises to a maximum of 1·45 at the melting point. The large ratio (equal to C_p/C_v) also accounts for the unusually high value of C_p (8·5 cal. mole^{-1} deg.$^{-1}$ C.) found by Clusius[3] at the melting point, since C_v is now reduced to 5·9 cal.mole^{-1} deg.$^{-1}$ C., the classical value. The value of the Grüneisen parameter appears to go through a maximum, with an average value of about 2·5. More accurate experiments at the lower temperatures are required before the detailed form of this variation can be known.

It is important to note that our results lead to an estimate of the density at absolute zero of 1·77 gm. cm.$^{-3}$, corresponding to a lattice parameter of 5·31 A., as compared with the previously accepted value of 5·40 A.

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July 11.

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Theoretical Calculations on Solid Argon

It is well known that a knowledge of the second virial coefficient of a gas does not suffice to specify the intermolecular potential of the constituent molecules. In fact, even if a simple formula of Mie–Lennard-Jones type is used as an approximation to the potential, the parameters are not uniquely determined by the second virial coefficient. On the other hand (as mentioned in the preceding communication) certain elementary properties of the solid state are sufficient to determine these parameters uniquely, and further observations on the solid and gaseous states can then be used as a test of the region of validity of this type of approximation to the potential. The recent development of experimental technique enabling data on the solid state to be determined with accuracy over a wide range of pressures and temperatures has provided valuable material for theoretical analysis.

When the isotherms for solid argon at high pressures determined by Stewart[1] at the Massachusetts Institute of Technology became available, one of us (I. J. Z.[2]) undertook detailed calculations to determine how the results compared with the theoretical predictions, and, if necessary, to modify the estimates of intermolecular potentials for the inert gases concerned. Although quite good agreement was obtained, the form of potential used was not completely satisfactory because of the uncertainty in the value of the density at absolute zero. The present accurate experimental results obtained at Queen Mary College for argon enable this uncertainty to be removed, and further detailed comparisons to be made between theory and experiment for this substance.

We have used the following approximation to the intermolecular potential energy:

$$\begin{aligned} \varepsilon(r) &= \lambda/r^{12} - \mu/r^{6} \\ \lambda &= 1{\cdot}63 \times 10^{-7}\ \text{A.}^{12}\ \text{erg.} \\ \mu &= 1{\cdot}05 \times 10^{-10}\ \text{A.}^{6}\ \text{erg.} \end{aligned} \qquad (1)$$

To calculate the thermal expansion and Gruneisen's γ ($= \alpha V/\varkappa_T C_v$ or $\alpha V/\varkappa_s C_p$), we have used the approximation of Henkel[3]. This approximation is of Einstein type but takes account also of anharmonic effects; it should be reliable at temperatures not too low compared with the Debye θ value. The results are as follows:

T (° K.)	20	40	60	80
ρ (gm. cm.$^{-3}$)	1·764	1·732	1·690	1·634
$\alpha \times 10^4$ (deg.$^{-1}$ C.)	4·6	10·5	14·6	20·0
γ	2·03	2·62	2·86	2·50

These are to be compared with the experimental values of the preceding communication.

It will be seen that the theoretical calculations are in good agreement with the experimental results. Calculations at higher pressures based on the above estimate of the intermolecular potential are also in good agreement with experimental isotherms given by Stewart[1]. A further check on the estimate of the potential is provided by the Debye θ value for solid argon at low temperatures. This can be calculated approximately and simply[4] for a potential of the form (1) and yields the value of 80° K., in good agreement with the experimental value derived by R. W. Hill[5] from measurements of the specific heat of solid argon at low temperatures. The values of λ and μ given in (1) are very close to those determined recently by Whalley and Schneider[6] from data for gaseous argon.

We may thus conclude that theoretical calculations of solid-state data based on the intermolecular potential (1) give results in reasonable agreement with experiment. Further experimental data, particularly at high pressures, would be desirable to provide a more searching test of the theory.

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I. J. Zucker

Wheatstone Laboratory,
King's College,
London, W.C.2. July 30.

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Nuclear Spin of Americium-241

During the recording of the spark spectrum of americium[1] in the third order of the Baird three-metre grating spectrograph, a number of spectral lines appeared as four resolved components of a probable six-member flag pattern. While describing the performance of a 30-ft. Paschen–Runge spectrograph, Tomkins and Tomkins[2] have published a photograph of the Am I line at 6405 A. showing it resolved into six components. The six component flag patterns, which lead to a nuclear spin of 5/2 for $_{95}\text{Am}^{241}$, have been confirmed by interferometric studies.

In the present investigation americium was excited in a hollow cathode cooled with liquid nitrogen. High dispersion was achieved by crossing a Hilger Universal Prism spectrograph with Fabry–Perot étalon plates coated with $\lambda/4$ layers of cryolite and zinc sulphide. A series of different spacers were used for eliminating errors due to overlapping orders. Fig. 1 shows the six components of the Am I lines at 4662·80 and 4681·67, the separations between the components being 0·230 ± 0·0015 cm.$^{-1}$, 0·212 ± 0·001 cm.$^{-1}$, 0·184 ± 0·0015 cm.$^{-1}$, 0·147 ± 0·002 cm.$^{-1}$, 0·104 ± 0·003 cm.$^{-1}$, and 0·274 ± 0·001 cm.$^{-1}$, 0·226 ± 0·002 cm.$^{-1}$, 0·180 ± 0·001 cm.$^{-1}$, 0·138 ± 0·002 cm.$^{-1}$, 0·101 ± 0·002 cm.$^{-1}$, respectively.

Since these and other hyperfine separations show a marked divergence from the interval rule, a relatively large quadrupole-moment is expected for americium.

On the assumption that the $5f_{5/2}$ shell is filled preferentially to the $5f_{7/2}$, the value of a nuclear spin of 5/2 for $_{95}\text{Am}^{241}$ is in accordance with Klinkenberg's[3] nuclear shell structure tables which are based on

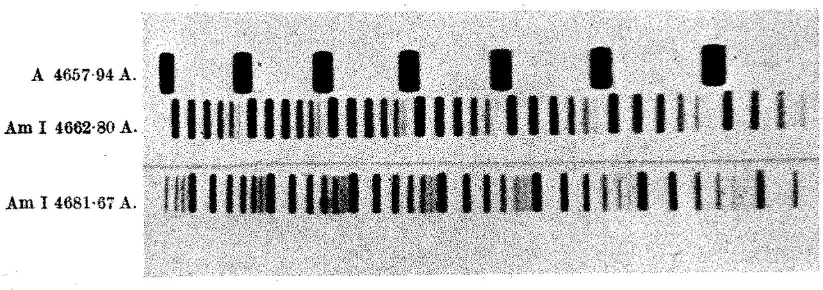

Fig. 1. Hyperfine structure of Am I lines at 4662·80 and 4681·67 A.

the single-particle nuclear shell model of Mayer[4]. This assumption is supported by the reported spin of 5/2 [5] for the odd proton nucleus of $_{93}$Np^{237}. Hence it would appear that the nuclei of $_{95}$Am^{241} and $_{93}$Np^{237} have a ground-state of $f_{5/2}$.

I am indebted to Mr. J. Ring of the Physical Laboratories, University of Manchester, for coating the Fabry–Perot plates and to Mr. N. Jackson of the Chemistry Division of this Establishment, for the preparation and purification of the americium.

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Separation of Particulate Materials into Size-Ranges

DURING an experiment a beaker was used for collecting a stream of small glass spheres issuing from a chute. A number of the spheres escaped over the edge of the beaker, after rebounding from the layer of material in the bottom, and on examination this fraction was observed to be of considerably more uniform size than the original sample; an observation which suggests a simple method for the separation of non-cohesive particulate materials into sized fractions.

The following test was then carried out.

Glass spheres having diameters of 0·02–0·06 in. were allowed to fall from a funnel into a polythene beaker 3 in. diameter and 3½ in. high, the height of fall being 12 in. The polythene beaker was placed within a beaker of 1-litre capacity which acted as a receptacle for the separated fraction.

The material was supplied until the inner beaker was filled to a depth of 1½ in., when the flow was stopped, the beaker emptied and the process repeated.

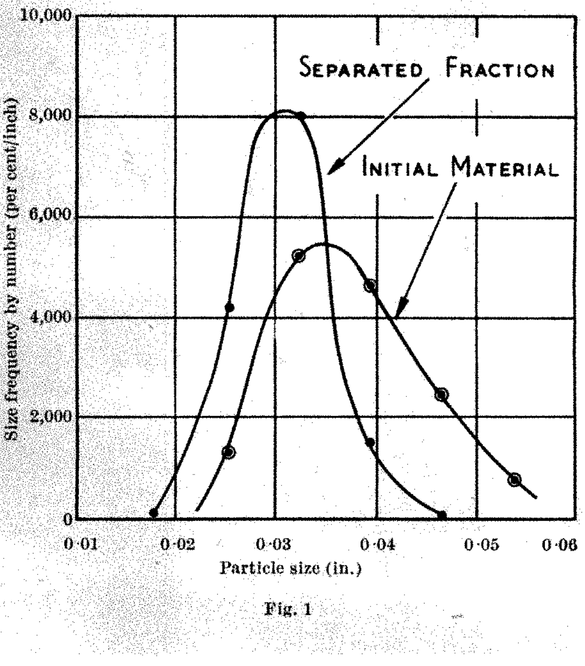

Fig. 1

The size-distribution curves for the original material and the separated fraction are given in Fig. 1.

In a further test 800 gm. of steel balls of ⅛ in. diameter and 200 gm. of steel balls of $\frac{1}{16}$ in. diameter were mixed. 7 gm. of the $\frac{1}{16}$-in. diameter balls, completely free from ⅛-in. diameter balls, were recovered after one pass of the mixture.

It is interesting to note that a possible explanation of the phenomenon is that in the manifold collisions which occur when the falling spheres are brought to rest, the particles of smaller mass acquire a higher mean velocity than those of larger mass, and this enables them to rebound to sufficient height to escape over the edge of the beaker. If this explanation is correct, then it would suggest a close analogy between the behaviour of a mixture of gases of different molecular weight and a powdered material having a wide range of particle size.

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Air-Flux Sensitivity of the Pulses of the Negative Point to Plane Corona in Air at Atmospheric Pressure

THE negative point to plane corona, glowing at atmospheric pressure in air, may be looked upon as a result of a large number of self-quenched electron avalanches per unit time. The effect of self-quenching occurs only in the case when an electronegative gas component is present and is due to a cloud of negative ions influencing strongly the electric field in the vicinity of the sharp end of the cathode[1]. When a sufficiently high potential difference exists between the cathode and a flat anode, the current pulses follow each other with a high frequency and the negative ions strongly decrease the amplitudes of the voltage pulses occurring on the resistance R placed in series with the point cathode[2,3]. For a sufficiently high frequency of the electron avalanches (increases with the applied voltage), the following approximation should describe the change of the amplitude of the voltage pulses due to the negative-ion concentration or pulse-frequency:

$$A \pm \Delta A \sim \frac{1}{N \pm \Delta N} \sim \frac{1}{K \pm \Delta K}$$

for $N_{V_1} < N < N_{V_2}$ and $V_1 < V_2$.

Here A is the amplitude of the voltage pulses, N their frequency, V_1 and V_2 are the values of the voltage, N_{V_1}, N_{V_2} are the frequencies of the pulses at certain critical voltages V_1, V_2. K is the negative-ion concentration in the vicinity of the cathode when the frequency of the pulses is N.

The values of N or K may be changed by: (*a*) blowing away a number of negative ions per unit time resulting in a decrease $(-\Delta K)$ of K; (*b*) cooling the vicinity of the sharp end of the cathode resulting in a decrease $(-\Delta N)$ of the number of primary electrons N initiating the avalanches.

All this suggests in general that a change of N or K for a constant voltage V $(V_1 < V < V_2)$ may be measured by the intermediary of the amplitude change of the pulses. This may be done by discrimina-

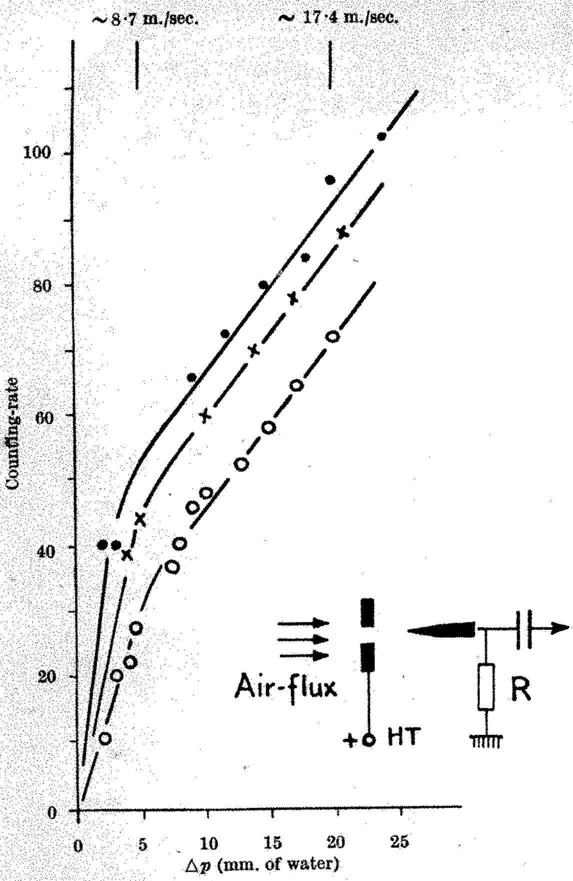

Fig. 1. The graphs show, in arbitrary units, the dependence of the counting-rate of the registered pulses, versus the air velocity, measured with a Prandlt's tube. The air velocity is given as a measure of the pressure difference: $\Delta p = \frac{\rho}{2} v^2$. Each curve was measured at different discrimination. V = constant

tion of those pulses the amplitudes of which are smaller than a certain preferred and fixed value.

To test the air-flux sensitivity, an atmospheric Geiger counter was used. The counter consisted of a sharp cathode and a metal face ring and was used together with a high-voltage stabilizer, a cathode follower, a discriminator unit and a counting-rate meter. The air-flux influence on the pulse amplitudes could be observed on the oscilloscope screen also. When an appropriate voltage V ($V_1 < V < V_2$) is put on the counter, a light phenomenon of the negative point corona can be observed at the sharp end of the cathode. On the oscilloscope screen one may see a large number of single pulses. The amplitude of these pulses is very small. When discriminating these pulses the counting-rate meter shows no counting-rate at all; but if an air stream is directed into the discharge space the amplitude of some of the pulses increases. The counting-rate meter registers now the increased pulses.

Fig. 1 shows some graphs of preliminary observations. Each curve is measured for a certain constant discriminating factor of the pulse discriminator and for a constant voltage. These graphs show the similar character of the curves. The preliminary oscilloscope observations show furthermore that there exists an inversion-like voltage, similar to that described by Mohanty[4] in the case of the Joshi effect.

I wish to thank Prof. J. Nikliborc for his kind interest in this problem.

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Motion of Sporadic-E Patches determined from High-Frequency Backscatter Records

New evidence of the motion of 'sporadic-E' ionization has been obtained at Stanford University from records of ionospheric sounding equipment which displays ground (or sea) backscatter as mirrored in ionospheric layers or reflecting clouds. Sporadic-E patches of relatively limited geographical extent (order of 10,000 sq. km.) often appear on the records of this apparatus, and their growth and motion can in some cases be followed. Whether this motion is due to physical translation of the ionized material (as by winds) or to some other cause such as motion of an ionizing agency is not known; however, it is of interest to compare observations made by this relatively new technique with earlier ones made by other means.

The backscatter[1-3] in use at Stanford employs a rotating unidirectional beam antenna of relatively low directivity, and a plan position (PPI) display. A 2-millisecond pulse having a peak power of one kilowatt is radiated at 17·3 and 30·66 Mc./s. The antenna rotates once per minute, and a photographic record is made of each scan in azimuth. The equipment has been operated virtually continuously since September 1952.

Detailed observation of E_s clouds or patches showed that the number which can be clearly distinguished as separate events is approximately 2,700 in the three-year period. Duration of the individual patches varied from a few minutes to a maximum of 10·5 hr., with a mean value of 3 hr. Every patch was examined for indications of motion. If during a period of one half-hour a given patch did not dissolve or become mingled with other activity so that it could no longer be studied as a unit, it was chosen for plotting. The centroid of the patch,

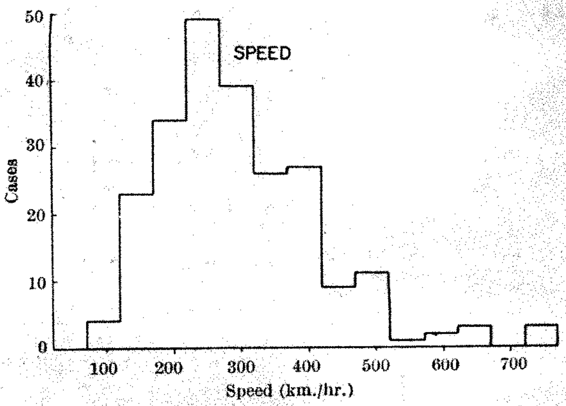

Fig. 1. Speed distribution of sporadic-E patches observed on high-frequency backscatter equipment

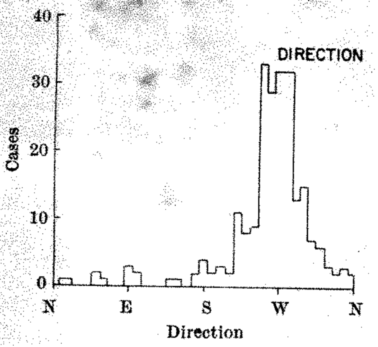

Fig. 2. Direction distribution of sporadic-E patches observed on high-frequency backscatter equipment

defined as the mean range and the mean angular position in azimuth, was plotted until the patch either moved out of range or was otherwise lost. A total of some 264 such tracks were studied and speed and direction information derived.

These results are shown in Figs. 1 and 2. The speed distribution has a peak at 250 km./hr.; but a few very high-speed cases raise the mean value to 300 km./hr. In only nine cases out of 264 were speeds greater than 550 km./hr. recorded. Direction is predominantly toward the west, and in 80 per cent of the cases it was within 45° due west. It is interesting to note that the mean speed is approximately one-fourth of the speed of the subsolar point at this latitude, and the average direction of patch motion is the same as that of the subsolar point.

Apparent speed of drift of these patches is in good agreement with that of ionospheric winds, as determined by the meteor trail drift method[7-9], and of E_s motion, as measured by the fading method[6,10]. However, the predominant direction of motion of the sporadic-E patches in this study does not agree with the predominant directions of motions determined by the other methods. Moreover, the present work brought to light no diurnal changes in the direction of apparent motion as have previously been reported.

Ferrell and Gerson have previously deduced sporadic-E cloud drift by a method somewhat analogous to the present one, utilizing radio amateur transmissions in the 50-Mc./s. band[4,5]. While the speeds which they reported were in rough agreement with those of the present study, the directions reported were variable and showed no particular tendency to favour the west. The number of patches observed in this study is far larger than the number reported by Ferrell and Gerson.

Supporting evidence for the reality of the patch position and time measurement was obtained with the aid of the C-3 vertical incidence ionospheric sounder at Stanford University. Forty-one of the tracks plotted had directions which carried them directly overhead at Stanford. From the trails, predictions of arrival time overhead were made and verified by searching for a peak in the sporadic-E penetration frequency, as indicated on the vertical sounder records for the predicted time. The agreement was close in 90 per cent of the cases. In only two cases did the patch fail to appear overhead. In both these instances the patches were receding from the sounder and extrapolation backwards in time was required. These patches, accordingly, may have been formed at times later than their calculated time of appearance overhead.

Further details will be found in a paper now being prepared for publication.

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High-Energy Particles in Solar Flares

AT a recent lecture delivered at Harwell, Dr. I. V. Kurchatov gave details of Russian experiments with high current-density gas discharges. One interesting phenomenon that was observed concerned the production of high-energy particles in the discharge, possessing energies greatly in excess of those that could be attributed to the Maxwellian distribution at the temperatures reached in the spark, and also greatly in excess of the electron-energy corresponding to the potential difference across the spark gap. This effect could be observed in deuterium through the production of neutrons and gamma-rays. The onset of this phenomenon was always clearly related to a certain behaviour of the spark, namely, to the second constriction that occurred. It must therefore be supposed that in the complicated electrodynamical processes that occur in sparks that become constricted in their own magnetic field, there occurs a mechanism for accelerating a small fraction of the particles to high energies. This can perhaps be understood in terms of multiple reflexions of ions in the interior of a rapidly converging cylindrical magnetic shock wave.

The interpretation of solar flares is not yet clear. The effect could well be interpreted as an electrical discharge; but in a gas already highly ionized before the discharge, it is necessary to find a reason for the sudden onset of the phenomenon. It could be that electric currents evenly distributed through large volumes normally flow in the vicinity of changing sunspots; but that in circumstances when the current density exceeds a certain value, an instability occurs causing the currents to become constricted along one or several lines due to their own magnetic fields (the 'pinch' effect).

High-energy particles are produced in solar flares, as is clear from certain radio observations and from the occurrence of associated cosmic-ray effects. If the interpretation of a flare given here is correct, the Russian experiments would seem to provide a laboratory analogy for this effect which will greatly facilitate further analysis.

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The *d*-Band Character of Metals and the Rate and Mechanism of the Electrolytic Hydrogen Evolution Reaction

It is known empirically[1] that for the hydrogen evolution reaction, log i_0 (where i_0, the exchange current density, is directly proportional to the rate constant of the reaction) increases linearly with increase of φ, the thermionic work function of the electrode substrate, for most metals, but may decrease with increase of φ for mercury, thallium and lead. The work function is eliminated in the potential terms governing the rate of hydrogen evolution in an actual cell. The origin of the dependence of rate constant upon φ must therefore be sought in the relation to φ of some other parameter upon which the rate of evolution of hydrogen depends.

It is simple to show[2,3] that if the reaction:

$$H_3O\cdot + e_0^- \rightarrow M\text{H}$$

(M = metal substrate) controls the overall rate of the hydrogen evolution reaction, log i_0 should increase approximately linearly with $\Delta H_{\text{ads.H}}$, the heat of adsorption of hydrogen on the metal. $\Delta H_{\text{ads.H}}$ is known experimentally for a number of metals. It is of interest here, however, to relate $\Delta H_{\text{ads.H}}$ to φ through the equation due to Pauling for the relation of the heat of formation ($-D_{M\text{H}}$) of the metal hydride, MH, to the heats of dissociation of MM and HH, and the electronegativities of M and H, that is, $-D_{M\text{H}} \neq \Delta H_{\text{ads.H}}$, but will differ from it essentially only by the image potential at the $M-$H interface; this potential is not primarily dependent upon φ. $-\Delta H_{\text{ads.H}} - D_{M\text{H}}$ is found to be 10–15 kcal. mole^{-1} for a series of metals (Fig. 1); the image potential[4] is approximately −15 kcal. mole^{-1}.

$$D_{M\text{H}} = \tfrac{1}{2}(D_{MM} + D_{\text{HH}}) + 23{\cdot}06\,(X_M - X_{\text{H}})^2 \quad (1)$$

In (1), D_{MM} and X_M can be related to φ by the equations[5]

$$D_{MM} = 23{\cdot}06 \times 0{\cdot}6\,\varphi/0{\cdot}52\,n \quad (2)$$

and

$$X_M = 0{\cdot}355\,\varphi. \quad (3)$$

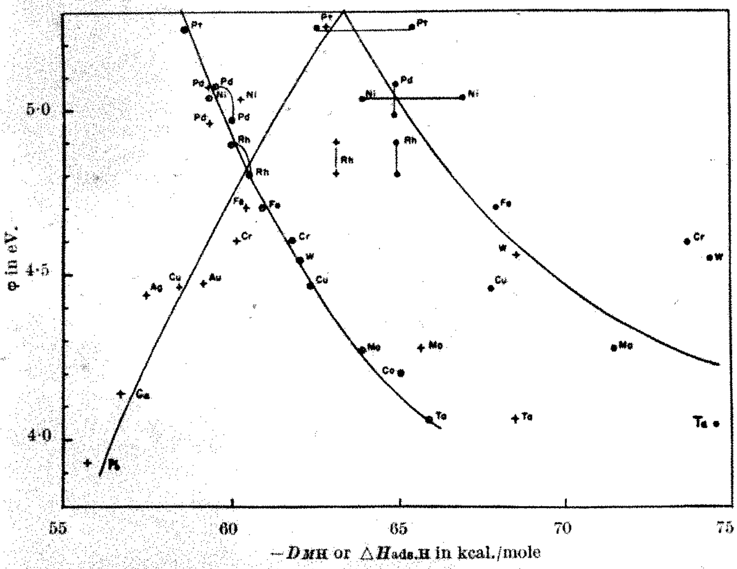

Fig. 1. Dependence of metal-H interaction energy upon electron work function. +—+, Values of $-D_{M\text{H}}$ calculated from equation (1) neglecting X_M. ●—●, Values of $-D_{M\text{H}}$ calculated from (1) including X_M as $f(\varphi)$. ⊙—⊙, Experimental values of $\Delta H_{\text{ads.H}}$ (refs. 5 and 7). Values of φ are mainly from the post-1950 literature and were chosen critically with regard to use of rigorous purification techniques

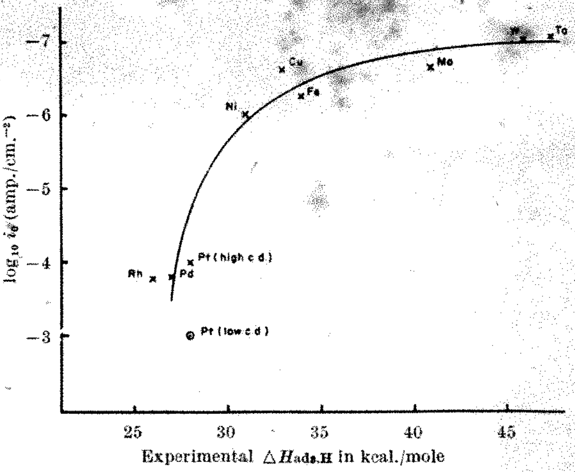

Fig. 2. Dependence of log i_0 upon $\Delta H_{\text{ads.H}}$ (both parameters measured under conditions of highest purification of solutions and surfaces)

If the electronegativity term in (1) is neglected (cf. ref. 6), the relation of $D_{M\text{H}}$ (or $\Delta H_{\text{ads.H}}$) to φ is as shown in Fig. 1 and, on this basis, it follows that $\Delta H_{\text{ads.H}}$ increases with increase of φ, so that if proton transfer determined the rate, log i_0 would increase with increasing φ, as is found empirically[1]. The conclusion from this kind of relationship that the rate-determining step for many metals was proton transfer was recently drawn by Ruëtschi and Delahay[6] in an application of the potential energy curve theory of Parsons and Bockris. If, however, the electronegativity term is included in equation 1, the relation of $D_{M\text{H}}$ (or $\Delta H_{\text{ads.H}}$) to φ is as shown in the second curve in Fig. 1. The trend is in the opposite direction to that obtained when the electronegativity term in (1) is neglected[6] and now agrees with the trend of experimental $\Delta H_{\text{ads.H}}$ values with φ. It follows that the experimentally observed plot of log i_0 against φ indicates that the rate constant of the hydrogen evolution reaction for many metals decreases with increase of the numerical magnitude of $D_{M\text{H}}$ (or $\Delta H_{\text{ads.H}}$); that is, behaves in the opposite sense to that theoretically expected if proton transfer determined the rate, and to that concluded by Delahay and Ruëtschi, who neglected the effect of electronegativity. The latter term in equation (1) contributes 0 and 20 per cent of the value of $D_{M\text{H}}$, depending on the metal. It is, however, an important term leading to variation of $D_{M\text{H}}$ with the metal.

It follows that for the large group of metals referred to (those for which log i_0 increases linearly with φ, namely, copper, silver, gold, molybdenum, tungsten, iron, nickel, cadmium, gallium, aluminium, rhodium, palladium, platinum) a desorption of hydrogen atoms must occur in formation of the activated complex in the rate-determining step. Such a rate-determining step is:

$$H_3O\cdot + M\text{H} + e_0^- \rightarrow H_2 + H_2O + M \quad (4)$$

the so-called 'electrochemical mechanism'[1], and the kinetic parameters characteristic of this reaction as the rate-determining step have in fact been observed[1,5] for a number of the above metals in acid solutions. For these metals of intermediate hydrogen overpotential, therefore, equation (4) determines the rate, whereas for the metals mercury, lead and thallium, it appears that the proton discharge is the rate-determining reaction (cf. ref. 1), and at platinum the desorption by recombination of adsorbed hydrogen atoms determines the rate.

The relation of i_0 to the structure of the metallic substrate arises as follows. It has been recently established[7] that decrease of d-character is associated with increased heat of adsorption of hydrogen. The exchange current density would therefore be expected to decrease with decreasing d-character, as is experimentally verified[5]. The relationship to φ arises similarly, as φ increases with the amount of d-character[5], owing to the lower energy of electrons when more are paired as the d-band becomes more filled.

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Detection of Free Radicals in Sodium Dithionite by Paramagnetic Resonance

It has been shown[1] that the photochemical oxidation of a bound oxalate ion leads to the formation of a free radical (assumed to be $C_2O_4^-$ or CO_2^-). In view of the formal analogy between the oxalate ion, $C_2O_4^{2-}$, and the dithionite ion, $S_2O_4^{2-}$, and the possibility of their undergoing oxidation by similar mechanisms[2], we have investigated the possibility of producing the corresponding free radical from the dithionite ion. The paramagnetic resonance apparatus was similar to that previously described[1]. All measurements of paramagnetic resonance absorption were made at liquid-oxygen temperature with the samples sealed in thin-walled evacuated glass tubes.

Samples of anhydrous sodium dithionite showed a weak paramagnetic resonance absorption having a g-value of $2{\cdot}01 \pm 0{\cdot}01$ and width of 12 ± 3 gauss, suggesting that it was due to a free radical. This weak absorption could still be detected after pumping under high vacuum at a temperature of 60–70° C. Treatment of the crystals *in vacuo* with a small quantity of degassed water caused an increase in the free radical content which grew during 1 hr. at room temperature. When sufficient water was added to dissolve the crystals completely at room temperature, and the solution was again frozen at liquid-oxygen temperature, no free-radical absorption could be detected. Part of the water was then evaporated into the side-arm until crystals separated. On freezing in liquid oxygen, a free-radical signal was again observed. On admittance of air the free radicals did not disappear until the mixture had stood for some time. The free-radical content of the anhydrous dithionite was also found to increase when wetted with ethyl alcohol.

The free radicals observed in the wetted anhydrous crystals were found to be quite stable in the absence of air and were observed after storage for several days at room temperature. The free-radical content was estimated to be approximately 6×10^{17} per gm., corresponding to the dissociation of about 0·01 per cent of the dithionite ions. This may not, however, represent the total quantity of free radicals present, owing to possible broadening of the absorption band in solution. It is not yet clear, therefore, whether the radicals are present only in the crystals or whether they are also present in the aqueous solution. It is possible that the radicals are stabilized by adsorption on the crystal surfaces[3]. Certainly no signal has so far been detected in those tests in which the crystals had completely dissolved.

The two most probable formulæ which have been suggested for the dithionite ion are $[O_2S.SO_2]^{2-}$ and $[OS.O.SO_2]^{2-}$. The second (mixed anhydride) formula is supported by chemical evidence[4]. Bassett and Durrant[4] postulate the existence of two forms of the free acid, one corresponding to each of these ionic structures. The first form has a similar structure to that of the oxalate ion. From the results of an X-ray analysis of crystals of anhydrous sodium dithionite, Dunitz[5] concludes that the dithionite ion can be regarded as a pair of SO_2^- units linked by a weak S—S bond, and he suggests that the SO_2^- radical occurs at least as a transitory species. The existence of SO_2^- radicals in aqueous solutions of dithionite has already been suggested[6] to account for the polarographic behaviour of sodium dithionite in neutral or alkaline medium. The SO_2^- radical would be expected to act as a reducing agent, analogous to the oxalate radical, owing to the reaction $SO_2^- \rightarrow SO_2 + e$, as suggested by Dunitz[5].

We wish to thank Dr. W. Furness, of Messrs. Brotherton, Ltd., for the sample of anhydrous sodium dithionite.

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Moult Adaptation in Relation to Long-Distance Migration

Marshall and Serventy[1] have recently directed attention to moult adaptation in the short-tailed petrel, *Puffinus tenuirostris*, of Tasmanian waters. In this species post-nuptial head and body moult takes place in the breeding quarters while moult of tail- and wing-feathers is postponed until the bird has arrived at its northern non-breeding quarters. From this the authors decide that "from the . . . data there emerges clear evidence of the evolution of a moult adaptation related to the migratory requirements of species that undergo a long post-nuptial migratory movement". That moult adaptation in relation to long-distance migration need not be a general phenomenon, and probably has only taken place in certain families of birds, is indicated by the following observations on two species of long-distance passerine migrants. In April 1953 a large number of swallows, chiefly consisting of the European swallow, *Hirundo rustica*, and the European house martin, *Delichon urbica*, perished in the neighbourhood of Cape Town, due to a short spell of adverse weather conditions. Of the thirty-five *H. rustica* examined, 99·1 per cent showed moulting flight-feathers, 65·7 per cent had moulting tail-feathers and 8·6 per cent had moulting body- and head-feathers. Of fifty-two *D. urbica*, 40·4 per cent had moulting wing-feathers, 75 per cent moulting tail-feathers and 94·2 per cent moulting body- and head-feathers[2].

It is in April that these swallows leave southern Africa on their long-distance flight to the northern breeding quarters. Moulting flight- and tail-feathers at this time must be a disadvantage to these birds. The above data show that the moult which these swallows undergo in their wintering quarter sets in late and is continuous with no hiatus between the moulting of body- and head-feathers and the wing- and tail-feathers. Swallows are also very much dependent on their wings just as petrels are. Still, moult adaptation in relation to long-distance migration seems to have taken place in one but not in the other.

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Injury from the Decompression Component of an Air-Blast Wave

PREVIOUS experiments have shown that about 80 per cent mortality is to be expected when 60-day old mice are explosively decompressed, in a matter of 30 m.sec., from a pressure of 80 lb. per sq. in. above atmospheric. Since the positive phase of an air blast wave is characterized by a shock front followed by a rapid drop in pressure comparable to explosive decompression, it was thought of interest to investigate the lethal effect of this component of the blast wave. Accordingly, mice were subjected to 80 lb. per sq. in. over-pressure for varying durations of time and then explosively decompressed. No lethal effect was observed until the mice had been under pressure for times longer than 100 m.sec. At 1 second the mortality had only risen to about 12 per cent, as compared with the control data on 80 per cent mortality which was obtained when the mice were under pressure for a matter of 1 min. It is therefore concluded that the explosive decompression component of the blast wave has no lethal effect *per se*. Details of this work will be reported later.

The opinions or assertions in this letter are the private ones of the writers, and are not to be construed as official or reflecting the views of the Navy Department.

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Spike Potentials produced by the Sea Lamprey (*Petromyzon marinus*) in the Water surrounding the Head Region

UNDER the auspices of the Fisheries Research Board of Canada an investigation was started recently in this laboratory on hearing in the sea lamprey. During preliminary observations, adult *Petromyzon marinus* were placed in rigid 'Lucite' cylinders of 1½ in. inner diameter. A row of silver electrodes had been placed in the wall of the tube at 1-in. intervals along a straight longitudinal line. Each of the electrodes could be connected individually with a d.c.-fed pre-amplifier. The last electrode in the row, located beyond the tail of the animal, served as reference electrode. The tube, filled with fresh water and containing the animal, was kept in a Faraday cage together with the pre-amplifier. The output of the amplifier was connected with a cathode ray oscilloscope. In the water surrounding the head region spike potentials were recorded from electrodes 15–20 mm. away from the animal's surface. Fig. 1 represents a recording from an electrode located immediately above the left eye of the animal. The triphasic spike has a duration of about 20 m.sec. and a potential of 200 μV.; the positive third phase has a potential of 30 μV. and lasts about 15 m.sec. Successive recordings from electrodes headwards or tailwards demonstrated that the highest potentials in the water were towards the anterior extremity of the animal, that is, surrounding the region of the head anterior to the eyes. The values of the potentials decreased rapidly posteriorly to the eyes and no spikes could be recorded from electrodes beyond a distance of 2–3 in. from the eyes towards the tail of the animal. The electrical field was therefore confined to the anterior end of the body.

By recording with continuously moving film and using single sweeps, the frequency of the spike potentials was determined. Fig. 2 represents a short section of such a film. The time scale is 0·1 sec. The spikes on this film recur with a frequency of 0·4 sec., but under different experimental conditions this frequency changed. It was established that the recurrence of the spikes is synchronous with the externally visible respiratory movements of the gill

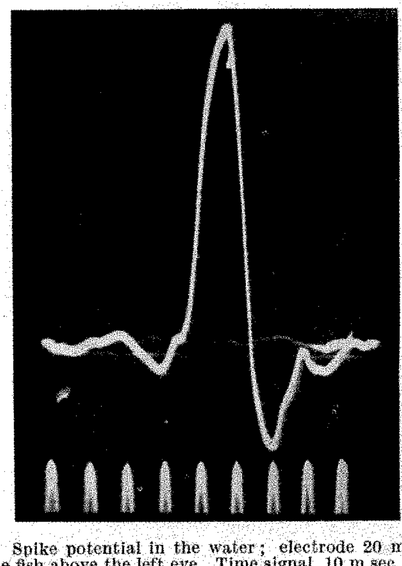

Fig. 1. Spike potential in the water; electrode 20 mm. away from the fish above the left eye. Time signal, 10 m.sec.; 200 V.

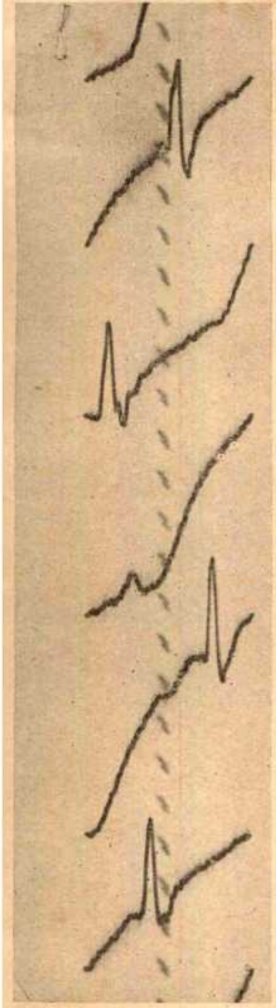

Fig. 2. Spike potentials recorded in the water surrounding the head of the sea lamprey. Time signal, 100 m.sec.

openings. This synchronization was determined by amplifying the spike potential sufficiently to light a 6-V. bulb and by making a motion picture of the gill movements and of the flashing bulb, held in the same photographic field. The spike potentials occur a fraction of a second before the onset of the closing movement of the gill openings. Fig. 3 represents a photograph of the head region of the sea lamprey, made by means of a photographic flash bulb fired by the amplified spike potential. The picture was taken with open camera shutter in complete darkness but for the firing period of the flash. It therefore represents the exact position of the gill openings at the moment the spike potential occurred. In Fig. 3 the gill openings are about to be constricted.

Detailed measurements of the electrical field were made in tubes of a more refined construction, and a number of recordings were made of potentials generated by lampreys in larger containers. Data obtained by these observations will be reported elsewhere.

At the present time, two main aspects of the observations made by us are being studied. (1) What is the source of the potentials recorded and (2) what are their functions, if any ? The source must be a powerful one since a potential of 200–300 μV., 20 mm. away from the animal, in fresh water, represents a considerable amount of energy at the source. In order to allow for the emission of this electrical energy into the water surrounding the head of the animal, a special organ or 'window' must be present in the skin, connecting the source with the outside medium. Preliminary experiments were made in order to determine the nature of this source, which may be the action potential of nerve or muscle. The shape of the spike potential represented in Fig. 1 resembles that of a nerve action potential in a conducting medium. Animals injected with strychnine sulphate, however, did not emit spikes of higher potential than non-injected animals. Treatment with curare and cocaine did not give conclusive information, and further experiments are now in progress to determine the source of the electrical field.

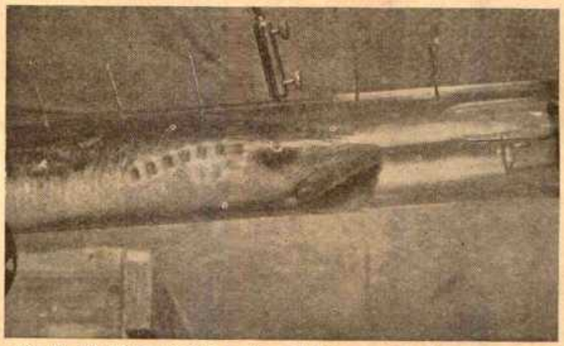

Fig. 3. Position of gill openings at the moment of occurrence of the spike potential in the water. Photoflash was fired by the amplified spike potential

As to the functions of these potentials in the life of the sea lamprey, it must be stated that the frequency of the spikes excludes their usefulness for 'radar' orientation. It is, however, very well possible that the lamprey is able to perceive changes in the electrical field surrounding its head and can thus sense the approximation of solid objects such as prey. In this connexion it may be pointed out that the lamprey's eyesight is poor and that the behaviour of lampreys in aquaria indicates that prey fish are attacked only when they are within a distance of a few inches from the lampreys.

We gratefully acknowledge the co-operation and assistance received from the Department of Lands and Forests of the Province of Ontario.

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Counter-Streaming Centrifugation of Bull Spermatozoa

PRELIMINARY experiments aiming at a separation of bull spermatozoa determining male and female sex were undertaken with a counter-streaming centrifuge[1]. Originally it was assumed that the female-determining spermatozoa, carrying a large X-chromosome[2], should have a greater volume or—the volumes being equal—a higher density than the male-determining ones, carrying a small Y-chromosome[2]. Later it was, however, demonstrated that the density of bull spermatozoa increases in the course of their physiological maturation[3]. This change in density is of such an order of magnitude that it totally obscures the difference in sedimentation-rate due possibly to the difference in volume between the sex chromosomes. Differences in sedimentation-rate might further be caused by as yet unknown differences in shape between the two kinds of spermatozoa.

In all experiments a slightly modified phosphate-buffer of Phillips and Spitzer[4] was used as suspension liquid. The separations were finished within thirty minutes. During this time the temperature of the introduced suspension liquid was lowered from 20° to 12° C. So far, only the fraction of spermatozoa retained in the centrifuge, representing a selection of larger and/or denser ones, has been used for inseminations.

In one experimental series the centrifuge was run at 1,200 r.p.m. and the rate of flow (12 ml./min.) of the suspension liquid was so adjusted as to make the retained fraction about half the introduced material. Of the 376 inseminated cows 187 became pregnant, corresponding to a fertility of 49·7 per cent. The mean fertility at the Artificial Insemination Station during the same time was 55 per cent. The sex of the calves was reported. There was no significant deviation of the sex-rate from that of the corresponding control group.

In another series the centrifuge was run at 1,100 r.p.m., and the rate of flow (16 ml./min.) of the suspension liquid was so high that only one-twentieth to one-fifteenth of the spermatozoa were retained in the centrifuge. They showed very low motility (over-ripeness[3] ?). For this reason, and on account of the scantiness of spermatozoa, only 24 inseminations were performed with this material. Of the cows 12 became pregnant, all belonging to different herds. One cow had to be slaughtered later. The 11 calves were all males. In the corresponding control group of 9 calves, 3 were males and 6 females.

The last series of experiments is being repeated.

I am very much indebted to the Artificial Insemination Association of Enköping for allowing me to perform these experiments, and to the chief veterinarian, Dr. T. Svensson, and to Dr. K. Idla for most valuable co-operation. The counter-streaming centrifuge was run by Mr. P.-Å. Lindström. Financial support from Ely Lilly and Co. is gratefully acknowledged.

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Blood-Histamine and Tissue-cell Anoxia in Mental Disease

WORK in our laboratories, *inter alia*, has been concerned for some years with the aberrant morphology[1] and physiological responses[2–4] of the peripheral capillary vascular system of patients with schizophrenia and other mental disturbances. More recently, we have been concerned with the effects of these responses of the minute vasculature on the oxygenation of the adjacent tissue cells. In brief, we have found that, under conditions of increased capillary pressure, lessened local blood-oxygen saturation and capillary corpuscular flow (often with intravascular erythrocytic agglutination), hydration, swelling, vacuolization, granularity and other degenerative changes reminiscent of cellular cloudy swelling occur progressively in the intervascular tissue substance[5]. These changes reverse themselves when the vascular conditions seemingly causing them also suffer a reversal. Although these changes have been observed from time to time in healthy subjects, they are much more characteristically seen, and for much longer periods of time, in psychiatric patients, and especially in psychotics. Also, these vascular and cellular responses seem to coincide in time with significant happenings in the mental state of the patients and the dynamic variations occurring in their state of consciousness (for example, a worsening of the pathophysiology takes place when hallucinations are experienced[6] or when a myoclonic seizure[7] occurs in an epileptic, while an improvement in these reactions coincides with recovery or subsidence of these events).

Our interest in the mechanism whereby the cell could conceivably be affected by a diminution in the supply of molecular oxygen in the capillaries led to a study of the histamine metabolism of psychiatric patients. Using the Lowry *et al.*[8] column chromatographic microchemical method of estimating blood histamine (modified by trebling the concentration of DNFB per aliquot) and 5-ml. blood samples obtained by venupuncture, we investigated both mentally healthy and mentally sick populations all in the non-fasting state. In the former ($N = 12$) we found a mean blood histamine-level of 88·86γ per litre ($s = 27{\cdot}43$), that is, very close to the mean of 82·0γ per litre for 'true' histamine reported by Lowry *et al.* and the figure of 86γ per litre obtained by Valentine *et al.*[9] from 16 non-fasting healthy subjects using Code's[10] modification of the original Barsoum and Gaddum[11] bioassay technique. In the latter population the mean levels were invariably greater, those for schizophrenia ($N = 29$) being 106·38γ ($s = 24{\cdot}84$) and contrasting with those for epilepsy ($N = 5$) at 139·42γ per litre ($s = 24{\cdot}57$), while those for other psychiatric conditions ($N_T = 66$) lay between these two values. An analysis of variance showed the differences between the means to be significant ($P = 0{\cdot}01$) and no significance could be attached to the possible variables of age and sex.

If these results are confirmed, their repercussions on stress-theory and on the role of histamine metabolism in this theory will be considerable; as they stand they strengthen the growing evidence favouring the relationship between tissue anoxia, mental disease and histamine release. We are currently engaged in extending our experiments in a longitudinal fashion in an endeavour kinetically to correlate the precise vascular and tissue events in circumstances of changing concentrations of blood histamine. The results contained in this communication will be published in greater detail in specialist journals elsewhere.

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Detection of Xanthine Dehydrogenase Activity in Soluble Proteins of Rat Liver separated by Paper Electrophoresis

IT has been shown by paper electrophoresis that xanthine dehydrogenase activity is bound to the globulin fractions of rat serum[1]. Using differential centrifugation, it was demonstrated that xanthine oxidase and xanthine dehydrogenase activities are present in the supernatant fluid corresponding to the 'cell sap' containing the soluble proteins of the rat liver[2].

A large number of proteins are present in the 'cell sap' fraction of the rat liver, and they have recently been separated by paper electrophoresis[3]. We were

Table 1. Protein and Xanthine Dehydrogenase Activity of Ten Rat Liver Supernatant Fluids

Component	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
Protein areas, per cent	4·70	17·24	13·04	14·21	17·52	10·03	8·40	5·26	3·55	2·66	3·15
*S.d.**	±1·97	±4·09	±3·61	±3·65	±5·40	±2·90	±1·42	±1·96	±1·09	±0·80	±0·73
Xanthine dehydrogenase activity, per cent	3·97	16·84	8·13	11·32	34·30	14·88	3·60	2·30	2·94	1·76	—

* $S.d. = \sqrt{\Sigma(d^2)/(n-1)}$

interested to know which of these fractions showed xanthine dehydrogenase activity.

Wistar white adult male rats weighing 150–200 gm. were used throughout the present work. The rats were killed by decapitation and the livers removed immediately after death and kept in crushed ice until fractionation. The differential centrifugation was carried out according to the technique of Hogeboom, Schneider and Pallade[4], as previously described[2]. The tissue homogenate was prepared by extracting the soluble proteins with 1·5 vol. of cold 0·25 *M* sucrose solution in a Potter–Elvehjem glass homogenizer. After the differential centrifugation the soluble fraction was separated and 0·05 ml. was applied to Whatman No. 3 filter paper strips for the electrophoretic separation. We have used an *M*/15 phosphate buffer *p*H 7·4 instead of borate buffer used by Adjutantis[3] since the borate was shown to inhibit the xanthine dehydrogenase activity[5]. The electrophoresis proceeded for 18 hr. using a potential difference of 250 V. which should give a current of 4–4·5 mA. in our experimental conditions.

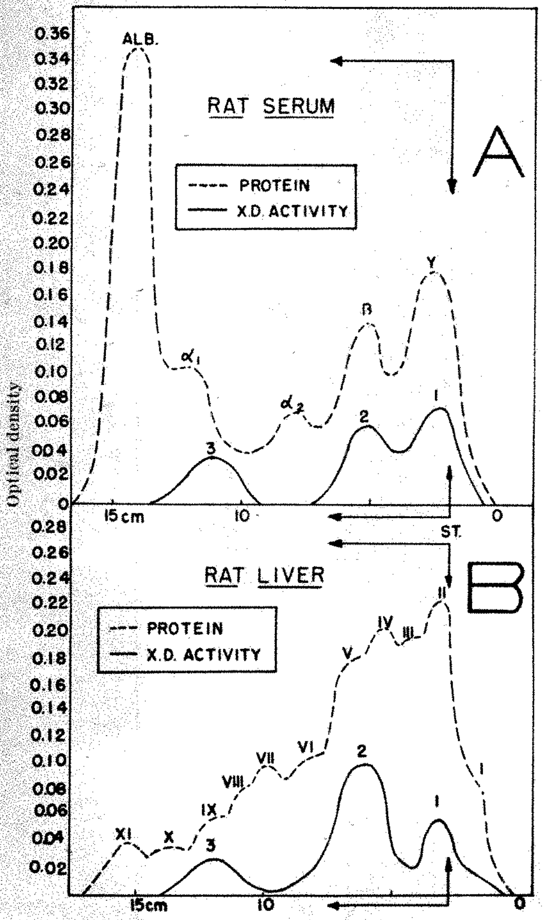

Fig. 1. Paper electrophoresis of rat serum (*A*) and liver supernatant fluid (*B*) on Whatman No. 3 filter paper using phosphate buffer *p*H 7·4. Arrows indicate site of application of samples and direction of run

Nitrogen determinations were performed on the soluble fraction of rat liver, as previously mentioned[2], to control the fractionation. The xanthine dehydrogenase activity was determined in the paper electropherograms, as shown for rat serum[1], by the reduction of the triphenyltetrazolium chloride to formazan, according to the method of Villela[6]. Control blanks without substrate were made simultaneously.

The experiments were performed on ten rats, and the results of the nitrogen determinations (1,031 ± 89 μgm. nitrogen per 100 mgm. fresh liver or its equivalent) showed the homogeneity of each sample, indicating that only proteins of the supernatant were present.

Eleven components were found by paper electrophoresis to be present in the soluble-protein fractions. The relative amount of each component was determined by planimetry of the areas according to the method of Pedersen[7] The results, together with the relative quantity (percentage) of xanthine dehydrogenase activity found for each fraction, are shown in Table 1 (mean of ten experiments).

The distribution of xanthine dehydrogenase activity in the protein fractions can be clearly seen in Fig. 1*B*. Three peaks are related to the protein fractions II, V and IX, and the values obtained from the calculated area are shown in Table 1.

In Figs. 1*A* and *B* the proteins and xanthine dehydrogenase activity diagrams of the liver and serum are shown for comparison. The protein fractions of rat liver and serum containing xanthine dehydrogenase activity give the same mobility-rate. Since it was also shown that xanthine dehydrogenase of rat liver and serum are both strongly influenced by carbon tetrachloride *in vivo* and *in vitro*[8,9], these results suggest that the xanthine dehydrogenase of liver and serum are probably similar.

This investigation was supported in part by grants from the Conselho Nacional de Pesquisas (E. Mitidieri) and from the C.A.P.E.S. (L. P. Ribeiro).

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Sodium and Potassium Content of Isolated Nuclei

It is well known that the concentration of sodium is low and that of potassium high in the intracellular space of most mammalian tissues. Nevertheless, an appreciable amount of each has been found in preparations of mitochondria isolated by differential centrifugation from homogenates of various tissues, particularly liver[1-4] and kidney[5]. The purpose of the present communication is to report on the association of sodium with another cellular component, the nucleus.

Nuclei prepared from calf thymus cells in 0·25 *M* sucrose–0·003 *M* calcium chloride solution[6,7], nuclei from calf thymus, liver and kidney isolated in non-aqueous media[8] and whole tissues similarly treated were kindly provided by Drs. V. G. Allfrey, A. E. Mirsky and S. Osawa, to whom we are greatly indebted. The sodium and potassium content of the isolated nuclei and whole tissues was determined by internal standard flame photometry after digestion with nitric acid.

Thymus nuclei prepared in non-aqueous media contained 238 μequiv. of sodium and 661 μequiv. potassium per gm. dry weight. Since the water content of the nuclei was 83 per cent, the sodium content was calculated to be 40 μequiv. and the potassium content 112 μequiv. per gm. wet weight. The sodium and potassium content of fresh thymus tissue averaged 38 ± 1·5 (s.e.) and 116 ± 1·5 (s.e.) μequiv. per gm. wet weight, respectively, and corresponded closely to the values of 43 μequiv. of sodium and 107 μequiv. of potassium per gm. wet weight found for the whole ground tissue after treatment with non-aqueous media. The similarity of the sodium and potassium concentration in the fresh and treated tissue suggests that there was no significant loss of sodium and potassium from the tissues into the media (petroleum ether, cyclohexane and carbon tetrachloride) during the non-aqueous procedures used for the nuclei.

The electrolyte content of nuclei isolated in sucrose solution was considerably lower, averaging 15 ± 0·8 (s.e.) μequiv. of sodium and 42 ± 2·1 (s.e.) μequiv. of potassium per gm. wet weight (42 experiments). In Table 1 these data are expressed as μequiv. per gm. dry weight. The sodium content of the nuclei isolated in sucrose averaged 87 ± 4·8 μequiv. per gm. dry weight with a range of 40–157 μequiv. per gm. dry weight; the potassium content averaged 244 ± 12·2 μequiv. per gm. dry weight with a range of 141–481 μequiv. per gm. dry weight. If the values obtained for nuclei isolated in non-aqueous media represent the natural cation content of the nucleus, an average of 62·5 per cent (range 17–73 per cent) of the original sodium and potassium is lost from the nucleus by the repeated washings with sucrose solution during the preparation.

The sodium and potassium content of liver and kidney nuclei isolated in non-aqueous media also proved to be approximately the same as that of the whole tissue (Table 1).

Table 1. THE SODIUM AND POTASSIUM CONTENT OF TISSUES AND NUCLEI (μEQUIV. PER GM. DRY WEIGHT)

	Na	K	Na/K
Isolated in non-aqueous media :			
Calf thymus : Whole tissue	257	627	0·41
Nucleus	245	639	0·38
	230	683	0·34
Calf liver : Whole tissue	144	274	0·53
Nucleus	171	322	0·53
Calf kidney : Whole tissue	433	372	1·16
Nucleus	431	410	1·05
Isolated in sucrose solution :			
Calf thymus : Nucleus	86	245	0·35

It is unlikely that sodium and potassium are uniformly distributed throughout the nucleus and cytoplasm. Whole tissue includes a considerable amount of extracellular fluid containing 140 μequiv. of sodium per ml. and only 5 μequiv. of potassium per ml. If the extracellular fluid of the thymus amounts to 10 per cent by weight, there will be 32 μequiv. of sodium and 119 μequiv. of potassium per gm. of cellular mass. Since the cell nuclei occupy 61 per cent of the thymus tissue[8], the content of sodium in the cytoplasm is estimated as 15 μequiv. per gm. and the content of potassium in the cytoplasm as 139 μequiv. per gm. Thus sodium appears to be present in significantly greater amounts in the nucleus than in the cytoplasm at large. The sodium content of the nuclei may have been over-estimated owing to inclusion of connective tissue fragments in the sedimented nuclear fraction. Studies of sodium binding by constituents of this fraction are in progress.

That the sodium and potassium content of the nucleus, or at least of its surrounding cytoplasm, has general functional significance is attested by the finding of Allfrey, Mirsky and Osawa that protein synthesis in isolated nuclei is strikingly dependent upon the presence of sodium ions in the suspending medium[9].

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Ultrastructural Organization of Bone

The high mechanical stability of bone tissue is obtained through the combination of the inorganic component hydroxyapatite with the inelastic fibrous protein collagen. Besides serving as supporting tissue, bone also plays an important part in the ionic homeostasis of the organism. A study of the ultrastructural organization of bone should contribute to a better understanding at the molecular level of these characteristic properties of the osseous tissues.

Through combined electron microscope and X-ray diffraction studies at high and low angles[1-4], the following general picture of the submicroscopic organization of bone can be derived. The fibrous matrix of bone, that is, collagen, appears capable of orienting the hydroxyapatite crystallites in a highly ordered way. Thus the rod- or needle-shaped apatite particles are attached precisely along the collagen periodicity. The X-ray evidence[2,3] derived from the profiles of the wide-angle lines and the low-angle particle scatter, and indicating the presence of rod-shaped apatite particles 40–75 A. wide and about 200 A. long, conforms with the results of electron microscope in-

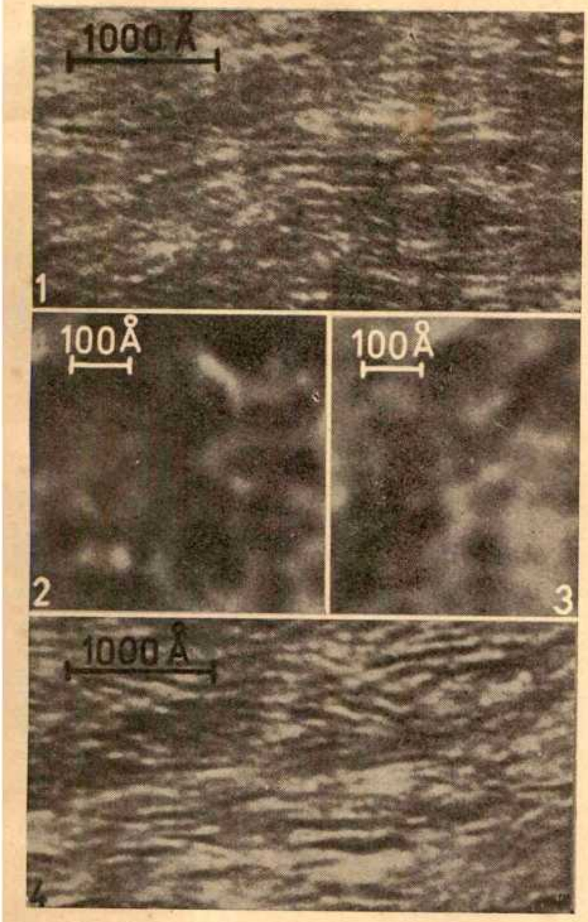

Fig. 1. Ultra-thin section of undecalcified hen bone showing orderly alignment of the apatite particles on collagen. × 200,000
Figs. 2 and 3. Cross-sections of individual apatite particles with surrounding areas of lower electron density. Taken on Kodak High Resolution Plates *KP* 41394. × 750,000
Fig. 4. Longitudinally oriented apatite particles with fine structure. × 200,000

vestigations of ultra-thin sections of bone[1]. The sections of undecalcified bone were produced with a Moran ultra-microtome equipped with a diamond knife[5], and examined at 50 and 100 kV. in an RCA *EMU 3B* electron microscope with compensated objective lens consistently giving a resolution of about 15 A. The examination of a great number of bone sections (human, rat, hen and fish specimens) 50–200 A. thick disclosed the predominance of rod- or needle-shaped apatite particles 30–40 A. wide and about 200 A. long (Figs. 1–4). In cross-sections, the apatite particles are hexagonal or circular and regularly arranged in a network (Figs. 2 and 3). The particles are surrounded by areas of lower electron density, which probably correspond to the dehydrated organic matrix.

Plate-like structures have been described in electron micrographs of bone[6]. In the present study, thin flakes about 500 A. in diameter were seen in some areas. At higher resolutions, however, these flakes seem to be aggregates of thin rods or particles of the same size as those seen in association with the collagen fibres.

Thus both X-ray diffraction studies and electron microscopy point to the existence of rod- or needle-shaped apatite particles about 40 A. in diameter and 200 A. long precisely aligned mainly along the periodic structure of collagen fibres. Further details will be described elsewhere.

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Nitrogen Output and Ecdysis in Crustacea

It has been observed[1] that nitrogen output in the shore crab, *Carcinides* is very low prior to moulting, but begins to increase over the last few days. An indication that it rises sharply after ecdysis has now been confirmed in *Asellus aquaticus* (Fig. 1). Feeding individuals were isolated in 2 ml. of water at 23 ± 0·5° C.; the water was renewed daily, and its content of ammonia and amino-nitrogen (as in *Carcinides* the predominant nitrogen-compounds excreted) was estimated by a micro-adaptation of the Sørensen method. Estimates were monitored by the use of Russell's phenate–hypochlorite method[2].

As in *Carcinides*, ammonia output is relatively low 5–6 days before ecdysis and shows a similar incipient rise up to the time of moulting (Fig. 1). After ecdysis it rises sharply and considerably and then declines more gradually to approach the initial minimal value in 10–15 days, that is, about 5–6 days before the next moult in this animal. The decline shows a minor oscillation reminiscent of those superimposed on the general decline in nitrogen output (following an initial peak) after amputation of limbs[3].

The exoskeleton is cast in two portions, often in succeeding 24-hr. periods. In Fig. 1 the mean record for such individuals (*E*) has been separated from that for animals (*A*), which cast both halves in the same

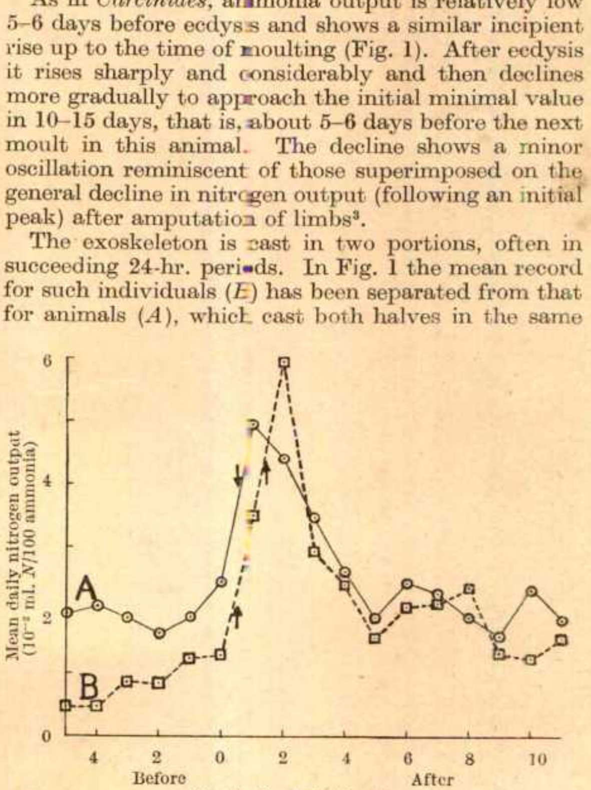

Fig. 1

24-hr. period (arrows mark times of casting). In both groups mean nitrogen output was maximal during the 24 hr. in which the second half was cast; it was not equal in the two 24-hr. periods occupied by ecdysis in *B*. Moreover, in some individuals of *A* output was maximal during the second day after the onset of ecdysis, so that it is not due merely to products of the exuvia, moulting fluid, etc., but is a component of metabolism, culminating soon after the completion of ecdysis. The following minor oscillation in output continued to show the difference in periodicity, of about one day, between the two groups.

The more protracted ecdysis in *B* may be related to the generally low nitrogen output of that group. The eye-stalk hormones of decapods suppress moulting except in the later stages of the intermoult[4], and they prevent excessive nitrogen loss from the tissues[5], and from the body[3]. The low nitrogen output in *B*, therefore, may indicate relatively high activity of a moult-inhibiting hormone.

The period of low nitrogen output in the middle of the intermoult corresponds to that, also hormonally controlled, of maximal cell-proliferation in the cockroach[6], and other arthropods. As in regeneration[7], nitrogen excretion is low when cell-proliferation is most rapid. Amputation of limbs before this critical time can 'put back the clock' of the moult-cycle to synchronize with that of the regeneration-cycle[6]; there appears to be considerable similarity in metabolism between the two cycles.

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Relative Growth of Organs and Tissues in Mammals

In the study of relative growth of organs and tissues, there are certain advantages in referring the relative weights to age, throughout the life-cycle. When results are expressed according to the allometric formula[1–3], $y = bx^{\alpha}$ (x = weight of animal, y = weight of organ, b and α = constants), time as an independent variable tends to be eliminated. When, however, the relative weights are expressed in relation to age or its logarithm, they are found to show maximal values at definite periods of the life-cycle, specific for and characteristic of each organ[4]. The curves of the relative weights, as functions of the logarithm of age, tend to follow one of the types in Fig. 1. Thus, in the rabbit, that of the brain follows, from the nineteenth day of embryonic life until adult age, curve 1 of Fig. 1, that of the liver and of the lungs, curve 2, with maximal values respectively at the twenty-fourth and at the twenty-seventh day of embryonic life; that of the kidneys, curve 3, with a maximum between the second and fourth weeks after birth; that of the stomach, curve 4, with a maximum between the fifth and tenth weeks; that of the muscles, curve 5, with a maximum after puberty; and that of the perirenal adipose tissue seems to follow curve 6 with maximal values only late in the adult age. The same sequence of organs, ranged according to periods of maximal relative weights, is likely to be found in other mammals, as is seen from observations of C. M. Jackson[5] on human brain, liver, lungs and kidneys the relative weights of which are maximal in the second, at the end of the third, in the fourth and between the seventh and eighth months respectively.

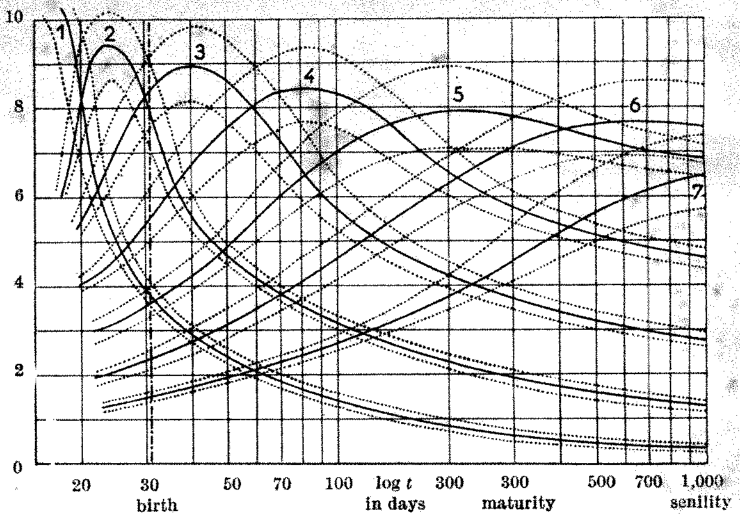

Fig. 1. Types of relative growth of organs, as functions of logarithm of age; ordinate: relative weights of different organs, expressed in convenient units (dotted lines enclose range of variations)

Yet, the growth curves of *absolute* weights of these organs are sigmoid, asymmetric and quite superposable with the growth-curve of the whole body. The existence of maximal values for relative weights seems to be due to the differences in growth-rates of the tissues: organs the absolute weights of which approach most rapidly the limiting weight of adult age have maximal relative weights in early embryonic stages, in opposition to the tissues the absolute weights of which approach slowly the limiting weight and the relative weight of which is maximal late in adult age[6]. When employing the allometric formula, which does not take account of age, positive allometry[7,8] may be observed for increasing relative weights, isometry for their maximal values and negative allometry for their decreasing values[6].

Differences in growth-rates of these organs can be related to the evolution of their chemical composition. Thus the amount of lipoid phosphorus for 100 gm. of fresh tissue, which increases regularly and continuously during embryonic and post-embryonic life until adult age, attains values of 250–270 mgm. per cent in the brain, 150–170 mgm. per cent in the liver, 120–130 mgm. per cent in the lungs, 100–110 mgm. per cent in the kidneys, 60–70 mgm. per cent in the stomach, 29–32 mgm. per cent in muscle and 5–7 mgm. per cent in the perirenal adipose tissue[9]. The same sequence is observed with the amounts of free cholesterol for 100 gm. of these organs[9], with the amounts of proteins and some other constituents.

Thus the sequence of organs is the same, when considering differences of their growth-rates, or differences of accumulation-rates of their lipoid phosphorus, of free cholesterol and of other constituents.

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Passive Transfer of a Tumour-resistant Agent by Serum Injections

THE question of passive transfer of tumour resistance (or immunity) appears still open[1-3].

We are working with Walker 256 rat carcinoma, subcutaneously transplanted to commercially available susceptible Wistar albino rats. Among hybrid rats (black or hooded) bred in our laboratory there are individuals capable of acquiring a high-grade resistance (immunity) to this tumour, that is, take at the first implantation and regression after some growth, then failure of growth at further implantations. In a previous experiment[4], we found that rats resistant to Walker carcinoma manifest also a significant delay in growth of 3,4-benzpyrene-induced sarcomas, as compared with the Wistar rats. We are breeding a black strain derived from these hybrids by brother–sister mating; every one of the eight sibs in the eighth inbred generation was found resistant to Walker 256 tumour.

In two experiments we injected pooled serum taken from resistant donors of hybrid origin after regression followed by repeated unsuccessful implantation in them of the tumour used, to Wistar rats implanted with the same tumour.

In the first experiment, summarized in Table 1, 21 Wistar females were implanted simultaneously with the Walker carcinoma and given from the same day either 1 ml. intraperitoneal daily of immune serum from resistant donors, or an equal dose of normal Wistar serum, or left untreated. After 12 days from the implantation the tumours were removed and weighed.

In the second experiment (Table 2) 40 Wistar males were used; one more control was inserted, namely, rats injected with normal pooled serum of donors from the tenth inbred generation of resistant rats not immunized by prior implantation of the tumour. The growth of the tumours was measured by calipers on two diameters and is represented in mm.[2] at the twenty-fourth day after implantation.

Table 1

Treatment	No. of rats	No. of takes	Mean weight of tumours (gm.)	Range of weights
Immune resistant serum	7	7	3 4	0·40–11·50
Normal Wistar serum	7	6	8 6	0·40–17·60
Untreated	7	6	9·3	5 50–14·20

Table 2

Treatment	No. of rats	No of takes	No. of regressions	Mean area of tumours (mm ^{2})	Range of tumour area
Immune resistant serum	10	[illegible]	2	360	25–945
Normal resistant serum	10	[illegible]	–	1,725	25–5,095
Normal Wistar serum	10	[illegible]	2	1,310	150–3,895
Untreated	10	[illegible]	–	1,220	75–3,005

Both experiments are in full agreement in tumour-growth retardation after injections of immunized serum of resistant rats. There are some differences in the number of takes and some regressions in the respective groups, owing probably to the sex difference of both groups (the tumour is a mammary adenocarcinoma which arose in a female; some hormonal antitumour factors may co-operate).

The quantitative evaluation of the supposed antitumour agent passively transferred by serum injections, as well as several other implications, are subject to further experiments (for example, in controls injected with non-immune sera there is a suggestion of either inhibitive or stimulative non-specific influence).

The reason for this successful transfer of a tumour-immunity agent by serum injections—in contrast with other reports—is seen in the contraposition of two homologous but heterogenetic strains, one of which is capable of developing an exceptionally high degree of specific antibody formation. The non-specific, anti-Wistar immunization (a Wistar tumour was implanted to non-Wistar strain of rats) seems negligible, as the total body-weight curves of all groups in the second experiment are nearly parallel.

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Fluorescent, Benthic, Pacific Coast Coelenterates

ORANGE fluorescing pigments have been studied extensively in red algae[1,2], where the fluorescence becomes apparent in the moribund plant; but such pigments would appear to be rare in the animal kingdom (see Klüver[3] for evidence of a red-fluorescing pigment in mammals). At depths greater than 10 m. where sunlight becomes deficient in the longer orange and red wave-lengths, divers have sometimes observed brilliantly luminous orange and red animals. Marden[4] noted the phenomenon while photographing a large unidentified anemone in the Red Sea at 20 m., and suggested the animal might have a fluorescent pigment. Our investigations show that certain animals do indeed possess the ability to fluoresce.

During many hours of diving in Californian and Mexican waters, we have found three fluorescent forms, all coelenterates belonging to the sub-class Zoantharia: *Corynactis californicus*, order Actinaria; *Balanophyllia elegans*, order Madreporaria; *Cerianthus* sp., order Ceriantharia. The anemone observed by Marden in the Red Sea was an actinarian. *Corynactis* is an aggregating form, while the others are solitary. Only occasional specimens of *Cerianthus* and *Balanophyllia* fluoresce; but entire small colonies of *Corynactis* (presumably derived asexually from the same individual) may possess the ability, although nearby colonies may fail in this respect. The situation seems reminiscent of pigmentation in the anemone *Metridium*, studied by Fox and Pantin[5], where colour can vary widely from specimen to specimen, yet exhibit constancy in a given individual and is presumably under genetic control. Environment might influence fluorescence, however, if a dietary pigment precursor is needed. It is not known if the intensity of fluorescence under natural conditions changes during the life of an individual; but the amount of fluorescent coloration in specimens of *Balanophyllia* and *Corynactis* kept for two months in our aquarium has not changed appreciably.

Whole specimens of *Balanophyllia* and *Corynactis*, as well as comminuted tissues, were subjected to various physical and chemical tests. Most of the specimens used exhibited a striking orange or red coloration at the time of collection from depths of 20 m. or more. Fresh tissues examined microscopically (× 500) gave no sign of symbiotic algae. Animals exhibited no luminescence when observed in a dark-room. When exposed, however, to well-filtered ultra-violet, violet, blue or green light, the luminous colour observed at the time of collection reappeared. Orange and red light did not excite the fluorescence. The two species, as well as individuals of the same species, differed somewhat in the colours of emitted light; but this could perhaps be caused by variations in concentration of other non-fluorescent body pigments, as well as by differences in the fluorescent pigments themselves. The intensity of emitted light varied directly with the intensity of the exciting light. Specimens that did not exhibit colour on the ocean floor did not fluoresce in the laboratory.

Whole or comminuted animals did not yield any orange fluorescent pigment to either acetone or ethanol. Intact specimens of *Corynactis* kept under acetone for two months have retained their fluorescence apparently undiminished, although they yielded considerable amounts of an orange-coloured pigment, probably carotenoid in nature. Boiling water irreversibly quenches the fluorescence in whole animals after one or two minutes, leaving a dull orangish specimen in the test tubes. The pigment, therefore, is apparently heat-labile, but is distinguished from the algal fluorescent pigment, phycoerythrin, by the stability of the fluorescence to acetone.

Further work is in progress in an attempt to isolate and characterize the fluorescent pigments, to determine their emission spectra, and to study their distribution in the animal kingdom.

This work was carried out during the tenure by one of us (W. J. N.) of a post-doctoral fellowship in marine biology. Grateful acknowledgment is made to Prof. Denis L. Fox, Prof. Carl L. Hubbs, Dr. Francis T. Haxo, and to Messrs. J. Stewart, H. Scotten and R. Ghelardi for advice and assistance. We are indebted to the Division of Marine Botany for the loan of equipment to produce monochromatic light.

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Effect of Age of Cotton Seedlings on their Susceptibility to *Rhizoctonia* Damping-off

DAMPING-OFF fungi are known to destroy seedling plants during the first four–six weeks after germination. Tint[1], in his studies on *Fusarium* damping-off of conifers, reported a direct correlation between resistance to invasion and increasing age of host. Matus[2] found that cotton plants were invaded by *Corticium vagum* throughout the growing period, although susceptibility appeared to decline as the plant grew older. Linnasalmi[3] also reported that attack by *Rhizoctonia solani* on cabbage, cucumber and tomato was most severe at the pre-emergence phase. Koba[4] stated that cotton seedlings proved very susceptible to damping-off caused by *Fusarium* spp. at the eight- to fifteen-day old stage when stored food is exhausted and photosynthesis is low.

The present experiment was planned to study the effect of age of seedlings of two varieties of Egyptian cotton, namely, Ashmouny and Giza 30, on their susceptibility to attack by *Rhizoctonia solani*, the cause of damping-off of cotton in Egypt.

The experiment was carried out at three temperature-levels, namely, 9°–18°, 15°–28° and 19°–34° C. Cotton seedlings were raised in sterile soil at a moisture-level of 60 per cent water-holding capacity. As soon as they appeared above the soil-level, twenty seedlings of each variety were exposed daily to the fungus over a period of four weeks. Inoculation was carried out by inserting disks from two-day old agar cultures of *Rhizoctonia solani* on the hypocotyls of the seedlings just above soil surface. Controls with disks of agar free from the fungus were kept under the same conditions. Seedlings, in each case, were kept under observation for a period of four weeks from exposure to the fungus and the number of damped-off seedlings recorded. A representative set of results is presented graphically in Fig. 1. Seedlings

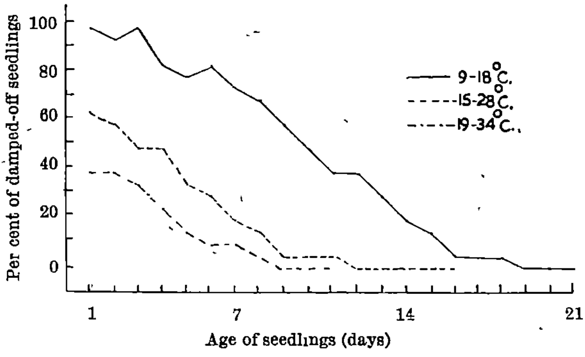

Fig. 1. Effect of age of Ashmouny cotton seedlings on their susceptibility to attack by *Rhizoctonia solani*

inoculated with disks of agar free from the fungus remained healthy throughout the whole experimental period.

The experiments showed that young seedlings of the two cotton varieties are very susceptible to attack by *Rhizoctonia solani*, and susceptibility decreases significantly with increased age of seedlings until they are completely resistant after about 19 days from emergence when raised at 19°–34° C., 12–15 days at 15°–28° C., and 19–22 days when raised at 9°–18° C. The decreased susceptibility with increased age is in full agreement with the previous findings of other investigators; but the fact that cotton seedlings became completely resistant to *Rhizoctonia* attack after a certain period of time, governed by the range of temperature prevailing during germination and emergence, is contradictory to the results of Matus[2], who claims that cotton plants are invaded by *Corticium vagum* throughout the growing period.

Seedlings of Giza 30 variety tend to remain susceptible to the fungus for somewhat longer periods than those of the Ashmouny variety, especially when raised at the lower temperature.

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A Chromosome Number New to *Linum*

THE genus *Linum* comprises some ninety species of which, apart from the garden cultivated plants (*L. grandiflorum*), *L. usitatissimum* is of economic importance. Chromosome numbers have been reported in the literature[1–3] for thirty of these species, the range of somatic chromosome numbers being 16, 18, 20, 28, 30, 32, 36, about 57 and about 86.

L. mysorense Heyne is a wild species distributed in the mountainous regions of India and Ceylon at altitudes between 3,000 and 6,000 ft. Material of this species collected from the Western Himalayas and the Western Ghats in India was found by us to possess $2n = 60$ chromosomes, a number hitherto not reported for any naturally occurring species of *Linum*. During microsporogenesis, 30 bivalents were invariably noticed. The pollen was fully fertile and seed-setting abundant.

The high chromosome number and the regular bivalent formation observed during meiosis would suggest that *L. mysorense* is a polyploid functioning like a diploid. In view of this, the diminutive form exhibited by the species has perhaps an adaptive significance. The plants are dwarf, being 8–40 cm. tall, and bear small yellow flowers, about 6 mm. in diameter. The pollen grains measure $60{\cdot}16 \pm 0{\cdot}56\mu$ in diameter and are significantly smaller than those of *L. usitatissimum* ($67{\cdot}50 \pm 0{\cdot}40\mu$), having $2n = 30$ chromosomes. The seeds also are very small—0·8 mm. long and 0·5 mm. broad, the range of corresponding measurements in respect of *L. usitatissimum* being 2·0–4·0 mm. and 1·2–1·8 mm. In peels of the lower and the upper epidermis of fully developed leaves, the stomatal length in the case of *L. mysorense* (33·3μ) was significantly greater than that in *L. usitatissimum* (26·6μ; the width of the stomata was about the same 16·6μ) in the two species.

We are grateful to Mr. V. C. Lele, of Simla, and Mr. V. D. Vartak, of Poona, for the seeds of *L. mysorense*.

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Chemical and Biological Determination of Copper in Soil

SEVERAL methods, chemical as well as biological, have been suggested for the determination of copper available to plants in soil. Steenbjerg's[1] method has been used here since 1940, and consists in the extraction of copper from soil with dilute hydrochloric acid of such concentration as to result in *p*H 2·00 of the soil suspension after shaking for one hour. This method has in this laboratory during the past three years been compared with bioassays of copper by means of *Aspergillus niger* according to Mulder[2]. Both methods are somewhat laborious and do not yield readily reproducible results, *inter alia*, because the time of sampling and the length of sample storage influence the results of at least the chemical method.

Investigations have been conducted in order to devise a simpler and more reliable method, and disodium-ethylenediaminetetra-acetate has been tried as an extracting agent, as suggested by Cheng and Bray[3]. The theoretical background for the extraction of heavy metals from soil by means of ethylenediaminetetra-acetic acid was recently discussed by Viro[4].

Preliminary tests were made in order to define the conditions of extraction, etc., and a two-hour extraction with a 0·02-*M* ethylenediaminetetra-acetate solution at its natural *p*H (4·5) was adopted; this results in a state of approximate equilibrium, at least in the case of soils containing less than 2 p.p.m. copper according to the method in question. Copper in the soil extract was determined colorimetrically as the diethyldithiocarbamate complex in the presence of an ammonium citrate solution of *p*H 9·0, which eliminates the interference due to other metals and prevents precipitation of iron.

The analytical procedure is as follows: 10 gm. of air-dry soil is shaken for one hour with 100 ml. 0·02 *M* ethylenediaminetetra-acetic acid solution. The suspension is filtered after standing for another hour, and an aliquot of the filtrate, with not more than 50 μgm. copper, is transferred to a 150-ml. separation funnel; 50 ml. is usually convenient. Approximately 10 ml. of 1 *M* ammonium citrate solution is added, and after thorough shaking a further 1 ml. 1 per cent solution of sodium diethyldithiocarbamate and 15 ml. carbon tetrachloride. After repeated thorough shaking for two minutes and standing until complete separation of the aqueous and the carbon tetrachloride phase, the latter is run through a filter into a small measuring flask or directly into the photometric absorption cell. The colour intensity is measured on

Table 1

Copper, p.p.m. by EDTA-extraction	No. of samples	Copper, p.p.m. means			S.D. bio-assay
		HCl extraction	EDTA extraction	Bio-assay	
0–0·5	17	0·17	0·41	0·94	± 0·557
0·6–1·0	88	0·21	0·83	1·15	± 0·405
1·1–1·5	64	0·25	1·29	1·31	± 0·368
1·6–2·0	34	0·29	1·76	1·59	± 0·409
2·1–2·5	23	0·37	2·30	1·61	± 0·460
2·6–3·0	9	0·33	2·82	1·66	± 0·472
> 3·0	54	1·30	6·99	(>2·50)	—*
Means, 238 samples:		0·26	1·29	1·31	

* This group was omitted from the calculation of means, because the biological method only permits the determination of 2·5 p.p.m. copper and less.

a Beckman spectrophotometer (model *DU*) at 440 mμ and with a 10-mm. absorption cell.

A number of soil samples from untreated control plots in field experiments with copper fertilizers conducted in 1955 were analysed in this way. The copper contents varied between 0·2 and 33·5 p.p.m., with an average of 2·3 p.p.m. in 292 samples. Table 1 shows a comparison between the results for the chemical and the biological method.

Extraction with ethylenediaminetetra-acetate in its present form removed on the average the same amount of copper from the soil as did the growth of *A. niger*, and five times as much as the hydrochloric acid extraction. The agreement between the ethylenediaminetetra-acetate extraction and the bioassay is best in the copper range of 1·0–1·5 p.p.m., probably because the visual estimation of the spore colour in the biological method is most reliable at this level. Fifty ethylenediaminetetra-acetate extracts from soils of varying type showed *p*H values between 4·27 and 4·58 (average 4·43), which is about the same *p*H level as found in the nutrient solution after growth of *A. niger* in the bioassay. This, together with the fact that copper ions are in both cases continuously removed from the soil/liquid system, may explain why these two essentially different methods show the same ability to extract copper from the soil.

The work is being continued, and a more detailed account of the method and its applicability to the diagnosis of copper deficiency in soil will be published elsewhere.

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Humus Decomposition in East African Soils

THE macro-respirometer described by Swaby and Passey[1] has been considerably modified while still retaining its chief advantages. The modified apparatus (Fig. 1) is relatively cheap, easy to make and sensitively reflects the magnitude of organic matter decomposition over any desired period. The respirometer vessel is an 8-oz. sample bottle in which the soil (usually 50 gm.) is placed. A small container with about 10 ml. of 2 *M* sodium hydroxide absorbs the evolved carbon dioxide. The unit is immersed in a thermostatically controlled bath 24 in. × 12 in. × 15 in. deep which holds fourteen such units. The hydrogen evolved at the cathode is collected in a 100-ml. burette. The electrodes consist of platinum strips, and the anode was easily prepared by inserting the platinum through a small slit in a 2-in. length of polythene tubing (Fig. 2) about 5 mm. in diameter. This was then joined to the end of the glass tubing (of slightly smaller diameter) leading from the respirometer, using Chatterton's compound. The platinum outside the polythene tubing was bound to the side with fine wire, leaving some for the terminal, and also sealed with Chatterton's compound. The electrodes were joined to a 6- or 12-V. accumulator.

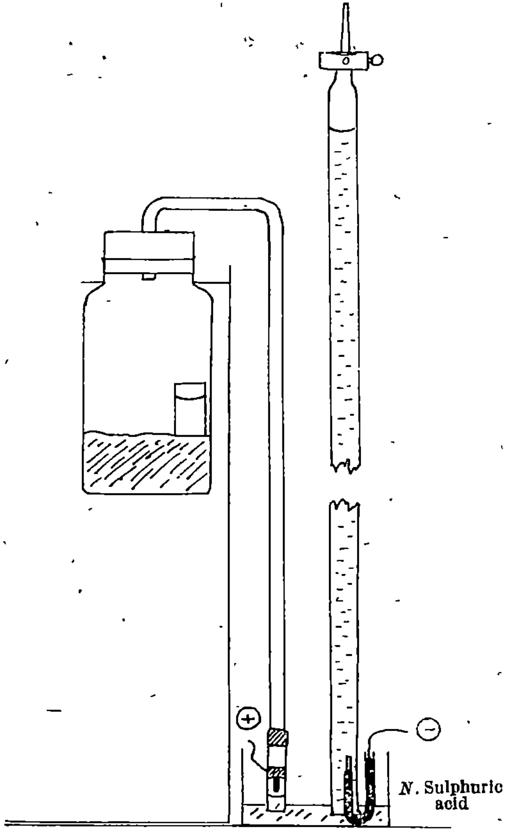

Fig. 1

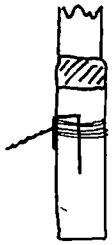

Fig. 2

As oxygen is consumed by the soil micro-organisms carbon dioxide is produced which is absorbed by the sodium hydroxide. This lowers the pressure in the respiration bottle so that sulphuric acid rises in the side-arm, makes contact with the anode and gererates oxygen. This diffuses back into the bottle until atmospheric pressure is restored, after which contact between the sulphuric acid and the anode is broken. This is restored when further oxygen is consumed. The volume of hydrogen simultaneously generated at the cathode is equal to twice the volume of oxygen consumed. Oxygen consumption and carbon dioxide output are usually about equal; but any unbalance is readily shown by respiratory quotient determinations.

With the soil samples so far tested in this apparatus organic matter decomposition followed a first-order reaction, that is, the rate of decomposition decreased with time and was proportional to the amount of decomposable material present. The decrease was shown not to be due to fall in pH, the accumulation of toxic products or the adverse effect of the respirometer environment on microbial activity.

Among the results so far obtained the following are of particular interest. When a soil was air-dried and rewetted an appreciable flush of decomposition resulted. Further successive dryings and rewettings produced effects similar in magnitude, rate of decomposition, and kind of organic material decomposed. The effect lasted for about five days. Oven-drying had a similar effect but of greater magnitude. The drying effect was shown not to be related to microbial stimulation, destruction of toxic compounds, the release of nitrogen, phosphorus and potassium or microbial death with subsequent decomposition of the remains. All the evidence available indicates that the drying effect is one of liberation from the clay of rapidly decomposable material which, under steady moist conditions, is protected by the clay from microbial attack. The magnitude of the effect is related to the degree of drying (influencing both the amount of material liberated and the rate at which it is re-absorbed and reprotected from microbial attack on rewetting); the kind and amount of clay and the amount of organic material associated with it. More exact relationships have yet to be worked out. A single air drying of a forest soil (5·4 per cent carbon) liberated rapidly decomposable organic material equivalent to 0·011 gm. carbon per 100 gm. soil (or 220 lb./acre-6 in. assuming this weighs 2×10^6 lb.). Replacement of this material, assuming it to be of a humic nature, would involve the decomposition of about 1,700 lb. of dry plant material on the basis that this contains 50 per cent carbon and loses 75 per cent of the carbon as carbon dioxide during decomposition to humus.

Similar behaviour was observed with sand–pure clay mixtures to which gelatine was added. Not only did montmorillonite have a much greater protective effect on gelatine decomposition than kaolinite, but also the protected gelatine could afterwards be partly released on successive drying and rewetting, thus paralleling the behaviour of the soil. With kaolinite the drying effect was much less marked. No doubt clays intermediate between these two extreme types would show intermediate effects.

It further appears that the organic material liberated on drying may also be liberated through displacement by other organic compounds. Thus, when gelatine was added to two moist soils, slowly respiring, the respiratory quotient (1·29) for the active decomposition period following the addition was almost identical with that following oven-drying and rewetting and considerably above the theoretical value (0·8) which was obtained during gelatine decomposition in sand–pure clay mixtures. Presumably a rapid exchange took place between the gelatine and the protected organic material, some of the former then being protected and the latter exposed to microbial attack.

These results indicate that part, at least, of the humus fraction under moist conditions is protected from, but not inert to, microbial attack. When it is released either by drying or displacement, it is rapidly decomposed. Further, since decomposition generally parallels ammonia accumulation there should be a quick release, through mineralization, of nitrate and other nutrients. Such behaviour has an obvious bearing on (*a*) the seasonal pattern of humus decomposition, (*b*) the nitrate flush which, as reported by Griffith[2], occurs at the start of the rains and is related to the degree of soil drying, and (*c*) the beneficial effects, so often reported, of burning. It is also possible that the so-called priming action of fresh organic matter on the breakdown of soil humus, generally ascribed to increased microbial activity, is in fact a displacement effect caused by an exchange between the organic matter decomposition products and those already associated with, and protected by, the clay.

There are several references in the literature both to the protective effect of soils and clays against the decomposition of organic compounds, and to the effect of drying on increasing soil fertility. The evidence described above, for the liberation of the protected material on drying, provides a link between these two observations. It also indicates a possible use for the respirometer in soil fertility studies.

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April 19.

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Transmission of Beet Mosaic Virus from *Stellaria media* and *Capsella bursa-pastoris* by *Myzus ascalonicus* Doncaster

During the winter of 1955–56, *Myzus ascalonicus* Doncaster was observed hibernating on chickweed (*Stellaria media*) in the field at Gembloux, next to a place where fodder beet had been cultivated in 1955 and harvested in October of the same year. With the view of testing if any of the aphids were bearers of beet viruses, adults and larvæ of the spring generation were put on fodder beet seedlings, var. 'Jaune de Vauriac' for 48 hr. (5–10 aphids a plant), between April 5 and May 2, 1956. After 20–30 days, three of the eighteen tested beets showed chlorotic and yellow translucid circular or irregular little spots on the young leaves. The symptoms were attenuated on the older leaves; these last became narrow and showed interveinal yellowing. The plants were stunted. Later, one of the infected beets showed a regular vein-yellowing on the young leaves.

The sap of one of the infected beets, mixed with 'Carborundum', was inoculated to healthy 'Jaune de Vauriac'; a general mosaic appeared on the young leaves of the five test plants within seven days, suggesting that the virus transmitted was *Beta* virus 2. Using the same source, a transmission was made to beet seedlings by *Myzus persicae* Sulzer

(1–2 min. on the source after 2 hr. fasting, 24 hr. on test plants, 10 aphids a plant). Mosaic was obtained on young leaves within 10–20 days.

The virus was transmitted from infected beet to chickweed seedlings in the same conditions by *Myzus persicae*. It was then re-transmitted from supposed infected *Stellaria* to beet seedlings by *Myzus ascalonicus* Doncaster (1–2 min. on the source, after 2 hr. fasting; ten aphids a plant; 24 hr. on beet). Two of the five tested plants showed mosaic on young leaves after 15–20 days.

According to preliminary results, beet mosaic is also transmissible from infected *Capsella bursa-pastoris* to beet by *Myzus ascalonicus*.

Using beet as a source, *Myzus ascalonicus* was not considered previously as a vector of beet mosaic virus[1]. The results of our trials show that this aphid is able to transmit the virus from infected *Stellaria media* growing in the field, and from artificially infected *Stellaria* and *Capsella bursa-pastoris*. So far as we know, these two weeds seem to be new hosts of the virus.

Myzus ascalonicus is known from the literature as a vector of beet yellows (*Beta* virus 4 Roland and Quanjer), and *Stellaria media* as a host of this virus. Although the transmission of beet yellows from chickweed in the field by *Myzus ascalonicus* has not yet been found with certainty in our trials, the first results indicate that it is most probable.

I should like to thank Dr. Roland, director of the Phytovirology Laboratory, for advice and criticism during this work.

This work was subsidized by the Institute for Scientific Research in Industry and Agriculture.

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Effect of Herbicide 2,4-D on Bean Chocolate-Spot Disease

THE herbicide 2,4-D (2,4 dichlorophenoxyacetic acid) has been recorded to affect fungal-host relationship. Ibrahim[1] demonstrated a reduction in the number of rust uredosori to one-fifth on treated oat plants compared with controls. Similarly, Crowdy and Wain[2] recorded a suppression in bean chocolate-spot disease treated with 2,4,6 trichlorophenoxyacetic acid. On the other hand, wheat plants treated with 2,4-D were found to be weakened, stunted and predisposed to a heavier infection with *Helminthosporium sativum*[3]. 2,4-D has been recorded to cause a depletion in the carbohydrate content of treated plants[4,5]; Weller and co-workers[6] observed a depletion of non-reducing sugars.

The present work aims at an evaluation of the possible role of 2,4-D in influencing the relationship between bean plants (*Vicia faba* L., Breed No. 34) and *Botrytis fabae* and the interpretation of such an effect in terms of: (*a*) pathological anatomy of infected treated and untreated plants; (*b*) fungal enzymic activity as influenced by host metabolism in absence or presence of 2,4-D; (*c*) host biochemical changes, in response to 2,4-D treatment, and their possible bearing on fungal development.

Table 1. PERCENTAGE LEAF-AREA INFECTION AND CARBOHYDRATE ANALYSIS (GM. PER 100 GM. DRY WEIGHT) OF LEAFLETS FROM DIFFERENTLY TREATED BEAN CUT SHOOTS

Criteria		Leaflet treatment		
		Fresh	Dipped in Water	Dipped in 2,4-D
Per cent infection		39%	36%	15%
Carbohydrate analysis	Hexose	2·995	2·306	1·957
	Sucrose	4·462	1·619	0
	Total sugars	7·457	3·925	1·957
	Poly-saccharides	3·727	3·932	2·170
	Total carbohydrates	11·184	7·857	4·127

Leaflets of bean cut shoots, previously dipped for five days in pure water or in aqueous solution of 5 p.p.m. 2,4-D sodium salt, or freshly cut, were sprayed evenly with a spore suspension of *Botrytis fabae* to ensure a film of suspension on both leaflet surfaces; similarly, treated cut shoots were left uninoculated to serve as controls. For each treatment, three plants were used; they were kept constantly under humid conditions. The disease criteria were measured on leaves (Nos. 4, 5, 6 and 7), 48 hr. after spraying, by a method adopted by Crowdy and Wain[2]. The number of lesions, on both surfaces of the leaflet, was calculated and the mean diameter of a large number of lesions was determined. Since the lesions are more or less circular in outline, the mean area of the infected lesions could be calculated from the formula (πr^2). The total infected area was afterwards obtained by multiplying the mean area of the lesions on both surfaces of each experimental leaflet; percentage infection could be thus represented as percentage ratio between total infected area and total area of both leaflet surfaces; the latter was determined by planimeter. The results (Table 1) indicated a considerable reduction in percentage infection in cut shoots previously treated with 2,4-D in comparison with those dipped in water or previously freshly cut. In addition, carbohydrate analysis was made by Maskell's method modified by Gawadi[7].

No pathological differences could be detected in the anatomy of infected leaflets under varying treatments. The fungal enzymic activity, as influenced by the 2,4-D treatment of bean leaflets, was tested by Brown's disk method, as follows: juices were squeezed from differently treated cut shoots, cold sterilized by Menon's technique[8], inoculated heavily with *Botrytis* spores and incubated for three days at 25° C. The reaction times for *Botrytis* macerating enzymes, obtained from differently treated juices, were found to be close (that is, ranging between 18 and 20 hr.), denoting a feeble enzymic activity. On the other hand, the herbicidal treatment results in a depletion in the carbohydrate content of the leaf, especially sucrose, which completely disappears; such depletion may interfere with the normal development and pathogenic potentiality of *Botrytis*.

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S. K. GAYED

Botany Department,
University of Cairo,
Giza.

July 8.

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FORTHCOMING EVENTS

Sunday, September 2—Wednesday, September 5

British Association for the Advancement of Science (at Sheffield).—Continuation of Annual Meeting.

Sunday, September 2

At 11 a.m.—(in Sheffield Cathedral)—Religious Service. Preacher the Rt. Rev. the Lord Bishop of Sheffield.

Monday, September 3

At 10 a.m.—Dr. T. Robertson: "The Presentation of Geological Information in Maps" (Presidential Address, Section C).

At 10 a.m.—Prof. D. Whitteridge, F.R.S.: "The Machinery of Posture" (Presidential Address, Section I).

At 8 p.m.—Prof. Sydney Chapman, F.R.S.: "The International Geophysical Year".

Tuesday, September 4

At 7.30 p.m.—Sir John Cockcroft, F.R.S.: "The Future Development of Atomic Energy".

Thursday, September 6—Wednesday, September 12

British Mycological Society (at Sheffield)—Autumn Foray.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Boots Research Fellow (medical or science graduate, preferably with some experience in tissue culture and virology) in Microbiology—The Secretary, The Wright-Fleming Institute of Microbiology, St. Mary's Hospital Medical School, Paddington, London, W.2 (September 8).

Draughtsman (man or woman) in the Geography Department—The Registrar, University College, Singleton Park, Swansea (September 8).

Lecturer in the Department of Mechanical Engineering—The Registrar, The University, Liverpool (September 8).

Research Assistant (with a good honours degree in biochemistry or chemistry) for work on problems of dermatophyte metabolism—The Registrar, The University, Leeds (September 8).

Assistant in the Department of Agriculture (Crop Husbandry)—The Registrar, University College of Wales, Aberystwyth (September 10).

Superintendent (medically qualified, experience of medical research including toxicological techniques, and preferably with a first- or second-class honours degree in physiology or other natural science) of the Medical Division, Chemical Defence Experimental Establishment, Porton, Wilts, to be responsible for groups carrying out pure and applied research in physiology, pharmacology, toxicology, biophysics and biochemistry—The Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting No. S.4618/56/7 (September 11).

Lecturer or Assistant Lecturer (with qualifications in the realm of mathematical analysis) in Pure Mathematics—The Registrar, The University, Hull (September 15).

Chair of Education in the University of Natal, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, September 20).

Scientific Officers (with a university degree of high standard and evidence of research achievement) in the Defence Standards Laboratories, Department of Supply, Maribyrnong, Victoria, Australia, for research work on paints and protective coatings including: (*a*) physics of the bond between coating and base; (*b*) the chemistry of pigments, fillers and binding media and rheology of paints, etc.; (*c*) actinic and chemical degeneration, embrittlement, etc.; and (*d*) attack from corrosive media and underwater organisms—The Senior Representative (A.P. 63), Department of Supply, Commonwealth of Australia, Australia House, Strand, London, W.C.2 (September 21).

Principal Physicist in charge of the Northern Ireland Radiotherapy Centre—The Secretary, Northern Ireland Radiotherapy Centre, Purdysburn, Belfast (September 24).

Botanist (with at least a second-class honours degree with botany as the main subject, and two years' postgraduate research experience in plant breeding) at the Rubber Research Institute of Malaya, Kuala Lumpur, to engage in the Institute's research programme relating to the improvement of planting material of *Hevea brasiliensis*—The Secretary, London Advisory Committee for Rubber Research (Ceylon and Malaya), Imperial Institute, London, S.W.7 (September 29).

Lecturer (preferably with a major interest in heat transfer, and a knowledge of some aspect on nuclear engineering) in Engineering (Mechanical)—The Registrar, The University, Manchester (September 30).

Lecturer in Orthodontics (Clinical) at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, October 15).

Laboratory Steward in the Department of Chemistry, Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, October 26).

Fellow (chemist with experience in radiochemical techniques) in the Department of Radiochemistry, Research School of Physical Sciences, Australian National University, Canberra—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, October 29)

Chief Mechanic and Technician in the Department of Physics, University College of Rhodesia and Nyasaland—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (October 31).

Assistant Lecturer (honours graduate in agricultural botany and a special interest in plant pathology) in Agricultural Botany—The Bursar, Royal Agricultural College, Cirencester.

Assistant Lecturer (Organic Chemistry)—Dr. L. N. Owen, Chemistry Department, Imperial College of Science and Technology, London, S.W.7.

Assistant (preferably male, with G.C.E. (advanced) in science subjects or equivalent qualification) in the Physics Department (Radioactive Isotope Laboratories), to assist in experimental and clinical work, using various physical and chemical techniques—The Secretary, Institute of Cancer Research, Royal Cancer Hospital, Fulham Road, London, S.W.3.

Biochemical Technician in the Surgical Unit—The Secretary, St. Mary's Hospital Medical School, London, W.2.

Lecturer in Pharmaceutics—The Secretary-Treasurer, Royal Technical College, Glasgow.

Lecturer (science graduate, preferably in microbiology, with experience in dairy technology)—The Principal, National College of Food Technology, Cranwood Street, City Road, London, E.C.1.

Professor of Horticulture—The Dean, Faculty of Agriculture, University of Alberta, Edmonton, Alberta, Canada.

Research Assistant (well-qualified graduate in chemistry) in Radiation Chemistry in the Department of Physical Chemistry, to investigate some aspect of the radiation chemistry of organic compounds—Prof. F. S. Dainton, School of Chemistry, The University, Leeds.

Research Associate in the Department of Physics to join the 500-kilovolt accelerator group—Dr. Paul Lorrain Institut de Physique, Université de Montreal, Montreal, Canada.

Scientific Officer (honours graduate in chemistry or biochemistry) in the Isotope Section engaged mainly in fundamental biological research using the isotopic tracer technique—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, quoting Ref. 56/11.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Makers of Modern Science. (From *The Times Educational Supplement.*) Pp. iii+44 (10 plates). (London: The Times Publishing Company, Ltd., 1956.) 2*s.* 6*d.* [256

Report of the Conference on Technical Education organized by the National Union of Students, at Regent Street Polytechnic, London, April 28th, 1956. Pp. 32. (London: National Union of Students, 1956.) [256

British Broadcasting Corporation: Engineering Division. Monograph No. 7: The Design of a High-Quality Commentator's Microphone Insensitive to Ambient Noise. By H. D. Harwood. Pp. 19. (London: British Broadcasting Corporation, 1956.) 5*s.* [256

Bulletins of Marine Ecology (formerly Hull Bulletins of Marine Ecology). Edited by Dr. A. C. Hardy, Dr. C. E. Lucas and K. M. Raw. No. 31, Vol. 4: The Plankton in the Irish Sea, 1951 and 1952. By Dr. D. I. Williamson. Pp. 87–11 +plates 19–31. 12*s.* Nos. 32 and 33, Vol. 4: The Hardy Plankton Indicator: a Study of the Variation Between Catches Taken by Day and by Night. By R. S. Glover and J. A. Pope. Notes on the Differences Between *Calanus Finmarchicus* (Gunn) and *Calanus Helgolandicus* (Claus). By J. Mauchline. Pp. 115–140. 6*s.* (Edinburgh: Scottish Marine Biological Association, 1956.) [256

British Museum (Natural History). Fossil Mammals of Africa No. 9: A Miocene Lemurois Skull from East Africa. By Sir Wilfrid Le Gros Clark. Pp. ii+6+1 plate. (London: British Museum (Natural History), 1956.) 5*s.* [256

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Model Form of General Conditions of Contract recommended by The Institution of Mechanical Engineers and the Institution of Electrical Engineers for the sale of Electrical and Mechanical Goods, other than Electric Cables (Home—Without Erection). Pp. 6. (Model Form C.) 2*s.* 6*d.* Model Form of General Conditions of Contract including Form of Agreement recommended by the Institution of Mechanical Engineers, the Institution of Electrical Engineers, and the Association of Consulting Engineers for use in connection with Export Contracts with Delivery F.O.B. or C I F. Pp. 7. (Model Form B.1.) 4*s.* 6*d.* (London: Institution of Electrical Engineers, 1956) [296

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Editorial and Publishing Offices of "NATURE"
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No. 4532 SATURDAY, SEPTEMBER 8, 1956 Vol. 178

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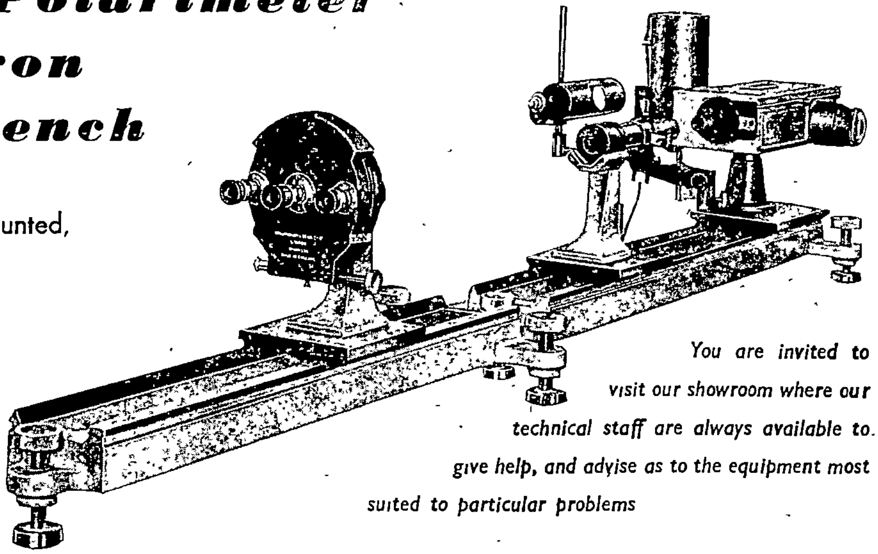

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HEALTH AND SAFETY IN INDUSTRY

NOT only Parliament but also public opinion in Britain generally was greatly shocked by the statement about the lack of precautions against fire in factories which was made in the House of Commons on May 18 by Mr. Robert Carr, Parliamentary Secretary to the Ministry of Labour and National Service. Mr. Carr's statement, lucid and admirable in itself, was made on a motion for the adjournment arising out of a fire in a Keighley woollen mill in February in which eight persons lost their lives and which was one of four occurring within a single month in Yorkshire woollen mills. Mr. Carr estimated that between 50 per cent and 70 per cent of the factories covered by the Factory Act of 1937 had no fire alarms; many of them were small and single-story buildings with extremely low fire risks, but nevertheless this is an excessive degree of non-compliance which Mr. Carr admitted could not be allowed to continue.

Most of his statement was devoted by Mr. Carr to an outline of the measures by which the Government proposes to secure greater compliance with the regulations. He said that he is against holding frequent public inquiries; but in the case of serious accidents involving loss of life and much damage, they might be very desirable from the point of view of public morale alone. As a first step, however, the Chief Inspector of Factories is writing to all factory occupiers covered by the regulations, reminding them of their obligation to instal fire alarms; and a rapid survey of the forty to fifty thousand premises affected is being made. A leaflet dealing with the installation of fire alarms and the types of fire alarm most suitable to different premises is also being circulated. Secondly, the Ministry is to speed up its examination of premises by instructing inspectors to make greater use of their existing powers, both in respect of notifying local authorities and also, where necessary, carrying out the examination themselves. Inspectors are being instructed to press employers to introduce fire-drill where suitable; and the decision whether or not to introduce regulations would be made in the light of the success attending such voluntary persuasion. The need for further special regulations to deal with abnormal fire risks is also being examined and it is proposed to intensify general advisory work on fire prevention, both by factory inspectors working in closer collaboration with the fire prevention officers and by publishing suitable literature on the subject.

In outlining this programme of positive action, however, Mr. Carr was careful to put the fire risk in its proper context. Injuries and fatalities caused by fire in industry in total are small, amounting to only one-quarter of one per cent of all the factory injuries reported to his Department. In all, about 180,000 people every year are injured sufficiently seriously to be reported to the Ministry, and some twenty million production days are lost every year as a result of factory accidents, or almost six times as many as were lost last year through industrial disputes. As Mr. Carr remarked, we cannot afford to continue the loss and suffering caused by these accidents.

Mr. Carr's statement received high praise when, some two months later, on July 16, the House of Commons debated the administration of the Factories Acts. Following Mr. F. Lee, who had opened the debate, Mr. Carr then emphasized that while the prime responsibility for health and safety in industry rests on industry itself—both employers and employees—the Government has a four-fold role. It must see that the factory law keeps in step with modern needs and developments; it must see that the minimum requirements laid down in the Acts and in the many codes of regulations made under them are observed; it must be able to advise industry as a whole on these matters; and it must undertake, and stimulate others to undertake, investigation, research and development. In this last connexion, Mr. Carr referred to the recent establishment of an Inter-departmental Committee on Industrial Safety Research, comprising representatives of government, research committees and the Ministry of Labour. Moreover, as a result of discussions with the Industrial Health Advisory Committee appointed in 1954, fresh investigations are proceeding, he said, under the auspices of the Medical Research Council and the Ministry of Labour, into health problems in various industries; for example, into dust problems in the foundry and cotton industries, the dangers arising from the use of toxic solvents and the widespread risk of dermatitis.

On the general situation, Mr. Carr said he believes it should be a matter for concern that the downward trend in the number of accidents reported each year under the Factories Acts up to 1952 had ceased, for during the past few years we have had about 160,000 accidents in factories and 25,000 accidents in other work places involving about 700 fatalities every year. There is a relative decline in accidents caused by power-driven machinery, and up to 66 per cent of all accidents in factories, as well as most accidents at other work places, such as building sites, are now caused in the handling of goods, by persons falling, stepping on or striking against objects, by falling objects or in the use of hand tools.

There are three important aspects of the whole question, with all of which the scientist and technologist are closely concerned, on which Mr. Carr also touched, particularly in speaking on July 16. The scientist and technologist obviously have often in the right of their special knowledge or experience an immediate contribution to make to industrial health and safety. That contribution is most apparent in the work of the Fire Research Organization and in that of the Industrial Health Advisory Committee and related bodies; but it will also be conspicuous in the 'good housekeeping' which Mr. Carr rightly said is an important factor in the prevention of accidents in industry.

Success here, however, does depend very largely on the existence of the right climate of opinion and, as Mr. Carr pointed out, employers and trade unions, jointly and severally, have a grave responsibility, both in education and in creating conditions conducive to the appreciation by everyone who works in industry of the need for safety. That, moreover, is no less true of the work of the factory inspectorate itself. Unsatisfactory standards of compliance with regulations under the Factories Acts and the failure of the inspectors to make greater use of the powers entrusted to them are due partly at least to the general climate of opinion. In the shock to public opinion given by loss of life, action is possible which cannot be sustained unless opinion has thus been brought to realize its necessity.

For legislation on safety matters to be effective, there must be the understanding which will ensure co-operation and support, not simply with industry but also on the part of local authorities and others. In the promotion of such understanding the scientist will often have an important part to play, and it is a responsibility which he should keep continually in mind. It may well be that such responsibility should be discharged increasingly through his professional associations, and this is a matter which should receive further careful consideration from such bodies.

The creation of favourable conditions for health and safety in the factory is, however, first and foremost a responsibility of management. Unless management has fully discharged that responsibility—and not merely complied with the legal obligations but established proper relations with the factory inspectors—the employee can contribute little or nothing, and his co-operation, even if it is secured, may be ineffective or frustrated. The position disclosed by Mr. Carr's statement on May 18 is a serious indictment of management. The evidence of neglect is disturbing; but still more alarming is the evidence of ignorance—not merely the ignorance of factory law, to which Mr. J. C. George and Mr. V. Collins referred, but still more the ignorance of scientific and technical matters.

If the first lesson to be learnt from the position disclosed as a result of the Keighley woollen mill fire is the importance of an alert and educated public opinion, within and without the factory, the second lesson is the vital importance of trained management. Even in the small factory, management to-day demands not merely skill in handling men but also an awareness of scientific and technical factors in many contexts which is not to be acquired without training in which science and technology must have some place. Quite as plainly as the advent of automation, considerations of health and safety in industry emphasize the need of education for management. Without some appropriate technical and scientific training, the manager of even a small works or factory cannot appreciate the factors which make for safety and for health, nor can he fully understand the warnings which a factory inspector may give.

To put the prime responsibility for industrial health and safety on management is not to deprecate the part of the factory inspectorate itself. While the inspectorate has emerged well from this debate, misgivings were freely expressed as to the ability of the Ministry to recruit inspectors of the quality required, and especially as to the numerical strength of the inspectorate. In his statement on May 18 Mr. Carr said that the Minister had just received the report of an inquiry by three senior officers into the staffing and organization of the factory inspectorate and some recommendations about the number of staff have been accepted.

Excluding certain senior posts at headquarters, the present authorized strength of the general factory inspectorate in Great Britain is 322; ever since the end of the War, when it stood at 309, it has been difficult to recruit up to the full establishment, though the number of vacancies had been reduced to 14 in 1953 and the service is now virtually at full strength. Mr. Carr pointed out that the only practical way of organizing the work of the general inspectorate is on a geographical basis, and that if we are to depend for general inspection on technical qualifications, we shall need both more inspectors and an ever greater variety of different specialists. The work of the general inspectorate certainly requires a knowledge of technical matters; but it is in itself an executive job, and many arts graduates have made excellent inspectors. Moreover, increase of the technically qualified content of the inspectorate must be considered in the light of the urgent need for technical man-power throughout the whole economy of Britain, and Mr. Carr suggested that it is in staffing its special branches, and particularly the engineering and chemical branch, that the fullest use can be made of the relatively few with technical qualifications.

Mr. Carr said further that the load on the engineering and chemical branch is particularly heavy, and at the moment it is unable to give as much help as is desirable in dealing with inquiries from the districts or in dealing at first hand with all problems calling for specialized knowledge. Moreover, its work will be substantially increased by the decision to expedite production of several new codes and regulations and advisory publications. It is accordingly proposed to increase the strength of this branch from 18 to at least 44, thus permitting one engineering inspector and one chemical inspector to be stationed in each division. There will also be an increase in the general inspectorate, particularly in order to enable the inspectors to pay more attention to building operations and engineering constructional work.

While the increase announced by Mr. Carr did not satisfy those who had urged a considerable expansion in the inspectorate—of the order of 25–30 per cent—it was accompanied by a reasoned explanation of the basis on which, since January 1, 1955, visits of inspection have been planned. The Ministry is satisfied that the more flexible arrangements then introduced were on the right lines. There is more, however in Dr. Barnett Stross's plea for expansion than Mr Carr was disposed to concede. But whatever the increase in the inspectorate, whether in the numbers with technical qualifications, in women, as Mr. G. Nabarro urged, or in those with non-technica qualifications, the effectiveness of its work largely depends on the support it receives not merely from within industry but also from public opinion generally.

It is in this connexion that salary scales can be important, and here again Dr. Barnett Stross's sustained argument deserves the widespread support of the professional bodies of scientists. It is not simply that, as was strongly urged in the debate, without reasonable salary scales the inspectorate will not attract men and women with the qualifications and character that are essential. If those scales are not comparable with those which men and women of such ability can obtain elsewhere, inspectors will not enjoy the standing in the community which will give the necessary weight to their recommendations and advice. This may well be increasingly true in a Welfare State in which attention is concentrated on material things.

There is a further factor to be considered here. The value of the inspectorate is derived largely from the experience it gains in observing and comparing the safety practices of the more progressive firms. A first-class inspector is able to put such experience at the disposal of new firms or of companies who are entering new and unfamiliar fields. For this to be done effectively demands first-class minds and men whose personality as well as knowledge command respect, and who are able to meet managers and directors on equal terms.

Such men—or women—cannot be obtained on the cheap, nor can we ignore the tendency already noted for their status and influence to be proportioned to the salary scales they enjoy. There are, as has already been indicated, many ways in which scientists and technologists can promote health and safety in industry—by co-operating in the task of education, by direct contributions to 'good housekeeping' and safety measures and practices and by their own professional competence as inspectors or managers. They should not neglect to see, however, that their professional associations lose no opportunity of promoting the formulation of safety codes and practices, or of strengthening the esteem and status to which the factory inspectorate in Great Britain is both richly entitled and on which the effective discharge of its responsibilities depends.

PALÆOGEOGRAPHICAL RECONSTRUCTION

Concealed Coalfields

A Palæogeographical Study of the Stratigraphy and Tectonics of Mid-England in Relation to Coal Reserves. By Prof. Leonard J. Wills. Pp. xiii+208. (London and Glasgow: Blackie and Son, Ltd., 1956.) 0s. net.

THE essential core of geological science lies in the establishment of the nature and ordered succession of events which together constitute the history of the Earth's crust. It is therefore a noteworthy occasion when an attempt is made to fulfil this ultimate aim by the application of the total geological evidence available to a restricted number of events even over a limited area such as the Midlands and North of England. This setting of the pieces into the rational puzzle of living stratigraphy is the life-blood of geological investigation, and by this means the Earth becomes an organism with a physiology of its own. Not all the pieces can ever be present in this puzzle; some have been removed by earlier operations, while other evidence is still deeply buried under the surface skin. It is here that diagnosis based upon related facts plays such an important part, and conjecture and reasoned hypothesis are essential tools. A complete recording of contemporaneous events and their succession represented in geographical pictures which will provide palæogeographical reconstructions of episodes in earth history is desirable. The essential pre-requisite is a sound chronology with short time-intervals, the pulse of the organism, such as can only be provided by effective zonal sub-division based on past life in the form of fossils. Even then, the success of reconstruction is dependent upon the nature and detail of the evidence available, and is furthermore subjective to the particular interest of the palæogeographer and to the fact that it is based upon a knowledge and interpretation of contemporary geological and geographical processes.

Despite these restrictions, careful analysis and diagnosis may unfold the distributions of sea or estuary, of lake or swamp, of mountain and valley, of desert and plain, and, in so doing, the vital physiology governing these occurrences may come to light. In such a manner an evaluation of the original distribution of the rocks is obtained and, in particular, the nature of the agents and processes both geographical and geological which have afterwards limited this distribution by separation into basins or blocks. When the rocks involved contain a national asset such as coal, the information is of prime importance.

With due humility, Prof. L. J. Wills has assembled the puzzle covering the succession of rocks which include the Coal Measures, Permian and Trias of formal stratigraphy. It would be difficult to find a more suitable succession of rocks for such a purpose. The chronology is well defined in the Coal Measures, there is wide diversity of palæogeographical change, and the factual evidence is as great as it could be due to mining and field mapping.

The first part of the book reviews the available stratigraphical evidence and contains the author's interpretation of this evidence and his methodology in its use. The introduction of new terms follows from the application of the evidence to palæogeographical studies, and sub-division of the rock succession from Coal Measures to Trias results. This is effected by the recognition of five 'Palstages' separated by six 'Palevents', a sub-division which does not necessarily follow that of established stratigraphical practice.

The 'Palevent' is a short-lived or sudden palæogeographical event of widespread occurrence and indicated by a marine horizon, a coal seam, or even terrestrial conditions involved in sudden changes of geography, and recorded by tectonic or new lithological features. These include the *subcrenatum* Marine Band, Cefn Coed–Aegir M.B., Brithdir–Tillery–Halesowen event (entry Tenuis zone), Second Malvernian movements, uplift of southern England which produced the Bunter Pebble Beds of the Midlands, and finally the transgression of the Rhaetic Sea. Doubtless other equally effective events could have been used, but these would not necessarily amplify the cardinal points of the author's reconstruction.

The 'Palstage' represents a period of time during which conditions were fairly constant, or subject to consistent changes, or cycles of changes controlled by physical conditions. On this basis there is further sub-division into sub-belts which more nearly follow accepted stratigraphical sub-division.

In order to emphasize the economic aspect of the coal reserves and their relationship to the thick masses of rock which often overlie the main workable coals, the author has instituted a major sub-division within the succession comprising the Coal Measures–Permian–Trias successions. This is his Palevent 2, the widespread invasion of the Coal Measure scene by the Cefn Coed–Aegir marine transgression. Thus below this horizon are recognized the Sub-Aegir belt consisting of a Lower Coal Belt and the Main Coal Belt, the hiatus of coal production in the major British Coalfields, and that part of the sequence most likely to be involved in large-scale coal production. Above the Aegir horizon are Coal Measures (Supra-Aegir Belt), often typical, and which do in fact contain some workable coals; but the higher belts—for example, Haleskeele Belt, Desert Rocks Belt and Bunter–Keuper Belt—show great changes of conditions, particularly in the Midland and North of England coalfields. Thus all rocks above the Aegir Marine Band constitute a 'cover' to the Coal Belt. The lower cover is usually conformable to the Coal Belt and Carbo-Permian in age, while the higher New Red Cover is always unconformable. Thus all the major British Coalfields are, or were originally, "covered coalfields", while those with an unconformable New Red Cover are concealed in the normal sense. Such coalfields may be thus both covered and concealed both in entirety or in part.

The second and third parts of the book are concerned with the specific coalfields of the Midlands and Northern England, and the thicknesses and variability of the various palstages involved are given with the Aegir Marine Band used as a datum. This aspect both of cover and concealment is of important practical value in an assessment of the accessibility of the Main Coal Belt below. The entire cover is the sum of two very different sets of variable factors, and the structure of one part is not always coincident with that of the other. While the original thickness of the covers was controlled by contemporaneous movements, the residual thicknesses of both are mainly determined by erosion following uplifts. For example, the loss by erosion following faulting is greater than that following folding. Some idea of the complexity of relationship between the two covers and between these and the Coal Belt is gained from the thirty structural arrangements which are given for the concealed coalfields.

The complex Midland geological structures are proverbial, but summarily the author concludes that the controlling physiology is "the general principle of deep seated block jostling at depth". Herein lies the responsibility for repetition of movements along the same lines at different periods; these movements, operative in one sense or another from time to time, have led to geographical changes with resultant control over geological accumulation. At the same time the sharp folding and lateral but more usually vertical displacement along faults operative even to post-Triassic times were the resultants of these block movements. No book attempting palæogeographical reconstruction would be complete without adequate illustration; the Palstage maps are intriguing, while the structural maps, isopachyte maps, and plates showing the accessibility of the Main Coal Belt and of the highest worked seams, present the factual and hypothetical evidence in a manner which bears scrutiny.

This book with its original presentation makes a fundamental contribution to geological science, and its methodology constitutes an all too rare occasion in geological literature. There are criticisms which may be directed at the terminology and correlation, but these are outweighed by the value of the broader palæogeographical contribution. Similarly, diagnosis may often be a fickle jade, but it has to be made; better a reasoned hypothesis than even an inspired guess. Here is a pattern derived from the accumulated evidence of geological research in all its aspects, whether these be considered as 'pure' or 'applied'; and that pattern not only indicates the value of such scattered research, but also provokes an inspiring challenge to those concerned with the resources and possible future developments of an important national asset.

L. R. Moore

PROGRESS IN SEMICONDUCTORS

Progress in Semiconductors

Vol. 1. Edited by Dr. Alan F. Gibson, Prof. R. E Burgess and Prof. P. Aigrain. Pp. vii+220. (London Heywood and Co., Ltd., 1956.) *50s.* net.

THE discovery of transistor action in 1948 set off many new studies of the physics of semiconductors; the search for satisfactory techniques of making transistors, phosphors and infra-red detectors led to many chemical and metallurgical studies. Application studies were also built up rapidly. So far, accounts of most of the later studies appear only in the original papers, the numbers of which are mounting rapidly and the collective reading of which is becoming an ever-increasingly formidable task. Relief has been afforded occasionally by some review articles, notably those appearing in the reports of two international conferences and in two issues of the *Proceedings of the Institute of Radio Engineers*. Something more regular is needed, however; integrating papers confined to, at most, one branch of the subject would be welcomed by newcomers to that branch and by workers in the other branches and critical reviews would freshen the minds of all.

The publishers and editors of "Progress in Semiconductors", which is to appear annually, recognize the needs and have set out to fill them. This firs volume has seven articles; physics predominates not surprisingly in view of the editors' background and not unfairly in view of the proportion of research it still attracts in the subject. The first article, how ever, is more general; it summarizes the advances in silicon, from preparation and properties to applica tions. It is well balanced and factual, but leaves th reader to deduce the current problems. The nex chapter directs attention to the important par played by germanium filaments in physical studies it describes the preparation of filaments and the methods by which they have been used in measuring drift mobility, diffusion constant, life-time, surfac recombination velocity, injection ratio at a point con tact, and noise. The theory of the Seebeck effect in semiconductors is explained in the next chapter. Thermoelectric effects with metals have for long provided thermometers; with semiconductors they promise other uses. The chapter is timely and should prove a useful reference for some years. Prof. G. F. J. Garlick contributes a chapter on the electrical properties of phosphors. Experiments can be more accurately defined now that single crystals of some phosphors can be grown, but results still need cautious interpretation. The next chapter explains the limitations of conventional junction transistors at radio frequencies and restates the merits of *p-n-i-p* and unipolar transistors. Written before the middle of 1955, it contains no mention of graded bases or of diffusion transistors. French authors provide the last two chapters, on the photo-magneto-electric (PME) effect and on field effects. The former effect has received much attention lately, and its finer points are better understood; it is being used to measure some basic properties of semiconductors and is well described here. Progress with field effects has been slow; the interpretation of results is hindered for lack of independent methods of measuring some surface properties.

The volume cannot escape some criticisms. The information content, per unit area, of some of the diagrams, particularly six at the beginning of the last chapter, is very low. The writing, in places, lacks the clarity and flow that one expects of good review articles—for example, those of "Advances in Electronics and Electron Physics", which admittedly has had several years in which to get into its stride. None the less, the new series has made a good start.

J. R. Tillman

ENZYMOLOGICAL RECIPES

Methods in Enzymology

Edited by Sidney P. Colowick and Nathan O. Kaplan. Vol. 2. Pp. xx+987. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1955.) 23.80 dollars.

THIS is the second of four volumes dealing with methods and techniques in enzymology, the first volume of which was published last year (see *Nature*, 177, 810; 1956). It completes the part of the series which is devoted to the preparation and assay of individual enzymes. The remaining two volumes are to cover preparation of substrates and special techniques used in the study of enzymes.

The 152 articles in this volume are arranged in five sections, namely: enzymes of protein metabolism; phosphate metabolism; nucleic acid metabolism; coenzyme and vitamin metabolism; and finally, respiratory enzymes. This arrangement of enzymes according to their functional relationship in the metabolic pattern tends to obscure important similarities between enzymes carrying out similar reactions; for example, the phosphokinases are scattered throughout the book, and indeed throughout Vol. 1 as well.

More than a hundred and thirty authors have contributed to the present volume, and the articles naturally vary considerably in style and quality, although there is a fairly standard system of headings, with sections on assay method, purification procedure, and properties for each enzyme. Some articles give a useful short review on the occurrence and metabolic importance of the enzyme being treated, together with several methods of preparation. In other cases the article is virtually a reprint from the original literature of a single paper on the preparation of the enzyme. The multiplicity of authors has led to a certain amount of duplication; for example, Elliott's method of preparation of glutamine synthetase from peas is quoted verbatim on p. 339 and again (under the heading of γ-glutamyltransferase, with which it is identical) on p. 264. In this case the reproduction of the original paper includes an inconsistency, most annoying to the worker who is attempting to use the procedure, which is probably a misprint in the original (3·7 l. is given as 0·05 vol. with respect to a volume which is more than 144 l.).

Only a part of the material in this book will be of any permanent value. When an enzyme has been obtained in a pure state in high yield, the method may become classical but many of the preparations given are necessarily merely extracts of tissues of exceedingly low purity, which will soon become outdated as research on the enzyme in question proceeds. On the other hand, as a summary of present knowledge of enzyme purification, the two volumes are remarkably complete.

From such a large collection it is difficult to single out any for special mention, and in any event, such a mention may merely reflect the interests of the reviewer. However, as samples may be mentioned some excellent accounts of the proteolytic enzymes of digestion, of the more well-defined components of the blood-clotting system, of the bacterial system which cleaves aromatic rings, and of the enzymes which break down coenzyme I. The whole section on the enzymes of coenzyme metabolism is perhaps particularly useful, as many of these enzymes are of very recent discovery and it would be difficult for the newcomer to the field to track down the relevant papers. A certain amount of material in this section has not been published elsewhere.

There is no question that this is a work which should be in every biochemical library and will be of value to all who at some time or other, for research or teaching, have to prepare enzymes.

Edwin C. Webb

MOTIVES IN THE CLASSROOM

Educational Psychology in the Classroom

By Prof. Henry Clay Lindgren. Pp. xv+521. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1956.) 40s. net.

THE educational psychologist is increasingly turning his attention to classroom problems; but this does not mean that he has all to teach and nothing to learn. The situation in the classroom is, however, more complex than earlier generations of teachers assumed and calls for the kind of understanding that contemporary psychology can supply.

Prof. H. C. Lindgren's book is written in this tradition and in a helpful spirit for the teacher. He stresses the value of group methods, of active learning and of the partnership between teacher and taught. Authoritarian methods are condemned. We understand that unless a pupil likes school, little headway will be made, for in a way the teacher is leader of his class only in so far as he is made so by his pupils. Lindgren also draws on sociological studies such as "Elmtown's Youth" and insists that to know a child's social class is very important to the teacher. He is well aware that, in its extreme form, this type of relationship may be peculiar to the American way of life; but the British reader will find much in these views worth giving a try.

Lindgren stresses also the relativity of human experience. Teachers often judge a pupil's actions in terms of their own values and experiences, failing to realize that a different set of values and perceptions may operate for the pupil. We need to look for less obvious motives; and to try to view things as the pupil sees them is to be commended.

In a book which emphasizes learning in and from the group in a relatively free and incidental way, learning theory is taken mainly from gestalt and field theory. In the last part there is material on assessing the results of learning, tests, guidance, children with special needs and the psychology of teaching. It is copiously illustrated with photographs and cartoons; but the British student may find them a little unusual and perhaps redundant. The text contains relevant non-technical examples, and there are suggestive exercises and full lists of references, particularly on the social and dynamic side.

The writer fuses the two themes of socialized group action and of a free learner enjoying equality of status with parent and teacher. On this matter of equality of status, I feel one must ask whether young children and even adolescents do not often expect adults to know more, to act as if they do, to impart their knowledge, to order the child's world a little and to allow him that amount of freedom he can manage. Freedom can be a burden as well as a boon. For all this, the book is a stimulating antidote for those who assume too readily the authoritarian role and hence are insensitive to the real forces in classroom life. E. A. PEEL

EDUCATION IN THE FREE WORLD

The Citadel of Learning

By James Bryant Conant. Pp. vii+79. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1956.) 16s. net.

THIS book is made up of three essays on the work of scholars and teachers and its relation not merely to the well-being of the United States but equally to the maintenance of freedom throughout the world, and the essays should command the attention and challenge the thought of many who will never be persuaded to read those scholarly volumes which have already appeared under the American Academic Freedom Project of Columbia University. It is no detraction from the excellence of the studies of Profs. R. Hofstadter, W. P. Metzzer and R. M. MacIver to suggest that in less than eighty pages Dr. J. B. Conant has given the gist of the story of the development of academic freedom in the United States and its meaning for the free society to-day. Indeed, although, especially in the second and third essays, he writes essentially in an American context, his wider vision gives his comments even greater relevance to the situation elsewhere than Prof. MacIver's penetrating comments and analysis, and British readers will be as grateful to Dr. Conant as those American readers to whom his volume is primarily addressed. It may be placed with those other notable contributions to Anglo-American understanding for which we are already indebted to a man who, as well as being a scientific worker and university administrator, lately served his country as United States High Commissioner and Ambassador to Western Germany.

The first of the three essays, which gives its title to the book, might be described as reflexions on the functions of a university provoked by a phrase freely translated from some words of Stalin. More particularly, Dr. Conant illumines the international function of a university—the advancement of learning—by examining what has happened among communities of scholars on the other side of the Iron Curtain, emphasizing that, from whatever angle art, literature, philosophy and science are viewed, they have been the outcome of both conflict and co-operation, a struggle among beliefs and a sharing of beliefs. Such creative activities are not confined to a university, but these are the only terms on which those within the university have lived and worked effectively for the advancement of learning in the past, and they are the only terms which will ensure the safety and vitality of the university as a citadel of learning in the future. Freedom and tolerance, Dr. Conant argues, go hand in hand in matters of the spirit; controversy is essential to a healthy condition in such a citadel.

In his second essay, entitled "An Old Tradition in a New World", Dr. Conant summarizes in masterly manner the re-shaping, within a century, of European ideas about schools and universities into a characteristic American tradition expressing the two ideals of equality of opportunity for all youth and equality of respect for all honest citizens. His summary, moreover, is critical, for though Dr. Conant believes these two ideals or doctrines are as significant for the future as for the past, he is not satisfied that American education has in all respects even started to outline the problems which the new position of the United States in the world has forced upon it. Some of these problems are indicated; by and large the same problems confront education in Britain to-day, so that this essay not only contributes to the understanding of American institutions and problems but should also stimulate thought among British readers about their own problems and the adaptation of their own institutions to the needs of the world in which we live.

When, in his last essay, Dr. Conant focuses his attention on some basic problems of American education, he is no less stimulating and provocative of fresh thinking to readers of other nationalities in considering problems of professional and technological education, the place of research in a university and the relations between teaching and research. There is a place for the heretic and the spirit of free inquiry in the education of professional men and women. "If the free world is to preserve that spirit which has made possible the growth of Western culture, the future leaders must as young men be impregnated with this spirit. They should early come to learn the significance of dissent and be exposed to an intellectual atmosphere where vital differences of opinion are not merely tolerated but encouraged." Dr. Conant's shrewd comments and criticisms point to dangers which are encountered in Britain no less than in the United States, and his wise counsel bears as closely on the expansion of British university institutions as it does on the re-shaping of American institutions to meet growing demands. R. BRIGHTMAN

Control of Nuclear Reactors and Power Plants

By M. A. Schultz. (McGraw-Hill Series in Nuclear Engineering.) Pp. viii + 313. (London: McGraw-Hill Publishing Company, Ltd., 1955.) 52*s.* 6*d.*

THE author sets out to analyse the characteristics of nuclear power plants, primarily using servo techniques. As an example of the method, skilfully applied to a set of problems, the work is of value; although perhaps more to those whose interest is in the method rather than the problems. This opinion is advanced for two reasons. First, the servo method gives qualitative information on stability, rather than quantitative data on the course of transients. The latter problems, in my experience, predominate in the field of reactor control. Particularly in the base-load power reactors now being designed in Britain, there is little difficulty with stability against oscillatory tendencies, simply due to the wide spacing of the time-constants of the effects which comprise the control sequence. Certain problems might conceivably arise from distributed effects, but these would not be amenable to servo methods of solution. Second, the design of a control system for a nuclear reactor is a project which justifies considerable, one might say unlimited, attention and effort. If the particular equations cannot be solved by conventional methods, numerical solutions using digital computors, or graphical solutions using analogue computors, could be obtained. The speedy methods of frequency diagrams, admirably adapted to the repetition design of similar systems, seem too cursory in the present context.

The curves of Figs. 3.1 and 3.2 appear to be reproduced on too small a scale to be useful, and, so far as they can be read, do not satisfy the obvious condition $\Sigma A_j = 1$.

On p. 122, eqn. 5.3 should read $v = A\omega \cos \omega t$, and on the same page, the statement "rod mass $= m$, in poundals" should presumably read "in slugs".

Referring to Fig. 10.7, the point of inflexion at 0·1 sec. suggests that a period of artificial acceleration is followed by deceleration, followed by acceleration again under gravity. This does not correspond with the explanation in the text. J. H. BOWEN

High Vacuum Technique

Theory, Practice, Industrial Applications and Properties of Materials. By J. Yarwood. Third edition, revised. Pp. vii + 208. (London: Chapman and Hall, Ltd., 1955.) 25*s.* net.

SINCE the end of the Second World War, when the second edition of J. Yarwood's well-known and useful handbook of vacuum practice was first published, both the demand for, and the supply of, vacuum apparatus have increased manifold. In addition, several innovations have been introduced: ultra-high vacua of 10^{-10} mm. of mercury and less have been attained and measured, and many new applications of vacuum procedures have been made. Nevertheless, fundamentally, vacuum practice remains the same, and in the third edition of his monograph Yarwood resists quite rightly the temptation to omit the standard basic material in favour of more attractive modern applications of vacuum techniques to industrial processes.

The text is illustrated by a large number of line-drawings which are remarkably clear, well drawn and beautifully reproduced. There are an extensive bibliography and numerous references to scientific articles and manufacturers' catalogues. Many useful data are contained in the several tables which are scattered throughout the text. One wonders, however, why the author did not adopt some standard accepted form for the abbreviations of the titles of the periodicals to which reference is made, and in addition why some authors' names are quoted in full and others not. But these are trivial blemishes, and the volume still remains one of the best elementary text-books on the subject of vacuum technique to which to introduce students of science, and for industrial and other research workers to have close at hand for rapid reference.

Methods of Mathematical Physics

By Sir Harold Jeffreys and Bertha Swirles (Lady Jeffreys). Third edition. Pp. x + 714. (Cambridge: At the University Press, 1956.) 84*s.* net.

THIS important work first appeared in 1946 (see *Nature*, **160**, 139; 1947); four years later a second edition, considerably revised, was issued. A third edition is now called for, and the authors have made further improvements, though on a much smaller scale. "Some theorems are stated more explicitly, a few proofs are added, and some are shortened"; others are generalized or given in more detail. After ten years, a book so widely used must now approach complete freedom from errors and misprints, thanks to the aid of many readers. The index combines subject and author references; the latter might appropriately include mention of acknowledgment in the prefaces.

Intuitionism

An Introduction. By Prof. A. Heyting. (Studies in Logic and the Foundations of Mathematics.) Pp. viii + 132. (Amsterdam: North-Holland Publishing Company, 1956.) 13.50 guilders; 27*s.*

TO the intuitionist, mathematical existence is synonymous with construction; to inquire whether a number which cannot be constructed nevertheless exists is to go outside the domain of mathematics, and enter that of metaphysics. The programme is positive, but may also claim the negative virtue of avoiding some of the paradoxes which beset the logical foundations of classical mathematics, so the classical mathematician may well wish to know how much of his domain must be sacrificed to purchase this freedom, and to see, for example, how a theory of measure and integration can be built up in a domain in which a bounded monotonic sequence need not tend to a limit. Under Brouwer's primacy, much work has been done in The Netherlands, and Prof. A. Heyting, of Amsterdam, has had the happy idea of producing a missionary tract. In the first chapter, a dialogue between an intuitionist, a classical mathematician, a formalist and others sets the stage and the intuitionist offers to produce his wares for inspection. Thus chapters on algebra, integration, logic, are specific examples of intuitionistic mathematics at work, cutting a cautious path through the tangle of difficulties, with a good deal of useful comment. Reading the book still requires the utmost concentration, but granted this, the fascination of the topic begins to emerge and it may well be that some young mathematicians will be encouraged by it to meet Prof. Heyting's call for more workers in this field. Those who feel themselves to be too old to learn new tricks will nevertheless be grateful to the author for this successful attempt to explain the intuitionist point of view and programme.

T. A. A. BROADBENT

CENTENARY OF THE UNIVERSITY OF MELBOURNE

By PROF. JOHN S. TURNER
Department of Botany, Melbourne

THE University of Melbourne held its centenary celebrations during the week beginning August 13. Delegates from a hundred universities presented addresses. The oration was given by Sir Ian Clunies Ross, and fifteen honorary degrees were conferred in the new Wilson Hall. There were Vice-Regal and Government receptions, and the Council of the University gave a banquet in the Hall at the conclusion of the ceremony.

To-day the metropolitan area of Melbourne sprawls over some 200 square miles and houses 1½ million people, more than 60 per cent of the population of the State of Victoria. In its University there are about eight thousand staff and students. In 1840 less than half this number of people were living in the raw pioneer township on the banks of the Yarra. Twelve years later gold was found, and the young Colony began its first hectic burst of growth. The opportunities were then even greater than now. Hugh Childers, later to be British Chancellor of the Exchequer under Gladstone, and just down from Cambridge, became Auditor-General in 1852, and a year later he put through an Act to found the University of Melbourne. This was four years before the first election to the new Parliament. In 1854 Mr. Justice Redmond Barry became the first chancellor. The obvious site for the University, the Domain, now the centre of Melbourne's great system of parks, was then covered with the tents of migrants, and 100 acres were allotted to the University two miles out of town in almost virgin bush. Here was built the first wing of a small stone Gothic quadrangle, which served the University as its home for another twenty years.

The University made slow progress in a community of pioneers and gold-miners. During the next fifteen years it granted only a hundred degrees. Nevertheless, it was wisely served by its first administrators and teachers. In 1853 there were only four universities in Britain, and Melbourne, therefore, had an unrivalled opportunity of attracting first-rate men to its chairs. The first four professors who lived and worked in the little stone quadrangle were exceptional men. Two of them were from Ireland: Sir Frederick McCoy, F.R.S., the first professor of natural science and the founder of Melbourne's National Museum, and W. E. Hearn, the great professor of law and history. M. H. Irving (classics) was from Oxford, and W. P. Wilson (mathematics) from Cambridge. They were followed by G. B. Halford in 1863, the holder of the first chair of the new Medical Faculty.

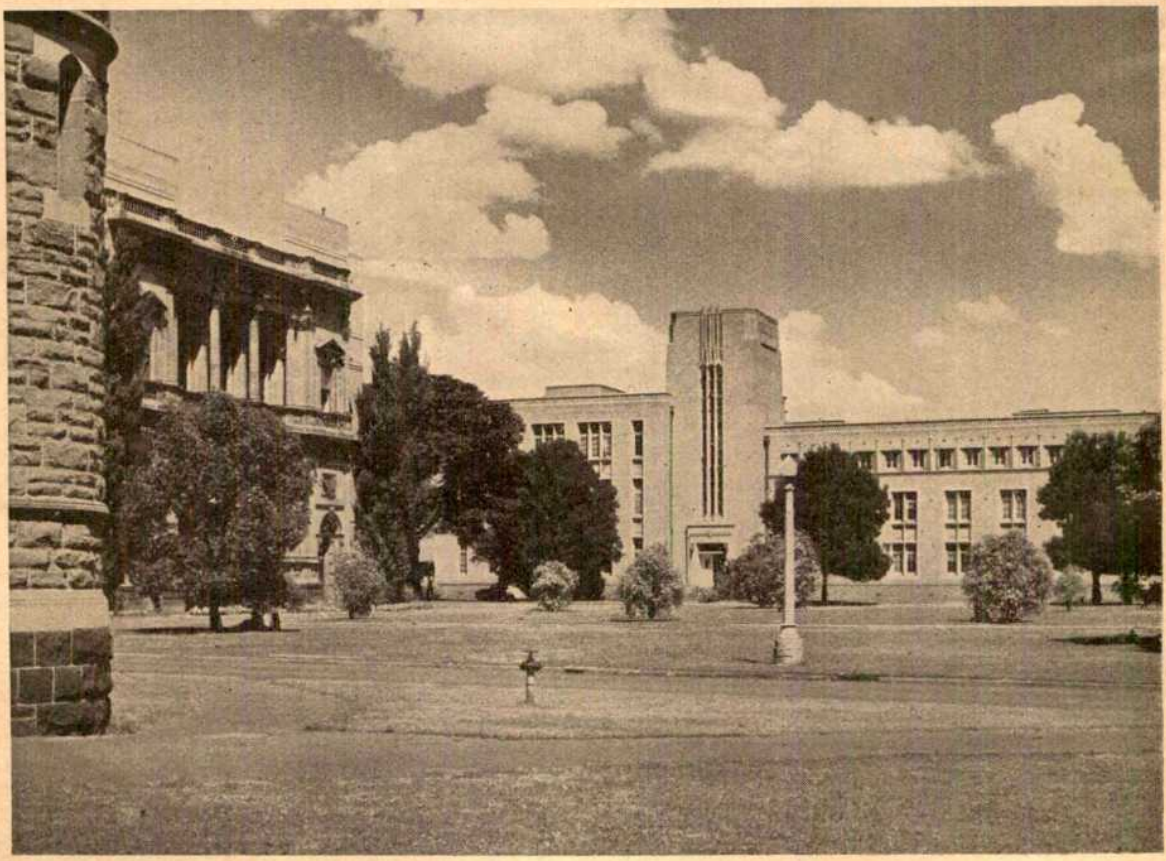
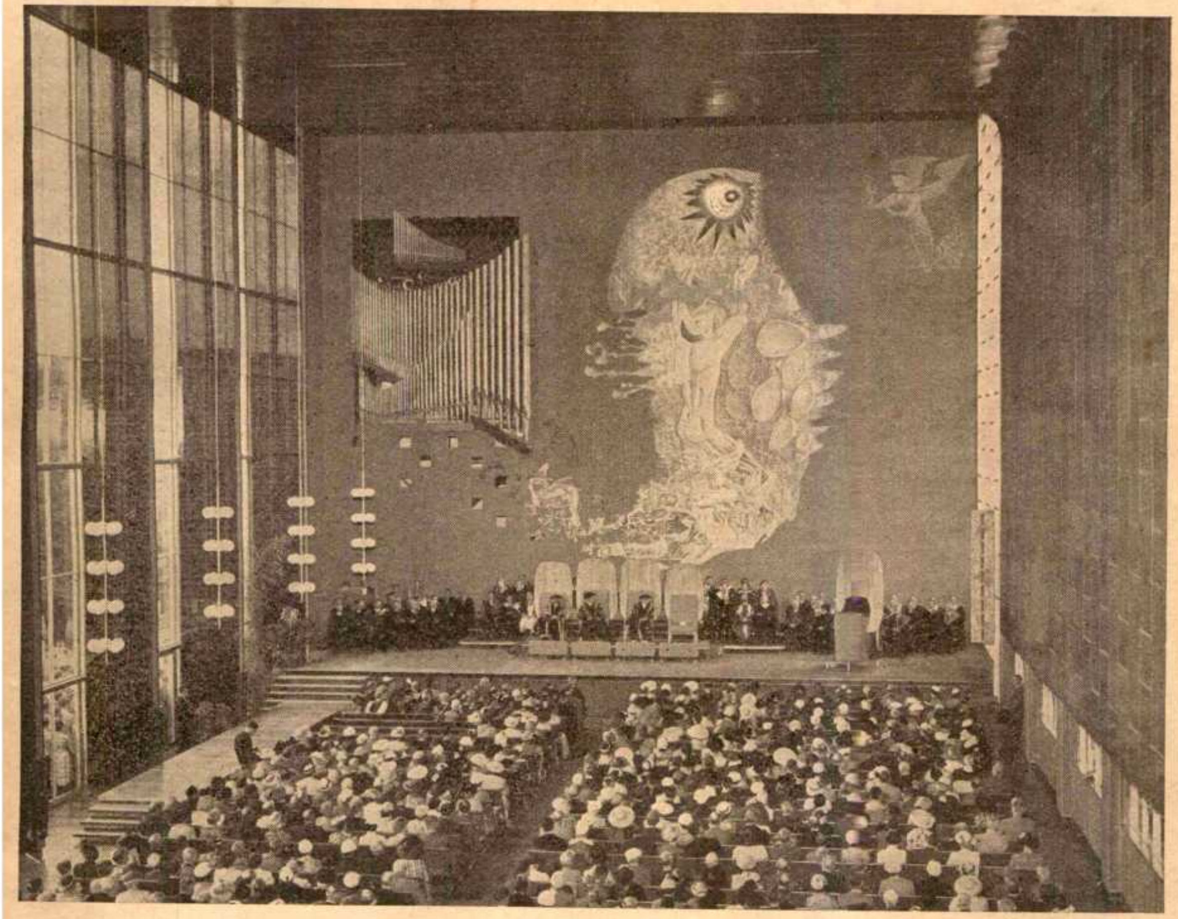


Fig. 1. The University of Melbourne. Left to right: Zoology, Commerce, Chemistry Schools



[*Photo : Visual Aids, University of Melbourne*

Fig. 2. Wilson Hall, University of Melbourne. The Premier of Victoria, the Hon. H. E. Bolte, addressing the meeting at the opening of Wilson Hall by the Governor, Sir Dallas Brooks

The University began its first move forward in the eighties. By that time most of the professorial houses were ready in the grounds—great red-brick Victorian mansions, now largely used for housing the overflowing departments. Five new professors, four of them Melbourne men, were appointed in 1882, and they were soon joined by four newcomers from Britain, who set a standard of scholarship and learning which Melbourne has consistently retained. They were T. G. Tucker (whom Cardinal Newman called the first Greek scholar of the day), David Orme Masson, chemist, Baldwin Spencer, the biologist who pioneered anthropological work on the aborigines, and Thomas Lyle, the first of a number of distinguished physicists. All three scientists became members of the Royal Society of London, and were later knighted, and their names are still remembered with affection and gratitude. The putation they built up for the infant University attracted others, and out of a long list it is perhaps fitting to mention Sir William Harrison Moore (law), Sir Ernest Scott (history), E. J. Nanson and J. H. Michel, F.R.S. (mathematics), T. H. Laby, F.R.S. (physics), Sir Charles Martin, F.R.S. (physiology), . W. Gregory, F.R.S., and E. W. Skeats (geology), W. C. and W. N. Kernott and H. Payne (engineering), W. R. Boyce Gibson (philosophy), G. W. L. Marshall-Hall (music), Sir Harry Brookes Allan (pathology), A. J. Ewart, F.R.S. (botany), W. E. Agar, F.R.S. (zoology), R. J. A. Berry and F. Wood-Jones, F.R.S. (anatomy) and L. F. Giblin (economics).

The University has been fortunate also in its administrators—it has had great legal chancellors like Sir Redmond Barry, Sir John Madden and Sir Charles Lowe, and an able succession of registrars. It is governed largely on British and Scottish lines, and although the supreme control is in the hands of a lay Council, a great deal of the government of the University is left to the Professorial Board and the Vice-Chancellor. The University made its greatest step forward into the modern period when it appointed Mr. (now Sir) Raymond Priestley as its first full-time vice-chancellor in 1936. Although he stayed only three years, his drive and energy saw the completion of the fine new Students' Union and the new Chemistry School. An inspiration to the staff, he was also instrumental in bringing town and gown together into a collaboration which resulted, under the present vice-chancellor, in the centenary appeal which raised more than half a million pounds. Priestley was followed by Sir John Medley, from Winchester and New College, Oxford. A man with wide contacts in the educational and business worlds of Australia, he brought to the University something of the grace of another period which is badly needed in an age of technocracy. He had to cope with the extremely difficult post-war period, when student numbers rose to alarming proportions. Under his rule, and that of his successor, Prof. G. W. Paton, an unusually friendly spirit of co-operation arose between the members of the different faculties. The University has remained well balanced in the humanities and science, and has built up exceptionally strong medical and technological faculties over the past seventy years.

As may be expected in a metropolitan university, only a small proportion of the undergraduates live in the five colleges. Four of these are church foundations, and they have played an important part in the University, largely owing to the ability of their heads, of whom the Rev. E. H. Sugden, Sir John McFarland, Dr. Alexander Leeper, Sir John Behan, Dr. D. K. Picken and Father Murphy are the best known.

The University still occupies its original site, and here are gathered twelve faculties, a staff of 427 full-time academics with 812 part-time teachers, and a student body of 7,500. The growth of the University has been largely unplanned, and the architectural styles vary from the original Gothic of the quadrangle to utilitarian red brick, Glaswegian academic, Scottish baronial, Renaissance and the plain Army hut, the fruit of two world wars. Lawns and some trees still survive from McCoy's original ambitious plantings, and there are now signs of considerable improvement. The Union, Chemistry School, Geology wing, the new Arts block and, more recently, the Beaurepaire Physical Education Centre and the magnificent new Wilson Hall (which replaces an early benefactor's Gothic Hall) are a sign of a new dignity to come. With a massive immigration and considerable inflation, the University is only slowly finding it possible to erect new departments; but the long-awaited Library is about to rise, and with it new engineering buildings and the first floors of a new Biochemistry School, the gift of Sir Russell Grimwade.

Since the Second World War the University has taken an increasing interest in the Near East, and there are some three hundred Asian undergraduates reading for degrees at present. A new college, International House, is nearing completion, and this will accommodate equal numbers of Australian and overseas students. Several senior members of staff have travelled recently in Asian countries to advise on educational matters, and a new Department of Indonesian Studies has been set up.

The University has played a great part in the training of leading public and professional men in Australia and elsewhere. This is not the place to assess its achievements in scholarship; but it must be remembered that until recently little attempt was made to encourage indigenous research schools above the M.Sc. level. A characteristic of the young Australian is his urgent desire to see the world, and especially Britain, and this has led to a constant outward stream of graduates, mainly to Oxford, Cambridge and London. While we must be grateful to these universities for the training they have given to these men and women, it must not be forgotten that they, in their turn, have undoubtedly added to the prestige of the research schools in Britain. The Ph.D. degree was instituted in Melbourne in 1946, and now most departments are building senior research groups. This is a matter of some difficulty because of the increasing demand for our students by industry and the Government services. The future of the University is at present in the balance. It is a hundred years old, but active and vital, still growing rapidly and bursting at the seams. In spite of large annual financial grants by State and Commonwealth Governments and some splendid endowments, the University will not be able to cope with the demands which will shortly be made upon it. The State high schools are accepting six thousand new enrolments and the Education Department is building ten new high schools per annum. It must often be difficult to decide on the proper date for the foundation of a new university; but no such problem exists in Melbourne to-day. The State needs another university and it needs it urgently. The public men in Victoria are not without vision, and ambitious schemes are already in operation which will ensure the provision of power and water for a greatly increased population. At this time of centenary we confidently look to another Childers to found a second university, so that the old one may mature to its full greatness.

THE ANTIGENIC STIMULUS IN TRANSPLANTATION IMMUNITY

By Dr. R. E. BILLINGHAM*, Dr. L. BRENT and Prof. P. B. MEDAWAR, F.R.S.
University College, London

I. Introduction

'TRANSPLANTATION IMMUNITY' may be defined as the state of acquired resistance which leads to the destruction of homografts, that is, of grafts transplanted between two different members of the same species. The chemical nature of the substances that provoke it has so far defied analysis. It is widely believed, for want of clear evidence to the contrary, that only *living* cells can elicit transplantation immunity; and this belief appears to be upheld by the fact that an otherwise highly active suspension of living spleen cells or leucocytes loses its antigenic power after treatment in any of the following ways: heating to 48·5° C. for 20 min.; drying from the frozen state; or freezing and thawing three or four times. It will be shown here that the power of cells to elicit transplantation immunity depends neither upon their being alive nor upon thei structural integrity in any anatomical sense; and that the antigens responsible for skin transplantation immunity are certainly nuclear substances, and probably desoxyribonucleoproteins.

We have worked with mice of two strains (domesti sublines of strains *A* and *CBA*) acting as donors o recipients at will. These strains differ from each other by upwards of 10–15 genetically distinguishabl antigens which affect the survival of skin homografts The median survival times of skin homograft transplanted from *A* to *CBA* mice or vice versa ar as follows: $A \rightarrow CBA$, 11·0 ± 0·3 days; $CBA \rightarrow A$ 10·2 ± 0·3 days[2]. These figures refer to mic receiving homografts for the first time. A secon homograft, transplanted after the rejection of a first is destroyed within six days[3]: healing is weak vascular breakdown is virtually instantaneous, and the epithelium of the graft survives, for so long as it survives at all, in an entirely indolent state. This accelerated breakdown of 'second stage' homografts has been made the basis of a simple direct test for the existence of a state of immunity or sensitivity. First, mice are injected with the preparations that are to be examined for their antigenic power; then, three to five days later, they are grafted with skin of the same genetic origin as the substances under test. The homografts are inspected six days after their transplantation. Complete or advanced breakdown by the sixth day reveals the existence of a powerful state of immunity, for a normal homograft of six days standing is soundly healed, fully surviving, well vascularized, and exuberantly hyperplastic.

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* Research Fellow of the British Empire Cancer Campaign.

The problem, then, has been to find out the source and nature of the substances which, injected into mice beforehand, cause skin homografts to break down about twice as rapidly as would otherwise have been the case.

An analysis making use of the principle of immunological tolerance had already shown that the antigens responsible for skin transplantation immunity are fully represented in all the living tissues of a single individual[4]. It was therefore not necessary to seek in skin itself the antigens which incite immunity against skin homografts. Most of our work has been done with splenic (wholly mesenchymal) and kidney (almost wholly epithelial) cells. Moreover, advantage has at all times been taken of the fact that the members of a single highly inbred strain of mice are for most practical purposes antigenically equivalent[5], so that (for example) the spleens or kidneys of a dozen *A*-line mice may be used as a source of antigens, and skin homografts from still other *A*-line mice may be used for testing for any state of immunity which those antigens might have provoked. The technique of skin grafting and of scoring grafts for their degree of survival has been described elsewhere[3].

2. Immunity caused by Disintegrated Cells

Spleen cells totally disrupted by ultrasonic irradiation in any of the following media were found to be powerfully antigenic: (*a*) buffered normal saline (0·15*M* sodium chloride, 0·001*M* phosphate buffer, *p*H 7·4); (*b*) normal citrate saline (0·135*M* sodium chloride, 0·015*M* trisodium citrate adjusted with citric acid to *p*H 7·4); (*c*) isotonic sucrose, 0·29*M*; and (*d*) water.

Cell suspensions were made by dividing clean, freshly removed *A* or *CBA* spleens (mean weights 112 mgm. and 78 mgm. respectively) into three or four parts and expressing the pulp through a fine-meshed stainless steel sieve by gentle but firm pressure with a flat-ended glass pestle. Connective tissue was retained by the sieve, and the larger cell clumps in the expressed pulp were broken up by sucking them in and out of a pipette. The mean cell yield was 221 m (m $= 10^6$) per 100 mgm. wet weight of spleen[6], a figure which includes naked nuclei as well as whole cells, because even quite gentle manipulation with a pipette will cause upwards of 20 per cent of spleen cells to be stripped of cytoplasm. In media lacking calcium ions this can be a minor nuisance, because with anything but the most gentle handling some of the cells are trapped and lost in fibrous clots caused by nuclear disintegration.

Cells to be disintegrated in media *a* or *b* were expressed into those media, washed by two or three centrifugations at low speeds, and resuspended to a final concentration of 100–200 m./ml. Cells ultimately to be resuspended and disintegrated in isotonic sucrose (*c*) were expressed into and washed in isotonic sucrose – calcium chloride (see below). The handling of cells to be extracted in distilled water is described under sub-heading 6.

For disintegration, aliquot volumes of 2·5–3·0 ml. were loaded into siliconed glass tubes (internal bore 10 mm., thickness 1 mm.) and held obliquely in the jet arising from a 340 kc./s. crystal transducer housed in transformer oil. Although longer and stronger exposures were admissible, it proved sufficient to expose each tube for 30–40 sec. to a nominal acoustic power output of 7·5 W./cm.^{2} (applied voltage 0·75 kV.)[7]. Latterly we have used a 50-W. 20-kc./s. transducer of the magnetostrictive type: the flat end of a parallel and vertically held half wave-length stub, coupled to the transducer, was applied to the surface of a 6–7 ml. volume of the suspension under treatment. 45–60 sec. exposure sufficed, provided that the exposure vessel was not more than 2–3 mm. wider than the stub. It will be noticed that these exposures fall very far short of what is necessary to disrupt bacterial cells[8].

Cells disintegrated in normal saline or normal citrate saline were broken into fine fibres of nuclear origin, interspersed with cytoplasmic matter, red-cell debris, etc. Antigenic activity was confined to the heavy insoluble fibrous fraction, which could be cleared of cytoplasmic and soluble matter by two or three sedimentations on the centrifuge at low speeds. In isotonic sucrose the cells were broken into very small round particles the smaller of which were not sedimentable by ordinary centrifugal forces. The antigenic activity of such a preparation was only just perceptibly reduced by centrifugation at 2,100 *g* for 20 min., that is, by exposure to more than twice the centrifugal force which, in less than half the time, would have sufficed to clear all whole cells or intact nuclei from a medium of this specific gravity; nor could the antigenic matter contained within a column 2 cm. deep be wholly sedimented by centrifugation at 11,000 *g* for 10 min.—an observation singly sufficient to dispel any idea that the antigenic activity of these 'particulate' preparations was due to contamination by whole nuclei or undisrupted cells. The specially important properties of the solutions formed by disintegrating cells in water are discussed under sub-heading 6.

Preparations made in media *a* to *d* were of about equal potency; the dosage (in cell equivalents) required to elicit violent immunity, such that a skin homograft transplanted three to five days after their injection would be destroyed within six days, was about 150–200 m per mouse. These experiments showed that transplantation immunity could be provoked by totally disrupted cells, but they gave no direct anatomical evidence of whereabouts in the cells the antigenic substances were to be found.

3. Location of the Antigens: Nucleus or Cytoplasm

Preparation of nuclei from spleen or thymus cells. Nuclei may be separated from spleen or thymus cells or leucocytes by fractional centrifugation after exposure to ultrasound in media containing calcium ions, namely: Ringer phosphate (containing 0·0028*M* calcium chloride, 0·0025*M* magnesium chloride, 0·001*M* phosphate buffer *p*H 7·4) or isotonic sucrose –

calcium chloride (0·0018M calcium chloride[9]). Cell suspensions prepared by the use of a sieve were washed two or three times by spinning at low speeds and then exposed to ultrasound of the intensity and duration described above. The nuclei were then separated by the use of barely sufficient centrifugal forces: two or three successive spins for 8 min. each at forces ranging from 200 to 700 g (for Ringer phosphate) or from 300 to 1,000 g (for sucrose–calcium chloride) down a fluid column height of 8–10 cm. would clear 2,000–4,000 m nuclei of visible cytoplasmic matter. The final preparation consisted of clean nuclei mixed with fibres of approximately the same specific gravity which could be shown to be artefacts of nuclear origin. Because of losses during exposure to ultrasound and the washes that preceded and followed it, only some 40 per cent of the original cells could be recovered as whole nuclei (mean yield 88 m/100 mgm. spleen). This yield could be improved by cutting down the time or intensity of exposure, but only at the proportionately increasing risk of allowing some nuclei to retain a cytoplasmic sheath. Unduly prolonged exposures reduced the yield of nuclei and increased the proportion of nuclear fibres.

Nuclei from kidney cells. Nuclei may be harvested from kidney cells by the judicious use of a high-speed blender. Clean decapsulated kidneys were cut into small pieces and washed in normal citrate saline. The pieces were then immersed in Ringer phosphate and exposed in a 100-ml. 'Vortex' flask to the action of an M.S.E. blender for 3–3½ min. at approximately 10,000 r.p.m. At this stage the preparation contained free nuclei, red cells, large quantities of cytoplasmic matter, and a multitude of short lengths of kidney tubules, but *isolated* living cells were extremely rare. The tubule segments were removed by repeated filtrations (if necessary, as many as fifteen) through a 3-cm.-deep column of loosely packed, well-rinsed glass wool; to avoid too great a loss of nuclei, not more than two filters were used. The nuclei in the filtrates were concentrated, and freed so far as possible from cytoplasmic matter, by four successive fractional centrifugations at low speeds. The final preparations contained nuclei together with about one-tenth their number of red cells, and they were appreciably contaminated by larger cytoplasmic particles and any agglutinates of smaller particles that may have settled with them. The presence of nuclear fibres, usually coinciding with an absence of red cells, was a sign that blending had been unduly fierce or prolonged. The nuclear yield was variable, but more than half our preparations fell within a modal class of 20–30 m per kidney. A greater yield is not to be expected, for the essence of this technique is that kidney tubules should *not* be cut up into cell-sized fragments. The nuclei are presumably extracted from the tubules by cavitational forces.

Test for the presence of intact cells. One ml. of a suspension containing 10–50 m nuclei in Ringer phosphate was exposed to the action of 0·01–0·10 mgm. trypsin for about 20 min. at room temperature. Naked nuclei are extraordinarily vulnerable to the action of trypsin; intact cells may therefore be spun down and looked for microscopically. Twelve and nine such tests on separate preparations of spleen and kidney nuclei revealed the presence of intact cells in three specimens and in one specimen respectively, but the degree of contamination could not, at the extreme, have exceeded 0·1 per cent. As a significant source of error, contamination of nuclei by living cells may be disregarded.

Preparation of cytoplasmic matter. It did not prove feasible to prepare a concentrated suspension of spleen cell cytoplasm uncontaminated by fine fibres of nuclear origin; but cytoplasmic particles have been prepared from kidney and liver by orthodox methods using isotonic sucrose[10] or normal saline as diluents. Having cleared the preparations of nuclei or nuclear matter, suspensions consisting predominantly of large or of small cytoplasmic particles were prepared by the use of moderate (5–8,000 g) or of high (25–40,000 g) centrifugal forces.

Location of antigenic substances. The substances which elicit skin transplantation immunity are exclusively confined to the nuclei of cells: preparations of kidney or liver cytoplasm (whether of larger or smaller particles, in high or in low dosages) were totally inactive. Indeed, in so far as they had any effect at all in the concentrations at which they were used, it was to reduce the homograft reaction below its normal level of intensity. Very highly concentrated suspensions of the scanty cytoplasm of spleen cells have occasionally been found to exercise the feeblest perceptible antigenic action, presumably caused by the fine nuclear fibres with which such preparations have invariably been contaminated.

4. Properties of Nuclei

A nuclear dosage of 100 m per mouse is more than sufficient to cause the total breakdown of a test homograft within six days of its transplantation; 25 m/mouse is an appreciably active dose. Under the same conditions of administration, 100 m nuclei are equivalent to about 5 m dissociated living cells. It is convenient to inject nuclei intraperitoneally at a concentration of 100 m/ml.; the intravenous route is at least as effective, but the subcutaneous route is much less satisfactory.

The injection of mice with nuclei or nuclear derivatives originating from other members of their own strain had no discernible effect upon their immunological responses.

Nuclei are unstable, and although we have not examined the consequences of doing otherwise, we have always prepared and kept nuclei in chilled media. Unlike living cells, nuclei could not be stored overnight in a balanced saline medium at 3°–5° C. without losing all but a small fraction of their antigenic power. The antigenic activity of nuclei or of totally disintegrated cells was reduced beyond a perceptible level of intensity by any of the following treatments: heating to 48·5° C. for 20 min., drying from the frozen state, or freezing and thawing three times. (Nuclei suspended in sucrose – calcium chloride were weakly protected against the damaging effects of these treatments.) With this evidence of instability it is not surprising that, in the past, antigenic activity should have been regarded as the prerogative of living cells. None of the treatments just described, except freezing and thawing in a salty medium, caused gross anatomical damage to the nuclei; the mere appearance of nuclei under the microscope is a remarkably poor guide to their antigenic power.

It was our normal practice to transplant test homografts of skin 3–5 days after the injection of the substances which were being examined for their antigenic power. A delay of 15 days allowed the state of immunity to become significantly weaker, and a delay of 30 days allowed it to fall to a level that was sometimes inappreciable in our test system.

The immunity produced by 'dead' preparations is therefore of much shorter tenure than that produced by 'solid' living grafts, such as skin homografts themselves[3]; we have yet to examine the duration of the immunity produced by the intraperitoneal injection of equivalent doses of dissociated living cells.

We have not yet succeeded in making active nuclear or disintegrated preparations from embryonic tissue. Yet there can be little doubt that the antigenic substances are fully developed long before birth, for the injection of so few as 5–10 m cells from 11½–12½ day mouse embryos caused the total breakdown, within six days, of test homografts of skin transplanted three days later. (The embryos were at a stage of development about equivalent to that of a 3 to 4-day chick.) It is known that, of the nine days that passed between the injection of the embryonic cells and the final scoring of the test homografts, about six days are required for the machinery of immunization to go into action and take effect; in the remaining balance of time, about three days, it is scarcely possible that the embryonic cells injected into adult mice should have advanced to the stage of development not normally achieved until birth. We may therefore take it that the transplantation antigens in mice are fully developed well before birth.

5. Action of Enzymes on Nuclei

Our study of the action of enzymes on nuclei has been complicated by their instability to mere incubation in 'physiological' media for 60 min. at 37° C. With rare and still unexplained exceptions, however, spleen nuclei, or the clean nuclear fibres prepared by the direct disintegration of spleen cells in normal citrate saline (sub-heading 2), were stable to 60-min. incubation in Ringer phosphate or Ringer bicarbonate (0·015*M* sodium bicarbonate, 0·001*M* disodium hydrogen phosphate) over the *p*H range 6·8–7·4; incubation at *p*H 5·5 (0·1*M* acetate buffer, 0·10*M* sodium chloride) or at *p*H 6·0–6·2 (phosphate buffer) was damaging but not totally destructive. On the other hand, kidney and thymus nuclei have given exasperatingly variable results, antigenic activity being sometimes lost after only 30-min. incubation. (This does not apply to kidney nuclei incubated with trypsin: see below.) The incubation of clean spleen nuclei deliberately contaminated with heavy inocula of kidney cytoplasm or red cells showed that these contaminants of kidney nuclear preparations were not to be blamed for their instability. We believed at one time that magnesium ions might be harmful—it was thought necessary, in certain experiments with desoxyribonuclease, to raise the concentration of magnesium chloride from 0·0025*M* to 0·10 or 0·0125*M*—but later experiments showed that this could not have been the whole explanation. The cause of the instability of kidney nuclei therefore remains obscure; if it is of enzymic origin, the enzymes must be presumed to be intranuclear.

For these reasons, our critical tests of the action of ribonuclease and desoxyribonuclease were made on spleen nuclei.

Ribonuclease. The incubation of spleen nuclei 100 m/ml. for 60 min. at 37° C. with ribonuclease 0·1 mgm./ml. in Ringer phosphate had no perceptible effect on their antigenic power; nor did the deliberate contamination of spleen nuclei with kidney cytoplasmic particles cause them to become vulnerable to the action of ribonuclease.

Trypsin. The gross anatomical action of trypsin on naked nuclei suspended in Ringer phosphate was spectacular: their membranes were disrupted almost instantly, and within three or four minutes at room temperature the preparation passed through a rigid fibro-gelatinous phase to form a largely clarified but only moderately viscous solution containing small quantities of miscellaneous debris in suspension.

The tryptic digestion of spleen or kidney nuclei (100 m/ml.; trypsin 0·1 mgm./ml.) in Ringer phosphate did not destroy and did not as a rule perceptibly impair their antigenic power; moreover, the serial sampling of digests in which the action of the enzyme had been stopped by adding trypsin inhibitor after 10, 20, 40 and 60 min. revealed no progressive deterioration as incubation went on. It should be observed, however, that this resistance to tryptic digestion was true *only* of nuclei prepared in the calcium-containing media which we have invariably used. Tryptic digestion of the nuclear fibres produced by the direct disintegration of spleen cells in normal citrate saline led to the formation of an almost unmanageably viscous solution with little or no antigenic power.

Desoxyribonuclease. Spleen nuclei 50 m/ml. were incubated for 60 min. at 37° C. with desoxyribonuclease 0·1 mgm./ml. in Ringer bicarbonate at a *p*H maintained between 6·8 and 7·2 throughout. After incubation, the nuclei, now translucent and grossly contracted, were spun down, resuspended in half the original volume of fluid, and injected intraperitoneally at a dosage of 1·0 ml. (100 m nuclei) per mouse. Under these conditions the antigenic power of the nuclei was completely or all but completely destroyed; control nuclei, receiving exactly parallel treatment in media lacking desoxyribonuclease, retained their antigenic power. Three points deserve special mention: (*a*) Ringer bicarbonate was used for these experiments because the weak buffer of Ringer phosphate could not prevent the *p*H of the incubation medium from falling precipitously to 6·2 or 6·4, that is, to a damaging level of acidity; (*b*) raising the concentration of magnesium chloride from 0·0025*M* to 0·0125*M* was not advantageous and might have been harmful; and (*c*) the use of lower concentrations of desoxyribonuclease or higher dosages of injected nuclei obscured the otherwise very sharp distinction between nuclei treated with desoxyribonuclease and their controls.

6. Solubility of the Antigens

It is implicit in all our methods of preparation that the antigenic substances, as they occur in their native form in nuclei or nuclear fibres, are insoluble in salt solutions of physiological strength (about 0·15*M*). The present section, an interim report on experiments still in progress, deals with their solubility in water and in strong solutions of salt.

Solubility in water. Spleen cells were prepared for aqueous dissolution as follows. The cells were expressed into, and washed in, buffered normal saline, and the spun sediment was resuspended in normal saline, to which three volumes of water were then added. The osmotically swollen cells were spun down, the pink supernatant fluid was rejected, and the somewhat gelatinous sediment was worked up in water with a coarse pipette. This aqueous suspension was exposed to ultrasound for 60 sec., whereupon most of the substance of the cells passed into a faintly opalescent and only moderately viscous solution. Matter in suspension was removed by centrifugation at 2,000 *g*. The supernatant fluid, injected in a dosage equivalent to 250 mgm. fresh splenic tissue per mouse, was highly active. When sodium chloride was added to restore its concentration to $0 \cdot 15M$, the bulky precipitate so formed was almost completely inactive: the supernatant fluid retained nearly all the antigenic power of the original solution. When, however, calcium chloride was added to bring its final concentration to only $0 \cdot 0025M$, the precipitate contained much the greater part of the antigenic matter, though some still remained in the supernatant fluid. It is evident, therefore, that the precipitates formed by adding sodium chloride and calcium chloride to aqueous cellular solutions have different properties. The precipitate formed upon the addition of calcium chloride is insoluble in water[11]; so also are nuclei prepared, as ours have been, in calcium-containing media.

We have had less satisfactory results with aqueous extracts of the washed nuclear fraction of kidney-cell disintegrates, prepared by a variant of the methods reintroduced by Stern[12].

Aqueous solutions clarified by centrifugation at 25,000 *g* for 30 min. are antigenically inactive, although they still contain matter precipitable by the addition of sodium chloride or calcium chloride.

Solubility in strong salt solutions. The antigenic power of nuclei prepared in calcium-containing media was reduced to about 25 per cent of its original value by extraction in molar salt solution; it could be completely abolished by prolonged extraction in $2M$ sodium chloride. In this sense, which is subject to obvious reservations, the antigens may be said to be soluble in strong solutions of salt. When $2M$ salt extracts of nuclei were clarified by centrifugation at 25,000 *g* for 30 min. and then diluted with 10 vol. water, the histone nucleate fibres so formed were found to be totally inactive, whether injected intraperitoneally or intravenously, or in their original or in a finely divided state. The same was true of the much more highly fibrous preparations of histone nucleate made from nuclear fractions which had at no time been exposed to bivalent metallic ions. Histone nucleate fibres of either origin were very rapidly digested by trypsin[13] to form immensely viscous solutions containing protein cleavage products and the sodium salts of desoxyribonucleic acids. Injected in high concentrations, before or after precipitation with ethanol, these crude preparations slightly but perceptibly impaired the homograft reaction, in the sense that test homografts transplanted on the same occasion (or two days beforehand, or three to nine days later) survived slightly longer than on normal mice. In lower dosages the fresh crude digests have repeatedly but not consistently been found to exercise an immunizing action of marginal intensity. In three experiments out of four, however, nuclei first exhausted by salt extraction and then mixed with crude DNA-containing digests blocked with trypsin inhibitor produced an immunity about equal to that elicited by 25 m fresh nuclei[14].

7. Nature of the Antigenic Substances

The antigens responsible for skin transplantation immunity in homografts exchanged between *A* and *CBA* mice comprise at least 10–15 genetically distinguishable substances[1]. They are wholly confined to the nuclei of cells. In their native form they are insoluble in physiological ($0 \cdot 15M$) salt solutions, but they are soluble in water, and may be precipitated therefrom by the addition of calcium chloride. The antigenic activity of nuclei can be weakened by extraction in *M* sodium chloride solution and abolished by extraction in $2M$ sodium chloride. The antigens are destroyed by digestion with desoxyribonuclease but not by digestion with ribonuclease or (under the conditions described in the text) with trypsin. They are highly unstable: in salty media, though somewhat less effectively in sucrose solutions, they are destroyed by freezing and thawing, by drying from the frozen state, and by heating to 48·5° C.

Three other properties of the antigens should be taken into consideration before passing judgment on their chemical nature: (*a*) an analysis based on the principle of immunological tolerance[4] has shown that the antigens responsible for skin transplantation immunity, so far from being peculiar to skin, are uniformly represented in all the living tissues of a single individual; (*b*) although living whole blood can elicit skin transplantation immunity (or tolerance[4]), its power to do so resides in the leucocyte fraction and is lacking from red cells, plasma and platelets[15]. (Platelets are of cytoplasmic origin and contain no desoxyribonucleic acid[16].) Finally, (*c*), the antigens are developed well before birth.

So far as we are aware, only one hypothesis can accommodate these findings: that the antigenic substances responsible for skin transplantation immunity are desoxyribonucleoproteins endowed with antigenic and therefore with genetic specificity. This hypothesis is made *likely* by our evidence, but the evidence falls short of proof. In particular, the properties of aqueous solutions of the antigenic substances, and of the precipitates formed from them by adding sodium chloride and calcium chloride, require further investigation. (It should not be forgotten that these aqueous solutions, particularly those prepared by ultrasonic methods, may be quite extensively degraded[17].)

If the antigens are indeed desoxyribonucleoproteins, they are almost certainly not, or not merely, nucleohistones. It is not, of course, to be expected that the genetically specific structure of a nucleoprotein should be even approximately reproduced when histone chloride and the sodium salts of desoxyribonucleic acids reassociate to form histone nucleate after diluting their solutions in strong salt[12,13,18]. On the other hand, we were surprised to find that the nucleohistone formed by adding sodium chloride in $0 \cdot 15M$ concentration to an antigenically active aqueous solution was itself inactive. The precipitate formed by adding calcium chloride in a concentration of $0 \cdot 0025M$ was strongly active, and the importance of the calcium ion made itself apparent in other ways; for example, in making the native nuclear antigens (*a*) stable to tryptic digestion, and (*b*) partly though not completely resistant to extraction by molar salt solution. The physical instability of the antigens suggests lipoprotein attachments, and it may well be, as several authors have suggested, that the nucleic acid is attached not merely to histone but also to the residual lipoid-containing 'acid' proteins of the nucleus as well[19]—an attachment in which bivalent metallic ions could well play an important part, for calcium[19] and magnesium[11] are both present.

There are well-recognized theoretical reasons for believing that the genetic and antigenic specificity of a nucleoprotein should reside in the desoxyribonucleic acid moiety, and in due course we hope to find out for certain whether or not this is really so. For this purpose it will clearly be necessary to devise some method for recombining desoxyribonucleic acid with nuclear protein which is much more efficient and reproducible than that described under sub-heading 6. It would be idle to discuss the origin of the weak antigenic action sometimes exercised by crude digests of histone nucleate fibres containing desoxyribonucleic acid until the possibility that it is due to desoxyribonucleic acid itself can be confirmed. At present it seems more likely to be due to the presence of small quantities of undissociated nucleoprotein—if indeed it is not due to substances of some altogether different kind.

Naked nuclei are only one-fifth to one-tenth as active as living cells in provoking transplantation immunity, and aqueous solutions of the antigens are weaker still. Part of the difference, perhaps a large part, can be attributed to the fact that they must be specially vulnerable to the endogenous desoxyribonucleases of the mice into which they are injected.

In view of the possibility that the antigenic substances are desoxyribonucleoproteins, we attach special importance to the experiments which have led us to believe that they are continually emitted by normal living cells[4].

8. Bearing on the Immunology of Transplantation

One important, if perhaps merely apparent, inconsistency between our work and that of others must now be resolved. It is known from a great wealth of genetical evidence that the transplantation antigens of an individual mouse comprise a multiplicity of substances which are intimately gene-controlled[20]. Some of the more important 'histocompatibility genes' which have been identified by genetical methods are already known from the pioneer work of Gorer[21] to determine a special system of iso-antigenic substances, hereafter '*H*-antigens' for short. *H*-antigens do not elicit skin transplantation immunity, and they are physically quite distinct from the nuclear antigens which we have just described. They are present in red cells and in cytoplasm; in mice, they are not formed until after birth[22]; and they are comparatively stable: lyophilized tissues, for example, are rich in *H*-antigens, though they do not elicit skin transplantation immunity. *H*-antigens are recognized and serologically labelled by their power to elicit the formation of orthodox serum iso-antibodies which can agglutinate homologous red cells, but there is clear evidence that these antibodies are not the effectors of transplantation immunity, at least of 'solid' grafts[23]. (It should be added that Bollag[24] has identified a system of iso-antigens in rabbits by purely serological methods. They cannot yet be classified with certainty; but their distribution, stability and solubility make it quite possible that they are nucleoproteins.)

The apparent paradox, then, is this: that the same histocompatibility alleles determine the formation *both* of the cytoplasmic *H*-antigens *and* of the nuclear antigens that are the prime movers in transplantation immunity. We can therefore only suppose that the two classes of antigens stand to each other in the relationship of secondary and immediate gene products; indeed, if our interpretation of their chemical nature is correct, the nuclear antigens consist of chromosomal matter. Certain questions suggest themselves immediately. Can the nuclear antigens elicit the formation of serum antibodies of the same kind as those produced by *H*-antigens, or, if not, can they specifically absorb the serum antibodies which *H*-antigens have formed? Again, how does it come about that homografts killed by, for example, lyophilization, and incapable of causing transplantation immunity, may yet elicit a brisk inflammatory response when implanted into animals which have been immunized beforehand by living homologous cells?[25] These and other questions[26] belong to the agenda of future research.

Summary

Cells totally disintegrated by ultrasonic irradiation retain their power to elicit skin transplantation immunity in mice. The substances responsible for this property reside wholly in the nuclei of cells, and are developed well before birth. They are inactivated by lyophilization, by freezing and thawing, and by heating to 48·5° C. They are inactivated by digestion with desoxyribonuclease but not with ribonuclease or, in certain stated circumstances, with trypsin. They are insoluble in salt solutions of physiological strength, but are soluble in water, from which they may be precipitated in an active form by the addition of calcium chloride; and they are extracted from nuclei by treatment with 2*M* sodium chloride solution. These facts, together with cognate evidence from other sources, make it probable that the antigens responsible for skin transplantation immunity are desoxyribonucleoproteins.

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OBITUARIES

Sir Harold Scott, K.C.M.G.

Sir Harold Scott, who died at Braintree on August 6, shortly after his eighty-second birthday, was widely known as a pathologist, a historian of tropical medicine, and an editor. After taking medical qualifications in 1897, he served in the South African War, returned to England and entered general practice and then went to Jamaica as Government pathologist. The First World War brought him once more into the R.A.M.C., and after its conclusion he became Milner Research Fellow at the London School of Hygiene and Tropical Medicine, where he elucidated the life-history of *Hymenolepis*. He was then appointed Government pathologist at Hong Kong, retaining this post for several years until compelled to retire through ill-health. Later he became pathologist to the Zoological Society of London, medical secretary of the Colonial Medical Research Committee, and in turn assistant director (1930) and director (1935) of the Bureau of Hygiene and Tropical Diseases, until his retirement in 1942.

As a pathologist he published a large number of papers and monographs on tropical subjects—particularly on the vomiting sickness of Jamaica, the central neuritis of Jamaica, and on tuberculosis in man and lower animals (based on his experience in Hong Kong and at the Zoo). He wrote several books, including "Some Notable Epidemics" (1934), but his most important literary work was his great "History of Tropical Medicine" (1939), which has been recognized throughout the world as a masterpiece. At the Bureau of Hygiene and Tropical Diseases he edited the *Tropical Diseases Bulletin* and the *Bulletin of Hygiene*, and it was under his direction that the *Bulletin of War Medicine* was created. He was appointed C.M.G. in 1935 and K.C.M.G. in 1941.

Scott was for many years associated with the Royal Society of Tropical Medicine and Hygiene, of which, to his great pleasure, he was elected president in 1943.

One of his most outstanding characteristics was a capacity for hard, sustained and conscientious work. He was a man of high intelligence and quick decision, and he worked rapidly, leaving himself ample time for the voracious reading which was his chief relaxation. He was a great buyer of books on all kinds of subjects, and accumulated a large and varied library, particularly rich in historical works. He loved his canaries and budgerigar, and the animals at the Zoo, and this no doubt stimulated his interest in the immense subject of the animal reservoirs of human disease, so important in tropical medicine.

Scott was a delightful companion, full of humour, which on occasion could be pointed, but which was modified by a rather old-world courtesy. Physically he was slight, good-looking, and always immaculately dressed. He moved with ease and assurance among the leaders of his profession and made many friends. His first wife died in 1933; his second wife, Eileen Anne, daughter of the Rev. R. P. Prichard, survives him.

Charles Wilcocks

Dr. E. Leonard Gill

E. Leonard Gill died in Cape Town on July 5. He was born in Reigate and after attending a Friends school, entered Owens College, Manchester, graduating in 1899. He then became a member of the museum staff at Manchester and so gained experience in museum arts and management. Later, he became curator of the Hancock Museum, Newcastle upon Tyne. Here he was responsible for large, important collections of fossils, birds and marine invertebrates, as well as the general contents of an old-established natural history museum. The maintenance of this large building, very old-fashioned in its design and furnishing, also fell to him, and the funds of the Society which owned it were, even then, inadequate.

Gill served in the Friends Ambulance throughout the First World War, returning to the Museum, when he began to modernize some exhibits. In 1922 he accepted a post in the Royal Scottish Museum; but in 1924 he became director of the South African Museum, Cape Town.

In the seventeen years he spent in this post, Gill revolutionized the Museum; its size was nearly doubled, the exhibition galleries were modernized and enlarged, and the scope of the Museum was extended to cover not only important South African antiquities, but also some art collections. Gill wrote descriptive labels, in Africaans as well as English, which brought the Museum into much closer touch with the general public, and increased this contact by circulating specially made museum cases to schools.

Gill published a few useful papers on fossil fish; but his chief interest was in birds. On his first visit to the Museum in Cape Town, he found on his table a dead bird just picked up and brought in. On its leg was a ring which Gill himself had placed there at a nest in the Farne Islands. Gill found that there was no small cheap book about South African birds, so that it was impossible for any ordinary man to know them, and thus to observe them intelligently. Hence he wrote an inexpensive book with many small but admirable figures drawn by Gill himself and his artist sister. This book was most useful, not only in South Africa but even farther north, and it has gone through several editions.

Gill added to the general interest in natural history, by newspaper articles in Africaans as well as English, and by lecture talks. Also he founded the South African Ornithological Society, which recently celebrated its silver jubilee.

Gill was a man of unusual character, willing to take great trouble to help anybody, friendly and helpful to everyone.

D. M. S. Watson

Mr. John A. Marsh

Through the death of John Anderson Marsh, which occurred on July 1, the Chester Beatty Research Institute (Institute of Cancer Research: Royal Cancer Hospital) has lost a greatly valued chief technician who had given it his loyal service for more than forty-six years. Appointed to the Institute on its foundation in 1909, he then worked for its first director, Alexander Paine, and for Casimir Funk and Jack (later Sir Jack) Drummond, at that time engaged in investigations of the 'vitamines' and of the amino-acid composition of tumours, respectively. Under his later directors, Archibald Leitch and Sir Ernest Kennaway, he played an essential part in assisting their contributions in the field of chemical carcinogenesis, first in studies with coal-tar, and later in the great development of the cancer-producing hydrocarbons.

A man of wide interests and much kindliness, Marsh inspired friendship in all his colleagues, not least in the numerous workers from abroad whom he had helped over the years, and who mourn him equally with ourselves. He had seen great changes in research, and throughout his long service at all times embodied the true worth of the chief technician. Both for his unique contribution and for his personal qualities, he will be ever gratefully remembered by all who knew him.

ALEX. HADDOW

NEWS and VIEWS

New President of the British Association: Prof. P. M. S. Blackett, F.R.S.

AT the meeting of the General Committee of the British Association for the Advancement of Science held in Sheffield on August 29, Prof. P. M. S. Blackett was elected to succeed Sir Raymond Priestley as president. Prof. Blackett was born in 1897 and educated for the Navy at Osborne and Dartmouth. After war service during 1914–18 he studied at Cambridge, where he took Part I of the Mathematical Tripos and Part II of the Natural Sciences Tripos in physics. He then worked under Rutherford in the Cavendish Laboratory until 1933. From 1933 onwards he has been successively professor of physics at Birkbeck College, London, University of Manchester and the Imperial College of Science and Technology, London. He received a Royal Medal from the Royal Society in 1940 and was awarded a Nobel Prize in 1948.

Prof. Blackett and those working with him have made significant contributions to three main fields of physical discovery: the interaction with matter of fast particles from radioactive sources, the nature of the particles in the cosmic rays and the magnetism of the Earth. During 1921–31 he was chiefly occupied with the development and operation of automatic Wilson cloud chambers and their application to the precise measurement of the parameters involved in collisions between alpha-particles and atomic nuclei. By painstaking work he showed that very infrequent inelastic collisions with nitrogen produced the then unknown isotope oxygen-17 by the capture of the alpha-particle and the ejection of a proton. In this period also he verified, with Champion, the Mott theory of the wave-mechanical diffraction scattering of slow alpha-particles. From 1931 onwards he applied and extended the cloud chamber technique to the study of the collisions involved in the cosmic rays, establishing (with Occhialini) the existence of nearly equal numbers of positive and negative electrons. This confirmed Anderson's discovery of the positive electron a few months before and extended it by giving strong evidence for actual pair production. In addition, the 0·5-MeV. scattered gamma-rays were identified as arising from the annihilation of positive and negative electron pairs. With a large magnet and a new counter-controlled cloud chamber, Blackett and his colleagues proceeded to study in more detail the nature and the energy spectrum of cosmic ray particles. Much valuable work on cosmic ray showers was carried out under his direction, and he himself explained the negative temperature coefficient of the cosmic rays in terms of the decay of the μ-meson.

These detailed studies led to a discovery which opened up the entirely new field of 'strange' particles when Rochester and Butler in Blackett's laboratory in 1946 found the first neutral V-particles and in 1947 the first charged V-particles. The identification by the Manchester team of V^0 decay into a proton and a pion and of the probable division of a V^1 particle into two pions, together with the best determination to date of the life-times of V^0 and V^1 neutral particles, are outstanding further discoveries. These were made possible by Blackett's energetic action in moving the equipment to the observatory of the Pic du Midi. From 1947 onwards he interested himself in the possibility, originally discussed by Schuster, of a 'fundamental' connexion between the angular momentum of a large rotating body, such as the Earth, and its magnetic field. Although experiments conducted and suggested by him gave no support to this idea, the sensitive magnetometer designed for this work has been used by him and by Runcorn at Cambridge in remarkable studies of palæomagnetism which give promise of throwing new light on polar wandering and continental drift.

Chemistry in Swansea: Prof. C. H. Hassall

PROF. C. H. HASSALL, professor of chemistry in the University College of the West Indies, has been appointed to the chair of chemistry in University College, Swansea (University of Wales), in succession to Prof. C. W. Shoppee, who has accepted the chair of organic chemistry in the University of Sydney, New South Wales, Australia. Prof. Hassall graduated in the University of New Zealand in 1941 and after war service went with a senior studentship of the 1851 Exhibition to Cambridge, and carried out research in organic chemistry with Sir Alexander Todd. In 1948 he accepted the chair of chemistry in the young University College of the West Indies, where he has been responsible for building up a new department, involving the design of laboratories, recruitment of staff and the development of teaching and research. During this period he has also managed to visit Harvard, where he worked in Prof. R. B. Woodward's laboratory for a time, and a number of university departments and industrial research laboratories in England working on organic natural products. These activities explain in part the close links which Prof. Hassall has formed between his department and industry in the West Indies and with several pharmaceutical firms in Europe. He has served as the United Kingdom representative on the Caribbean Research Council and is a member of the advisory committee of the Institute of Social and Economic Research, Jamaica. His research work has been mainly in the field of the structural chemistry of organic compounds of biological activity such as steroids, polypeptides and antibiotics.

Weather Forecast Service in Britain by Telephone

THE automatic weather forecast service by telephone which came into operation in Britain at midnight on March 4 has been a great success. In the first month 561,377 calls were received from the public, a number far exceeding the number made to the London Forecast Office in any month; the number of calls to the Office during February was 17,128. This experience is similar to that in other countries. The number in the first month was probably boosted by mere curiosity, for the number of calls in July was 339,384. Clearly the automatic system provides an 'on demand' weather forecast service quite beyond the capacity of a forecast office answering direct inquiries. The mechanical arrangements of the forecasting service are described by W. R. Hanson in the July number of the *Meteorological Magazine*. The forecasts are prepared in the Meteorological Office and recorded on tape at telephone exchanges of the General Post Office. They do not, as has been the arrangement elsewhere, consist of the nearest applicable stock phrases, but are compiled to express the forecaster's opinion as nearly as possible within the limits of the time allowed—which must be at most 30 sec. The forecast can be revised at any time, and there is provision for automatic switching in of a second tape if the first breaks down and for keeping the service going during recording of a new forecast.

Nuclear Research Reactor at the Massachusetts Institute of Technology

THE National Science Foundation, Washington, D.C., has made a grant of 500,000 dollars to the Massachusetts Institute of Technology towards the construction of a nuclear research reactor, plans for which have been under way since 1952. The remaining cost, which will be at least 2,000,000 dollars, will be borne out of funds raised by Massachusetts Institute of Technology alumni and by a grant from the Rockefeller Foundation. The reactor will use enriched uranium-235 as fuel, and will be cooled and moderated by heavy water. The main core will be surrounded by a graphite reflector and housed in an air-tight building with a dome-shaped roof, the site for which is 136 Albany Street, Cambridge, Mass. Construction is already under way and is expected to be completed in the autumn of next year. The design of the reactor has been chosen to give the maximum degree of safety together with facilities for a large number of experiments in nuclear physics, which will be the principal function of the reactor. However, it will also be made available for research in solid-state physics, food technology, genetics, chemical and nuclear engineering, and medicine. The whole project is under the general direction of Dr. Manson Benedict, professor of nuclear engineering in the Department of Chemical Engineering. Dr. T. J. Thompson, formerly chairman of the Design and Construction Committee of the Omega West Reactor of the Los Alamos Scientific Laboratory, has designed the reactor and will supervise its construction.

Gwerin : a New Journal of Folk-lore

A NEW journal of folk-lore, *Gwerin* (Welsh for 'folk'), has been inaugurated, and the first number appeared in June. The forty-eight pages of the number contain three main articles, the first on how certain straw-rope granaries near Cork are made, a second on some Hebridean traditions, and a third on the manufacture in Suffolk of wooden rakes and scythe sticks. It is not easy to make descriptions of how things are constructed readily intelligible, and it is virtually impossible to make them exciting. Therefore, if the new journal is to survive, one might suggest that plenty of room should be set aside for the legend and fairy-tale side of the subject, which always has a great appeal. But constructional descriptions should be recorded somewhere even if only the accounts are deposited in some recognized museum. The straw-rope granaries make an interesting article, and it must be news to many that rakes and scythe sticks were a special feature of rural industries in Cambridgeshire and the neighbouring counties of Suffolk and Bedfordshire. It is good to know that story-telling and traditional music are still popular in the Hebrides and that they have not been ousted by the modern, 'popular' entertainment that pours forth over the radio and television and from so many printing-presses and film studios. There is, indeed, room for a journal devoted to folk-lore, and all will wish the new venture every success.

Makers of Modern Science

THE series of ten articles, each devoted to a brief description of one of the great prime movers in the development of science, which appeared originally in *The Times Educational Supplement*, has now been reprinted and issued as an attractive booklet, entitled "Makers of Modern Science" (pp. 44+10 plates. London: The Times Publishing Co., Ltd., 1956; 2*s*. 6*d*.). Each article is accompanied by a full-page photograph of its subject. The aim of the contributors, present-day eminent men of science, is to write about their subjects in a way which would not appear absurdly elementary to specialists in science and yet which would not be too repellently difficult for specialists in humanities. It is hoped that the articles will act as a bridge of general conversation between arts men and scientists. Except for Louis Pasteur and Charles Darwin, the prime movers are physicists or chemists who laid the foundations for our present-day knowledge of the structure of matter and of the atom in particular—Galileo, Newton, Dalton, Faraday, Mendeleev, J. J. Thomson and Rutherford. The late Dr. Sherwood Taylor, who took a large part in the preparation of the series, contributes the article on Galileo, and this represents one of the last writings of this distinguished historian of science. Sir Lawrence Bragg is the author of the article on Faraday; Dr. Charles Singer on Pasteur; Prof. J. R. Partington on Mendeleev; Sir George Thomson on his father; and Prof. P. M. S. Blackett on Rutherford.

Basic Concepts and Methods of Psycho-analysis

THE centenary of Freud is commemorated in a recent number of the *British Journal for the Philosophy of Science*, which contains seven articles that attempt, with considerable though varying success, to clarify some of the basic concepts and methods of psychoanalysis. Two contributions state in very clear terms the theoretical and practical difficulties that arise from the over-determination of mental phenomena—that is, the fact that many of these data are explicable in terms of different, and incompatible, laws and hypotheses. Similar problems are, of course, encountered in other fields of science, so that this number of the *Journal* is of quite general interest.

Commonwealth Fund Fellowships for Advanced Study and Travel in the United States

A NUMBER of Commonwealth Fund fellowships are again being offered by the Commonwealth Fund, New York, to British subjects for study and travel in the United States. All expenses of travel, study and living will be met, with some adjustment of stipends for married men. The fellowships which are open to British men or women who have not previously worked or studied for more than a few months in the United States are in six categories as follows. *General:* twenty fellowships to graduates of universities in Great Britain or Northern Ireland; candidates must be available in London for interview in March 1957; age, 23–32; tenure, 12–21 months; applications by December 15. *Home Civil Service:* five fellowships to permanent members in the higher ranks of the Civil Service in Great Britain, three for the administrative grades and two for the scientific and professional grades; age, preferably less than 40; tenure, 9–15 months; applications by December 10. *Australian and New Zealand Civil Services:* five fellowships to Civil servants in the Governments of Australia and New Zealand; age, less than 40; tenure, 9–15 months; applications (to Dr. H. Carlyle Forster, Box 4079, Melbourne, and the Public Service Commission, Wellington, N.Z., respectively) by November 1. *Oversea Civil Service:* two fellowships to Civil servants in the Governments of British Colonies, Protectorates, and Trust Territories; age, less than 40; tenure, 9–15 months; applications by November 17. *Journalism:* three fellowships to journalists practising in Britain and engaged on the opinion-making or broadly editorial side of their profession; age, 23–35; tenure, 9–15 months; applications by December 31. *American Studies:* four fellowships to faculty members appointed to or holding posts in American studies in universities in Britain; candidates to be nominated by their universities; tenure, 4–15 months (these fellowships are not limited by previous study in the United States). Application forms and further information can be obtained through British universities or through Government departments, or from the Warden, Harkness House, 35 Portman Square, London, W.1.

Seventh International Astronautical Congress

THE Seventh International Astronautical Congress, sponsored this year by the Associazione Italiana Razzi (Piazza S. Bernardo n. 101, Rome, Italy), will be held in the Congress Palace, Rome, during September 17–22. A total of forty-two papers will be presented at the Congress, as follows: United States, 18, including six on the Vanguard satellite and related problems; Italy, 8; Germany and Austria, 4 each; Holland, 2; and Great Britain, Holland, Egypt, Poland, Sweden and Argentina, 1 each. Arrangements have been made for simultaneous translation service in Italian, French, English and German. Further information can be obtained from the British Interplanetary Society, 12 Bessborough Gardens, London, S.W.1.

Announcements

THE thirty-second meeting of the Australian and New Zealand Association for the Advancement of Science will be held in Dunedin, New Zealand, during January 16–23, 1957, under the presidency of Sir Macfarlane Burnet. Enrolment forms, to be completed by December 12, and further information can be obtained from the honorary local secretary, Prof. J. R. A. McMillan, Science House, 157 Gloucester Street, Sydney, N.S.W. Those seeking accommodation should complete the necessary form and return it by October 31 to Dr. R. E. Corbett, Department of Chemistry, University of Otago, Dunedin, N.I., N.Z.

THE Scottish Group of the Nutrition Society will hold a symposium in Dundee on September 29 on "Nutrition in Pregnancy". The papers to be read will deal with both human and animal nutrition. Those interested should write for further particulars to Dr. J. Davidson at the Rowett Research Institute, Bucksburn, Aberdeenshire.

THE fourth in the series of international conferences on Alpine meteorology will be held in Chamonix during September 17–19. The topics to be considered will be: precipitation in mountain areas; the types of weather in the Alpine region and their classification; radiation in mountain areas; and the bioclimatology of the Alps. Further information can be obtained from the Secretariat of the Congress at 72 rue Pasteur, Lyons, Rhône.

THE Textile Institute will hold a conference in Zurich during September 13–17 at which the subject of "Static Electricity in Textiles" will be discussed. This will be the second in the Institute's series of overseas conferences, and more than a hundred textile experts and scientists from Britain will join about the same number from other parts of Europe and from North America. Further information can be obtained from the Development Officer of the Textile Institute, 10 Blackfriars Street, Manchester 3.

A SYMPOSIUM on "Recent Studies in Yeast and their Significance in Industry", jointly arranged by the Dublin and District Section, the Microbiology Group and the Food Group of the Society of Chemical Industry, will be held in the Rupert Guinness Hall, St. James's Gate, Dublin, during September 17–19. The symposium will be open to non-members of the Society on payment of a registration fee of 25*s*. Further information can be obtained from Dr. A. K. Mills, Chemist's Laboratory, Arthur Guinness Son and Co. (Dublin), Ltd., St. James's Gate, Dublin.

THE Ford Foundation has given a grant of 400,000 dollars to the European Organization for Nuclear Research to help in strengthening co-operation in nuclear physics research, primarily with the United States and with other countries not members of the Organization. The grant is to be spent over five years and will be used mainly for enabling guest professors and young scientists to work in the Organization.

THE University of Padua is offering a Gabriella Zuccari scholarship of 300,000–600,000 lire for research of at least six months duration at the Zoological Station, Naples, during 1957. The scholarship is open to any person for research in zoology, comparative anatomy, physiology or embryology. Application forms, to be returned by October 31, can be obtained from the Administrative Director of the University of Padua.

THE report for 1955 of the Chemical Research Laboratory, Teddington (pp. 88+1 plate. London: H.M.S.O., 1956; 4*s*. net), contains an interesting survey of work carried out there. Some of the activities are linked with that of the United Kingdom Atomic Energy Authority and include the extraction of uranium and other metals, the separation of rare earths, and related problems. Other work is on the preparation of semi-conductors in a very pure state, paper chromatography, and the bacterial breakdown of aromatic substances available as waste-products.

ERRATUM. In the article entitled "The Neutrino" in *Nature* of September 1, p. 446, equation 7 should read:

$$\sigma = \left(\frac{G^2}{2\pi}\right)\left(\frac{\hbar}{mc}\right)^2\left(\frac{p}{mc}\right)^2\frac{1}{(v/c)}$$

APPLIED RESEARCH AND DEVELOPMENT WITHIN THE INDUSTRIAL GROUP OF THE U.K. ATOMIC ENERGY AUTHORITY

By L. ROTHERHAM* and DR. A. B. McINTOSH†
Industrial Group, U.K. Atomic Energy Authority

IN the United Kingdom Atomic Energy Authority, the Industrial Group is responsible for the design, construction and operation of plants for the production of fissile material and for the prototype power stations such as that at Calder Hall or Dounreay. It deals with sanctioned commitments dispersed at sites throughout the whole country, and has three main branches with clearly defined responsibilities, each under its own director. The design and construction of reactors and process plants are the responsibility of the Engineering Branch, and their operation and level of production are the business of the Operations Branch.

The Research and Development Branch deals with development work affecting the Industrial Group, and its laboratories are suitably related to geographically separated works sites. It is responsible for the removal of difficulties preventing full production in any part of a production plant, the development of works processes, the provision of information for the design of new plants and prototype reactors, and the longer-term studies arising from production and design. Close collaboration is maintained with the Research Establishment at Harwell, which undertakes part of the work.

The Branch has its administrative centre at the Industrial Group headquarters at Risley, where the headquarters of the Engineering and Operations Branches are also located. Continuous consultation is thus assured between the main centres of administration, finance, engineering and operations.

There are five Laboratories and, except for some specialized fields in which Harwell is responsible, these provide the development effort for all sanctioned construction projects. The Capenhurst Laboratories deal mainly with problems of an engineering nature, such as fluid flow and heat transfer. At Windscale, the Laboratories are largely devoted to radioactive chemistry, metallurgy and physics, arising from reactor problems at Windscale, Calder and Chapel Cross, and to the chemical problems of plutonium separation. Culcheth is responsible for the selection and development of reactor materials and for research work on the extraction of these if they are not commercially available. This is extended on a narrowed front at the Springfields Laboratory, which is responsible for the development of fuels and fuel elements. The new Laboratories at Dounreay are concerned with experimental reactor technology.

Planning and Progress of Applied Research

In the development of nuclear power there is necessarily a closer contact between scientists and engineers than in many well-established activities, because each new venture represents a major advance in technology. Applied research must be regarded as an essential complement to engineering and should be organized as such.

Both Engineering and Operations (or Works) Branches require the support of timely, authoritative and responsible scientific opinion to form the basis of major engineering and operational decisions. Decisions should not have to be made from the information nearest in character arising from a distantly related research problem. Investigations must aim at providing the precise information on the day it is required. It must be research applied to industrial needs and not pure research. Only applied research can be designed to influence commitments already made. The emphasis must always be on obtaining necessary techniques or data by a particular date. All work must therefore be planned and progressed in the same way as the Engineering Construction or Production Programmes to which it is linked.

The system of organization which has been developed begins with a study of work requirement aimed at providing the scientific personnel with a profitable programme of research and development. Such a programme, however, is no more than a declaration of intention. It must be integrated with a system of executive management which, in providing the machine to discharge the programme, preserves scientific integrity, and yet allows firm direction and control.

Many different and competing schemes may be judged as suitable for feasibility study, development or design, although restrictions may eventually be imposed due to limitations in available engineering effort. A widely dispersed research and development effort stretched over too many projects is less effective than a more concentrated attack on a narrow front. At the earliest possible stage responsible assessment must decide the most profitable direction for the application of the available applied research and development effort. The constant need for selecting only projects from which the greatest return will be obtained leads to the dual needs of strategic and tactical planning and to the development of two types of organization, functional and executive, each directly responsible to the director. The resolution of the separate points of view leads to the formulation of research policy which must conform to the overall policy of the Board of Management. The initiation, control and termination of all work necessary in the execution of this policy is effected by the wise use of delegated financial authority. The Director o Research is chairman of the Research Board formed for this purpose. The Secretary is the senior scientis in charge of central administration, and the members from the Branch are the heads of all the experimenta establishments and the chief scientists responsible for functional activities. Members from outside the Branch are the Directors of Administration, Engineering, Operations, Stores and Accounts and Technical Policy or sufficiently senior deputies.

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* Director of Research and Development, U.K.A.E.A. (Industrial Group).

† Head of Culcheth Laboratories, U.K.A.E.A. (Industrial Group).

A body constituted in this way brings together a group of the most senior staff appropriate to consider the action arising from all matters affecting general and technical policy, organization and finance.

The procedure adopted is for a short paper to be prepared by one of the Research Board and circulated to other members prior to debate. On the Organization and Finance side, typical subjects under constant review are methods of reporting of work, training schemes, staff structures complements and accounting procedures. On the technical side the attitude to specific research projects is clarified by debate following presentation of papers from both functional and executive points of view.

Firm direction of experimental work to a policy is assured if control is exercised on capital and operational expenditures, staff recruitment and the requisitioning, initiation, progress and termination of work.

Annual Budgets

Each year the heads of experimental establishments submit to the Research Board estimates of their capital and operational expenses for the next financial year. A total is agreed for each and the collective budget is presented by the Director to the Board of Management for approval. Ultimate acceptance and voting of funds does not constitute authority to spend.

Each proposed item of expenditure beyond a small sum must be separately justified during the financial year. The Director of Research and Development has a delegated financial authority from the Board of Management which he ordinarily exercises through the Research Board. A lower authority is further delegated to each establishment head. Beyond the delegated authority, submission must be made to the Board of Management; but no proposal will go forward without prior discussion at and support of the Research Board.

A statement of running costs under separate cost headings is available for consideration at each meeting of the Research Board. These are issued by the Accounts Branch and show the actual budgeted expenditure for the period together with the recorded and budgeted cumulative total fraction of the year's expenditure. These statements are among the most important documents for laboratory management.

Requisition, Initiation and Review of Work

A sanction procedure has been carefully worked out and coupled with a formal system of work requisition and initiation. Where a large allocation of effort is involved which is equivalent to major operational expense, a formal justification must be made as a development proposal which will briefly detail the problems, methods of approach proposed, staff utilization and associated capital expenditure according to a timed programme of the work.

Each month the Research Board has before it a statement giving all jobs due for review or completion in that month. This includes a comparison of the estimated and the recorded labour expenditure and cost. Departures from the initial timed plan in the expenditure of labour or finance or in technical progress must be accounted for to the Board's satisfaction.

A progress statement on each job in the Branch Programme is made each two months, and opportunity is afforded each member of the Research Board to raise any question regarding the work. The collected progress statements, which give for each job the object of the work, the priority, estimated effort, starting and finishing dates, review dates and brief up-to-date progress statement are forwarded for the approval of the Board of Management. This document is unique in its value to chief engineers, works general managers, and all workers in the field.

Staff

The staff position in each laboratory is considered each month and curves show how recruitment in the Branch compares with that forecast. Recruitment campaigns or embargos are approved as a result. Other aspects discussed include recruitment difficulties in particular grades or non-uniformity in duties of grades from laboratory to laboratory.

Because there is a shortage of scientists, it has been an item of policy to take positive steps to ensure the most efficient use of every member by selecting the most rewarding items of research on which to utilize available effort. Such programming of work cannot do more than indicate directions for effort. It is for executive management to form a tactical plan to ensure that each member is suitably and wholly employed.

Survey of Competitive Demands

In many fields of modern engineering and works practice, as with atomic energy, highly specialized sciences either do or should form the basis of the activity.

A design project which may begin as an idea in the Research Branch, although initiated as a result of experience or inspiration in any of the branches, becomes a sanctioned commitment only after successful study of feasibility. Each commitment sanctioned requires planning to ensure that all facets are covered so that the target date is met. Formal or informal discussion of basic technical points on which key decisions are necessary usually leads to demand for scientific investigation. Such demands compete with one another, and it is a specialized study to assess the comparative weight which should be allowed for each.

All engineering and production programmes must be interpreted so that effort can be deployed in phase. Work performed out of phase denies effort to essential and relevant studies of the moment. This timing is vital in the later allocation of laboratory priorities.

The research programme can be designed to influence the trend of development. Responsible anticipation should lead to an endeavour to prepare for the future. Refinements or developments apparent at the research stage should receive consideration so that sufficient evidence may be available to justify development studies. The question "Where do we go next ?" is properly answered by the research programme.

Central Technical Administration

Closely planned activities, requiring prompt central administrative action, justify the existence of an Administration Group, to act as liaison with the main Administrative, Finance, Engineering and Operations Branches. Under a technical head, this is mainly a technical group distinct from professional or financial administrators. They are in a position to have a better appreciation of the needs of the

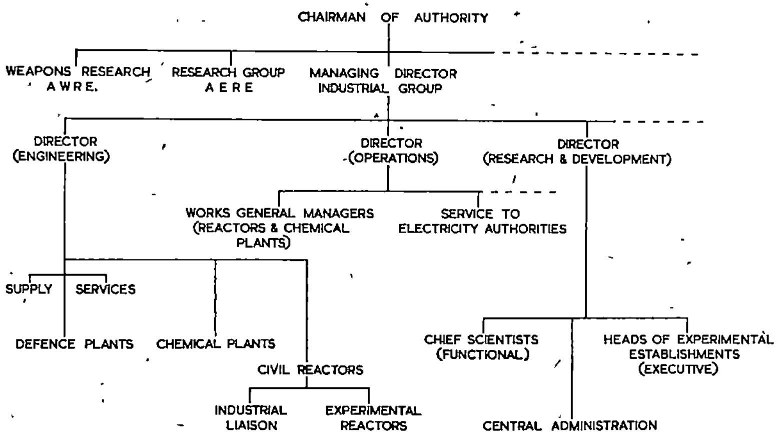
CHAIRMAN OF AUTHORITY
WEAPONS RESEARCH A.W.R.E.
RESEARCH GROUP A.E.R.E.
MANAGING DIRECTOR INDUSTRIAL GROUP
DIRECTOR (ENGINEERING)
DIRECTOR (OPERATIONS)
DIRECTOR (RESEARCH & DEVELOPMENT)
WORKS GENERAL MANAGERS (REACTORS & CHEMICAL PLANTS)
SERVICE TO ELECTRICITY AUTHORITIES
SUPPLY
SERVICES
DEFENCE PLANTS
CHEMICAL PLANTS
CIVIL REACTORS
INDUSTRIAL LIAISON
EXPERIMENTAL REACTORS
CHIEF SCIENTISTS (FUNCTIONAL)
HEADS OF EXPERIMENTAL ESTABLISHMENTS (EXECUTIVE)
CENTRAL ADMINISTRATION

Fig. 1. Relationship of Research and Development Branch to activities requiring development effort

scientific staff and thus to act as a bridge between the main administration and the Branch.

The group collates the records supplied by all laboratories to form a master record of all effort in the Branch. These records of utilization of scientific and experimental effort are invaluable in the overall planning of work and in determining what commitments can be undertaken in the future.

The head of the Central Administration, as secretary of the Research Board, is responsible for the organizing of all business of the Research Board from the issuing of the agenda to the compilation of the minutes.

The Central Administration also has responsibility for all library and information services, although this does not extend further in the laboratories than ensuring uniformity of system. Much of the detail of methods used in the allocation and accounting of labour was worked out by the Central Administration.

Allocation of Responsibilities

The senior staff structure developed for the functional and executive control of applied research is shown in Fig. 1 in relation to the activities requiring development effort. Specific responsibilities carried by all members are integrated at the Research Board to result in agreed executive action. All bodies other than the Research Board are advisory, and all work arising from them must follow the formal Research Board sanction procedure. This is essential if firm control is to be maintained on the work of the experimental establishments. Fig. 2 shows the focal nature of the Research Board and the parts played by both functional and executive organizations in the representation of the Branch. Normally executive representation is required only for sanctioned commitments involving major effort.

The essential functional responsibility is to prepare a strategic plan linked to the overall scheme of development approved by the Board of Management, and then to co-ordinate all research and development effort according to that plan. Although tied to key dates for five to ten years, this must be sufficiently fluid to allow revision at, say, yearly intervals according to changing emphasis and the impact of experience. Promising researches must be related to an intimate knowledge of works practice and industrial development. Interchange of views and discussion on technical research problems must be arranged.

In general, sanctioned commitments always have the higher priority, but appreciable effort must be devoted to work in the earliest stages of feasibility and research studies. Such work suffers if done in isolation because the benefits conferred by expert consultants is lost. The findings of the work must be made known to all who can assist in assessing the directions in which they may be exploited. This is a functional responsibility, and staff with such duties should have direct access to the scientific workers at all levels in the laboratories so that the most up-to-date picture can always be presented. When the activity is large enough, it is convenient to divide the functional responsibilities into chemistry and chemical engineering, physics and engineering, and metallurgy, each under a senior member of the staff or chief scientist directly responsible to the Director of Research and Development.

The officer in charge of functional work should be of senior status, so that he has at least parity in discussion with chief engineers, works general managers, and heads of experimental establishments. Because of the difficulties in the comparative assessment of competing demands, a man of mature ability and experience able to take a detached view is essential for this work.

By collaboration with all parties who have an interest and can express a responsible opinion, the chief scientists advise on the forward forecast of research and development. Existing engineering commitments will have higher priority, and experi-

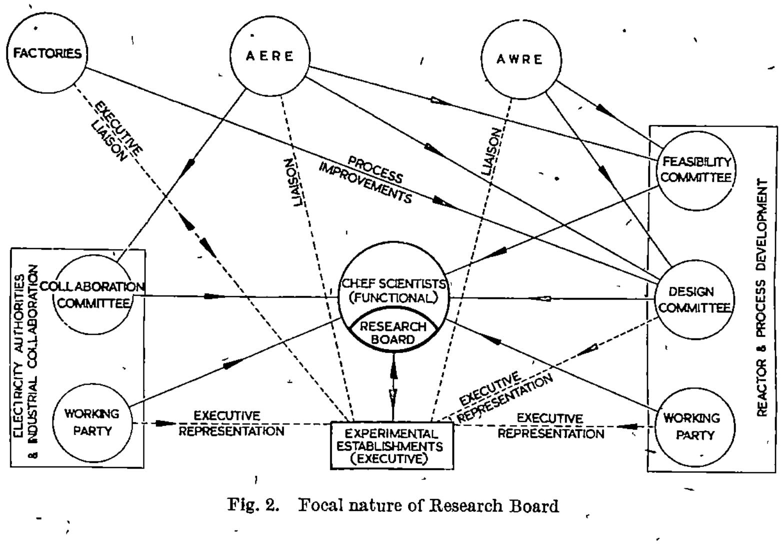

Fig. 2. Focal nature of Research Board

ence in the laboratories may suggest modifications. The several views are unified at the Research Board. After it is agreed, the strategic plan can be detailed, based on the accumulated records of work which should be compiled at the laboratories and from which the effort and cost of investigations similar in nature can be deduced.

The value of such a strategic plan is that it should show realistically how many development projects can be dealt with within existing strength, when key decisions are necessary related to overall construction or production plans, the expected utilization of labour and the possible need for recruitment. After formal executive approval, it should be distributed to senior members of other branches to apprise them of the extent of effort applied on their behalf and to allow the opportunity for further discussion on over-all policy. Executively, it provides the key to effective utilization of effort.

Where a number of experimental establishments is involved, an important functional responsibility is to ensure that all work is co-ordinated according to the agreed plan, and all but necessary duplication avoided. Constant discussion with the experimental workers should mean that new findings are applied expeditiously even before publication.

Where facilities to cater for some aspect do not exist anywhere in the organization, arrangement for extra-mural research to be carried out by some other organization is appropriate to functional responsibility, although the management of such work when initiated is executive.

During the preparation of the budget submissions, the co-ordination of financial requirements can be made a functional responsibility, and thus the various schemes from the separate establishments can be dovetailed before consideration by the Research Board. This is a logical consequence of strategic planning.

Where the organization is large, strategic planning will embrace all aspects in all establishments or groups. Tactical planning applies only to the establishment, group or section the effort of which is under consideration, and is necessary to the efficient discharge of the executive responsibility of management.

INTERNATIONAL PROTECTION OF BIRDS

The sixth Conference of the European Continental Section of the International Committee for Bird Preservation was held in the village of Beetsterzwaag, Friesland, Holland, during June 3–7, under the chairmanship of Dr. Boje Benzon (Denmark). The meeting was attended by delegates of the national sections of Austria, Belgium, Denmark, France, Germany, Great Britain and Northern Ireland, Italy, Netherlands, Norway, Sweden and Switzerland, together with representatives of the International Union of Biological Sciences, the Conseil International de la Chasse and an observer from Luxembourg.

One of the most important achievements of the European Section was the drawing up of an International Convention for the protection of birds which was signed *ad referendum* by the representatives of twelve European powers in Paris in 1950. Switzerland was the first country to ratify it in 1954, and was followed by the Netherlands, Spain, Belgium and Iceland; but in spite of the new Bird Protection Act of 1954 on which great hopes were placed, the United Kingdom Government has still expressed inability to ratify. This Convention is a revision of the Paris Convention of 1902, which was confined to birds useful to agriculture only, and embraces the modern conception of bird protection—that as a main principle all birds should be protected—exceptions being made for species which are considered harmful, and for special circumstances and conditions. After a frank discussion, the general feeling of the meeting was expressed in a resolution pointing out that certain governments might be hesitant to ratify the Convention on account of minor differences, and directing attention to the 'escape clauses' provided.

In another international agreement, vitally affecting birds, the International Convention for the Prevention of the Pollution of the Sea by Oil, the United Kingdom, however, has taken the lead, for it was at the Inter-Governmental Conference convened in London in 1954 that this Convention was drawn up. The United Kingdom was the first country to ratify it, in 1955; the representatives of Denmark, the German Federal Republic and Sweden reported that their Governments had since taken this step, while others stated that their respective Governments were in the process of passing, or on the point of introducing, legislation to enable ratification. Thus after more than thirty-five years, during which thousands of sea-birds have perished annually, a concrete step forward to combat this evil has been made.

The diminution of the birds of prey all over Europe is causing concern, and it was unanimously agreed that these birds were in need of better protection and that to achieve this end education as to their value was urgently required. In this matter Great Britain, where full protection is accorded to all birds of prey except the sparrowhawk (*Accipiter nisus*), is outdistanced only by The Netherlands, where all birds of prey, without exception, are protected. This overall protection was recently given in Holland as a result of the frequent mistakes which had been made in shooting other species which are difficult to distinguish from the sparrowhawk.

Reports on the diminution of the white stork were given from several countries, though from Austria and Hungary came news of an increase in numbers. The causes of the diminution of this large white and black bird are varied; as with most species, more intensive cultivation being considered one of the prime reasons. It was stated that large numbers of storks meet their death by flying into overhead wires and tall chimneys, and France and Spain were blamed for the fact that though the stork is legally protected in those countries, the law is not enforced and large numbers are shot. It was alleged that in Spain hunters especially aim at killing ringed storks as they like to collect the rings as trophies, and in view of this it has been decided in the Netherlands to cease all ringing of young storks for the present. A French speaker stated that from his personal observations, white storks certainly did not appear to be diminishing in Central Africa, and put forward the suggestion that numbers of this species might possibly be losing their habit of northerly migration. In Holland and other countries suitable platforms have been erected to encourage storks to nest, and this scheme has already met with encouraging success; it would appear, however, that the birds are becoming lazy, as it has been observed that they prefer nests already prepared to a mere nesting platform.

The use of pesticides and their effect on wild life was dealt with at length by speakers from The Netherlands and Germany and supported by statements from Belgium, France, Great Britain, Sweden and Switzerland. The great difficulties of this problem were fully realized and it was agreed that in view of the time required fully to assess the effects of pesticides on wild life and the constantly changing situation with regard to the production of these substances, this subject should be kept permanently on the agenda of the Committee. In the meantime, a resolution was passed urging all Governments to take the necessary steps to prohibit the further use or sale of any pesticide which had been proved to be excessively destructive to birds and other forms of wild life.

Among other subjects discussed at the meeting were the control of the export and import of wild birds' eggs, birds which are a menace to other species, the protection of the skylark and the effect of shooting during severe frost. National representatives also reported on the establishment of new bird reserves, particularly on migration routes, and the state of bird preservation in their respective countries.

Throughout the meeting it was evident how difficult it is for one country to pass and maintain protective measures unless her neighbours do likewise, and that, to ensure the effective preservation of birds, international collaboration is imperative. But the cordial atmosphere which prevailed, and the obvious desire of all national representatives, without exception, to co-operate to the fullest extent, were striking features of the discussions.

Immediately before the Conference, a meeting of the Executive Board of the International Wildfowl Research Bureau (a branch of the International Committee for Bird Preservation) was held under the chairmanship of the honorary director, Dr. Edward Hindle, at which the problems of the conservation of wildfowl, the Anatidae in particular, were dealt with.

PHYLLIS BARCLAY-SMITH

INTERNATIONAL SCIENTIFIC RADIO UNION

AN account of the eleventh general assembly of the International Scientific Radio Union, held in The Hague during August 23–September 2, 1954, has already appeared in *Nature* (September 3, 1955, p. 451); and this, together with a later account (*Nature*, April 7, p. 652), dealt with three (Parts 1, 4 and 8) of the eight parts of Vol. 10, which forms the published proceedings of the assembly. The remaining five parts have now been published*.

Part 2 deals with the work of Commission II on "Radio and Troposphere". As the chairman's summary of the proceedings shows, this Commission is very active in research on the influence of meteorological conditions on the propagation of radio waves by normal refraction processes to distances well beyond the horizon, and by the phenomena of scattering to distances of several hundred kilometres.

"Ionospheric Radio", the title of Commission III, is covered in Part 3. During the general assembly, this Commission held six technical sessions which dealt with the behaviour of the ionosphere at high latitudes, the morphology of the *D*-layer, rocket investigations of the ionosphere, absorption and forward scattering by the ionosphere, and with geomagnetic distortion and storms in the *F*2-layer. Many of the resolutions of the Commission are concerned with the important and very active part to be played by the International Union in the programme for the forthcoming International Geophysical Year.

The proceedings of the deliberations by Commission V, "Radio-Astronomy", are described in Part 5. The work of this Commission has already resulted in the publication of three special reports (see *Nature*, December 10, 1955, p. 1110), and the whole subject is being actively pursued on a basis of international co-operation. Sub-commissions have been established to study continuous measurements of solar radio emission, and to explore the possibilities of standardizing equipment and measuring techniques. The importance of making adequate frequency allocations for radio astronomy is emphasized; and in the case of such frequency bands as those in which the neutral hydrogen line is located, there is a need for international agreement on such allocations.

Part 6 describes the work carried out at the general assembly by Commission VI on "Radio Waves and Circuits". The resolutions of this Commission show that its work ranges over a wide field, including information and its measurement, the spectra of random signals, band-widths and time-constants, and the applications of abstract algebra to new circuit arrangements for equipment and antenna systems.

The title of Commission VII is "Radioelectronics", and the report of the chairman given at the end of Part 7 shows that there has been much discussion as to the manner in which the Commission will fit into the general pattern of the International Union. During the meetings, discussions were held on the subjects of solid-state and gaseous electronics, valves for microwave optics and electronics, and on the generation of radiation by gaseous processes; the last being dealt with jointly with Commission V as a subject of mutual interest. A recommendation was made to form a joint commission between the International Scientific Radio Union and the International Union of Pure and Applied Physics to provide means for the discussion of topics in electronics which do not properly belong in the field of radio.

All the publications referred to above contain full details of the scientific sessions, all the national reports in full, together with, in most cases, carefully selected lists of references; the summarizing reports of the respective chairmen with the resolutions of the Commissions adopted at the general assembly are also included. The publication of these remaining parts completes the official record of The Hague meeting of the International Scientific Radio Union, 1954.

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* International Scientific Radio Union. Proceedings of the 11th General Assembly held in The Hague from August 23rd to September 2nd, 1954. Vol. 10, Part 2. Commission II: Radio and Troposphere. Pp. 90. 1956. 100 Belg. fr.; 14*s.* 6*d.*; 2 dollars. Vol. 10, Part 3. Commission III: Ionospheric Radio. Pp. 194. 1955. 200 Belg. fr.; 29*s.*; 4 dollars. Vol. 10, Part 5. Commission V: Radio-Astronomy. Pp. 114. 1955. 125 Belg. fr.; 18*s.*; 2.50 dollars. Vol. 10, Part 6. Commission VI: Radio Waves and Circuits. Pp. 140. 1955. 150 Belg. fr.; 21*s.* 6*d.*; 3 dollars. Vol. 10, Part 7. Commission VII: Radioelectronics. Pp. 140. 1956. 150 Belg. fr.; 21*s.* 6*d.*; 3 dollars. (International Scientific Radio Union, 42 rue des Minimes, Brussels.)

NATIONAL INSTITUTE OF AGRICULTURAL BOTANY, CAMBRIDGE

REPORT FOR 1956

AT the annual general meeting of the Fellows of the National Institute of Agricultural Botany, held in Cambridge on July 13, Prof. E. T. Jones, director of the Welsh Plant Breeding Station, received the Institute's Cereal Award for his work in breeding the new winter oat 'Powys'. This variety combines the best features of the well-known *S.* 147 and *S.* 172 and has shown outstanding merit in a series of trials. It will not, however, be available for general distribution this year.

The thirty-sixth annual report* presented at the meeting records continued expansion of the work of the Institute and plans for further building-extensions have been under active consideration. Some changes in the organization of cereal trials have been completed, which will reduce the time before a decision regarding recommendation can be made from four to three years. 'Preliminary' trials of new varieties are now grown at four of the thirteen regional centres, and with the aid of special plot combine-harvesters reliable results can be obtained in the first year. The more promising varieties go into 'main' trials, with larger plots at more centres, incorporating three levels of nitrogenous top dressing, in addition to a basic dressing to ensure adequate supplies of phosphorus and potassium. Another new feature is the trial of varieties used as 'controls' during the past thirty-five years, to see how far modern cereals are improvements on the older ones. The transfer of responsibility for the production of stock seed of all the Aberystwyth strains of grasses and clovers from the Welsh Plant Breeding Station to the Institute has necessitated much reorganization of technical work and contracting arrangements, and a special granary extension for these seeds is in course of erection. Progress continues with the plans for supervising the quality of seed stocks grown in Britain. Cereal crops entered for inspection again exceeded 100,000 acres, and nearly 54,000 acres were field-approved. A Comprehensive Certification Scheme for special cereal seed stocks was operated on a limited scale for the first time in 1955, and it is hoped that the arrangements for the National Comprehensive Certification Scheme for Herbage Seed will be complete in 1956.

The report also provides useful information regarding the performance of different varieties of potato, pulses, roots, fodder and oil crops, and field vegetables. Management trials carried out with lucerne showed that the best time for the first cut is the early bud stage. This both gave the best-quality hay, and, as a result of the earlier second growth, enabled four cuts to be taken each season. For those interested in grasses, the classification of some seventy strains of perennial rye grass according to their time of flowering, and the results of trials with hormone weed-killers on grass seed crops are of particular value, relatively safe times for spraying being given for the different Aberystwyth strains.

Details of the work of the Official Seed Testing Station are included in the report. The large increase in cereal samples received for testing and the high percentage with germination which fell below the authorized minimum standard reflect the bad harvesting conditions in 1954.

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* National Institute of Agricultural Botany. Thirty-sixth Report and Accounts, 1955. Pp. 54. (Cambridge: National Institute of Agricultural Botany, 1956.)

STUDIES IN MUTAGENESIS

Production of Bacteriophage Mutants by a Disturbance of Deoxyribonucleic Acid Metabolism

IN experiments in which the pyrimidine derivative 5-bromouracil was incorporated into the deoxyribonucleic acid of $T2r^+$ bacteriophage, according to the method of Dunn and Smith[1], it was observed that a large number of a variety of plaque-type mutants appeared among the progeny phages, as illustrated in Fig. 1. The observation of this apparently powerful mutagenic effect of 5-bromouracil led us to an investigation of the conditions upon which the production of phage mutant depends.

In a typical experiment, a culture of *Escherichia coli*, strain *B*, was grown with aeration at 37° C. in complete medium supplemented with 50 μgm./ml. 5-bromouracil, for four generations to a density of 2×10^8 cells/ml. (Complete medium is a glucose-salts medium[2] supplemented with 1 mgm./ml. sulphanilamide, 1 mgm./ml. vitamin-free casein hydrolysate, 25 μgm./ml. xanthine, and uracil equal to 5 per cent of any 5-bromouracil added. We had found that when commercial 5-bromouracil, which contained a 5 per cent uracil contamination, was added to complete medium, no further pyrimidines were necessary for bacterial growth. In complete medium plus pure 5-bromouracil, however, the bacteria required uracil for growth.) The bacteria were then centrifuged and resuspended in the same volume of complete medium plus various concentrations of 5-bromouracil, infected with 3×10^8 $T2r_2$ phages per ml., and the infection was allowed to proceed for 3 hr. At this time the bacteria were centrifuged, and the supernatant fluids were diluted and plated on broth agar. The results are presented in Fig. 2, where the 'infective yield' (the ratio of the number of infective, that is, plaque-forming, progeny to the number of input phage) is plotted as a function of the 5-bromouracil concentration in the medium. The percentage mutants (100 times the ratio of all mutant plaques to the total number of progeny plaques) is seen to be maximal at the concentration of 5-bromouracil giving minimal infective yield. No mutants were produced in the absence of 5-bromouracil. The quantitative results were observed to vary somewhat, depending on the exact growth conditions employed.

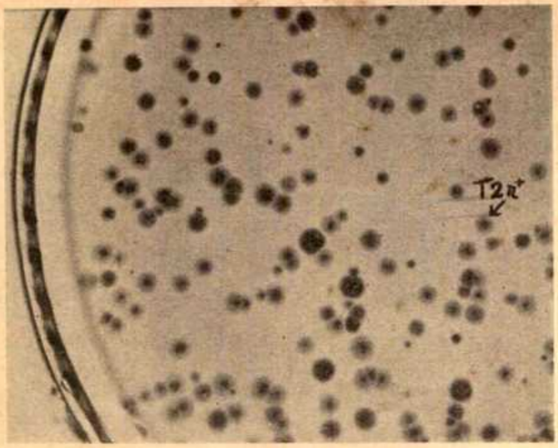

Fig. 1. Infective progeny of $T2r^{+}$ resulting from growth in complete medium plus 5-bromouracil

We have also studied the effects of other uracil derivatives and have found that 5-chlorouracil and 5-iodouracil, both of which are incorporated into phage deoxyribonucleic acid[1], gave yield and mutation patterns similar to those of 5-bromouracil, but that neither 5-aminouracil nor uracil itself produced mutants. In the absence of sulphanilamide, none of the three halogenated uracil derivatives had any mutagenic effect. Only plaque-type mutants have so far been investigated, but these have at times represented as high as 15 per cent of the total infective progeny. A large number of these mutants have been picked and replated three or more times on broth agar, and in almost all cases they kept their mutant identity. These mutants must, therefore, be stable and do not need 5-bromouracil to reproduce.

The appearance of mutants during growth in the presence of 5-bromouracil and sulphanilamide could be attributed either to a mutagenic action or to a selective enrichment of the mutants already present in the original stock at a frequency of 10^{-3}. The latter possibility was eliminated by the following two experiments. First, a one-step growth experiment[3] was performed. *E. coli* B was grown in complete medium plus 5-bromouracil as previously described and then infected in the same medium with one $T2r_2$ phage for every ten bacteria. After phage adsorption, but before lysis, the infection mixture was diluted into first and second growth-tubes containing 10^3 and 10 original phages per ml., respectively, and aliquots from each of the two tubes were plated at intervals before and after lysis. We found that mutant production was optimal when the phages were grown in the presence of at least 10^8 cells/ml. In order to simulate mass culture conditions in this experiment, the dilutions were made into a spent medium, that is, complete medium plus 50 μgm./ml. 5-bromouracil in which *E. coli* B had grown for 3 hr. and from which the bacteria had been afterwards removed by filtration. After lysis we found that while the total number of phages had increased some eighteenfold, the number of mutant phages had increased five hundredfold. To explain this result as due to selection, one would have to postulate a burst of five hundred for each pre-existing mutant. In this medium, however, the mutants were shown to have bursts of the same magnitude as the original stock. The second type of experiment was a single-cell burst experiment[4]. *E. coli* B was again grown as previously described, but this time infected with more than one $T2r_2$ phage per bacterium. After a few minutes, the unadsorbed phages were inactivated by dilution into $T2$ antiserum, and the infected bacteria were further diluted down to a level of about 10 cells/ml. Single drops of this dilution were distributed into each of sixty-six tubes, and after allowing ample time for lysis to occur, each tube was plated separately.

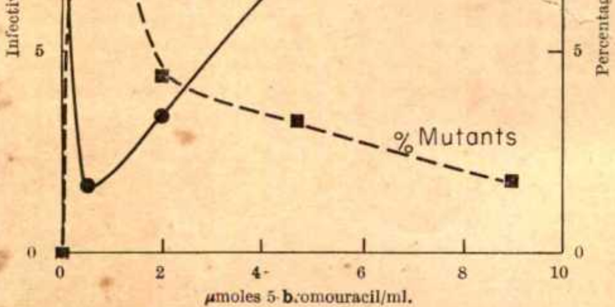

Fig. 2. Pattern of action of complete medium plus 5-bromouracil on phage production and mutation

In this experiment mass culture conditions were maintained by making the dilutions into a culture of 10^8 cells/ml. of uninfected $T2$-resistant *E. coli*, strain *B*/2 growing in complete medium plus 5-bromouracil. The results are given in Table 1. Any pre-existing mutant should have developed into a clone of mutant progeny. This was not observed; rather, of the thirteen plates containing mutant plaques, twelve had one mutant per plate and one had two mutants. The quantity A is calculated from the number of bacteria originally infected with phage. B is obtained from the Poisson formula, $P(O) = e^{-n}$, where $P(O)$ is the proportion of plates containing no plaques, and n is the number of infected bacteria per plate. The ratio of B to A, the fraction of the infected bacteria which released phage, is equal to 1, and therefore every infected bacterium produced infective phage. C is calculated from the number of plates which contain no mutant plaques, again using the Poisson formula. The ratio of C to B is the fraction of infected bacteria which released mutant phage. Since in the original infection mixture only one out of every 10^3 bacteria was infected with a mutant phage, the mutants appearing after lysis from 1 in every 4 bacteria must have arisen through mutation and not selection.

Table 1. SINGLE-CELL BURST EXPERIMENT

No. of plates	No. of plaques/plate	No. plates with mutants
28	0	—
11	1–5	2
13	6–9	4*
9	10–21	4
5	22–85	3
A, infected cells/plate (calculated from input)		0·75
B, infected cells/plate (calculated from Poisson law)		0·86
Ratio of *B* to *A*		1·1
C, infected cells/plate yielding mutants (calculated from Poisson law)		0·22
Ratio of *C* to *B*		0·26

* One plate contained 2 mutants

The mutagenic effect of 5-bromouracil in the presence of sulphanilamide must certainly be connected with a disturbance of deoxyribonucleic acid metabolism or structure. Another instance, in a different system, of mutagenesis resulting from an interference with deoxyribonucleic acid metabolism, more specifically thymine metabolism, is presented in the following communication by Coughlin and Adelberg. The most obvious proposal to explain the mutagenic action of 5-bromouracil is that the incorporation of this base into deoxyribonucleic acid may be directly responsible for the appearance of phage mutants. Both Dunn and Smith[1] and we have found that a large proportion of phages (total phages being estimated from optical density at 260 mμ) containing 5-bromouracil are non-infectious. The amount of thymine replaced by 5-bromouracil seemed to depend on the 5-bromouracil concentration in the medium. We have obtained a phage preparation the thymine of which was completely replaced by 5-bromouracil, but 9 per cent of the total phages still formed plaques of normal and mutant type. As yet, however, no correlation can be made between the amount of thymine replaced by 5-bromouracil and the percentage of mutants among the surviving infective progeny.

Sulphanilamide is known to inhibit methyl transfer by interfering with folic acid formation, consequently reducing the ability of the bacteria to synthesize thymine. But the combination of 5-bromouracil and sulphanilamide has further metabolic effects, not yet clearly defined, on reactions required for pyrimidine biosynthesis. Aside from its incorporation into deoxyribonucleic acid, 5-bromouracil inhibits thymine utilization, is reversed by thymidine competitively, and inhibits uracil formation or utilization.

While at present no definitive mechanism for the mode of action of 5-bromouracil and sulphanilamide can be proposed, it is hoped that further investigations of the biochemical aspects of this system may lead us to a better understanding of the biochemical nature of mutagenesis.

We are grateful to Drs. G. S. Stent, J. D. Smith, E. A. Adelberg, and W. M. Stanley for valuable discussions and suggestions, and to Mr. J. Toby for taking the photograph.

This work was aided by grants from the Lederle Laboratories and the Rockefeller Foundation.

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[2] Herriott, R. M., and Barlow, J. L., *J. Gen. Physiol.*, **36**, 17 (1952).

[3] Adams, M. H., in "Methods in Medical Research" (ed. J. H. Comroe, jun.), **2**, 25 (Yearbook Publishers, Inc., Chicago, 1950).

[4] *Ibid.*, p. 35.

Bacterial Mutation induced by Thymine Starvation

THE phenomenon of 'thymineless death' of *Escherichia coli* strain 15T^-, a thymine-requiring mutant, was discovered by Cohen and Barner[1]. Their experiments demonstrated that these bacteria lose their ability to give rise to colonies following incubation in a thymine-free synthetic medium which supports rapid growth of the prototrophic parent strain *E. coli* 15.

The purpose of this report is to present experiments which indicate that thymine starvation of these organisms has a mutagenic effect on the surviving cells. The effect of thymine starvation on the appearance of new mutants has been studied in the following manner.

The parent strain employed, *E. coli* 15 $T^-H^-N^s$, requires both thymine and histidine for growth and is unable to grow in the presence of 100 μgm. of *nor*leucine per ml. This strain was kindly supplied by Miss Hazel Barner, who isolated it following ultra-violet irradiation of *E. coli* 15T^-. The mutational event chosen for the study of mutagenesis was the one which conferred independence of histidine on the parent strain. An exponentially growing culture was placed under conditions of thymine starvation by washing it twice with distilled water and resuspending it in a 'basic mineral medium'[2] containing 2 mgm. of glucose and 10 μgm. of histidine per ml. At various times, aliquots were withdrawn from the thymine-free medium, chilled and divided into two samples. One sample was plated on broth agar for determinations of viable cell counts. The other sample was washed twice in distilled water and concentrated by centrifugation, then shaken for twenty minutes to free the suspension from clumps of cells. Aliquots of 0·1 ml. of the concentrated cell suspension containing about 1 × 10⁸ cells/ml. were then spread on the surface of agar plates of 'basic mineral medium' containing 2 mgm. of glucose and 2 μgm. of thymine per ml. of washed agar. Colony counts of the presumptive histidine-independent mutants were made after incubation at 37° C. for five days, and random colonies were picked and tested to verify their thymine-dependent and histidine-independent conditions.

The ability of this procedure to recover histidine-independent (H^+) mutants was checked in the following manner. A suspension was prepared containing a known number of H^+ cells, and aliquots of this suspension were mixed with suspensions of histidine-dependent (H^-) cells in various ratios approximating actual experimental conditions. The individual suspensions and the mixtures were washed, concentrated and plated as described above; the results indicated that these procedures afford quantitative recoveries of mutant cells present in predominantly wild-type populations.

The results of a typical experiment are presented in Table 1, where it can be seen that a hundred-fold proportional increase of H^+ mutants appeared among the survivors of 185 min. of thymine starvation. This can be compared with the results of an ultra-violet irradiation of the same parent strain, which yielded a two-fold proportional increase of H^+ mutants among the survivors of a dose killing 98·6 per cent of the cells.

The results in Table 1, however, can be taken as only presumptive evidence of a mutagenic effect of

Table 1. PROPORTIONAL INCREASE IN H^+ MUTANTS DURING THYMINE STARVATION

5·8 × 10^7 cells, genotype $T^-H^-N^s$, suspended in thymine-free synthetic medium at time zero. Conditions as described in text

Minutes thymine starvation	Per cent killed	H^+ mutants per 10^8 viable cells	H^+ mutants per ml.
0	0	22	13
80	56	42	10
140	87	101	8
185	99	2,540	10

thymine starvation, since the absolute number of viable mutants per ml. of suspension did not increase. This could mean that thymine starvation exerted only a selective effect: that is, the H^+ mutants initially present in the untreated population could have survived thymine starvation better than the population at large.

An experiment was therefore performed in which a pure culture of T^-H^+ cells was subjected to thymine starvation. The H^+ cells were found to 'die' at a rate comparable to the rate of 'thymineless death' of H^- bacteria. Nevertheless, the possibility still remained that H^+ cells might behave differently in a suspension of mixed H^+ and H^- cells, where interactions between the two cell types might significantly alter the survival of H^+ organisms. Consequently, a more direct experiment was designed to test the survival of the H^+ cells under conditions simulating those of the actual mutagenesis experiment. For this purpose a small number of H^+ cells was mixed at zero time with a suspension of H^- organisms. The two cell types were distinguished by the presence of genetic markers for *nor*leucine sensitivity (N^s) and *nor*leucine resistance (N^r), respectively. The $T^-H^-N^r$ strain was obtained by plating a washed exponential phase culture of $T^-H^-N^s$ cells directly on synthetic growth medium containing 100 μgm./ml. of *nor*leucine, while the $T^-H^+N^s$ strain was obtained by plating the survivors of 185 min. of thymine starvation on synthetic medium lacking histidine.

The proportion of spontaneous *nor*leucine-resistant mutants in the original suspension of $T^-H^+N^s$ cells was 103 per 10^8 viable cells. However, only 220 cells of the latter type were added per ml. of mixed suspension at the beginning of the experiment, so that the presence of any significant numbers of $T^-H^+N^r$ cells among them was deemed highly unlikely.

A summary of the results of this experiment is presented in Table 2. The surviving numbers of added $T^-H^+N^s$ organisms per ml. of original suspension at any given time during thymine starvation was calculated by subtracting the number of colonies formed on agar containing glucose, thymine and *nor*leucine, from the number of colonies arising on similar medium devoid of *nor*leucine. The validity of this method was verified by picking a random sample of H^+ mutants from the *nor*leucine and minimal plates and testing them for sensitivity to *nor*leucine as well as for histidine independence and thymine dependence. From the data presented in Table 2 it can be seen that all the $T^-H^+N^s$ cells added at the beginning of the experiment were eliminated from the population after 225 min. of thymine starvation, establishing that a selective mechanism favouring the preferential survival of histidine-independent cells is not operative during our experimental conditions. Hence the substantial increase in the proportion of $T^-H^+N^r$ mutants can best be explained as resulting from an induction of new mutants.

Table 2. THYMINE STARVATION OF $T^-H^+N^s$ CELLS IN MIXED SUSPENSION WITH $T^-H^-N^r$ CELLS

Cells of type $T^-H^-N^r$ mixed with cells of type $T^-H^+N^s$ at time zero to give final cell densities of 6·2 × 10^7 and 220 per ml., respectively. Details in text

Per cent H^-N^r cells killed	H^+N^r mutants per ml.	H^+N^r mutants per 10^8 viable cells	H^+N^s mutants per ml.
0	53	86	220
13	7	14	—
50	20	65	82
76	50	345	1
92	59	1,162	0

It may also be noted in Table 2 that while the $T^-H^-N^r$ cells undergo a 13 per cent reduction in viable cell count due to thymine starvation, the $T^-H^+N^r$ cells are reduced from 53 per ml. to 7 per ml.: a reduction of 87 per cent. This disproportionate death of H^+ mutants which have arisen spontaneously in a growing culture of H^- cells has been observed repeatedly in the early stages of thymineless death, and is probably a consequence of the multinucleate condition of the bacteria and the dominant nature of the H^+ condition[3]. If the loss of viability due to thymine starvation is the result of random nuclear inactivation, as indicated by the work of Fuerst and Stent[4], then a bacterium would die only after all its nuclei had been inactivated. An H^+ mutant, on the other hand, would effectively disappear from the population following inactivation of only those nuclei specifically carrying the H^+ mutant character. If a significant proportion of the H^+N^r bacteria were heterokaryotic with respect to the H^+ genotype, bacterial cell 'death' would not be equivalent to mutant or nuclear 'death'. Hence in the initial stages of 'thymineless death', where the majority of the bacteria are presumably in a multinucleate condition, the mutant (H^+) count would decrease at a faster rate than the viable count.

It should be noted that in the reported experiments no provision was made for the delayed expression of mutation, since the washed cells were plated directly on media devoid of histidine. Indeed, the results of one experiment in which the survivors were plated on limiting amounts of histidine showed that only a fraction of all the induced mutants is recovered with our standard procedure. The true number of induced mutants is, therefore, greater than that indicated by the figures in the tables.

Any explanation of the causative mechanism for the reported mutagenesis would be strictly speculative at present. It is of interest, however, that Dunn and Smith[5] have reported an increased appearance of the base 6-methylaminopurine in the deoxyribonucleic acid of strain 15T^- under conditions of limiting thymine, and the relation of the metabolism of this base to the mutagenic activity of thymineless death is now under investigation.

The experiments of Litman and Pardee (see previous communication) have indicated a correlation between appearance of coliphage mutants and interference with deoxyribonucleic acid metabolism. From our experiments it might also be inferred that bacterial mutation can be a consequence of disrupted deoxyribonucleic acid metabolism. For the moment, however, we can conclude only that the state of specific thymine starvation is mutagenic in *E. coli* for the one phenotypic property studied.

This work was supported by the Division of Biology and Medicine of the U.S. Atomic Energy Commission and by a grant from the National Science Foundation.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

The Sun's General Magnetic Field

SOME of the recent theoretical discussions of the magnetic field of the Sun have tended to throw the subject into a state of confusion[1–3]. In particular, H. Alfvén[3] asserts that ". . . it is at present impossible to derive a value of the sun's general magnetic field from spectroscopic measurements", and that "quite without justification it is assumed that Zeeman-effect measurements give an accurate value of the solar magnetic field".

Such a statement is in conflict with the published observations of weak solar magnetic fields, and of the discussion that has been given to these observations[4]

Alfvén begins with the not unreasonable assumption that in the turbulent photosphere there is equipartition of energy between the kinetic and the magnetic modes. He argues that the intensity of the spectral line in which the Zeeman effect is measured s a function, f, of density, ρ, and temperature, T, and that in the granules ρ, T and the magnetic field H are coupled, so that "it is not at all likely that the average Zeeman effect gives an average of the magnetic field". Alfvén assumes (apparently on the basis of a particular theory of the origin of sunspots) that there is a general field H_0 of the order of 10 gauss. This is superimposed on the turbulent field H_t, so that in some parts of a granule the resulting field is $H_0 + H_t = + 10 + 300 = + 310$ gauss, whereas in other parts of it the field is $H_0 - H_t = + 10 - 300 = - 290$ gauss. The average then depends on the function f (ρ, T) and the way in which ρ and T are coupled with H. If f is systematically smaller for positive values of H_t than for negative values, 'the measured H_m may very well be negative even f the real field H is positive, and its absolute value may differ by orders of magnitude". Hence, accordng to Alfvén, "no conclusion can be drawn about the general magnetic field from the Zeeman-effect measurements and the results of these measurements are not relevant".

I believe that Alfvén greatly over-estimates the mportance of the possible coupling of H with line ntensity, and that his conclusion may readily be refuted by consideration of the published observaions.

According to Alfvén's argument, the systematic effect of f and the way in which ρ and T are coupled with H should provide a large bias (probably subject to a centre-to-limb effect) underlying the much maller true field. But the measurements of the Zeeman effect are absolute, and they show no trace f bias. Vast areas of the Sun, and occasionally, near sunspot minimum, the greater part of the solar disk, how no observable field distinguishable from zero. The limit is about 0·5 gauss for the 'noise' peaks, nd much lower for any possible bias.

A further very significant result that was brought ut in the discussion of the extensive series of observaions with the solar magnetograph concerns the measred magnetic fields of bipolar magnetic (BM) regions, which exhibit a vast range of total magnetic flux. The large bipolar magnetic regions, while young, characteristically contain leading and following sunspots of opposite polarity. For such spots, G. E. Hale[5] established the well-known laws of magnetic polarity that pertain to the N- and S-solar hemispheres and to the alternation in successive 11-year sunspot cycles. As we have indicated, well-defined bipolar magnetic regions have approximate equality of positive and negative flux in the respective parts; the observations substantiate the concept of a localized loop of a submerged toroidal field rising above the surface, as suggested by Cowling[6]. Now in the N- or S-hemisphere of the Sun, in a given sunspot cycle, the same relative polarity of leading and following parts of all well-defined bipolar magnetic regions is exhibited over the whole range of magnetic intensity, from the very strong, spotted bipolar magnetic regions ($H \approx 3{,}000$ gauss) down to those (unspotted) of minimal size having average field intensities of only one or two gauss. Furthermore, weak bipolar and unipolar magnetic (UM) regions are frequently identifiable and measurable for days or weeks as they are carried across the disk by the solar rotation, even though they may be surrounded by vast areas having no outstanding field.

This disposes completely of the idea that the turbulent field of the granules systematically reverses, or appreciably biases, the measured Zeeman effects of weak magnetic regions on the Sun.

If, then, the polarity and approximate magnetic intensity of weak bipolar magnetic regions can be reliably observed, there is no reason for doubting the observations of weak fields, consistently positive near the north pole, negative near the south pole, that constitute the 'general' magnetic field of the Sun. After correction for darkening at the limb and for the presumed projection factor, the average intensity of the general field near the poles has been stated to be of the order of one gauss[4]. This is an order of magnitude weaker than the field required by Alfvén's theory of sunspots, and as Alfvén states, his solar model "seems to be in striking conflict with the Zeeman-effect measurements if these are interpreted in the naive way as really measuring an average field". Since there is as yet no generally accepted theory of the magneto-hydrodynamic effects in solar granules, and since it would appear that such a theory, when finally perfected, will probably lead to rather minor refinements of the measured field intensities when averaged over large regions, we may have to continue with the present interpretation of the observations.

It may be mentioned that a second solar magnetograph[7], incorporating certain technical improvements and operating with the advantage of the better sky of Mount Wilson as compared to Pasadena, confirms the existence and polarity of the weak polar fields of the Sun previously reported.

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Determination of Changes in the Dimensions of the Earth from Palæogeographical Data

Essentially, there are two opinions concerning the volume of the Earth: (1) its volume is decreasing, that is, the Earth is shrinking; (2) its volume has remained practically constant during geological times.

Geological observations have clearly established that the volume of the hydrosphere has grown throughout the geological past; the increase, however, has not been more than about 4 per cent of the whole volume since early Cambrian times.

In the case of a shrinking Earth, the average depth of the oceans must have increased. As a consequence of the higher sea-level, the area of the continents covered by sea water should be increasing.

If the volume of the Earth has remained constant, the amount of water-covered areas is influenced only by crustal movements and, on average, it should oscillate about a constant value.

The problem of the constancy or otherwise of the volume of the Earth can be solved, therefore, on the basis of palæogeographical data. We have only to establish the amount of the areas covered by sea water in different geological ages: a definite increase in the average values means a shrinking Earth, whereas their constancy indicates that on balance the volume of the Earth has not appreciably changed.

Fig. 1 represents the water-covered continental areas computed from the palæogeographical maps of T. M. Strahow; Fig. 2 is a similar diagram compiled from thirty-four palæogeographical maps recorded by H. Termier and G. Termier.

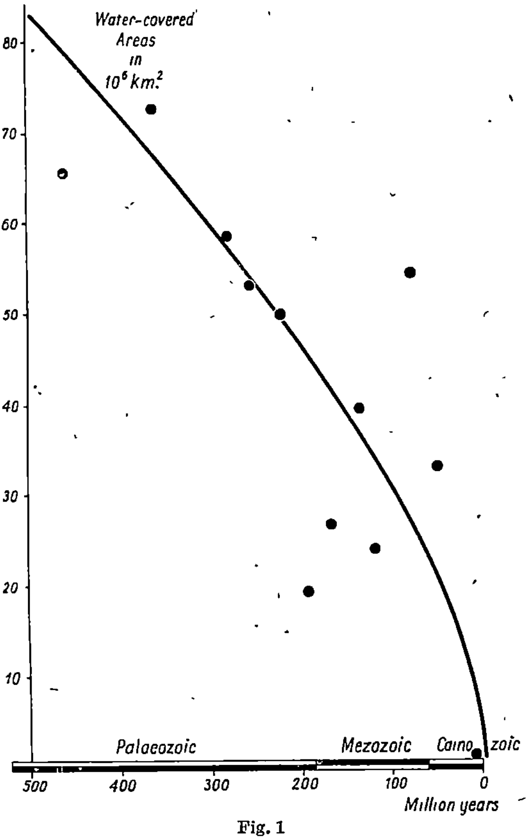

Fig. 1

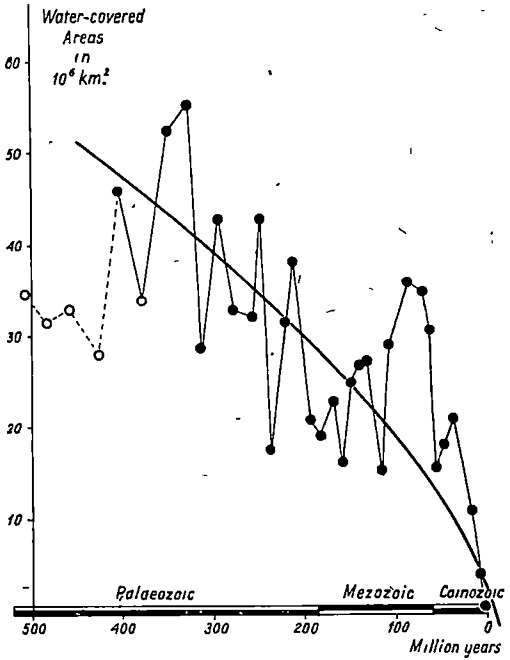

Fig 2

In both diagrams the data plotted show a definite decrease in the course of the geological ages, indicating that there has been a cumulative increase of the radius of the Earth. Indeed, palæogeographical data provide evidence for the hypothesis that the Earth has expanded.

Figs. 1 and 2 can be used for giving the average rate of increase of the radius of the Earth, assuming that, on average, the hypsographic character of the Earth has remained the same since early Palæozoic times. Fig. 1 yields a radius increase of 0·66 mm./year; Fig. 2, compiled from the Termiers' data, gives 0·4 mm./year.

It is concluded that the annual increase of radius, according to palæogeographical data, has averaged about 0·5 mm./year during the past 500 million years.

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Magnetic Perturbation of the Lowest Triplet States of Aromatic Molecules by Dissolved Oxygen

The absorption spectrum of benzene in the region 2795–3650 A. has been measured by Miss Pitts[1]. She observed a shoulder at approximately 2900 A. which has been tentatively assigned by Pariser[2] as a transition to a ${}^3E_{1u}$ state. Since it had been shown that oxygen dissolved in benzene absorbs strongly in this region[3], the spectrum has been re-investigated using pure benzene saturated with air or with nitrogen A Beckman Model *DU* spectrophotometer with 5-cm. silica cells was used, and the results obtained are shown in Fig. 1. No shoulder around 2900 A. can be detected, although in most other respects the curve for air-saturated benzene is in reasonably good agreement with that of Miss Pitts. The absorption

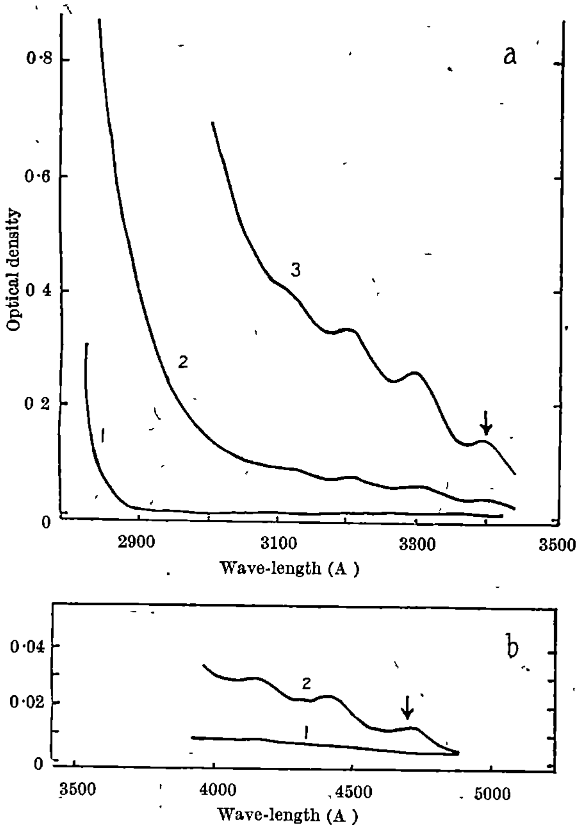

Fig. 1. (*a*) Absorption of liquid benzene saturated with (1) nitrogen; (2) air; (3) oxygen. (Blank—'Spectroscopic' methyl cyclohexane.)
(*b*) Absorption of naphthalene (2·8 *M* in ethylene dichloride) saturated with (1) nitrogen; (2) oxygen; and measured in a 5-cm. cell (Blank: A solution of methyl cyclohexane in ethylene dichloride.)
All measurements at approximately 22° C. Arrows indicate the position of the shortest wave-length phosphorescence bands (ref. 4)

spectrum of the pure compound at room temperature therefore seems to provide no evidence for a triplet-level of benzene at about 34,000 cm.$^{-1}$.

A striking effect was, however, observed at longer wave-lengths. The well-established[1,4] 'triplet'-bands around 3300 A. disappeared when the dissolved atmospheric oxygen was replaced by nitrogen. Conversely, they appeared much more strongly in benzene saturated with pure oxygen (see Fig. 1*a*). There is little doubt that these bands are in fact due to a transition to a triplet state (probably ${}^3B_{1u}$[2]). Thus they show the usual approximate 'mirror image' relationship with the phosphorescence bands[4]. (The absorption band at 3507 A. reported by Miss Pitts had not been observed previously, and was not found in the present work, even when 10-cm. cells were used.) The effect of the dissolved oxygen may accordingly be attributed to spin-orbit perturbation of the triplet-level by the inhomogeneous field of the paramagnetic oxygen molecule. (Oxygen dissolved in benzene has its normal paramagnetic susceptibility[5].) That magnetic perturbation of higher singlet–triplet transitions might be responsible for the principal absorption shown by oxygen dissolved in aromatic solvents was originally considered by Kasha (personal communication). A magnetic perturbation of a singlet–triplet transition has previously been observed in emission by Yuster and Weissman[6], who found that the phosphorescence life-time of the gadolinium complex of dibenzoyl methane was about 1/50 of that expected from the life-times of the lanthanum and lutetium complexes. Since a saturated solution of oxygen in benzene is approximately 11 *M* with respect to benzene, and only 0·008 *M* with respect to oxygen, the perturbing effect of the oxygen molecule is very much greater than that of the gadolinium ion, in spite of its smaller magnetic moment. Weak (possibly collisional type) complex formation probably takes place between benzene and oxygen, but it is unlikely that this alone will appreciably increase the singlet–triplet probability.

It is clear that the unperturbed singlet–triplet bands of benzene must be considerably weaker than has been previously supposed. This is supported by the long phosphorescence life-time of the benzene triplet[4].

Similar effects have also been observed for naphthalene, where the singlet–triplet bands in absorption were located for the first time (Fig. 1*b*). Magnetic perturbation by oxygen (possibly under pressure) may therefore, in certain cases, be a useful alternative to the heavy-atom technique[4] for detecting and confirming triplet-levels of aromatic molecules. The triplet-level of bromobenzene is already considerably perturbed by the heavy bromine atom, and very little change in the well-defined triplet absorption band was observed on saturation with oxygen.

Finally, it may be noted that the above results support the suggestion[7] that the quenching effect of oxygen (and nitric oxide) on the fluorescence of aromatic hydrocarbons is due to a magnetic perturbation which facilitates the excited singlet–triplet radiationless transition.

I wish to thank the University of Oxford for an I.C.I. Research Fellowship.

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Pitch of Inharmonic Signals

IT is well established that a sound consisting of adjacent harmonics is perceived as having the pitch of the fundamental frequency. This pitch is to be attributed to a component of subjective perception, that is, the combined impression of some or all of the tones presented. Such a component, which is not susceptible to further aural resolution, is called a residue[1].

This phenomenon has been studied by the use of an amplitude-modulation method which permits the production of inharmonic signals as well. A pure-tone carrier A_x is modulated by a signal consisting of N components with frequencies B_x, $2B_x$, etc. The modulator produces a signal containing the carrier and the upper and lower side-bands. The components are equidistant but not necessarily harmonic.

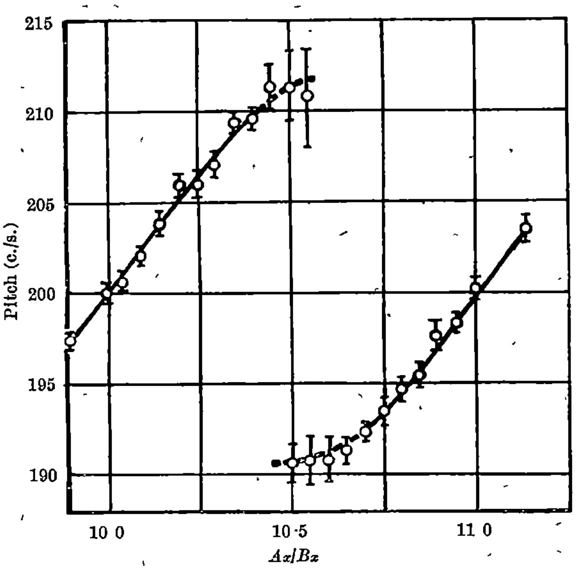

Fig. 1. Pitch versus carrier frequency. Modulation frequency 200 c./s.

It is observed that such 'coherent' inharmonic signals sound as stable and smooth as harmonic signals. The pitch has been determined by alternating the signal (X) with a harmonic signal (S) of adjustable fundamental frequency. The comparison signal (S) is produced by the same method as (X), the modulation frequency B_S being synchronized by the carrier A_S. The listener is then asked to vary the frequency A_S (which causes a corresponding variation of B_S) until the sounds (X) and (S) have the same pitch. The pitch-level of (X) is then the frequency B_S.

A typical result showing the dependence of pitch on the carrier frequency is shown in Fig. 1. In this experiment B_x has been kept constant. From Fig. 1 it will be noticed that the pitch increases with increasing carrier frequency. The relative variations of pitch in the neighbourhood of a harmonic situation are slightly larger than the relative variations of the carrier frequency. Midway between two harmonic situations, the pitch is indeterminate. The point exactly half-way is characterized by the component frequencies being odd multiples of half the modulation frequency. Careful listening reveals no trace of a pitch corresponding to $\frac{1}{2}B_x$, notwithstanding the low tonality of the sound.

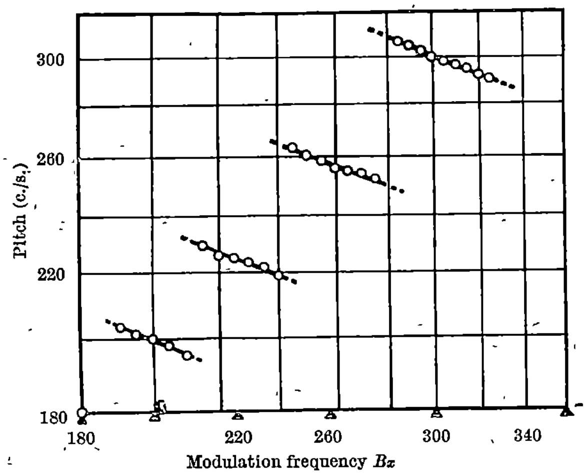

Fig. 2. Pitch versus modulation frequency. Carrier frequency 1,800 c./s.

When the pitch in the neighbourhood of a harmonic situation is exactly proportional to the carrier frequency, the pitch should be independent of the modulation frequency. The deviations from proportionality were therefore isolated in a second experiment in which the modulation frequency is varied. Fig. 2 shows a typical result of an experiment with constant carrier. Around a harmonic situation, the pitch drops with increasing modulation frequency B_x. The graph is again composed of several branches that are centred around harmonic situations and separated by regions of doubt.

A coherent inharmonic signal repeats itself over a much longer time than the period of the modulation signal. In the experiments, no beats due to the inharmonicity are observed, as long as the components of the stimulus are perfectly equidistant. This means that, when the envelope of the wave-form is constant, the tone quality of the residue is not affected by variation of phase or frequency of the fast oscillations within the envelope (which are determined by the carrier). In experiments that involve a change of the envelope, for example, by using an incoherent modulation signal, the residue quality is found to be affected[2].

It seems that the tone quality of the residue is greatly determined by the envelope of the signal, and the pitch by the 'fine-structure'. This simplified separation of phase and pitch effects is manifest in nearly all cases, except when the signal approaches the frequency-modulation condition[3].

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Cleavage Fracture of Bismuth Single Crystals

EARLIER work[1] on the tensile stress necessary to cause cleavage fracture in zinc single crystals has shown that Sohncke's law was not obeyed. (Sohncke's law states that a crystal will break when the stress normal to the cleavage plane reaches some critical value). However, it is clear from the literature[2] that for some metal single crystals, notably bismuth, antimony and tellurium, Sohncke's law is obeyed. A study of the cleavage fracture of bismuth crystals was therefore undertaken in an attempt to discover the underlying cause of the difference of behaviour of zinc and bismuth.

The bismuth used contained 0·008 per cent lead; 0·0046 per cent tin; 0·0040 per cent iron; 0·0024 per cent antimony; 0·0018 per cent arsenic; 0·0015 per cent copper; 0·0015 per cent sulphur. It proved impossible to extract single crystals grown in precision-bore tubes without causing mechanical twins, and a technique for growing single crystals from a metal rod was developed from a method described by Noggle[3]. A moist mixture of alumina with an alumina clay bond was rammed around a poly-

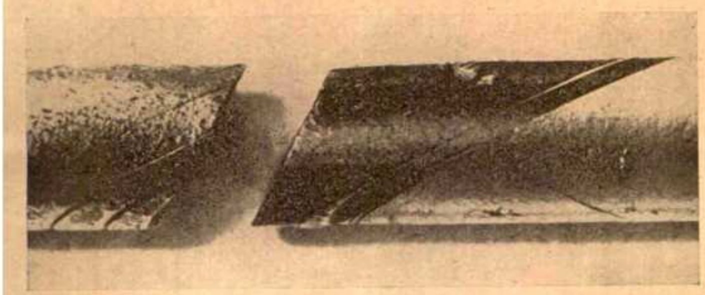

Fig. 1. Fractured bismuth crystal, illustrating crystallographic difference between cleavage and composition planes. × 3

crystalline rod to form the mould and, after drying, the single crystal was then grown. The mould material powdered very easily and the single crystal could be extracted without damage. The crystals used were about 7 mm. in diameter and at least 60 mm. long.

The crystals were orientated by the Laue back-reflexion method. The rhombohedral lattice of bismuth is very nearly face-centred cubic, and high accuracy of angular measurements is necessary to distinguish a (111) plane with certainty from a $(11\bar{1})$. (Both types of planes are possible cleavage planes.) The necessary angles and method used are to be published elsewhere. As yet, it has not proved possible to grow crystals of all orientations, and tensile tests have so far only been carried out on crystals with χ_{111} (the angle between the (111) plane and the longitudinal axis of the crystal) between 0° and 35°. Before the tensile test, all crystals were first etched and examined carefully for any signs of twins; generally none was visible. They were then electro-polished. The tensile tests were carried out at room temperature, the load being applied as axially as possible. In two of the crystals there were signs of twins developing as the load was increased to fracture; the behaviour of the other crystals gave no cause for suspecting the development of twins during the increase of load. But all crystals were etched after fracture so that the position of any twins could be observed.

This etch revealed a totally unexpected feature which apparently has not been noted in the earlier work on bismuth single crystals. The cleavage fracture did not, as in zinc, separate two parts of the specimen with the same lattice orientation, but was a plane separating a large twin from the original matrix. Fig. 1 shows clearly that on one side of the fracture there is a large twin extending completely across the crystal diameter. The other side of the fracture is almost entirely the original matrix, although there are one or two small twin lamellæ.

The crystallographic nature of the planes of the cleavage has been established as the $(11\bar{1})$ plane in the matrix and (111) plane in the twin. This is not the same as the normal composition plane of the twin and matrix, the (110). The difference between the two planes is obvious in Fig. 1. Thus, while the phenomenon resembles the 'parting' phenomenon in calcite[4], there is a difference in that the latter occurs at the twin/matrix composition plane. Zappfe[5] has seen the development of cracks between twins and matrix in bismuth–antimony alloys, which he describes as 'parting' on the twin matrix composition plane. But since he was working on polycrystalline material, crystallographic identification was difficult and the phenomenon may have been the same as that described here. Cahn[6] has found evidence of the existence of 'parting' in uranium; but he also could not examine the matter in any detail because of experimental difficulties.

The tensile stresses necessary to cause fracture in the crystals have been measured. There is a considerable scatter in the results, probably associated with the small amount of plastic deformation before fracture, usually less than 6 per cent. However, it is clear that the resolved stress perpendicular to the cleavage plane is approximately constant for all the twenty-six crystals breaking between twin and matrix, the average value being 583 gm./mm.^{2}. This is somewhat lower than the value of 695 gm./mm.^{2} determined by Wassermann[7] for 4-mm. diameter crystals of similar orientations.

It was found that in all the above twenty-six crystals the resolved stress across the most favourably orientated twin plane and in the twin direction exceeded the critical value for the growth of twins, as determined by Gyndyn and Starsev[8]. Four crystals did not show this phenomenon of separation as described above, but broke by a true cleavage on either a (111) or a $(11\bar{1})$ plane. In three of these four crystals the applied stress was not great enough to cause a twin to grow. It was interesting to note that in these crystals also the resolved stress perpendicular to the cleavage plane was less than in the main group of crystals.

Our thanks are due to Messrs. Mining and Chemical Products, Ltd., for the gift of the bismuth used in this work.

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Detection of Iodine-containing Substances on Paper Chromatograms

THE most sensitive chemical method of detection of iodine-containing substances on paper chromatograms is the application of the ceric sulphate–arsenious acid reaction[1]. By the use of this method the iodine-containing substances are indicated by white spots on a yellow background. Fletcher and Stanley[2] obtained white spots on a brown background by spraying such chromatograms with 1 per cent *o*-phenylenediamine in acetone.

We added ferroine to the ceric sulphate–arsenious acid reagent to make up the final concentration of this compound to 0·01–0·0066 M. The technique of detection was the same as that described by Bowden *et al.*[1]. By using this method we have obtained red spots on a blue background. This contrasting colour reaction is stable for approximately 48 hr., and may be registered simply by direct photography.

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Detection of Triterpenoid Glycosides on Paper Chromatograms

IN the course of our investigations of *Echinocystis lobata* seeds, it became desirable to locate triterpenoid glycosides on paper chromatograms by means of a colour reaction. A modification of the Liebermann–Burchard test described by Neher and Wettstein[1] was unsatisfactory for this purpose. We found that the original Liebermann–Burchard reaction applied to paper chromatograms with comparatively little alterations gave more satisfactory results, permitting a reliable detection of the spots.

The procedure is as follows. The dried paper chromatogram is placed on a glass plate and sprayed with a mixture of equal volumes of chloroform and acetic acid anhydride. A thin layer of concentrated sulphuric acid is spread on a glass plate and the treated filter paper strip laid on it. Additional sulphuric acid is smeared on the top of the strip with a glass rod. After a few minutes, the triterpenoid glycosides develop red-coloured spots. The starting line and the front, as well as the spots, can be marked on the other side of the glass plate in order to obtain the R_F values. This has to be done before the paper is destroyed by the sulphuric acid. Using Whatman No. 1 paper, after 15 min. the destruction is so far completed as to prevent the precise measurement of distances. The sensitivity of the test can be increased by examination of the chromatogram in ultra-violet light. The spots show orange fluorescence. In Table 1 are collected results, observed with pure echinocystic acid glycoside, isolated from *Echinocystis lobata* seeds. Similar results are obtained with methanolic extracts from the seeds.

The presence of the usual plant constituents (for example, oligosaccharides and amino-acids) does not interfere with the reaction. This method has been applied to the detection of triterpenoid compounds of several plants known to contain triterpenes[3]. Ethanolic extracts (70 per cent v/v) were chromatographed with butanol/acetic acid[2] and the chromatograms treated as described above. The results are shown in Table 2.

Table 1. PAPER CHROMATOGRAPHY OF ECHINOCYSTIC ACID GLYCOSIDE

Solvent	R_F	Sensitivity in visible light	Sensitivity in ultra-violet light	Paper
Butanol/acetic acid according to Partridge (ref. 2); descending	0·36	10γ	1γ	Whatman No. 1
Ethyl acetate with 0·08 addition of 1·5 per cent acetic acid and 2 per cent methanol, saturated with water until slight cloudiness appears ; ascending	0·08	10γ	1γ	Whatman No. 1

Table 2. PAPER CHROMATOGRAPHY OF EXTRACTS FROM TRITERPENE-CONTAINING PLANTS

Plants	Solvent	R_F of glycoside	Paper
Callendula off.	Butanol/acetic acid according to Partridge (ref. 2)	0·8	Whatman No. 1
Arnica montana		no definite spot*	
Tussilago farfara		0·18 and 0·65	

* A coloured trail along the strip from the start to the front.

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Separation of Pyridine Mono-Carboxylic Acids on Paper Chromatograms

CHEMICAL methods using cyanogen bromide and aromatic amines[1-3] (König reaction) and an acid-indicator[4] for the detection of pyridine carboxylic acids on paper chromatograms have been reported. But the toxic character of cyanogen bromide causes difficulty ; and it has been observed that good spots with acid-indicator are often not produced, particularly when the acid concentration is very low. A very convenient method has been found for detecting these acids on the filter paper by spraying with a solution containing cupric ions followed by benzidine; also their efficient separation from the mixture has been achieved.

In our experiments α-, β- and γ-pyridine carboxylic acids were used individually or as a mixture. The paper (Whatman No. 1 ; 15 cm. × 24 cm.) after development (ascending technique) for 4–6 hr. at 30 ± 0·5° C. with the solvent (as described in Table 1) was completely dried by a current of hot air. It was next sprayed with a 0·2 per cent solution of copper sulphate (anhydrous) in a water–ethanol mixture (5 : 4, by vol.) and dried carefully in an oven kept at about 60° C. The dried paper, on spraying with a 0·1 per cent solution of benzidine in 50 per cent ethanol, revealed well-defined bluish spots against a light-brown background. 10–15 μgm. of each component acid could be separated and detected on the chromatogram.

Copper salts, for example, sulphate, chloride, acetate, etc., have been employed as detection reagents ; but copper sulphate has given the most satisfactory result. Butanol with a mobile phase acidified with acetic acid gives the best separation and also raises the respective R_F values when compared to butanol alkalized with ammonia[1]. The other solvent systems studied produced high R_F values but contributed little towards resolution. Better results are given when the chamber is maintained fully saturated with respect to the solvent system.

Table 1. R_F VALUES OF PYRIDINE CARBOXYLIC ACIDS

Substance	Solvent			
	n-Butanol/acetic acid/water (4 : 1 : 1)	*n*-Butanol saturated with 1·5 *N* ammonia	*n*-Propanol conc. ammonia water (20 : 1 : 4)	Phenol saturated with water
Picolinic acid	0·63	0·15	0·57	0·56
Nicotinic acid	0·89	0·21	0·61	0·88
*iso*Nicotinic acid	0·76	0·22	0·67	0·90

We wish to thank Prof. S. K. Bhattacharyya for his interest and encouragement. Our thanks are also due to Messrs. Sarabhai Chemicals for a gift of *iso*-nicotinic acid.

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A Simple Method of *Rh* Determination

IT has been shown that about 0·5 per cent of human sera possess a thermostable factor agglutinating *O Rh*+ red cells sensitized with anti-*D* antibodies. Only those sera were taken into account which agglutinated sensitized red cells at least in 1 to 8 dilution in saline. Weaker sera gave unreproducible reactions. The strongest serum observed had a titre of 128. According to our experiments[1], the agglutinating factor in the sera observed is an antiglobulin antibody. It may be absorbed from the sera by sensitized red cells and it may be neutralized in the sera by incomplete antibodies regained at 56° C. from cells. This antiglobulin antibody reacts only with immune antibodies after their denaturation in serological reaction, and therefore it is not neutralized by normal serum or by immune serum containing unchanged antibodies (Fig. 1). The discussion on the nature of this antibody and on its eventual role in pathology will be given elsewhere. Here we wish to stress the practical application of our findings.

(1) A 3 per cent suspension of red cells sensitized with incomplete antibody was tested with human antiglobulin sera. Cells sensitized with all anti-*D* sera gave strongly positive reactions. Tests performed with other incomplete antibodies gave various results depending only upon the strength of the sensitization and not upon the specificity of antibody used. Since the human antiglobulin antibody is not neutralized by serum proteins (other than denatured antibody) the washing of sensitized cells can be omitted.

(2) *Slide agglutination test with mixed serum.* All the incomplete sera may be easily changed into saline agglutinating sera simply by mixing with human antiglobulin sera. After preliminary experiments, the following technique was adopted. Undiluted antiglobulin serum is mixed in equal proportions with undiluted incomplete anti-*Rh* serum. To one drop of mixed serum on a slide is added one drop of 3 per cent saline suspension of red cells with corresponding *Rh* antigen. The slides are allowed to stay in a wet chamber at room temperature for 20–30 min., after which clear-cut results are obtained. The agglutination is a very firm one and does not disappear after vigorous shaking.

In this manner fifteen anti-*D*, three anti-*c*, one anti-*C* and one anti-*e* incomplete sera have been tested. In all cases the mixed serum gave the expected reactions. The controls with cells of non-corresponding *Rh* types were always negative. The titre of a mixed serum was 4–16. The mixed serum can be stored frozen for at least five months. This method of *Rh* determination is much simpler than any other used.

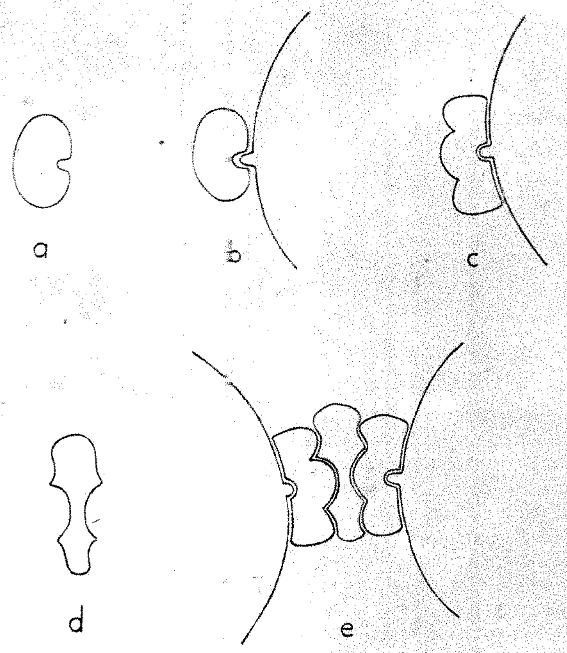

Fig. 1. (*a*) Incomplete antibody; (*b*) serological linkage with red cells; (*c*) denaturation of the antibody molecule in reaction with antigen; (*d*) human antiglobulin antibody; (*e*) agglutination of sensitized red cells

(3) *Antiglobulin test with platelets.* The chief difficulty in carrying out the antiglobulin test with platelets (and also leucocytes) is the necessity of saline washing, which causes clumping of these cells. With our human antiglobulin sera, washing can be omitted. Our preliminary experiments are promising.

While our investigation was in progress, we saw the interesting paper in *Nature* of Lewis and Chown[2]. It is now clear that these authors were using a very weak human antiglobulin sera. Therefore they obtained agglutination with mixed sera and could produce this phenomenon only with some anti-*Rh* sera. The negative results with sensitized cells made impossible a correct interpretation of the results.

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Carnosine Phosphate as Phosphate Donor in Muscular Contraction

CARNOSINE phosphate was first synthesized by Severin, Georgievskaya and Ivanov[1] by a method very similar in detail to that for creatine phosphate[2]. They showed that this method yields as a rule a diphosphate, both phosphate bonds being high-energy; but that the one which is not on the imidazole ring is more labile. In the presence of muscle extract the latter is transferred to adenosine diphosphate.

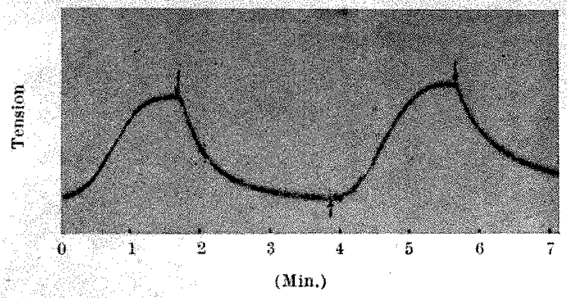

Fig. 1. Isometric tension of extracted muscle fibre in solution containing carnosine phosphates equivalent to 30 millimoles of phosphorus and 4 millimoles of magnesium chloride. ↑ pH 7, ↓ pH 6

In another direction it has been shown by a number of workers[3-5] now that transphosphorylation to adenosine diphosphate is an essential, though not in itself sufficient[6], part of the relaxation mechanism in muscle. Furthermore, the possibility of an unidentified phosphate donor has been noted[7] in connexion with the failure to observe an increase of adenosine diphosphate during a muscle twitch.

Carnosine phosphate was prepared by the method of the Russian workers. The measured N/P showed that a 50 per cent mixture of di- and mono-phosphates was obtained. A solution containing 30 mM phosphorus final concentration was tested by the method of Goodall and A. G. Szent-Györgyi[8] for the relaxing action of creatine phosphate on the glycerol-extracted muscle fibre. The results indicated in Fig. 1 show an effect practically identical with the latter.

The result strongly supports the claim of the Russian workers and raises the question of the presence and role of this substance in muscle. All muscles contain carnosine or anserine (in which the less labile phosphate site is occupied by methyl) in amounts up to 20 mM. It was noted in the course of phosphorus-determination that carnosine phosphate is much more acid-labile than creatine phosphate. This may account for its non-detection in muscle so far.

This work was aided by a grant from Muscular Dystrophy Associations of America, Inc., to Dugald E. S. Brown.

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Appearance of Serine upon Alkaline Incubation of Iodinated Polytyrosine

3,5-DIIODOTYROSINE is known to be a precursor of thyroxine[1,2]. The formation of thyroxine from two diiodotyrosine residues leads obviously to the formation of a three-carbon α-amino-acid. Thus simple dismutation would lead to alanine[2,3], while an oxidative mechanism involving the formation of a labile intermediate of quinonic structure should yield serine[1,2,4]. In the latter case, serine could be formed either by the direct hydrolysis of the labile intermediate[4], or by the hydration of dehydroalanine formed upon molecular dissociation of the labile intermediate[1]. If the unsubstituted 3,5-diiodotyrosine is used in the reaction, dehydroalanine formed may also be hydrolysed to pyruvic acid and ammonia. Johnson and Tewkesbury identified these two products in their reaction mixture[4]. Pitt-Rivers identified alanine among the products of the aerobic incubation of N-acetyl-L-diiodotyrosine chromatographically, but stated that alanine could have been formed afterwards from pyruvic acid[5].

Iodinated polytyrosine was chosen for the re-investigation of the products of alkaline incubation of diiodotyrosine present in a peptide chain. The high-molecular weight compound seemed suitable for this purpose, as it was expected that the high local concentration of diiodotyrosine residues in the macromolecule might facilitate the reaction between the residues. Furthermore, the protection of both the carboxyl- and the amino-group of 3,5-diiodotyrosine is known to increase the yield of the reaction[2,5].

Poly-L-tyrosine[6] (number average degree of polymerization 30) was iodinated with 0·2 mole of iodine per mole of tyrosine residue, using the iodination technique described previously[6]. The iodinated polymer was hydrolysed with 6 N barium hydroxide for 8 hr. at 120°, and the barium was removed as barium sulphate. A paper chromatogram (n-butanol/glacial acetic acid/water, 25 : 6 : 25) of the hydrolysate showed on spraying with ninhydrin three spots, identified as tyrosine, monoiodotyrosine and diiodotyrosine.

A 1 per cent solution of the iodinated polymer in a bicarbonate buffer pH 10·2 was incubated at 37° for a week. The polymer was precipitated with hydrochloric acid and hydrolysed as above. Paper chromatograms (n-butanol/glacial acetic acid/water, 25 : 6 : 25) of the hydrolysate showed on spraying with ninhydrin six spots: the three original spots (tyrosine with R_F 0·36, monoiodotyrosine with R_F 0·58 and diiodotyrosine with R_F 0·66), as well as three new spots, one with R_F 0·17 travelling identically with serine, one with R_F 0·80 travelling identically with thyroxine or 3,5,3′-triiodothyronine, and a faint spot with R_F 0·73. Alanine moves in the chromatographic developer mixture used with R_F 0·23, and in a mixture of alanine with the hydrolysate investigated the spot of alanine could be clearly separated by chromatography from the spot corresponding to serine. Treatment of the chromatogram of the hydrolysate with cerium sulphate–sodium arsenite[7] showed that the compounds travelling with R_F values of 0·73 and 0·80 contain iodine. The hydrolysate was developed also in n-propanol/water/concentrated ammonia (100 : 50 : 1) and in water-saturated phenol, and in both cases the chromatograms showed a spot moving identically with serine. In order to confirm the identity of serine on the chromatograms, a larger amount of the hydrolysate was chromatographed and the band corresponding to serine was eluted. A specific serine-requiring mutant *E. coli* K$_{12}$W–1977, kindly supplied by Dr. J. Lederberg, assayed on a minimal medium described by Tatum and Lederberg[8], responded to the concentrated eluate.

It can be seen from the above that serine, but no alanine, is formed during the alkaline incubation of iodinated polytyrosine. The spots moving with R_F values 0·73 and 0·80 are probably iodinated thyronines.

Similar experiments have been carried out on poly-L-tyrosine samples of average degrees of polymerization 8 and 50, iodinated with 0·2 and 0·7 mole of iodine per mole of the tyrosine residue respectively. A polymer composed on the average of fifty α-amino-acid residues, of which 14 moles per cent were tyrosine, 20 moles per cent were monoiodotyrosine and 64 moles per cent were diiodotyrosine, contained after incubation 2 moles per cent of serine in the hydrolysate. The amounts of the various α-amino-acids were determined by quantitative ninhydrin colorimetry after chromatography.

We wish to thank Dr. Rosalind Pitt-Rivers for helpful suggestions and for samples of thyroxine and 3,5,3′-triiodothyronine, and Prof. E. Katchalski for his continued interest in this work.

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Effect of L-Thyroxine on Carotene and Vitamin A Metabolism in the Cow and the Chick

IT has long been known that vitamin A metabolism is related to the functioning of the thyroid gland[1-3]. The relation between thyroid hormone and fæcal excretion of ingested carotene has been demonstrated by Cama and Goodwin[4] in the rat, and by Chanda *et al.*[5] in the cow and the goat. The effect of the thyroid on the storage of dietary carotene as vitamin A in the liver of rats has also been demonstrated[3]. Chanda and Owen[6] studied the changes in the carotene and vitamin A content of cow and goat milk as effected by parenteral administration of DL-thyroxine. More recently, Chanda, Clapham and Owen[7] have reported their findings on the effect of anterior pituitary thyrotrophic hormone on the simultaneous changes in the partition of carotenoids and vitamin A in the blood serum and the milk of cows.

Since the development of new methods for the synthesis of crystalline L-thyroxine by the Glaxo Laboratories, Ltd., the galactopoietic action of the hormone has been studied by British workers[8]. The present communication reports briefly the effects of synthetic L-thyroxine on carotene and vitamin A metabolism in the cow and the chick.

Two experiments were carried out. In the first, six cows of the Hariana breed were divided into three groups of two each, and the experiment was divided into four periods, the first and last of which served as control periods. Each of a pair of cows received daily by mouth 6 gm. L-thyroxine triturate during period (2), and 8 gm. during period (3). A second pair each received parenterally 7·5 mgm. and 10 mgm. DL-thyroxine per day during periods (2) and (3) respectively. The remaining pair served as controls; but one of them received 6 gm. and 8 gm. lactose per day during periods (2) and (3) respectively, while the second cow received 10 ml. normal saline per day during periods (2) and (3). The hormone was also administered parenterally in 10 ml. solution prepared according to the method of Chanda and Owen[6].

In a second experiment, groups of one-week old chickens of Rhode Island Red and White Leghorn breeds were for eight weeks given a feed mixture containing the hormone; one group received 1 gm. L-thyroxine triturate per 10 lb. feed, and a second group received 20 mgm. DL-thyroxine (mixed in 980 mgm. lactose) per 10 lb. mixture. The diet of the third group of birds, which acted as controls, contained an equivalent amount of lactose only. The triturate contained 1 per cent L-thyroxine. There were ten birds of each breed in each group. Two birds of each breed from each group were killed on the day the feeding of experimental diet started, and, thereafter, at intervals of two weeks. Samples

Table 1. CONCENTRATION OF β-CAROTENE, VITAMIN A ESTER AND VITAMIN A ALCOHOL IN COW BLOOD SERUM AND OF VITAMIN A ESTER IN COW MILK-FAT

Treatment in periods (2) and (3)*	β-Carotene in blood (μgm./100 ml. serum) Period				Vitamin A ester in blood (I.U./100 ml. serum) Period				Vitamin alcohol in blood (I.U./100 ml. serum) Period				Vitamin A ester in milk (I.U./gm. fat) Period			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Saline control	964	942	904	856	23	27	24	19	91	90	90	90	25·2	24·7	24·8	24·2
L-Thyroxine (orally)	973	1,075	1,218	919	26	45	52	24	91	91	97	88	24·7	32·4	39·1	28·5
DL-Thyroxine (parenterally)	991	1,191	1,328	969	26	34	41	21	95	98	108	93	25·5	29·2	32·0	26·9

* There were two cows in each treatment: five determinations were made for each cow during each period. Mean values of the two cows in each period are recorded here.

Table 2. PARTITION OF VITAMIN A IN BLOOD SERUM AND LIVER OF CONTROL AND HORMONE-TREATED RHODE ISLAND RED CHICKS

Treatment	Serum vitamin A alcohol (I.U./100 ml.)			Serum vitamin A ester (I.U./100 ml.)			Liver vitamin A ester (I.U./gm. tissue)			Liver vitamin A alcohol (I.U./gm. tissue)		
	Initial*	Final†	Change	Initial	Final	Change	Initial	Final	Change	Initial	Final	Change
Lactose control	69	115	+46	8	46	+38	42	225	+183	17	51	+34
L-Thyroxine	66	137	+71	10	58	+48	45	290	+245	19	79	+60
DL-Thyroxine	68	140	+72	11	62	+51	46	302	+256	22	86	+64

* One-week old chicks at the commencement of hormone treatment.
† After 8 weeks of hormone treatment.

of blood, liver and intestine from individual birds were analysed separately for carotene and vitamin A.

The partition of carotenoids and vitamin A in milk, blood and other tissues was carried out by the method already described by me and my associates[6,10,11] at the Hannah Dairy Research Institute.

Cows. L-Thyroxine administered orally caused an increase in the β-carotene and vitamin A ester content of the milk fat of Hariana cows in much the same way as was observed previously in the milk fat of Ayrshire cows treated with DL-thyroxine parenterally[6]. It was further observed in the present experiment that the β-carotene and vitamin A ester content of blood serum increased during thyroxine treatment, and that the increases in milk and blood vitamin A ester were greater when the hormone was given orally than when it was given parenterally (Table 1). As no preformed vitamin A was present in the diet of the cows, the latter effect was due probably to greater conversion of dietary carotene into vitamin A in the intestines (see experiment with chicken). The increases in the β-carotene content in the blood (Table 1) and milk due to hormone treatment were greater in cows treated parenterally than in cows which received the hormone orally.

The vitamin A alcohol content of both the milk and blood serum lipids remained fairly constant, except during noticeable hyperthyroidism during period (3), when increases occurred only in the cows treated with hormone. It was further observed that the effects of thyroxine on carotene and vitamin A metabolism were independent of the responses in the milk yield.

Chicken. Vitamin A ester contents of blood and liver determined at two-week intervals showed a gradual increase with age in all the groups, but the rate of increase was accelerated by the hormone treatment. The vitamin A alcohol levels in the blood were also built up at a greater rate in the birds treated with hormone than in the control birds. This is evident from Table 2, in which only the initial and final value for Rhode Island Red birds are recorded for the sake of brevity.

In order to find out whether the greater concentrations of vitamin A in the birds treated with hormone were due to greater conversion of carotene to vitamin A in the intestine, an experiment was carried out in which twelve Rhode Island Red birds were divided into two groups of six each. Both groups received a carotene-free and vitamin A-free ration, but one group received 1 gm. L-thyroxine per 10 lb. feed mixture. The birds were initially four weeks old; the dietary and hormonal treatment were given for four weeks. After the treatment period, two birds of each group received 1 gm. arachis oil only, while the remaining four birds received 10 mgm. β-carotene in 1 gm. arachis oil. The birds were killed 4 hr. after the meal of β-carotene, and the different segments of the intestines were analysed by the methods of Thompson, Ganguly and Kon[12].

The results recorded in Fig. 1 show that the birds treated with thyroxine converted orally administered β-carotene into vitamin A at a higher rate in their small intestines than the controls which were denied the hormone treatment. It seems reasonable to suppose that the greater concentrations of vitamin A in the blood and liver of the treated birds were due mainly to greater conversion of carotene into vitamin A in the intestines (Fig. 1).

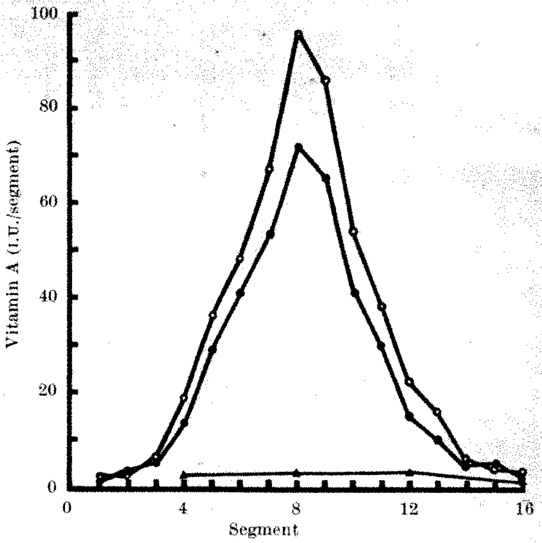

Fig. 1. Vitamin A in the wall of sixteen segments of the small intestine of vitamin A-deficient Rhode Island Red chicks 4 hr. after a meal of 10 mgm. β-carotene in 1 gm. arachis oil (80–90 per cent of the vitamin A was present as vitamin A ester). ○——○, L-thyroxine-treated chick dosed with β-carotene in arachis oil; ●——●, control chick dosed with β-carotene in arachis oil; ▲——▲, L-thyroxine-treated chick dosed with arachis oil (four segments only). Each point in the curves indicates the mean value for four chicks, except that two chicks were dosed with arachis oil only (see text)

The physiological and biochemical significance of these findings will be discussed when full accounts of these and other experiments, which are in progress, are published.

I wish to thank Dr. L. C. Sikka for his interest in this work and Mr. P. B. Sen for permission to use the Unicam *SP*500 spectrophotometer in the Laboratory of the Department of Physiology, University of Calcutta. Thanks are also due to Dr. T. F. Macrae, of Glaxo Laboratories, Ltd., for a generous gift of synthetic sodium L-thyroxine triturate.

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Fluorescence of Adrenaline and Noradrenaline with Ethylene Diamine

Weil-Malherbe and Bone[1] claimed to have estimated the relative proportions of adrenaline and noradrenaline in mixtures of the two by the different colours of fluorescence given by these substances when coupled with ethylene diamine and extracted into *iso*-butanol. We attempted to repeat this work but obtained varying results. We therefore investigated further the mechanism of the reaction.

Oxidation is an essential preliminary: for this, oxygen or other oxidizing agents such as manganese dioxide or potassium ferricyanide may be used; it is not sufficient to rely on the air dissolved in the solutions. Too high a pH at this stage reduces the yield of the fluorescent products.

The reaction proceeds in several steps; the relative rates of formation and decomposition of the intermediate products depend on temperature, pH and concentration of ethylene diamine.

The first step is the development of a substance having an absorption maximum at 350 mμ. This substance is not fluorescent or appreciably extracted by butanol. Optimum conditions for its formation are pH 9·5, ethylene diamine concentration 0·4 per cent (v/v); the yield is maximal in 15 min. (see Fig. 1).

At higher concentrations of ethylene diamine, this substance forms and decomposes rapidly: it gives rise to another substance with an absorption maximum at 405 mμ; an *iso*bestic point is shown at 370 mμ (see Fig. 2). This material is fluorescent and is extracted by butanol, in which solvent it has an absorption maximum at 415 mμ. The optimum conditions for its formation are pH 11 and an ethylene diamine concentration of 5 per cent (v/v); at pH 10 or 12 the maximum absorption at 405 mμ is only about 60 per cent of that obtained at pH 11. The optimum temperature is between 50° and 70° C., the yield being maximal in 1·5–2 hr. Higher concentrations of ethylene diamine make little difference other than to shift the absorption maximum slightly towards a longer wave-length.

This substance with absorption maximum at 405 mμ is comparatively stable. At higher temperatures, higher pH, or on prolonged incubation it decomposes to give rise to a product having an absorption maximum at 330 mμ, which is also fluorescent.

Finally, we examined the butanol extracts of the noradrenaline and adrenaline derivatives of ethylene diamine prepared under the conditions which gave the maximum amounts of the substance having an absorption maximum at 405 mμ. These extracts were chromatographed both on filter paper (Whatman No. 1) and on cellulose powder columns; they were developed with water-saturated butanol. A similar result was obtained with either method.

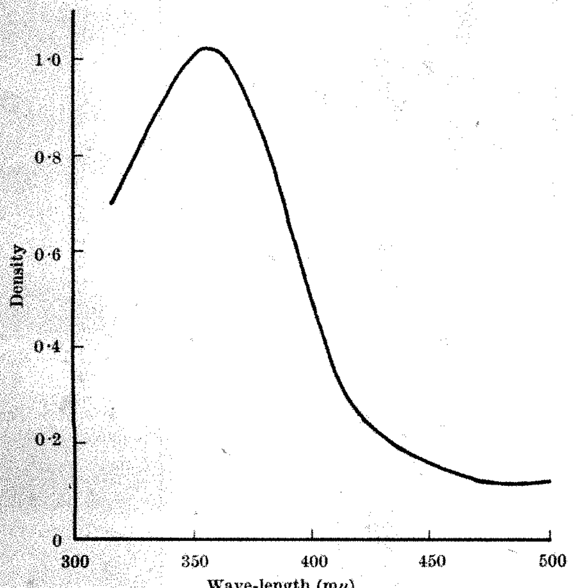

Fig. 1. Absorption spectrum of product having extinction maximum at 350 mμ.
Ethylene diamine 0·4 per cent (v/v) adjusted to pH 10·1 with sulphuric acid. Noradrenaline 10·0 μmoles per 100 ml. Solution saturated with oxygen and incubated at 50° for 16 min.

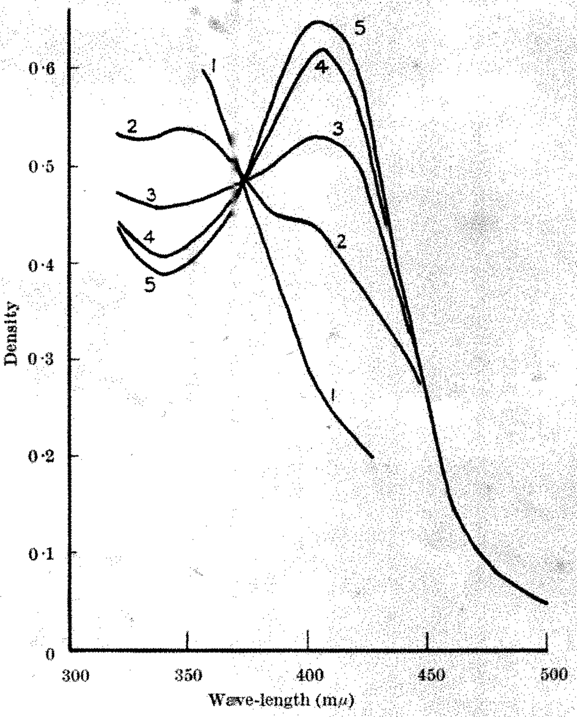

Fig. 2. Time-course of the reaction between ethylene diamine and noradrenaline.
Temperature 51°. Ethylene diamine 3·3 per cent (v/v) adjusted to pH 11 with sulphuric acid. Oxygen bubbled through the solution continuously, evaporation being prevented by a reflux condenser. Noradrenaline 7·0 μmoles per 100 ml. added at zero time.
Curve (1), 10 min.; (2) 21 min.; (3) 35 min.; (4) 58 min.; (5) 130 min.

The noradrenaline derivative separated into two fractions: the greater part, R_F 0·64, fluoresced bluish-green; the lesser part, R_F 0·24, fluoresced yellow. The adrenaline derivative also separated into two fractions: the greater part, R_F 0·37, fluoresced yellow; the lesser part, R_F 0·69, fluoresced green.

We have also obtained evidence from the emission spectrum of the noradrenaline derivative that the proportions of the two fluorescent products depend on the concentrations of noradrenaline and of ethylene diamine.

We conclude that there must be at least two fluorescent derivatives of noradrenaline and adrenaline, and that in order to obtain reproducible results the conditions must be very carefully controlled.

We are indebted to Mr. J. R. P. O'Brien for his direction, and Mr. G. Newman for his assistance.

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Spore-like Structures in the Tubercle Bacillus

ELECTRON microscopy of ultra-thin sections of avian tubercle bacilli growing on various solid media has revealed details of their internal anatomy. In the initial phase of growth, the structure was similar to that described in the ordinary bacteria[1-3]. Each rod contained a central dense core in the form of a thread or group of granules within an electron-transparent area (Fig. 1). This structure is believed to represent the nuclear apparatus. There appeared to be some correlation between the phase of growth of the bacillus and the configuration of the dense core. When division by transverse fission took place, each daughter cell contained its own nuclear apparatus. The cytoplasm of the avian tubercle bacilli showed certain differences from the bacteria, and contained large, fairly dense granules (300 A.); but the general pattern of reproduction appeared to be the same.

In later stages of development, under certain conditions, the avian bacilli had a very different internal structure. When grown as slide cultures on thin chicken plasma–embryo extract clots, they did not all divide directly by transverse fission; some of them elongated into filaments, and round bodies were observed forming in the cytoplasm. At first these bodies were difficult to distinguish from the remainder of the cytoplasm; but later they were clearly seen. The nuclear apparatus was still present during the early stages of the formation of the round bodies and was quite distinct from them. The number of round bodies increased until they filled the whole filament except for a peripheral region which contained cytoplasmic granules and dense, metaphosphate bodies (Fig. 2). The round bodies were of uniform internal density and each was enclosed in a dense outer membrane. During the final stages of development some of the filaments contained large vacuoles which appeared to be associated with the formation of the round bodies. Cross-walls were present dividing the filaments into sections each of which contained two or more dense bodies.

In previous studies of unsectioned avian tubercle, rows of vacuoles[4] or intracellular units[5] of varying density and with sharply defined membranes were observed. The interpretation of these units presented some difficulties. They varied in density and were certainly not sap vacuoles as suggested by Knaysi, Hillier and Fabricant[6]; nor could they be identified with the protoplasts[7] of other bacteria, as they were embedded in the cytoplasm. The most likely assumption seemed to be that they were spores, and this was suggested[5]. Our observations on thin sections support this interpretation. From a recent paper by Chapman[8] on spore formation in *Bacillus cereus* and *Bacillus megaterium*, it is seen that the spores in these organisms are strikingly similar to the round bodies in the avian tubercle bacilli.

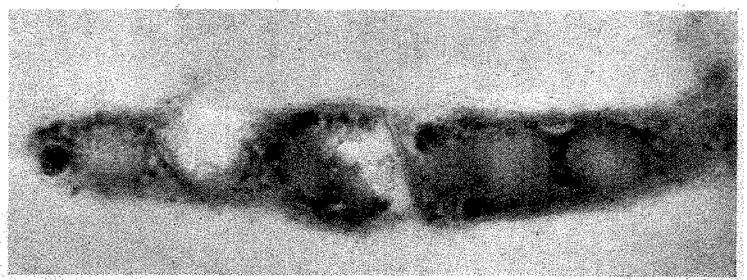

Fig. 2. Dividing filament containing row of spore-like bodies. Note cytoplasmic granules surrounding spores. × 40,000

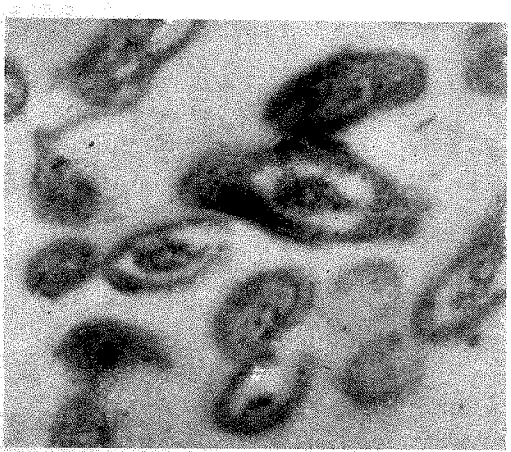

Fig. 1. Elongating rods with central vacuole containing dense structures (nuclear apparatus). Cytoplasmic granules. × 35,000

From this evidence it is suggested that under certain conditions the avian tubercle bacillus produces spores. In future experiments the spore-like bodies will be isolated and their subsequent behaviour studied to test the accuracy of this hypothesis.

We are indebted to Dr. V. E. Cosslett and Mr. R. W. Horne, of the Cavendish Laboratory, Cambridge, for providing electron microscope facilities.

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Effect of Electrolytes on the Rate of 'Supercontraction' of Wool Fibres

WOOL fibres have been shown to shorten (supercontract) when held in steam and rapidly stretched and relaxed, or when treated with hot solutions of reagents breaking disulphide bonds, with cold solutions of metal ammonium hydroxides, or with hot solutions of formamide, certain phenols, or lithium bromide (see Alexander and Hudson[1]).

The effects of phenols, formamide, metal co-ordination complexes, and lithium bromide have been attributed to the rupture of hydrogen bonds, and the effects of most other treatments to splitting of disulphide cross-links. Alexander[2] suggests that lithium ions, being small and having high polarizing power, would be able to combine with polarizable groups of the proteins when the ions are sufficiently concentrated to be incompletely hydrated. He adduces, in support of this theory, the very great increase in rate of supercontraction with increasing concentration of lithium bromide at concentrations corresponding to about ten molecules of water per lithium ion.

In order to gain greater insight into the mechanism of supercontraction in lithium bromide solutions, wool fibres have been immersed in concentrated solutions of various salts buffered at *p*H 6·5–7·0 with 0·1 *M* tartrate or phosphate, maintained for 1 hr. at 100° C., and changes in length measured. Corriedale 56's wool, cleaned by rinsing repeatedly with cold light petroleum, cold ethanol and water, was used for these experiments. The cations investigated were potassium, sodium, lithium, calcium, strontium and beryllium, and the anions, acetate, chloride, bromide, iodide, thiocyanate, trichloracetate and benzoate; supercontraction was obtained with salts containing each of these ions, and several salts, notably lithium and calcium iodide, were more effective than lithium bromide.

The observation by Miss June Griffith (unpublished) that the presence of free halogen in the halide solutions inhibits supercontraction has been confirmed. Removal of free halogen with thiosulphate resulted in supercontraction of the wool at lower salt concentrations and gave greater uniformity of the results.

Curves relating the amount of supercontraction of wool to the concentration of reagent have been constructed for each salt. On arranging the salts of a particular cation in order, according to the concentration required to bring about a certain degree of supercontraction, for example, 25 per cent, the anions have been found to occur in the order of the lyotropic series. With lithium salts the approximate concentrations required for supercontraction of this order were: acetate, $> 12\,M$; chloride, 8·5 *M*; bromide, 4·5 *M*; iodide, 3 *M*. With a series of iodides the concentrations required were: potassium, 6 *M*; sodium, 5 *M*; lithium, 3 *M*; strontium, 3·5 *M*; calcium, 2 *M*.

The results resemble those obtained by Lennox[3] and Jordan Lloyd and Garrod[4] when investigating the effects of a similar series of salts on the thermal shrinkage of collagen. As collagen contains no disulphide linkages and the salts investigated have no known reaction with cystine or its peptides, it is reasonable to conclude that the primary reaction with wool does not involve disulphide bonds but is similar to the denaturation of soluble proteins. The demonstration by Beauregard, Brown and Harris[5] that cross-linking with ethylene dibromide did not prevent supercontraction of wool with lithium bromide also emphasizes this fact.

The above results invalidate Alexander's[2] explanation of the action of lithium bromide, since 3 *M* lithium iodide, which is as effective as 5 *M* lithium bromide, contains about seventeen water molecules per cation; also it is unlikely that sodium and potassium ions form complexes with proteins in the manner suggested for lithium ions. An alternative explanation is possible if the tendency for ions to be adsorbed on the wool proteins varies in much the same way as their tendency to become adsorbed on non-protein colloids and on carbon, the small highly hydrated ions being adsorbed least readily and the large, less hydrated ions being adsorbed most readily. The effective molecular charge of a negatively-charged protein would then tend to increase in the presence of high concentrations of a salt of a readily adsorbed anion and a cation which is not readily adsorbed. Any marked increase in molecular charge of the wool proteins would impose stresses on intramolecular and intermolecular bonds, resulting in disaggregation and disordering of the wool proteins. In this regard the effect would be similar to that of anionic wetting agents on the intercellular proteins of the wool cortex[6].

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Cytotaxonomy and the Migration of Primitive Peoples

A FEATURE of the island-to-island migrations of Polynesian and other Pacific races is that the natives carried with them certain of their cultivated food plants and established them in their new settlements. Some of the original plantations have survived until the present day, and it may be possible to trace the paths of early human migration through a study of the distribution of the food plants.

Certain species of taro (*Colocasia antiquorum* Schott and the closely related (if not synonymous) *C. esculenta* Schott) seem particularly suitable for cytological study since they do not flower readily in many localities and rarely, if ever, appear to set viable seed. The method of propagation is to cut off the base of the rootstock (which is eaten) and replant the upper portion which includes both roots and shoot. Less frequently, in certain varieties, clonal segregates are obtained. Because of these exclusively asexual reproductive modes, the chromosome number is likely to remain constant over long periods.

While the majority of varieties studied to date (some sixty in number) have a diploid chromosome number of 28, the triploid figure of 42 has occasionally shown up. Of particular interest is the fact that a 42-chromosome variety has been found in New Zealand, in a locality (Cavalli Islands) and in circumstances which strongly suggest that it has survived there since the earliest known Maori settlement. A preliminary examination of some twenty varieties from the Polynesian region of the Pacific has failed to bring to light any triploid types. On the other hand, as a result of recent investigations in New Caledonia, two varieties were found with 42 chromosomes.

While it is too early to draw any conclusions from these findings, it is interesting to note that 42 chromosomes have been recorded independently by Japanese and Indian cytologists for the variety *gigantea*. With no evidence so far to the contrary, it is not inconceivable that the New Zealand variety has derived from a south-east Asian source via the Malayan Peninsula and the chain of islands to the south and east.

It must be stressed, however, that the bearing of such evidence, alone, on the origins of the Maori cannot extend beyond the nearest neighbouring island in a chain of this sort, since it is entirely within the realms of possibility that the Maori acquired the taro while *en route* from a totally different area of the Pacific. Nevertheless, by an extension of the method (since presumably the forerunners of the Maori carried comparable food plants in prior migrations) it may be possible to trace the origin of this and other racial groups progressively farther and farther back into prehistorical times. Further studies along these lines are being planned, utilizing in addition other species of taro (*Xanthosoma*, *Alocasia*, *Cyrtosperma*) as well as *Ipomoea* spp. (sweet potato and kumara) and the yam (*Dioscorea*).

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Histamine of the Reptilian Stomach and Lung

WRIGHT *et al.*[1] have demonstrated that the stomach of *Testudo graeca*, *Tachysaurus rugosus* and *Tiliqua nigro-lutea* secretes hydrochloric acid and some pepsin in response to large doses of histamine but is only slightly responsive to vagal stimulation. The histamine concentration of the stomach of *Tiliqua nigro-lutea* (closely related to *Tachysaurus*) was therefore investigated in November 1955. The full thickness of stomach of one lizard was cut up, after scraping off contents, and boiled in Tyrode. The concentration of histamine on titration was 75 μgm./gm., which is a high level.

Histamine was demonstrated in the Tyrode-boiled extract by assay on the isolated jejunum of the guinea pig suspended in Tyrode, before and after treatment with anti-histamine. when the response of equivalent doses of histamine always equalled that of the titrated stomach extract. Assay on the systemic blood pressure of the atropinized cat confirmed the concentration exactly. Further, paper chromatography with two solvents (propyl alcohol–acetic acid–water and butyl alcohol–acetic acid–water) yielded equal runs with pure histamine hydrochloride and stomach extract, one run of which is illustrated in Fig. 1.

Extract for the chromatography was obtained by the modified method of Code[2] for histamine extraction of the whole stomach of another lizard which contained a comparable amount of histamine. Barger and Dale[3] found 19 μgm. histamine/gm. in the intestinal mucosa of the ox, Kellaway and Trethewie[4] a maximum of 48 μgm. histamine/gm. in the whole perfused gut of the guinea pig, and unsqueezed adult guinea pig lung (Australian) contains usually 20–40 μgm. histamine/gm. [5].

The lungs of these reptiles showed no evidence of histamine in them, only a 'slow-reacting' substance like that described by Kellaway and Trethewie[4] or 'slow-contracting substance'[6,7].

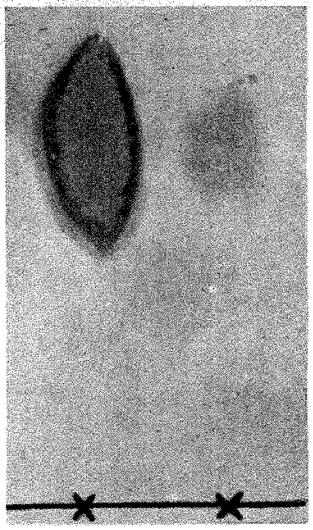

Fig. 1. Chromatogram of lizard stomach extract compared with histamine dihydrochloride, with propyl alcohol – acetic acid – water solvent

The paper chromatography was kindly performed by Mr. Peter Morgan.

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A Case of DDT Poisoning in Fish

A SERIES of experiments were conducted at Khartoum by a private company concerning the control of *Tanytarsus lewsii*, a green chironomid. During these experiments, a section of the Blue Nile was sprayed by air at Soba Village about ten miles above Khartoum, with an emulsifiable oil containing 30 per cent DDT and 0·5 per cent 'Lissapol'. The equivalent of 440 lb. DDT was sprayed over an area in order to give a calculated DDT content of 0·09 p.p.m. It was hoped that by the time treated water reached Khartoum, the DDT concentration would have been diluted four times. The concentration of DDT at the time of arrival at Khartoum was 0·017 p.p.m. and was then maintained at a level of 0·003 p.p.m. for six hours.

The same day, it was reported that "hundreds of fish were found dying" at Burri Village about two miles above Khartoum, at about the time the treated water was expected to arrive there. Two of these fish were brought to these laboratories on the following day. Prior to chemical examination, they were submitted to Dr. Rzoska, of the University College Khartoum, for post-mortem examination, who reported the following findings :

"The dead fish was a specimen of *Labea* sp., a plant feeder. The gills were almost white.

"The dying fish was a specimen of *Synodontis schall*, a carnivorous bottom feeder. It was severely bloated.

"The sudden appearance of a large number of dead fish of different species at the same time points to poisoning as the cause of death, and not to disease."

The two fish were then examined for the presence of DDT in different organs using the method of Schechter *et al.*[1] after a preliminary separation of the DDT from the fatty matter using the method of Schechter *et al.*[2]. The following results were obtained :

Fish	Organ	Weight taken (gm.)	Weight DDT found (μgm.)	DDT in organ (p.p.m.)
Labea sp.	gills	4·32	4	0·9
	viscera	14·26	36	2·5
	flesh	12·33	nil	nil
Synodontis schall	gills	7·04	19	2·7
	viscera	26·29	2,080	79
	fatty deposit	1·37	87	64

These results lend some support to previous work showing that fish are highly sensitive to DDT, and that non-fatty animals are more sensitive than fatty animals (summary in Hinton[3]). The *Labea* was found dead some eight hours after spraying, whereas the *Synodontis* survived thirty-six hours.

However, the possible effect of the surface-active agent should not be overlooked.

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Occurrence of Paracolon Bacteria in a Tropical Marine Environment and their Classification

LATE or non-lactose fermenting bacteria are of wide interest in the clinical field because of their association with gastroenteritis and urinary infections. Because they form colourless or white colonies on coliform differential media, they are usually overlooked during the isolation of coliforms. Clemesha[1] was probably the first to recognize the importance of these organisms in India, when he stated that "a class of organisms which ferment glucose but not lactose is not only exceedingly common in water . . . but the significance of these bacteria is of great importance to the water analyst". Topley and Wilson[2] also felt that "there seems no doubt that they are a more common constituent of normal intestinal flora under tropical than under temperate conditions". In India these 'Paracolon' bacteria are misclassified in the genus *Escherichia* or *Aerobacter* despite the fact that lactose fermentation is a fundamental characteristic of the latter organisms. Topley and Wilson[2] defined 'Paracolons' as those which do not ferment lactose or ferment it slowly and have the 'IMViC' reaction $++--$. Stuart *et al.*[3] suggest the term 'Paracolon' for papillæ-forming anaerogenic and slow lactose-fermenting *Escherichia*-like organisms associated with gastroenteritis. Breed *et al.*[4] have accorded generic rank to *Paracolobactrum*, including them as an appendix to the tribe Escherichiae.

While working on the coliform types in green mussels[5], we isolated some 'paracolons' also. Two are similar to *Paracolobactrum aerogenoides*, whereas eight others belonged to *Paracolobactrum coliformae*. Three of these were malonate-positive but differed from those of Schaub[6]. All the cultures fermented glucose and all but one fermented sucrose. Dulcitol was not fermented by any of them whereas a few fermented adonitol. Gelatin liquefaction was not common, neither did many produce hydrogen sulphide. Lactose fermentation was mostly negative and very delayed if positive. All the *Escherichia*-like paracolons produced indole, in agreement with the findings of Kligler[7] and Ferguson and Wheeler[8]. Though *MR*-positive coliforms ferment glycerol, only two of the *Paracolobactrum coliformae* fermented glycerol. A few cultures were weakly urease positive in Christensen's medium but none in Rustigian and Stuart's, thus excluding their relationship to *Proteus*. Our cultures were all peritrichous when very young (5 hr. old) but they showed 'degenerate peritrichous' flagella when 18 hr. old.

Breed (personal communication) would include polar flagellate glucose-fermenting (aerogenic) but non-lactose fermenting organisms in the new genus *Aeromonas* Kluyver and Van Niel. The culture described by us as *Paracolobactrum coliformae* var. *marinum*[9] was found later to be monotrichous and would belong to *Aeromonas* but for the fact it is *MR*-positive. Flagellation is an important diagnostic characteristic in distinguishing the Paracolon-Aerobacter from *Aeromonas*. The failure of some coliform bacteriologists to determine the type of flagellation has led to misclassification of *Aeromonas* as *Paracolobactrum*, as emphasized by Breed. Sen and Dutt[10], describing a lactose anaerogenic but glucose aerogenic organism, identified it as *Aerobacter cloaceae*, though it should properly be classified as *Paracolobactrum aerogenoides* (or as *Aeromonas*, if flagellated at the poles). In view of the reported role of paracolons in the etiology of gastric infections, and that of *Aeromonas* in causing diseases of cold-blooded animals, more attention should be paid to their proper classification.

Detailed descriptions of the paracolon cultures will be published elsewhere. We thank Dr. Robert S. Breed for useful discussion and for a preprint of the section on the genus *Aeromonas* prepared for the 7th edition of "Bergey's Manual".

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Availability to Dinitrofluorobenzene of some Amino Groups in Human Dentin and Ox Hide Collagen

HUMAN dentin (containing 80 per cent by weight of mineral material), ox hide collagen, and samples of dentin which were partially demineralized at 4° C. by soaking in either 1 *N* hydrochloric acid or 1 *N* trichloracetic acid, or 15 per cent versene (*p*H 7·3), were assayed for α- and ε-amino groups using Sanger's dinitrofluorobenzene method[1].

0·2 gm. of tissue was added to 0·5 gm. dinitrofluorobenzene (excess) in 66 per cent ethanol saturated with sodium bicarbonate and shaken for 36 hr. at room temperature. The dinitrophenyl protein thus formed was washed with water and ethanol, and hydrolysed for 16 hr. with 6 *N* hydrochloric acid in a sealed tube at 105° C. After extraction of the hydrolysate with peroxide-free ether, separation of the water-soluble ε-N dinitrophenyl lysine and ε-N dinitrophenyl hydroxylysine was achieved by means of paper-chromatography, using butanol/acetic acid/water (4 : 1 : 5) as solvent. The yellow spots were cut out, eluted into 5 ml. of 1 *N* hydrochloric acid, and their optical densities at 360μ recorded on the Beckman spectrophotometer.

Distinct differences between the availability of amino groups of dentin and those of similarly treated hide collagen were observed :

(1) Only 50–60 per cent of the total lysyl and hydroxylysyl ε-amino groups of hide collagen were available to the dinitrofluorobenzene[2], whereas in human dentin the availability of these amino groups increased linearly from 6 per cent in untreated dentin to more than 90 per cent in the fully demineralized dentin[3].

(ii) A linear increase (from zero to 10 micromoles/gm. protein) in the concentration of N-terminal amino groups during demineralization of dentin was observed. In accordance with other workers[2], no N-terminal amino groups were detected in hide collagen.

(iii) The molar ratio (*R*) of ε-N dinitrophenyl lysine to ε-N dinitrophenyl hydroxylysine, obtained from the dinitrophenylation of hide collagen, was almost theoretical (3·9)[4]; but in dentin collagen this ratio increased in a linear manner from 0·8 to 2·9 (theoretical maximum 3·7)[5], when plotted against the percentage dissolution of mineral material (Fig. 1). This implies that, especially in the early stages of the decalcification process, the availability to dinitrofluorobenzene of hydroxylysyl ε-amino groups exceeds that of the lysyl ε-amino groups, in spite of the much higher concentration of lysine residues. The same results were obtained using each of the abovementioned demineralizing solutions.

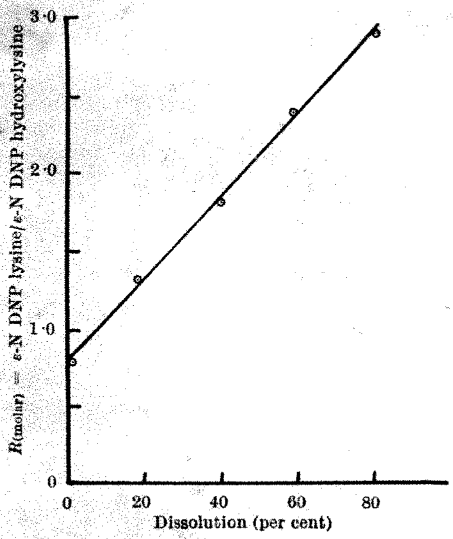

Fig. 1. Relative availability, to dinitrofluorobenzene, of lysyl and hydroxylysyl ε-amino groups of dentin collagen, during mineralization

Other workers[6] have suggested that polar side-chains of amino-acid residues in proteins and peptides may act as binding sites for ions ; and since the anionic binding power of the ε-amino groups of hydroxylysine is weaker than that of lysine[7], bound anions are expected to be liberated at a greater rate from hydroxylysyl than from lysyl amino groups, during demineralization.

It is therefore suggested that the ε-amino groups of lysine and hydroxylysine may play a part in the combination of mineral material with the protein matrix of human dentin.

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Correlation between Deoxyribonucleic Acid Content and Volume of Individual Nuclei in Different Tissues of the Rat

IT has been shown that in the liver[1], and in several other organs[2], of the rat the nuclear classes determined according to the deoxyribonucleic acid content correspond to the nuclear volume classes. An objective analysis was performed in order to see if in the individual nuclei of a given organ a correlation exists between deoxyribonucleic acid content and volume. The results of measurements obtained with E. Pisi[2] were used in this study. The relative deoxyribonucleic acid content of the individual nuclei was obtained by means of the histophotometrical method of L. Lison[3]. The great majority of the nuclei being practically spherical in shape, the nuclear volume was calculated by a simple geometrical formula from the projection surface.

Fig. 1 summarizes the results obtained for the thyroid gland for two rats (105 and 106). The regression lines and the correlation coefficients *r* (0·816 and 0·536) show that, if the degree of correlation can be varying in the same organ from one individual to another, in each case a real linear correlation exists between the deoxyribonucleic acid content of the different nuclei and their volume.

Similar results were obtained for other organs, which like the thyroid gland contain practically only one nuclear class (kidney, endocrine pancreas). In organs with different nuclear classes (liver, exocrine pancreas) conditions seem to be more complicated ; they will be the subject of a further study.

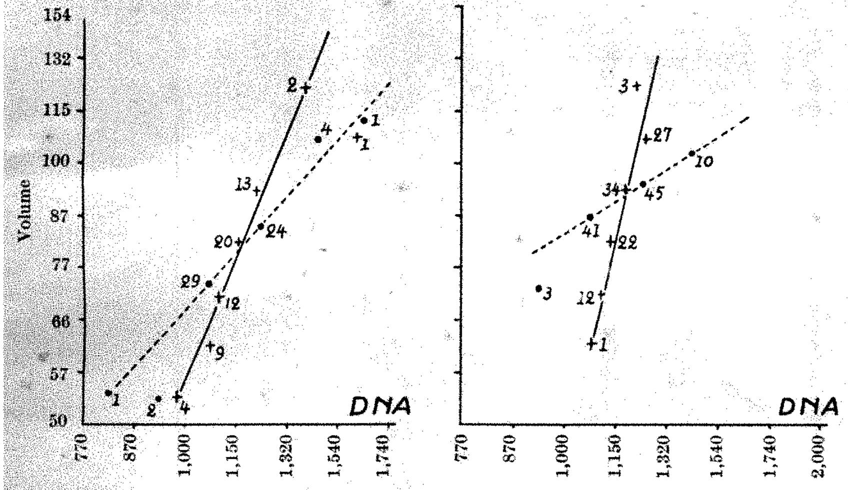

Fig. 1. Correlation between deoxyribonucleic acid content and nuclear volume in the thyroid gland of the rats 105 and 106: regression lines. Left: Thyroid gland of rat 105; *r*, 0·816; *n*, 61. Right: Thyroid gland of rat 106; *r*, 0·536; *n*, 99. *n*, number of measurements (the number of measurements from which the corresponding mean value was calculated are indicated next to each point); *r* = correlation coefficient

These investigations were carried out with a grant from the Fonds National de la Recherche Scientifique.

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Human Fœtal Ventricular Outputs

In a comprehensive study of the fœtal circulation in the lamb, G. S. Dawes, Joan C. Mott and J. G. Widdicombe[1] showed that in the fœtus the left ventricular output exceeded that of the right ventricle. In a study of the ventricles of the post-natal human heart[2], I showed, by observations of the weight of the ventricular mass and of its parts, that right ventricular atrophy is the normal event in the period immediately following birth, and that the weight ratio between right and left ventricles which is characteristic of adult hearts is normally found from the age of six months onwards. Additional unpublished observations on the thickness of the ventricular walls during the period of right ventricular atrophy suggest that in the human fœtus, as in the lamb, the output of the left ventricle exceeds that of the right. As experimental observations of the type performed on the fœtal lamb are unlikely to be made on a human fœtus, these observations may be of some interest.

The measurement of the thickness of the ventricular walls is unsatisfactory both in theory and in practice. One big difficulty is that of making observations at strictly comparable points on the ventricular walls of different hearts. For this and other reasons, I originally determined to rely only on observations of the weight of the myocardium in the survey quoted above. However, when it became obvious that right ventricular atrophy was a normal post-natal event, I began to measure the thickness of the ventricular walls in order to compare changes in such measurements with the changes in weight. In order to obtain reasonably comparable observations, the measurements were made with flat-bladed callipers reading to 1/10 mm. at five points. These were: (*a*) anterior wall of the infundibulum, and (*b*) across the infundibulo-ventricular crest (crista supraventricularis). In both these measurements one blade of the callipers was inserted through the pulmonary orifice of the right ventricle, parallel to the interventricular sulcus in the first, and parallel to the atrioventricular sulcus in the second. (*c*) The posterior wall of the right ventricle—calliper inserted into the tricuspid orifice posteriorly and directed parallel to the interventricular sulcus on the inferior surface of the heart. (*d*) The lateral wall of the left ventricle, between the anterior and posterior groups of papillary muscles. (*e*) The thickest part of the septum.

In each of these measurements the callipers included the trabeculæ and avoided the bases of the papillary muscles. The measurements were made on specimens which had been fixed in 10 per cent formol-saline for 2–3 days.

In practice the septal and left ventricular wall measurements always resembled each other closely. For this reason only the measurements of the free wall of the left ventricle are quoted. Table 1 gives a summary of the findings at four age periods.

Table 1. MEAN THICKNESS OF VENTRICULAR WALLS IN MM.

Age period	No. of specimens	Right ventricle (*a*)	(*b*)	(*c*)	Left ventricle (*d*)
Full term	19	4·2	6·1	4·1	5·2
4–6 months	12	2·5	3·8	2·9	8·0
Second year	8	2·9	4·4	3·0	9·0
Sixth year	4	3·8	6·1	3·9	10·4

The infundibulo-ventricular crest is always by far the thickest part of the right ventricular free wall, and in the fœtus is normally thicker than any part of the left ventricular wall or septum. The atrophy of the right ventricular wall in the early months is profound and is not made up, in thickness, until six years have passed. In contrast the left ventricular free wall and septum grow rapidly in thickness from the beginning.

An estimate of the surface area of either ventricular free wall may be obtained by setting its weight (used as a measure of the volume of the myocardium) against its thickness. In the case of the right ventricle, the weight of its free wall in gm. was divided by its thickness, measured across the infundibulo-ventricular crest, in mm., and for the left ventricle the weight of its free wall divided by its thickness. The resultant figures are arbitrary, and are only used for comparing one heart with another, or one group of hearts with another. These two calculations were made for each specimen, and taking the first two age groups summarized above, give mean estimates of surface area as shown in Table 2.

Table 2. Mean Estimate of Surface Area of Free Wall

Age period	No. of specimens	Right ventricle	Left ventricle
Full term	19	1·0	1·5
4–6 months	12	1·5	1·9

In an irregular cavity such as a cardiac ventricle, surface area will be related to volume in roughly the same way as in a sphere, where volume increases as the cube of the radius, and surface area as its square. Therefore, changes in surface area may be made to indicate changes in volume by raising them to the power of 3/2. Thus the increase in the volume of the right ventricle in the period chosen would be indicated by $(1\cdot5/1\cdot0)^{3/2} = 1\cdot8$, and that of the left ventricle by $(1\cdot9/1\cdot5)^{3/2} = 1\cdot4$.

This suggests greater increase in the capacity of the right than of the left ventricle in the period chosen. At the period 4–6 months an adult type of circulation with equal ventricular outputs is certain. The inference can thus be drawn that the functional capacity of the right ventricle before birth is less than that of the left ventricle. As the fœtal ventricles pump against the same peripheral resistance, a lesser capacity implies a lesser output. This conclusion is in accord with the belief that the general pattern of the circulation shown in the fœtal lamb is repeated in the human fœtus.

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Delayed Implantation in the Grey Seal, *Halichoerus grypus* (Fab.)

Early in March 1870 a large grey seal cow was killed by Prof. W. Turner. "A large corpus luteum was in the left ovary but the uterus was empty[1]."

On January 3, 1956, we killed a grey seal cow on the Pembrokeshire coast. A moderate-sized corpus luteum, containing a central cavity, was found in the left ovary (Fig. 1). Externally the uterus showed no sign of pregnancy; but, in the left uterus, a blastocyst was found measuring 2·3 mm. by 1·8 mm., lying free in the lumen (Fig. 2). Its cells were virtually free of mitotic figures. The surrounding uterine epithelium and glands showed no evidence of impending implantation.

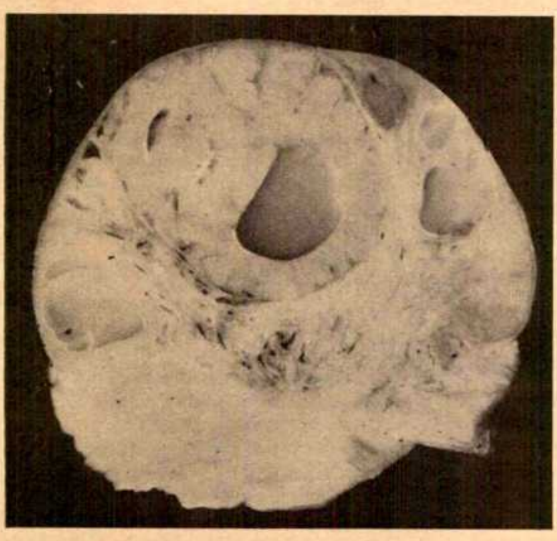

Fig. 1. Hand section of the left ovary, showing the corpus luteum with central cavity

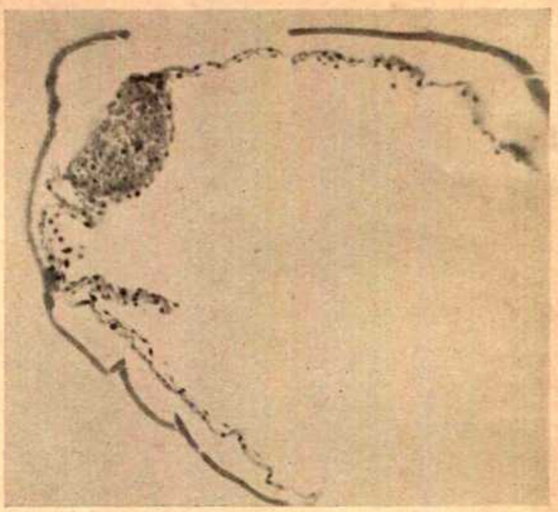

Fig. 2. Vertical section through the blastocyst, showing the zona (broken at one point), the trophoblast, primary endoderm and the inner cell mass

Three bulls all more than 90 in. in total length were shot at the same time. Two of these had the neck and shoulder development characteristic of sexually mature males. There were no sperm, however, in the testes or in the epididymes of any of the three bulls. Fertilization must therefore have taken place some time previously. Mating on the Pembrokeshire coast has been observed during September–October. Consequently delayed implantation seems apparent. Turner's original observation supports this conclusion.

Delayed implantation of the blastocyst has been previously recorded in two other Phocid seals; in the common or harbour seal by Fisher in 1954 [2] and in the elephant seal by Gibbney in 1953 [3].

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A Culture Technique for *Venturia* spp. and a Turbidimetric Method for the Estimation of Comparative Sporulation

Growth and sporulation of *Venturia inaequalis* and *V. pirina* have been extensively studied in artificial culture. Miller[1] obtained objective measures of sporulation and also concluded that inoculum concentrations greater than 200,000 conidia per ml. had little effect on the final yield of conidia. Montgomery and Moore[2] grew cultures of *V. inaequalis* on sterilized apple twigs from which the bark had been removed. They obtained rapid growth and sporulation, and could remove most of the conidia easily without disintegration of the substrate, by shaking the cultures with water. In the following methods the advantages of a firm substrate have been coupled with the use of media of known or constant composition for studies of comparative sporulation under various nutritional conditions, and for the provision of routine supplies of conidia for fungicide bioassay.

The cultures are grown on filter paper cylinders standing in nutrient solutions. Whatman 541 filter paper is cut into rectangles of a size to produce, when rolled, cylinders of convenient length and diameter. These cylinders are then slipped into and held centrally by stainless steel rings. The dimensions I have used are 4·5 cm. × 3·5 cm. rectangles, rolled into cylinders 4·5 cm. long, and held by stainless steel rings as follows: outer diameter 5/16 in., thickness 1/64 in. and width 1/32 in. The cylinders are placed in 6 in. × ½ in. B.S.S. standard test-tubes and heat-sterilized before addition of nutrients. Culture media at pH 5·6 (for example, 10 per cent malt extract, as suggested by Miller[1]) are sterilized by filtration and 1-ml. aliquots are then dispensed aseptically into each tube.

Inoculum suspensions of conidia or mycelial fragments are prepared in sterile glass-distilled water. Each suspension is strained through fine organdie muslin into a 5 in. × ½ in. test-tube packed with cotton wool, inside a 6 in. × 1 in. boiling-tube. After filtration the muslin is removed and the plug of the outer tube replaced. Filtration is necessary owing to the otherwise inevitable blockage of pipettes, used for dispensing inoculum, by large mycelial fragments. Inoculum concentration is adjusted visually to an approximate turbidity of 0·1 (see below), which is equivalent to 2–300,000 conidia per ml. Each tube is inoculated with a volume of suspension calculated as sufficient just to cover the paper cylinders (0·2 ml. for the dimensions given above) and the tube is shaken and rotated to ensure even distribution. The cultures are incubated horizontally for 14–21 days at 18° C. They may be killed by the addition of two drops of formalin and stored at 5° C. to await estimation of sporulation.

Comparative sporulation is determined by turbidimetric estimation of suspensions produced from each culture, in order to avoid time-consuming counts of spore concentrations and the use of sampling methods. The following procedure has been adopted for the preparation and estimation of suspensions.

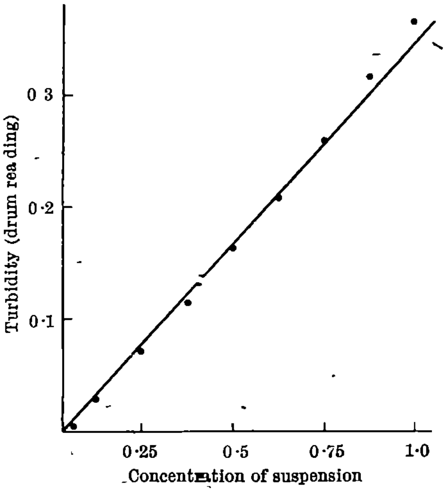

Fig. 1. Linear relationship between dilutions of a concentrated spore suspension and turbidity

Cultures of *V. inaequalis* are shaken vigorously for 1 min. with distilled water (6 ml.) and those of *V. pirina* gently for the same time. Vigorous shaking of the latter is undesirable as they produce comparatively few conidia, and the strongly segmented subaerial mycelium tends to disintegrate. Each spore suspension is strained through one thickness of fine organdie muslin into a 6 in. × 1 in. boiling-tube. The process is repeated with a further 6 ml. of distilled water and gentle shaking. This treatment yields 10–12 ml. of suspension, containing 95–99 per cent of the conidia and a few small fragments of mycelium. Each suspension is centrifuged at 2,000 rev./min. and the supernatant liquid replaced by distilled water; this is repeated until no trace of colour remains in the liquid, in order to avoid interference with the turbidimetric estimation. The final spore deposit is resuspended in either 1 ml. or 10 ml. of distilled water, depending on its magnitude, and the suspension stored at 5° C. in the presence of formalin, to prevent microbial deterioration.

The turbidity of each suspension is recorded using a Hilger photoelectric absorptiometer (Spekker) with neutral filters and cells of 1 cm. path-length, micro-cells being used for the 1-ml. suspensions. An examination of the relationship between dilutions of a concentrated spore suspension and turbidity showed it to be almost linear over the range of drum readings 0·02–0·3; but beyond this range there was an increasing departure from linearity (Fig. 1). Concentrated 10-ml. suspensions are therefore adjusted by dilution to give readings in the 0·02–0·3 range and the necessary corrections applied to give directly comparable estimates of spore production by the cultures. Readings below 0·02 cannot be accurately determined, and 1-ml. suspensions are therefore prepared, the observed drum readings being divided by 10 to obtain results comparable with those of the 10-ml. suspensions. All results are expressed as comparable turbidities.

Results obtained by the use of these methods have been briefly reported by Kirkham[3], and Kirkham and Flood[4], and will be described in detail elsewhere.

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Intake of Streptomycin by Peach Leaves

Previous work[1] has shown that streptomycin sulphate, when applied as an aqueous spray to foliage, prevented the development of blast of stone fruit, caused by *Pseudomonas syringae* van Hall. Mitchell *et al.*[2] found that streptomycin was taken in and translocated upwards to the leaves when applied in a lanolin paste to bean plant stems. As part of a programme designed to gain knowledge of the movement of streptomycin in peach trees (*Prunus persica* (L) Batsch), investigations were carried out to determine whether streptomycin can be taken in through uninjured leaf surfaces and become systemic.

In one series of experiments, seedlings (var. Golden Queen) grown in pots in a glasshouse were sprayed with aqueous solutions of streptomycin sulphate and, after varying intervals, were washed by immersing the foliage in running water for four minutes, to remove surface streptomycin. The presence of antibacterial activity subsequent to washing was determined by inoculating the plants with *Ps. syringae*. All plants in an experiment were inoculated on the same occasion. The percentage infection obtained when a concentration of 100 μgm./ml. streptomycin base was used is given in Table 1. Plants were dry approximately one hour after spraying.

Table 1. *Ps. syringae* INFECTION OF PEACH LEAVES WHEN WASHED AT INTERVALS AFTER SPRAYING WITH 100 μGM./ML. STREPTOMYCIN

	Time after treatment before plants were washed				Differences for significance at 1 per cent
	Check	15 min.	2 hr.	3 days	
Per cent leaf infection*	100	97	89	65	
Equivalent angle	90	84	75	54	21
Mean lesion diameter (mm.)	10·7	11·6	9·5	7·3	3·2

* Number of lesions out of 20 inoculation points on each of five plants.

Since a time-interval between spraying and washing was required before infection was significantly reduced, it would seem that washing removed surface streptomycin; and that the significant reduction in infection with plants washed three days after spraying was due to streptomycin retained by the leaves. This experiment has been repeated with substantially the same results. Similar results were obtained when leaf tissue extracts from similarly treated plants were assayed by the paper-disk plate method, using *Bacillus subtilus* A.T.C.C. 6633 as test organism. The only extracts which inhibited the test organism were from plants washed three days after spraying.

More conclusive evidence that streptomycin was taken into leaf tissues was obtained by painting solutions containing 1,000 μgm./ml. streptomycin on the under surfaces of leaves for three consecutive days, followed by washing the plants and inoculating upper leaf surfaces. In one such experiment, 11 lesions developed on treated leaves and 71 on untreated leaves.

Preliminary investigations indicate that the time required for streptomycin sulphate to enter leaves in effective or measurable quantities is influenced by the climatic conditions; for example, the period was reduced when treated plants were held at high (> 90 per cent) relative humidity.

When aqueous solutions of streptomycin sulphate containing up to 1,000 μgm./ml. streptomycin base were painted on proximal or distal half leaves, and plants placed in an atmosphere of greater than 90 per cent relative humidity, no antibacterial activity was detected in untreated areas by either bioassay or plant infection techniques. Activity was detected, however, in treated and washed half-leaves of the same plants. No indications of streptomycin translocation were obtained when a colloidal streptomycin formulation with high lipoid solubility properties was painted on half leaves or sprayed on half plants.

When whole peach leaves, except for the petioles, were placed in aqueous solutions of streptomycin, no reduction in streptomycin concentration was detected by bioassay, but when macerated peach leaf tissue was added to streptomycin solutions, the amount of activity detected in the supernatant liquid was considerably reduced[3]. The reduction was not due entirely to dilution or to a change in *p*H.

Charles[4] suggested that xylem elements may be negatively charged and therefore interfere with translocation of positively charged streptomycin molecules.

The work outlined above indicates that streptomycin can enter peach leaves following foliar applications, but no evidence can be found that it becomes truly systemic when applied to leaves. These findings are not inconsistent with the view that streptomycin may become bound in leaf tissues in some way following foliar sprays.

I am grateful to Dr. H. R. Thompson for statistical analyses and to Glaxo Laboratories, England, for supplying the colloidal streptomycin formulation.

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Effects of Temperature and Length of Day on the Sex Expression of Monoecious and Dioecious Angiosperms

IT has been demonstrated[1] that production of female flowers in *Cucurbita pepo* is delayed when plants are grown in high temperatures and during long photoperiods. Previous investigations indicated a similar effect of temperature and length of day on the sex of *Ambrosia*[2].

In natural summer conditions monoecious plants of *Mercurialis ambigua* L. fil. produce one female flower and a cluster of male flowers in each leaf axil. Ten plants were grown in 24-hr. photoperiods and thirteen in 8-hr. photoperiods throughout their lives at day temperatures of 26°–32° C. and night temperatures of 17°–21° C. All plants produced male flowers from the second foliar node upwards; but long days significantly delayed the production of female flowers. The average degree of femaleness attained at each node in each group of plants, as a percentage of the maximum possible, is given in Table 1. 100 per cent of femaleness at a node is reached when all plants of the group have two female flowers at that node.

In a second experiment, plants were grown in continuous light (8 hr. natural daylight supplemented by 16 hr. light at 500 ft. candles from a mercury lamp). Twelve of these plants were grown at a constant temperature of 24° C. and another twelve at 15·5° C.

Table 1. AVERAGE PERCENTAGE OF FEMALENESS

Day-length	Node numbers			
	2	3	4	5
8 hr.	3·8	61·5	92·5	100
24 hr.	0·0	15·0	35·0	80

Table 2

Temperature	Node number 2	3	4	5	6	7	8	9
24° C.	4·5	13·7	27·5	32·0	41·0	50·0	54·5	54·5
15·5° C.	67	100	100	100	100	100	100	100

All produced male flowers at each node; but development of female flowers was strongly delayed at the higher temperature. Percentage femaleness, shown in Table 2, was determined as in the previous experiment.

Female plants of *Cannabis sativa* L. are known to produce male flowers under certain conditions[3]. My investigations indicate that environmental conditions affecting the sex of monoecious *Cucurbita* and *Mercurialis* affect female hemp similarly. Female plants can be induced to grow through a male phase before reaching their normal female expression.

When plants were grown in continuous light for 45 days at a day temperature of 21°–26° C. and a night temperature of 15·5°–21° C. and then transferred to 8-hr. photoperiods at the same temperature, male flowers were produced at the lowest flowering node (node 7 or 8) of the female plants.

These results are particularly interesting as they indicate the possibility that growth of female as well as monoecious plants through a male phase before they produce female flowers is a general phenomenon. Female plants normally reach the female phase before flowers develop and usually produce no male flowers, but by artificially delaying the attainment of femaleness, male flowers are produced.

The work is supported by a grant from the Agricultural Research Council, and experimental facilities have been supplied by the Nuffield Foundation.

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Soil Transmission of Scottish Raspberry Leaf-Curl Disease

LEAF-CURL is the most important virus disease occurring in the raspberry-growing districts of eastern Scotland, where it has been known for many years[1]. It seems to be caused by raspberry ringspot virus, which can be transmitted by mechanical inoculation from raspberry plants with leaf-curl disease to plants of *Chenopodium amaranticolor* Coste and Reyn. and several other species[2]. None of the many kinds of arthropods tested as possible vectors transmitted the virus[2], and it seemed likely that the virus might be soil-borne.

In May 1955, soil was collected from the site of a recent severe outbreak of raspberry leaf-curl, potted and kept in a heated, insect-free glasshouse. Raspberry root-cuttings of the variety Malling Jewel were planted in the pots and also in pots containing the steam-sterilized potting mixture (John Innes potting compost No. 2) usually used. No symptoms of virus infection were observed in 1955; but in April 1956 fifteen out of thirty-two plants growing in soil from the leaf-curl site showed symptoms of leaf-curl. Local lesions were produced in leaves of *Chenopodium amaranticolor* inoculated with sap extracted from the leaves of each raspberry plant with symptoms: the *C. amaranticolor* plants were not infected systemically. Plants grown from root cuttings in sterilized potting mixture showed no symptoms of leaf-curl, and sap from them produced no lesions in leaves of *C. amaranticolor*.

It is also interesting that soil collected from the site of this particular leaf-curl outbreak harbours at least two other viruses. A virus of the tobacco-necrosis type was isolated from the first roots that grew on Malling Jewel root-cuttings planted in soil from the leaf-curl site: three out of eight plants contained the virus. No virus was detected in the roots of control plants grown in sterilized potting mixture. The virus resembled the tobacco necrosis viruses in producing large, discrete, necrotic lesions in the inoculated leaves of French bean variety Prince, in infecting plants of many other species without becoming systemic and in having a thermal inactivation point of between 90° and 95° C. when heated for ten minutes. No previous record is known of a virus of this type in raspberry.

Cadman[2] showed that sugar-beet seedlings became infected with a virus of the ringspot type when grown in potted soil from this leaf-curl site. I have repeatedly confirmed this finding by inoculating sap from macerated seedlings on leaves of *C. amaranticolor*, which develops local lesions and systemic symptoms when infected with this virus. Most of the infected seedlings were symptomless, and the virus appeared to be present more often in the roots than in the shoots of seedlings and never in the shoot only. No virus was isolated from sugar beet grown in sterilized potting mixture. Cross-protection tests in *Nicotiana tabacum* var. White Burley and in *Petunia nana* failed to show any relationship of the virus from sugar beet to raspberry ringspot virus. Its properties will be described elsewhere. Soils which, like the one used in these experiments, harbour three distinct plant viruses may be exceptional; but it seems more likely that soil-borne viruses are much commoner than has hitherto been suspected.

Raspberry ringspot virus and the ringspot virus from sugar beet both seem to resemble viruses of the tobacco-ringspot group. Many viruses of this type have been described, and they cause numerous diseases of economic importance: none is known to be transmitted by an arthropod vector from plants not infected by another virus, although it has been suggested that tobacco ringspot virus is transmitted by the aphid *Myzus persicae* from *Gladiolus* plants also infected with yellow bean mosaic virus to healthy *Gladiolus*[3]. The results described above now suggest that viruses of the tobacco-r[illegible] type may commonly be transmitted thro[illegible]

Scottish Horticultu[illegible]
In[illegible]

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[1] Harris, R. V [illegible]
Res. Sta. [illegible]

[2] Cadman, C. [illegible]

[3] Smith, F. [illegible]

FORTHCOMING EVENTS

Monday, September 10—Saturday, September 15

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH (at Government Offices, Horseguards Avenue, London, S.W.1)—Third International Congress on "High Speed Photography".

Thursday, September 13

OIL AND COLOUR CHEMISTS' ASSOCIATION, LONDON SECTION (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Mr. A. D Hibberd: "Recent Developments in Titanium Oxide Pigments".

Thursday, September 13—Monday, September 17

TEXTILE INSTITUTE (in the Congress House, Zurich, Switzerland)—Conference on "Static Electricity in Textiles".

Friday, September 14—Saturday, September 15

BIOCHEMICAL SOCIETY (on Friday in the Department of Biochemistry and Pharmacology, University College, Dublin, and on Saturday in the Department of Biochemistry, Trinity College, Dublin), at 10.30 a.m.—Scientific Papers.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LABORATORY MANAGER (with recognized engineering apprenticeship, and corporate membership of a senior professional Institution or equivalent qualifications, and broad experience in electrical and mechanical engineering)—The Establishment Officer, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting Ref. 550/2 (September 17).

MATHEMATICAL PHYSICIST (with an honours degree and research or industrial experience) IN THE RESEARCH LABORATORIES, Central Electricity Authority, Leatherhead, to carry out work with a mathematical background in applied physics, such as flame radiation, stress analysis, fluid flow or temperature turbulence, and to assist colleagues with the mathematical side of their work—Director of Establishments, Central Electricity Authority, Winsley Street, London, W 1, quoting N/644 (September 17)

CHEMIST (with a university degree, or equivalent qualification, in chemistry, preferably with training in physics or geology, willing to spend periods of up to six months in the field on soil surveys) IN THE DEPARTMENT OF RESEARCH AND SPECIALIST SERVICES, Federation of Rhodesia and Nyasaland Ministry of Agriculture, for duties including routine and research work on soil fertility and on all related agricultural products and problems—Public Service Attaché, Rhodesia House, 429 Strand, London, W.C.2 (September 22).

RESEARCH ASSISTANT (with an honours degree in biochemistry or pharmacology) to work on the biochemistry of hypoglycæmic sulphonamides—Department of Pharmacology and Therapeutics, Queen's College, Dundee (September 22).

SCIENTIFIC OFFICER (with a university degree in agriculture or agricultural botany and a sound knowledge of the principles of genetics and practical plant breeding, preferably with experience in the inspection and certification of seed potatoes) IN THE PLANT BREEDING DIVISION, Ministry of Agriculture, Loughall, Co. Armagh, for work on potato breeding—The Secretary, Civil Service Commission, Stormont, Belfast, N. Ireland (September 24).

SCIENTISTS (with good honours degrees in physics, engineering, mathematics or a relevant social science, with ability to handle data and preferably with experience in industry or operational research) FOR THE SCIENTIFIC DEPARTMENT, Field Investigation Group, London Headquarters, National Coal Board, to assist in teams studying production and human problems in the coal industry—National Coal Board, Staff Department, Hobart House, London, S.W.1, quoting SS/379 (September 24).

SENIOR LECTURER IN PATHOLOGY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, September 24).

LECTURER IN BACTERIOLOGY—The Secretary of University Court, University, Glasgow (September 28).

ORGANIC CHEMIST [illegible] BIOCHEMIST (preferably with experience), to undertake synt [illegible] ioactive compounds for metabolic investigations at th [illegible] d Research Station, Institute of Cancer Researc [illegible] ital, Chalfont St Giles—The Secretary, Chest [illegible] ute, Fulham Road, London, S.W.3, qu [illegible]

[illegible] special interest in general, [illegible] TRY—The Registrar, The [illegible]

[illegible] Registrar, University [illegible] eptember 30)

[illegible] electrical engineer- [illegible] ce in the design [illegible] GE OF NUCLEAR [illegible] . B. Kipping, [illegible] bridge (Octo-

PHYSICAL CHEMIST or BIOCHEMIST for investigations on nucleo proteins and other biological substances—The Secretary, Cheste Beatty Research Institute, Fulham Road, London, S.W.3, quotin "J.A.V.B." (October 1).

SENIOR LECTURER or LECTURER IN PHYSICAL CHEMISTRY o INORGANIC CHEMISTRY at the University of Melbourne—The Secretary Association of Universities of the British Commonwealth, 36 Gordo Square, London, W.C.1 (Australia, October 12).

LECTURER IN SOCIOLOGY and a LECTURER IN BOTANY at the University of Natal—The Secretary, Association of Universities of the Britis Commonwealth, 36 Gordon Square, London, W.C.1 (October 15).

FELLOW (chemist, with experience in radiochemical techniques IN THE DEPARTMENT OF RADIOCHEMISTRY, Research School of Physica Sciences, Australian National University, Canberra—The Secretary Association of Universities of the British Commonwealth, 36 Gordo Square, London, W.C.1 (Australia, October 29).

LECTURER (with a university degree in electrical engineering preferably with experience in heavy electrical engineering and prepared to teach in this branch) IN ELECTRICAL ENGINEERING at the University of the Witwatersrand, Johannesburg—The Secretary Association of Universities of the British Commonwealth, 36 Gordo Square, London, W.C 1 (October 31).

DIRECTOR OF THE UNIVERSITY OF LONDON COMPUTATIONAL UNIT —The Secretary to the Senate, University of London, Senate House London, W C.1 (November 15).

AGRONOMIST (with a good honours degree and preferably with some practical experience) at the Gambia Rice Farm, to undertake experiments in the cultivation of irrigated rice and of alternative crops suitable for dry season cultivation under irrigation—The Director o Recruitment, Colonial Office, London, S.W.1, quoting BCD.63/12/08

ASSISTANT EXPERIMENTAL OFFICER (with a knowledge of biochemistry or chemistry) to assist in metabolism studies in the Director's laboratory—The Secretary, Rowett Research Institute, Bucksburn Aberdeenshire.

ASSISTANT REGIONAL TRIALS OFFICER (graduate in agriculture o botany, preferably with practical experience in crop production) a Norfolk Agricultural Station, Sprowston—The Secretary, Nationa Institute of Agricultural Botany, Huntingdon Road, Cambridge.

CHEMIST (with at least five years research experience in some field of polymer chemistry), to lead a team to carry out a basic study of the mechanism, kinetics and properties of linear type polymers—The Director, Inveresk Gate, Musselburgh, Midlothian, Scotland.

CHIEF ENGINEER (with a degree in civil engineering and at least five years experience in high level administration in the engineering field) IN THE DEPARTMENT OF HOUSING, Jamaica, to take charge of engineering section covering subdivision layouts and development, construction of houses, and workshop producing prefabricated components for houses—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.160/32/02/T.

GEOLOGISTS (2) (with first- or good second-class honours degree in geology, preferably with a background of mathematics and physics) IN THE GEOLOGICAL SURVEY DEPARTMENT, for water supply work and general geological survey—The Director of Geological Survey, P.O. Lobatsi, Bechuanaland Protectorate.

GRADUATE (with a good honours degree in economics, preferably with statistics as a subsidiary subject, with an interest in manufacturing industries and aptitude for mathematical methods) in a department concerned with operational research and the relations and interactions of technology and economics, for duties primarily in problems concerning costs but also to participate in the other work of the department—Dr. D. W. Hill, Director of Research, The British Cotton Industry Research Association, Shirley Institute, Manchester 20.

GRADUATE IN ZOOLOGY or PHYSIOLOGY, to work on the breeding and feeding of small laboratory animals, mainly mice—The Director, Laboratory Animals Bureau, M.R.C. Laboratories, Holly Hill, Hampstead, London, N.W 3.

MATHEMATICS GRADUATE (with good knowledge of higher mathematics) for programming work for an electronic computer—The City Treasurer, City Hall, Norwich.

PHYSICIST or ELECTRICAL ENGINEER, Scientific Officer grade (with a first- or second-class honours degree in physics or electrical engineering, or equivalent qualification, and preferably with some electronics experience), with the Ministry of Supply, R.A.E., Aberporth, for research and development on electronic instrumentation—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.338/6A.

SCIENTIFIC OFFICER or SENIOR SCIENTIFIC OFFICER (honours graduate, or equivalent, in chemistry or biochemistry), for research work on amino-acids in animal nutrition—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire.

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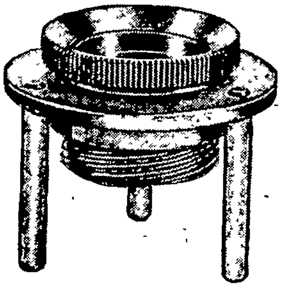

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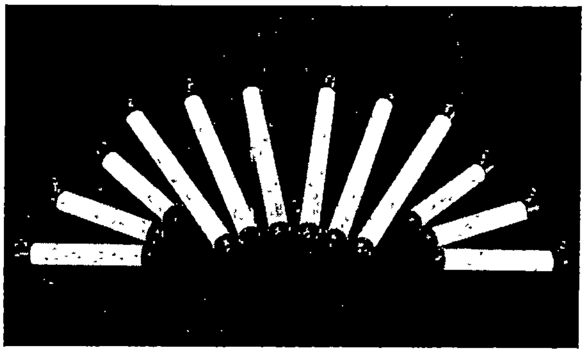

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Prospectus on application Tel.: NORth 1686

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Session 1956-57 Postgraduate Evening Courses begin September 24, 1956 Available subjects. Acoustics, Nuclear Physics, Optics, Physical Principles of Electronics, Quantum Mechanics, Semiconductors, Theory of Electro-magnetism. Ancillary courses include Elementary Electronic Circuit Theory.

Enrolment · Tuesday, September 18, and Wednesday, September 19 6 to 8 p.m.

New students should make early written application to the Secretary, Physics Dept, Chelsea Polytechnic, Manresa Road, S.W.3, for further details.

IMPERIAL COLLEGE

CHEMICAL ENGINEERING DEPARTMENT

Course of ten lectures on "The Principles of Explosion Prevention and Control" by Dr. J H Burgoyne, Mondays at 2 30 p.m., commencing October 15, 1956.

Further details from Deputy Registrar, City and Guilds College, Exhibition Road, S W 7

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COURSE FOR B SC. (SPECIAL) DEGREE IN PHYSICS

A course of four years duration suitable for students engaged in industry will begin on September 24, 1956. Students will attend two terms full-time and one term part-time each session and may register as internal students of the University of London

Application forms from the Principal, Chelsea Polytechnic, Manresa Road, S W.3.

UNIVERSITY OF BRISTOL

DIPLOMA IN PLANT PATHOLOGY AND PROTECTION

A postgraduate course leading to the above qualification will commence on October 1, 1956 The course is conducted in part at the Long Ashton Research Station, and includes opportunities for original investigation in any approved field of plant pathology (including entomology) or crop protection. It extends over a full session of three terms ending in June or July.

Honours graduates in botany, zoology, or chemistry, who wish to be considered for this course, should make early application to the Registrar, from whom full particulars may be obtained

SIR JOHN CASS COLLEGE

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The College prepares students by full-time, by part-time day and by evening courses in · Botany; Mathematics; Chemistry; Physics; Geology; Zoology, for the intermediate examination and the B Sc. general degree of the University of London for internal and external students and for the examinations of the Royal Institute of Chemistry, of the Institution of Metallurgists, and of the Institute of Physics. Full-time and part-time courses are also held for the B Sc. internal and external special degrees in chemistry, in mathematics and in physics, and for the B Sc. (Eng.) metallurgy degree. There are full-time courses for the London external special degrees in botany and in zoology. Facilities are provided for full-time and part-time research and postgraduate study and short courses of lectures are held on a variety of special topics

Applications for enrolment for the academic year 1956-57 may be made on forms to be obtained from the Secretary.

OFFICIAL APPOINTMENTS

UNIVERSITY OF BIRMINGHAM

DEPARTMENT OF EXTRA-MURAL STUDIES

Applications are invited for an appointment as Resident Staff Tutor. Applicants should have special qualifications in either (i) Physical Science or (ii) Industrial Studies (in which the tutor would be expected to develop work with industry in both trade union and management studies). The tutor's duties will be partly to organize extramural work in East Birmingham and partly to teach and develop work in his subject Salary in Grade II (£650 by £50 to £1,350 with efficiency bar at £900). Initial salary according to qualifications.

Applications (eight copies), together with names of two referees, should be sent by September 30, 1956, to the Director of Extra-Mural Studies, the University, Edmund Street, Birmingham, 3, from whom further particulars may be obtained

G. L. BARNES,
Secretary.

The University,
Birmingham, 15

THE ROYAL SOCIETY

ALAN JOHNSTON, LAWRENCE AN
MOSELEY RESEARCH FELLOWSHI

Applications are invited by the Council
Royal Society for the Alan Johnston, La
and Moseley Fellowship for research int
problems of human and animal health an
eases and the biological field related thereto
Fellowship will be tenable at any place ap
by the Council of the Royal Society Cand
should supply the usual personal details an
the names of two referees. Testimonials w
be considered. Applicants and referees at
tance may write direct to the address given
without first obtaining forms. The subject
proposed research and the place at which it
be carried out, together with the name
Head of the Department, should be given.
appointment will be for two years in the fi
stance, from January 1, 1957 (or such late
as Council may agree) and will be ren
annually up to a maximum of five years.
be subject to the conditions governing
Society Research Appointments. The stipen
be £1,250 per annum, with annual increme
£50 per annum, with superannuation bene
which the successful candidate will be requi
contribute 5 per cent of annual stipend a
which the Society will make a contribution
per cent.

Applications should be made on forms
obtained from the Assistant Secretary, The
Society, Burlington House, London, W.1
should be received as early as possible, i
case not later than October 1, 1956.

UNIVERSITY OF MANCHEST

Applications are invited for the pos
Lecturer in Engineering (Mechanical)
ference will be given to candidates w
major interest in heat transfer. A knowled
some aspect of Nuclear Engineering would
advantage University regulations permit tea
staff to read for the degree of M.Sc., and
Applications will also be considered
engineers who would be interested in a tem
appointment for two or more years. Salary
£650 to £1,350 per annum Membersh
F S S.U. and Children's Allowance Sc
Initial salary according to qualifications an
perience

Applications should be sent not later than
tember 30, 1956, to the Registrar, the Univ
Manchester, 13, from whom further parti
and forms of application may be obtained
plications by airmail (no forms) will be cons
from overseas candidates.

UNIVERSITY OF LONDON COMPUTATIONAL UNIT

Application is invited for the post of Di
of the Computational Unit which is to be
lished by the University and which wi
equipped with a Ferranti Mark II Mercury
tronic computer. The appointment will date
October 1, 1957, or other date as may be a
Salary £2,100 with family allowances and me
ship of F S.S.U.

Further particulars may be obtained fro
Secretary to the Senate, University of Lo
Senate House, W.C.1, to whom applications
copies), should be sent not later than Nov
15, 1956.

UNIVERSITY OF MELBOURN

AUSTRALIA

Applications are invited for a position of
Lecturer or Lecturer in Physical Chemist
Inorganic Chemistry The appointee will
pected to take up duty on or about Mar
1957 The salary ranges are: Senior Le
£A.1,850 to £A 2,150 per annum, Le
£A 1,300 to £A 1,800 per annum. Supera
tion similar to F.S S U. will be provided

Further particulars and information as
method of application may be obtained fro
Secretary, Association of Universities o
British Commonwealth, 36 Gordon S
London, W.C 1 The closing date for the
of applications, in Australia and Londo
October 12, 1956

A PHYSICAL CHEMIST OR BIOCHE
is required for investigations on nucleopr
and other biological substances. The p
permanent and superannuable, and is suitab
a candidate with the Ph D. degree. A gra
with a good honours degree in chemistry
wishes to work for the Ph D degree w
however, also be considered Salary acc
to age and qualifications —Applications, wit
names of two referees, and marked "J.A
should be sent to the Secretary, Chester
Research Institute, Fulham Road, S W
October 1, 1956

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Enrolment.

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Evening Classes, September 17 to 21, 6 to 8 p.m (1406)

RITISH RAILWAYS RESEARCH DEPARTMENT

ssistant Librarian (female) required in British ways Research Laboratories at Derby, prebly under 25 years of age. Good general eduion, with G C E. English and French (or man), preferably at advanced level Library ociation First Professional Examination or d general experience in library routine. Typing ntial. Duties would include cataloguing, ining and preparation of material for Monthly tracts Review, compilation of bibliographies, general library duties such as preparation of erial for binding, stock-taking, checking loans, Salary £198 to £572 (according to age) lical examination Free and reduced rate elling facilities

pplications, stating age, qualifications, etc., to sent to Director of Research, British Trans- Commission (British Railways Division), 222 ylebone Road, London, N.W 1

RINCIPAL SCIENTIFIC OFFICER REed by the Atomic Weapons Research Establnent, Aldermaston, Berks, to conduct a promme of research into certain aspects of weapon gn. The work embraces a wide field of int but will be mainly electrical in character. licants should possess a first- or second-class ours degree in physics or electrical engineer- and have at least three years' postgraduate arch experience in one or more of the followfields. (a) Spark or arc discharge processes Generation of high energy high voltage pulses. Capacitor development. Salary: £1,390 to 80 per annum Contributory superannuation me. Married officers now living outside the blishment's transport area will be eligible for sing on one of the Authority's estates; alternly assistance towards legal expenses incurred ouse purchase may be payable.—Requests for ication forms, by postcard, to the Senior Retment Officer at the above address Please te ref A 1,000/34.

ANCHESTER REGIONAL HOSPITAL rd have a vacancy for a male or female Junior ntific Officer in the Blood Transfusion Service. honours degree in science, pharmacy or biology sential Duties will consist of technical work he Blood Transfusion Service Laboratories ry £525 by £25 to £628 during a probationary od normally of three years, then it is £650 by (3) by £35 (3) to £845—Applications, stating qualifications, previous experience (if any). the names of two referees, should be sent ediately to the Director, Blood Transfusion ice, Roby Street, Manchester, 1, from whom her particulars may be obtained.

OMPUTOR REQUIRED BY PNEUMOosis Field Research Unit of N C B 's Scientific t, in London G.C E with mathematics at " level, or equivalent required. Appointment erannuable), according to qualifications and rience, within inclusive scales as either Scien- Technical Officer 3 (£472 to £642 male, £428 572 female) or Scientific Technical Officer 4 1s 6d at age 15, rising to £9 19s 7d male, emale at age 27)—Write, with full particulars ge, education, qualifications and experience, National Coal Board, Staff Dept, Hobart se, London, S W.1, marking envelope SS/385, re September 17, 1956.

INISTRY OF AGRICULTURE, FISHERIES Food require temporary Assistant Technical cers at London and Kendal. Duties concerned (i) production and distribution of agricul- l lime, (ii) fertilizer subsidy. Travelling ined Qualifications: degree in agriculture, at least 21 Starting pay £621 (London) (provincial) if 25 or over; less below age Maximum £918 (London) £878 (provincial) r for women—Forms from Ministry of our and National Service, Technical and ntific Register (K), 26 King Street, London, 1, quoting G.301/6A

IENTISTS REQUIRED BY NATIONAL Board's Field Investigation Group of Scien- Department at London Headquarters, to assist eams studying Production and Human prob- in the Coal Industry Good honours degree physics, engineering, mathematics, or a rele- social science is required, with ability to dle data, experience of industry or operational arch an advantage. Appointments (super- able) according to qualifications and experi- , within inclusive scales, as either Scientist 2 to £1,290 male, or Scientist 3, £617 to £1,125 —Write, with full particulars of age, eduon, qualifications and experience, to National Board, Staff Department, Hobart House, don, S W 1, marking envelope SS/379, before tember 24, 1956 For those interested, innal interviews can be arranged to discuss the with senior members of the staff.

WOOLWICH POLYTECHNIC

LONDON, S E 18
PRINCIPAL. J. S. TAIT, Ph D, B Sc., A R T C., M I.E E., M I Mech.E

Applications invited for: (i) Senior Lecturer in Organic Chemistry—high academic and research qualifications are essential, facilities for research available (ii) Lecturer in Inorganic and Physical Chemistry—candidates should be able to teach their branch of Chemistry to Special (Honours) Degree standard, facilities for research available The proposed salary scales are: Senior Lecturer, £1,350 by £30 to £1,550; Lecturer, £1,200 by £30 to £1,350; plus London Allowance of £36 to £48

Particulars and application form from Clerk to Governors, to be returned by September 21, 1956

UNIVERSITY OF LEEDS

DEPARTMENT OF LEATHER INDUSTRIES

Applications are invited for appointment as Lecturer in the Department of Leather Industries at a salary on the scale £650 by £50 to £1,350 a year, according to qualifications and experience Candidates should be graduates in chemistry with a knowledge of modern synthetic resins and rubbers and the person appointed will be required to give instruction in and to investigate the application of these to various leathers.

Applications (three copies) stating date of birth, qualifications and experience, together with the names of three referees, should reach the Registrar, The University, Leeds, 2 (from whom further particulars may be obtained) not later than October 15, 1956

WESTERN AUSTRALIAN MUSEUM AND ART GALLERY

DIRECTOR OF THE MUSEUM

Applications are invited for appointment as Director of the Western Australian Museum The salary range is £A 2,400 to £A 3,000 per annum with superannuation similar to the F S S.U. or under the State superannuation and family benefits act if that can be arranged Commencing salary will depend on qualifications and experience. Conditions of appointment may be obtained on application to the Agent General for Western Australia, Savoy House, London, or Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1.

Applications should be addressed as follows Hon Mr. Justice Wolff, President, Museum and Art Gallery of W A., c/o The Supreme Court, Perth, Western Australia. The closing date for applications is November 30, 1956

A. A WOLFF,
President

UNIVERSITY OF SHEFFIELD

Applications are invited for a post of Lecturer or Assistant Lecturer in Chemistry with special interests in general or inorganic or in physical chemistry. Salary scales: Lecturer £650 by £50 to £1,350. Assistant Lecturer, £550 by £50 to £650, with F.S S U and family allowance Initial salary according to qualifications and experience

Further particulars should be obtained from the Registrar, to whom applications (three copies), should be sent by September 29, 1956

UNIVERSITY OF SYDNEY

AUSTRALIA

Applications are invited for the position of Senior Lecturer in Aeronautical Engineering, to work in the field of Aerodynamics Salary will be in the range £A.1,800 by £A 70 to £A 2,150 per annum, plus cost of living adjustment (£A 52 men £A 39 women), and will be subject to deductions under the State Superannuation Act The commencing salary will be fixed according to the qualifications and experience of the successful applicant Finance available for home purchase to married male members of staff.

Further particulars and information as to the method of application may be obtained from the Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1. The closing date for the receipt of applications in Australia and London is October 8, 1956

UNIVERSITY OF LIVERPOOL

Applications are invited for appointment to the post of Lecturer in the Department of Applied Mathematics, at an initial salary within the range £650 to £1,000 per annum, according to qualifications and experience.

Applications, stating age, academic qualifications and experience, together with the names of two referees, should be received not later than September 20, 1956, by the undersigned, from whom further particulars of appointment may be obtained.

STANLEY DUMBELL
Registrar

BIRKENHEAD EDUCATION COMMITTEE

BIRKENHEAD TECHNICAL COLLEGE

Principal: C V. Vinten Fenton, M Sc., A M I Mech E., A M.I.E E

Applications are invited for the following appointments Science Department, Three Assistants Grade B (for physics, general chemistry, mathematics). Salaries in accordance with the Burnham Technical Report

Further particulars and forms of application may be obtained from the undersigned, to whom completed applications should be returned by September 22, 1956.

H. GLYN WILKINSON,
Director of Education.

63 Hamilton Square,
Birkenhead.

UNIVERSITY OF BIRMINGHAM

DEPARTMENT OF MEDICAL BIOCHEMISTRY AND PHARMACOLOGY

Applications are invited from science graduates for a research appointment (financed by the Colonial Products Council) in the Department of Medical Biochemistry and Pharmacology Applicants should preferably hold the degree of Ph D, and will be required to undertake investigations on natural products of potential pharmacological interest The salary will be in the Grade II Lecturers' scale (£650 to £1,350) according to experience.

Applications should be sent by September 15, 1956, to Professor A C Frazer, Department of Medical Biochemistry and Pharmacology, the Medical School, Birmingham, 15

G. L BARNES,
Secretary.

The University,
Birmingham, 15

CHELSEA POLYTECHNIC

Grade B Assistant required for temporary post for one year in the Department of Physics, mainly for classes of G C E (Advanced level) standard Burnham scale, commencing rate according to age, qualifications and experience

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D S.I.R REQUIRES AN ASSISTANT EXperimental Officer. Physical Chemist, at the Food Investigation, Low Temperature Research Station, Cambridge, to assist in studying the microbiology and chemistry of spoilage in eggs Qualifications: G C.E. Advanced level in Chemistry and Physics Over 22, pass degree or H N C in Chemistry generally expected. Salary £350 at age 18 to £755 (men) £350 to £675 (women) Equal pay scheme —Forms from Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W 1, quoting reference F 579 6A. Closing date September 22, 1956.

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EDUCATION FOR MANAGEMENT

IT is still less than ten years since the Urwick Committee issued its report on education for management and only nine since the British Institute or Management was established. In that period, owever, increasing attention has been given both o the selection of managers and administrators and o the training they should receive and where it is best given. Particular aspects of the broad problem have been discussed in connexion with the Civil Service and its reform, and following a report on ducation for management by one of the productivity eams which visited the United States in 1951, it has been discussed at conferences arranged by the Federation of British Industries and the universities of Great Britain as well as in connexion with the xpansion of university education in general and of technological education in particular. The Fleck Report on the coal industry in Britain emphasized he significance of leadership at the highest level or the efficient running of an industry, and also he importance of the coal industry, or any other industry, taking positive steps to throw up its own leaders, while Sir Eric James's little book "Education or Leadership" had already provoked a wider discussion on the implications of the post-war changes n the educational system of Britain.

There had thus been a good deal of discussion on the selection and training of managers before he recent public concern about automation had tressed the increasing importance of efficient management and the need for even greater care in the election and training of managers. At the annual general meeting of Unilever Ltd. on May 24, Lord Heyworth devoted a large part of his chairman's address to the importance of good management in industry, the qualities required in a manager to-day and the best means of finding and developing the necessary talent. Emphasizing that merit should be he only test of suitability for managerial rank, and hat no particular social or educational background s demanded, Lord Heyworth described briefly the methods of selection adopted by Unilever Ltd. For he scheme run in Great Britain, about half the uccessful candidates come from inside the firm, and of the external candidates most of them have had a university education; and Unilever's experience in he United Kingdom is that a degree in any field an form an adequate background and provide uitable mental training for the general side of business, though there are many posts for which a echnological education is essential.

Lord Heyworth remarks that the attitude of the universities to industry, as well as that of industry o the universities, is changing, and that the tradiional resistance to the employment of graduates is fast disappearing, while the universities are increasingly ready to co-operate with industry. He also aid that the most important training of the potential manager is done individually and on the job, and that it must be flexible and selective. There is no general scheme, and unless the right men are sent on the right courses, there can be a waste of time and even positive harm. For more senior managers the firm uses the opportunities provided by such institutions as the Administrative Staff College at Henley, and the advanced courses available at places such as the Harvard School of Business Administration, and he stressed the value of meeting in this way people from completely different fields of business, from the Civil Service and the nationalized industries. Industry, he remarked, should ensure that it sends students of high quality, and it can also help by seconding first-class men to assist on the instructional side; and if universities are to develop the teaching of business administration, he favoured the experiment of seconding the university teacher to industry for a year or two to gain an inside view of how industry works.

While the fullest use should be made of conferences and similar techniques for keeping a manager's mind supple and alert, it is also essential to delegate real responsibility. Special care, too, is necessary to avoid the dangers of inbreeding; but it is necessary to strike a mean, although more interchange between one business and another at senior levels has its merits in spite of practical difficulties. Unilever itself possesses an advantage in that the international diversity of its business enables it to widen the experience of many managers by postings to countries outside Britain. Such postings, and also promotions, are the work of 'placement committees', responsible for watching the progress of promising men and selecting and recommending the right man for the right vacancy. On the whole, this has proved the most satisfactory method; but methods of recruitment and selection and training require continuous examination.

Lord Heyworth's observations are the more interesting in the light of the report on "Management Succession" which was issued almost simultaneously by the Acton Society Trust*. In earlier reports the Acton Society Trust has already examined problems of training and promotion generally in nationalized industries. The present report is limited to the recruitment, selection, training and promotion of managers. It is not a manual of such methods, but represents the results of an examination of the policies and practices used for securing a succession of managers by more than fifty very large organizations, and attempts to set forth the lessons that can be learnt from their experience.

The general aim of the investigation, which was sponsored by the Joint Committee on Human Relations in Industry of the Department of Scientific Research and the Medical Research Council, and financed from Counterpart Funds derived from

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* Management Succession: The Recruitment, Selection, Training and Promotion of Managers. Pp. vii+139. (London: Acton Society Trust, 1956.) 10*s*. 6*d*.

United States Economic Aid, was to gain knowledge which might assist management both in the larger and also in smaller companies, where many of the problems are similar. First, it analyses the educational background and careers of existing managers, and particularly attempts to discover what opportunities existed in the past for promotion from the shop floor. Next, it reviews the problems encountered in recruiting, selecting, training and promoting these managers and the methods used for solving them, while finally the attitude of employees to the promotion policies of a few selected companies are summarized.

This report accordingly is a contribution to the solution of one of the key questions in industry to-day—that of ensuring an adequate supply of managers of high calibre; and one of its most startling findings is that one-third of the very large companies the practices of which were studied are making no systematic efforts to secure such a succession. Of the 3,327 managers whose background was studied, more than half began as manual or clerical workers and went only to an elementary or an ordinary secondary school. One in five went to a public school, more than one in four to a grammar school and only one in five has a degree, and less than one in five a professional qualification. Nevertheless, the analysis of the background of the younger managers suggests that the successors to present managers will be better educated and more qualified and that, as might be expected from the wider educational opportunities, the proportion rising from the bottom will decrease.

It is the next two or three chapters that are of particular interest to the scientist. An analysis of the background of present managers with the view of discovering which factors are most advantageous from the point of view of promotion indicates that arts degrees, and especially when taken at Oxford or Cambridge, are far more advantageous than science degrees, and technical qualifications come well below a science degree. Non-technical professional qualifications appear to be more advantageous, however, ranking well above a science degree and even above an arts degree except one obtained at Oxford and Cambridge. Men from major public schools seem to have done well whether they possess a degree or not; but the results of this study raise the questions whether different criteria are applied in selecting arts graduates and graduates in science or applied science, and whether the latter class of graduates are given adequate chance to show if they have qualities justifying promotion to the highest managerial posts. It should be noted, however, that the staff of research departments were not included in the sample; and at the other end the disadvantage under which men holding the position of foreman suffer suggests the question whether they are given a fair chance of training and selection for promotion.

These are questions which demand consideration not only within industry but also in planning the expansion of technological education and to some extent the development of university courses, particularly postgraduate, since there is evidence that higher degrees in any university or faculty are much more advantageous than science degrees, though les so than first degrees in arts. The greater educationa opportunities and the higher standard required fo management have clearly made most companies look to the universities to supply more of their futur managers. It is true, as Lord Heyworth points out that training for management must be given largely within industry, even if industry does not requir the assistance of the universities and colleges o technology in giving such training; but the univer sities will be in a better position to supply industry with the type of graduate it desires if industry co-operates more closely and indicates clearly th qualities it is looking for in the graduates it seeks.

Conferences arranged by the Federation of British Industries have already done something in thi direction; but this study by the Acton Society Trus directs attention to one aspect of the present search for talent that is particularly serious in the existing man-power situation. Competition is intense for th more able recruits, and few companies can get all they wish; yet there are great differences in th wastage of graduates between different companies For graduates in science and applied science, these have varied in the past five years from 6 per cent to 63 per cent, and the average of 29 per cent for twelv companies is too high to be regarded with indifference For arts graduates the average is 32 per cent; and it appears that many companies have much to learn about the selection, introduction and training o graduates; they do not seem to be aware of the principle that scarce material must be used with forethought and economy.

The elimination of such preventable wastage i one means of reducing the shortage of talent; bu few companies have paid sufficient attention to locating talent and developing it in their own organ izations. The experience of companies which have paid considerable attention to this problem suggests that, in the absence of an active policy, many who are suitable for promotion will be overlooked. In a large organization it is impossible for the directorate to b aware of all its potential talent, nor is it safe to rely on the judgment of a man's immediate superior, even if he is made aware of his responsibility for looking for promising younger men.

The search for talent is neither easy nor withou difficulties, some of which appear very clearly in the chapter in this report which discusses the effect o promotion policies on staff generally. The exact method adopted is, however, less important than the way in which it is used and the spirit behind it and it is clear from this report that if British industry paid more attention to the subject, to the inequalities of opportunity which exist in different departments and to the problems of introducing and training graduates, and took more care with fundamenta training and planned experience which really broadened the individual through varied experience and intellectual stimulus, there might be less need to complain of shortage of talent. Ambitious young men, both during their initial training and even more when it is finished, and before they are given real responsibility, must inevitably feel frustration from time to time, and attempts to meet this difficulty would help to reduce the wastage and might well contribute to the elimination of some of the absurdities into which the present severe competition for talent has led recruitment. Moreover, there are the intangible factors, such as the climate of opinion.

The study shows beyond question that the shortage of good managers, particularly at the top, is both more noticeable and more noticed than in the past. This is due partly to the greater demands made on management by the need to make the best possible use of limited resources in a setting of full employment; partly to the growing complexity of management, which necessitates a high standard; and partly to greater specialization, which makes it more difficult to produce general managers and has restricted the number of people suitable for a particular job. Automation, which is scarcely mentioned in the report, has made it even less likely that the right kind of manager will turn up spontaneously when required, and may well have increased the importance of those scientific and technical qualifications which at present seem to rank low as qualifications for promotion. Unless, in fact, industry gives much more attention to the planning of management succession and to the identification and training of potential managers at an early age, the shortage of managers is likely to become even more acute, and with increasing educational opportunities such early selection will become more and more important; managers will be drawn increasingly from a more highly selected group than in the past—from rather more restricted backgrounds with higher educational qualifications.

There is no one answer to the problems of management succession and development; but what matters above all is the attitude of mind which is brought to bear upon them. If a firm is to attract and retain able people, it must be apparent that able employees can get on and will not be overlooked, that managers themselves recognize management development as an important part of their responsibilities and that unexpected as well as expected managerial vacancies can be filled without difficulty with really well-qualified people from within. This is only possible if management at the top makes it manifest that it is really aware of and interested in such problems, and seeks to foster the all-important favourable climate of opinion.

Nor is all this a matter of concern to industry alone. The recent discussions on the introduction of automation have shown how closely efficient management touches on social and economic welfare. It is not merely that all grades of management will need fuller knowledge of the technical factors that influence their decisions. Good management can do much to soften the impact of technological innovation on labour and even directly on society; and while the prime responsibility rests on industry, the education policy of Britain could well be shaped to increase the probability that industry's intake at all levels will be equipped as fully as possible to seize the opportunities which industry puts in the way of its personnel. Nor should it be forgotten that the nation's interests, as well as those of industry itself, demand vision and enterprise as well as technical competence in its leaders, and that educational and economic policy contribute largely to the formation of the conditions and climate of opinion which favour enterprise and imagination.

These are all factors to be heeded in considering the expansion of technological education, the universities' plans for the next quinquennium, and economic and social policy in general, as well as the measures industry—as individual units or in concert and in co-operation with the universities—could take to secure a reasonable succession of managers of the highest quality.

PEACEFUL USES OF ATOMIC ENERGY

Proceedings of the International Conference on the Peaceful Uses of Atomic Energy

Held in Geneva, 8 August–20 August, 1955. Vol. 8: Production Technology of the Materials Used for Nuclear Energy. Pp. ix+627. Vol. 9: Reactor Technology and Chemical Processing. Pp. x+771. (New York: United Nations; London: H.M. Stationery Office, 1956.) 10 dollars; 70*s*.; 43 Swiss francs each vol.

THESE are two volumes which must be read by all the chemists, physicists, and metallurgists working on nuclear reactors, for they contain a vast amount of information on the fissile and fertile fuels, on the moderators graphite and heavy water, and on the canning materials such as beryllium, zirconium, steels, and aluminium. Many of the articles are exhaustive treatises on special subjects.

The importance of Vol. 9 cannot be over-estimated; it reports the sessions devoted to the metallurgy of thorium, uranium and plutonium, the fabrication of fuel elements, such as the stainless-steel liquid-metal bonded slugs used in the sodium-graphite and breeder reactors, and the dispersion-type elements as used in the materials testing reactor and in the 'swimming-pool' reactors. The use of liquid metals, and the corrosion they cause, is extensively reported almost for the first time, the chemical processing of irradiated fuels occupies a score of papers, and finally the storage and disposal of wastes are reported. The review of wastes with which the volume opens ought to have been grouped with Session 23*B* on wastes at the end of the volume.

It is unfortunate for the reactor metallurgist that fission occurs primarily in uranium, for no more obtuse metal could have been found! Fig. 30 of Foote's review paper on the physical metallurgy of uranium well illustrates this: a two-inch rod of uranium produced by swaging a cast bar elongates six times its original length merely as the result of cycling 3,000 times between 50° C. and 600° C. The first problem then is to ensure random orientation and fine grain-size; attainment of high purity and alloying can help this, and alloying can impart increased strength to withstand the internal forces created by the substitution of two atoms of fission products for one of uranium. Chiswick and Kelman's paper (557) and Pfeil's (416) report this subject extensively. Thorium, several times more plentiful than uranium, has a simple cubic crystal structure and so exhibits no such changes on thermal cycling. Carlson's very long paper on the metallurgy of thorium is exhaustive, dealing with many of the alloys in great detail and referring to the precautions to be taken in fabricating and machining this element and its alloys.

Plutonium is almost an unknown quantity metallurgically; it is a pity that there is no paper on the fabrication of the fuel elements for the breeder reactors in this volume; but the intermetallic compounds are described in paper 826.

Uranium is canned in aluminium tubes in several reactors, and we are indebted to Kiessling of Sweden for a good description of the solid-state reactions between uranium and aluminium over a wide temperature range, although we need a supplementary account of the effects of radiation on the boundary layers between these elements. Anodic coating of the inside of the aluminium can, or the provision of an aluminium silicon layer, delays interdiffusion up to 300° C. For higher-temperature operation the oxide of uranium has been considered in a short paper (559), and Howe reports (paper 825) the zirconium-clad rods for use up to 800° C. (or possibly 1400° C. for thorium–uranium systems), and the liquid metal (NaK) bonded rods in stainless steel for the breeder reactor. For lower-temperature reactors, especially the water-moderated reactors, and research reactors, uranium has been dispersed as UAl_4 throughout an aluminium mass afterwards clad in sheet aluminium to retain the fission products (papers 561 and 953 report fully on the materials testing reactor fuel elements).

The liquid metal technology holds great hopes for the future; the liquid-sodium (or NaK) cooling is essential for fast breeder reactors, while reactors employing the liquid bismuth–uranium, bismuth–thorium mixtures would—if successful—avoid the refabrication of fuel elements. There has been a lot of experience gained with Na (or NaK) over many years—it came as a surprise to me to learn that valves on all American aero-engines and on many American cars are cooled with liquid sodium. Paper 123 recounts General Electric experience on the first breeder reactor, and the problems of the important sodium-graphite reactor are fully described by North American Aviation. The liquid bismuth fuel breeder reactor is still being studied as a possibility, and paper 118 is exceptionally interesting in the descriptions of the use of titanium and zirconium as inhibitors in reactions between uranium and graphite and uranium and steel at the temperatures around 500–700° C. It is interesting to note that early use of inhibitors was developed by the General Electric of America for mercury boilers. Again, information is needed as to whether these inhibitors are equally successful in the presence of neutron flux, and metal loop tests threading through reactors are necessary.

In the Chemical Session 20, the Westinghouse paper (537) deals with the important problem of corrosion in the water-moderated power reactors operating at high temperature and shows the effectiveness of the 'Zircalloy-2', a zirconium–tin alloy, in reducing the effects of corrosion; apparently there is no complete solution in sight. Another way of avoiding chemical digestion and refabrication of fuel elements is to purify the fuel in molten metallic form by liquid metal solvent extraction—using an element such as silver which dissolves plutonium and many fission fragments, but is not dissolved by uranium. Voigt fully describes this in paper 592.

For the reactor metallurgist the interest of Vol. 8 lies in the records of Sessions 16 and 17, which dealt with the moderators and some constructional materials of reactors. There are massive papers from the United States on heavy water, graphite, zirconium and beryllium, supported by others dealing with special points of purification or analysis. This is another volume which shows the tremendous extent to which America contributed to the success of Geneva by disclosing so much secret work; but the contribution from some small countries such as Portugal and the Argentine are nevertheless important and most welcome.

Benedict surveys (paper 819) the production processes for heavy water; so far heavy water has been a by-product of processes which have borne the main cost of production. These, however, have not been and are not likely to be of a scale large enough for reactors of the future using heavy water as coolant and moderator—needing a charge of, say, 50 tons per 100 MW.; thus the Norsk Hydro Co. in the course of producing a million cubic feet of hydrogen per hour electrolytically for ammonia synthesis produces a mere 2 tons of heavy water per year. When huge quantities are needed, single-purpose processes will be required using water as the primary feed, and four of these processes are analysed in detail. There is need for further developments of catalysts to make these reactions cheap enough to compete with the by-product processes. A paper by Gaunt describes an infra-red absorption method of determining the deuterium content of heavy water, a method which could be applied to continuous monitoring.

The review by Currie *et al.* on graphite (paper 534) is very informative except on chemical analysis of trace elements. One of the major problems is the 15–30 per cent variation of the physical properties of graphite made from different sources of coke by the same processing methods. The Pechiney Co. in France reports similar variations of properties, and another paper from France deals with the estimation of boron in graphite down to a few parts in one million.

The zirconium paper by Shelton *et al.* reviews the early history of the Kroll and iodide processes for the manufacture of metallic zirconium after separation from hafnium. Initially the Kroll sponge was refined by the iodide process; but now after careful control of contaminants ductile metal is made by arc melting the Kroll sponge, and costs only £3 per lb. It is disappointing that in the section on alloys there is no reference to the important 'Zircalloy-2'. The separation of hafnium by the liquid counter-current extraction process is described; the Russian paper describes the recrystallization method of separation developed by Coster and Hevesy. No mention is made of the use of hafnium.

Beryllium production is described in papers from the U.S.S.R. and the U.S.A. The Russian method is the electrolysis of the fused chlorides (beryllium and sodium) followed by distillation of the metal *in vacuo*, and sintering of powder before hot pressing rods and tubes at 600° C.; the American method is the reduction process of the fluoride by magnesium yielding a metal of 99·5 per cent purity. Even after redistillation the metal is no more ductile than less pure samples and the conclusion is reached that, unlike zirconium, there is little hope that further removal of metallic impurities or oxygen will result in greater ductility. Alloying and the use of oxygen scavenging elements has led nowhere. The cost of the metal has been borne primarily by the beryllium–copper industry; but it is anticipated that the nuclear power industry will now cheapen production. It is interesting to learn that long exposure of the metal in the materials testing reactor (Idaho) caused no significant changes in properties.

The first half of this volume is devoted to the ores of uranium and thorium and the production of the metals, and makes interesting reading to the non-specialist. We learn that the ion-exchange methods are revolutionizing uranium ore processing plants and yield high-grade concentrates directly from the leach liquors. Florida processes ore in the form of phosphate for artificial fertilizer manufacture, so that 00 gm. of uranium per ton results as a by-product. Yugoslavia shales treated for mercury yield 136 gm. of uranium per ton as a by-product. Rich zircon ores of Brazil contain up to 4 per cent uranium. Many of the Witwatersrand ores mined for gold contain uranium (but no quantitative figures are given), and as the cost is borne by gold it is likely that uranium will now be extracted from low-grade ores. The Canadian and South Australian rich ores are mined solely for uranium, and no figures are given for these. The U.S.S.R. tells us nothing.

Thorium content of Brazilian monazite averages per cent and uranium 0·3 per cent; a very far-reaching paper (850) from the United States points out that due to the ionic radii of uranium and thorium these elements are localized in a small fraction of igneous rocks and that a high percentage can be leached from granite without digesting the rock as a whole. This opens up the possibility of extracting millions of tons of uranium; interesting, but will not thermo-nuclear reactions save us from dissolving up the world's granite?

T. E. Allibone

METALLURGY OF ZIRCONIUM

The Metallurgy of Zirconium
Edited by Benjamin Lustman and Frank Kerze, Jr. (National Nuclear Energy Series. Division 7—Vol. 4.) Pp. xviii+776. (London: McGraw-Hill Publishing Company, Ltd., 1955.) 75*s*.

IN 1948 the production of zirconium in the United States was measured in hundreds of pounds: by 953 it was measured in hundreds of tons. "The Metallurgy of Zirconium" is not only a reference book, but also gives some account of the extremely rapid scientific and technological development over this short period of time. It is an exhaustive treatise, and the editors are to be congratulated for assembling the efforts of more than fifty authors into a coherent whole.

The extraction methods, and in particular the Kroll and iodide large-scale processes, are dealt with in detail. A full chapter devoted to the latter process gives an excellent account of the development of an extraction method from virtually the laboratory scale to the full-scale production plant. This type of information is all too rare in technical literature.

Metals of interest in the field of nuclear energy are characterized by the stability of their oxides, carbides, nitrides, etc. Because of this, difficulties arise in the development of fabrication techniques; neutral heating atmospheres are normally needed, and the choice of container materials for the molten metals is very limited. In the case of zirconium, the development of arc-melting techniques capable of producing 1,000-lb. ingots has circumvented the container problem and is described in detail. Additional small-scale methods for melting are also described—namely, auto-crucible, skull, drip and levitation melting—all of which must be of interest where very reactive metals are concerned. Potential users of zirconium would do well to pay attention to the section of Chapter 6 on the recovery of scrap, which points out the many difficulties associated with reclamation of machine scrap. Powder metallurgy techniques which have proved of great value in the fabrication of beryllium and thorium, and to a lesser extent uranium, appear to be of less use in the case of zirconium but are obviously well developed. Zirconium of high purity is very ductile at room temperatures, and an account is given of a wide range of cold-working operations. Despite the great affinity of zirconium for oxygen at elevated temperatures, hot-working operations can apparently be carried out without the use of protective furnace atmospheres. Pickling in acid is afterwards required to remove the contaminated surface layers.

The chapter on the physical metallurgy of zirconium and its alloys leaves little to be desired, the only physical constant which proved difficult to find being the X-ray density. Partial or complete equilibrium diagrams are given in the appropriate section for thirty-two binary alloy systems, and brief results are given for a further five systems. Engineering data are given at length in the chapter on mechanical properties, and the marked effect of minor amounts of contaminants upon these properties is emphasized. These contaminants have an equally marked effect upon the corrosion behaviour of zirconium, as detailed in Chapter 11. Most of this latter information is made available for the first time, having been previously placed in the category of 'Classified' material. This is also true of a good deal of the information in other chapters, as is stated in the introduction.

It is difficult to find fault with this book. The overall impression it leaves is one of admiration for the technological achievements described; perhaps this feeling is tinged with envy for the scientific resources of the United States, where an effort involving at least fifty senior scientists and technologists, complete with supporting staffs, could be mounted to investigate the metallurgy of just one metal.

J. Williams

INTRODUCING GEOLOGY

Geology and Ourselves
By F. H. Edmunds. Pp. 256+12 plates. (London: Hutchinson's Scientific and Technical Publications, 1955.) 21*s*. net.

MR. F. H. EDMUNDS in his long experience on the staff of the Geological Survey of Great Britain has met with a lively interest in his science and its economic applications. Accordingly, he has written this introduction for the layman to show the importance of geology in everyday life.

Almost half the book is devoted to a simple general survey of geology. A short account of the early history of the subject is followed by a neat splitting of modern geology into its four main compartments : physical geology ; mineralogy and petrology ; palæontology ; and historical geology. This is followed by chapters on geological surveys and maps, on the relatively new sciences of geophysics and geochemistry, and finally an interesting short chapter on the methods of drilling boreholes in the ground.

The second half of the book introduces economic geology, and the author is able to draw upon his practical experience in the selection of some suitable British examples. There are chapters on water supply, building materials, engineering geology, coal mining, ores, petroleum geology, and on geology and agriculture. The penultimate chapter refers to a number of other aspects of applied geology, such as the problems of mining subsidence, but concludes strangely with a few paragraphs on early man. A final chapter touches briefly on the possibilities for amateur work in geology.

This book, as the author writes in his preface, is "in no sense a text-book". The second part would justify its inclusion in a school library, but otherwise it is suitable only for the general reader. Such a book, intended for the layman, should be attractively illustrated and interestingly written. Compared with some of the beautifully illustrated popular science works to which we are becoming accustomed, this book makes a poor impression. Of the photographs a few, such as the one of a fissure produced by mining subsidence, are impressive ; but others, such as the small aerial view of King George V Dock during construction, are of doubtful value. The diagrams throughout are uninspired, and the writing, though clear, is pedestrian in style.

Errors are few, though Chapter 4, on historical geology, contains several. It is stated, for example, that Great Britain "contains representatives of every one of the geological systems from the Cambrian upwards", while later, under "Miocene System", we find that "there are no Miocene deposits in Great Britain". In the stratigraphical table on pp. 76–77 Oligocene rocks are incorrectly referred to as being restricted to the Isle of Wight. In this table, too, the Devonian rocks are curiously listed stratigraphically as comprising Lower Old Red Sandstone, Marine Devonian, and Upper Old Red Sandstone. Finally, the placing of the Downtonian Series in the Silurian instead of in the Old Red Sandstone is not in accordance with the practice now followed by British workers on these rocks. There are several misprints in page and plate references which could easily have been avoided. The contents list on p. 5 contains two of these incorrect numbers.

C. H. HOLLAND

PROTECTIVE CURRENT TRANSFORMERS

Protective Current Transformers and Circuits

By P. Mathews. (Advanced Engineering Textbooks.) Pp. xv+253+4 plates. (London : Chapman and Hall, Ltd., 1955.) 36*s*. net.

MEMBERS of the staff of the British Thomson-Houston Company are preparing a series of advanced text-books on electrical engineering, and the second book of this series covers the subject of protective current transformers. This is the first book of any standing on this subject and will b welcomed by all concerned with the design and us of protective gear for the wealth of information i contains, supported by the authority of a leadin designer. Mr. Mathews does not shirk any of th difficulties of his subject and has written his book fo the benefit of workers in this field of engineering. I is scarcely to be considered suitable for engineerin students. The title of the book suggests two subjects but it is clear that the author is mainly interested i transformers : circuits are discussed only in so far a they affect the transformer design. It is perhap somewhat surprising that the author does not giv an introductory chapter surveying the whole field o protection and indicating the function of the transformer in this field, but apparently he assumes hi readers to be already well versed in the genera subject and he starts immediately on the transformer

The book is divided into two parts, the first dealin with design for steady-state conditions and the secon with design for transient conditions, which ar becoming more important with the increasing use o high-speed protection. Each chapter has its ow references—a procedure which is preferable to collecting all the references in one block.

The author bases his treatment on the linea theory of current transformation but does not mak clear why the vector theory is unsatisfactory. Hi development of the linear theory is on the whol clear and easy to follow except for some awkwar jumps. For example, he introduces ratio error befor he has defined ratio and he passes from the genera theory of coupled circuits to the theory applicable t single turns only without any clear dividing line This leads him into a minor error when he state that the leakage inductance of a toroidal secondar winding with respect to a bar primary is zero, statement which is only true for a single-tur secondary, although it is a close approximation for single-layer secondary. For multi-layer secondar windings the leakage inductance is negative. It i noteworthy, however, that minor blemishes of thi kind only occur in relatively unimportant places, an the author has evidently taken great trouble t develop a sound treatment of the important parts o his subject. The reading of the book is perhaps mad a little more difficult by the author's ruthless disregard of the standard symbols of the Britis Standards Institution. Some sympathy may well b felt for him when he finds himself at variance wit this Institution over the irrational definitions of rat error and the sign conventions for phase angle transformers adopted by this body ; he is on les sound ground when he uses a small 'e' to indicat current, small and capital letters indiscriminately fo r.m.s. currents, $\log_e$ instead of ln, and other variatio from standard usage. The coming of new words always an attractive occupation and the author ha allowed himself the luxury of creating the wor 'decroachment'. Whether others will accept th rather ugly word remains to be seen.

It is inevitable that the minor faults mentioned i this review should appear disproportionately im portant ; but there appear to be no major faults an the treatment of the transient operation of tran formers, in particular, is excellent.

It would not be out of place to include a word praise for the publishers and printers for the attracti lay-out of the book, the pleasing contrast betwee the type and the paper surface and the very fe errors.

A. H. M. ARNOLD

WORLD POPULATION GROWTH AND ITS REGULATION BY NATURAL MEANS*

By DR. C. B. GOODHART

University Museum of Zoology, Cambridge

RECENT discussions on the future of humanity have tended to be rather discouraging, and there are plenty of eminent authorities who are prophesying disaster. World population is now multiplying so fast that at the present rate it is bound eventually to outgrow its food supply, however much that can be increased, and then famine and disease will intervene to prevent further population growth, unless indeed the hydrogen bomb provides an effective and relatively humane alternative to more orthodox Malthusian agents. The only solution seems to be the immediate and universal application of a policy of deliberate family limitation, and few are so optimistic as to believe that this is either practicable or likely to be effective in time to save us from the crash.

It is important to remember, however, that population increase is primarily a biological phenomenon and that the arguments of Malthus, though mathematically sound, are based upon the assumption that man has some specific and constant rate of reproduction which will be the same in the future as in the past unless it is artificially altered. This is a biological assumption that remains to be proved, so I wish to consider whether there are any conceivable ways in which it could be falsified by natural, as well as by artificial, means. Predictions in human demography are notoriously uncertain, and Malthus's disregard of possible increases in production proved him wrong during the past century, so we will do well to examine rather carefully any other assumptions upon which his theories rest.

In the first place we must recognize that man has a rather low reproductive rate, compared with most other animals. A woman who has ten children is reckoned highly fertile, and with fifteen she approaches the prodigious, and yet the domestic pig, of comparable size and on much the same diet, produces as many every year. In man, multiple births are rare, women are fecund for only about half their lives, conception may be inhibited during lactation and more or less complete sterility is surprisingly common. These checks on fertility must be the result of natural selection, for if there had been any real overall selective advantage in higher fecundity it could easily have been evolved. Women are well adapted anatomically for nursing twins, and the tendency to have them is certainly inherited, so that their comparative rarity must mean that, owing probably to higher mortality, there can be no real selective advantage in multiple births even though, potentially, they could increase fertility. Is it possible that the mean fecundity of man could be still further lowered by natural selection? If it could be halved during the next few generations that would probably solve our problems. At first sight this seems unlikely since we usually think of evolution as a slow process working through hundreds of generations; but there is an exception to this rule, where populations are already genetically heterogeneous for the characters involved, especially where the heterogeneity, or polymorphism, results from a balance of advantage between opposing genetic factors. Here, any change in selection pressure may alter the balance quite rapidly and lead to large changes in the composition of the population by altering the proportions in it of the two opposing types.

In Great Britain, for example, we are polymorphic for hair colour and texture: dark, fair and red hair, curly and straight, are all common genetically inherited characters, and quite closely related races may have markedly different proportions of the various hair types, which, if they were subjected to selection, would not remain constant from one generation to the next. We are certainly also genetically heterogeneous for factors affecting stature, though here there are many genes involved and there is a graded series of different heights without any clear breaks as are found for the different hair types. The mean stature of the population seems to have increased by an inch or two since the Middle Ages, and this change may well be the result of natural selection if large people are more affected by food shortage and bad conditions of life than are small; improved conditions now allow more of the largest individuals to survive, so that the average height of the population has increased. There is plenty of evidence that man is also genetically heterogeneous for factors affecting fertility, and if the selective value of the different types were altered there would be a similar change in the mean fertility of the population, quite apart from any artificial restriction of family size. To take an extreme example, one type might have a mean family size of 10, and the other of 2 (though actually, as for stature, there will be a whole series of intermediates), so that a race with 90 per cent of the high fecundity type and 10 per cent of the low would have a mean family size of more than 9, while in another, with the proportions reversed, it would be less than 3. If for any reason these proportions were to be changed in the course of time as a result of natural selection the mean fertility would be greatly altered, and if the selection was strong an effect would be shown after only a few generations. In human beings, of course, fertility depends not only on natural fecundity but also on psychological and social factors which may limit the fertility of physiologically fecund individuals; but these other factors, like physiological fecundity, may well be at least partially inherited.

The present rate of increase in the numbers of man is quite exceptional; the population of the world has certainly doubled and may have trebled itself in the last half-dozen generations; but the increases have not been the same in all races and classes of mankind. We rightly pay most attention to the teeming millions of Asia and Africa which are now multiplying at such an extraordinary rate; but during the same period many races have had stable or declining numbers, and some are heading towards extinction. The African Bushmen, Australian Aborigines, Red Indians and Eskimoes should not be forgotten when the present mean rate of world population increase is extrapolated into the future. A century ago in Western Europe we had as high a rate of natural increase as any race before or since, and yet it has been arrested and even reversed, admittedly partly by artificial means, in four generations, and the same could happen with other races as well.

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* Paper read on September 5 before Section D (Zoology) of the British Association meeting at Sheffield.

The selective advantages of fecundity are obvious and they are particularly strong in dense populations living under unhygienic conditions and subject to acute epidemic disease and a high rate of infant mortality. Cholera and plague strike indiscriminately at rich and poor, strong and weak, alike, and where only a fraction of the children born can hope to live to rear families of their own, only the larger families will be represented in the next generation, irrespective of the quality of the individuals concerned, for small families are liable to be wiped out completely. Thus in these dense disease-ridden communities selection for fecundity is relatively stronger than for most other qualities. In primitive races of pastoral nomads or hunters, however, who live widely separated under hygienic conditions, disease may be less important and the principal limiting factors will be periodical shortages of food. Here fecundity loses much of its selective advantage compared with such other qualities as strength and intelligence, and may even become a liability. In a bad year an Eskimo might be able to find enough food to keep one or two children from starving; but if it had to be shared among ten all would be weakened by hunger and die. It is just these primitive nomadic peoples that seem unable to recover their numbers after they have been afflicted with diseases introduced from outside. Individually they are often more virile and fitter in all respects but fecundity, compared with other races living a much less healthy life in dense centres of population, who seem able to replenish themselves almost immediately after the most disastrous epidemics. Yet we must remember that for 99 per cent of his history man has lived as a nomadic hunter and food collector; the densely settled agricultural and urban communities characteristic of the last few millennia are really a very recent development. We cannot, therefore, assume that the high fecundity found in these dense and unhealthy aggregations of population are necessarily typical of the species; it might well have been evolved in response to these rather special conditions, and if selection pressures alter in the future, reproductive rates would alter too and might revert to the lower levels characteristic of our remote nomadic ancestors which would be more 'typical' of the species as a whole. Improvements in medicine, which would allow more children to reach maturity and so lessen the risk of extinction of lower fecundity lines, would diminish the relative advantage of high fecundity, which will have been disproportionately increased when man, at the dawn of history, abandoned his former more healthy nomadic way of life.

However, it is notorious that declining numbers are found not only in primitive peoples brought into contact with civilization, but also in many of the most advanced nations and classes, whose declining numbers certainly cannot be attributed to genetical selection by famine. It has been suggested that the conditions produced by civilization and a high standard of living may in themselves be unfavourable to fertility, and it is certainly true that the more or less stable population in north-western Europe at the present time owes much to the introduction of artificial methods of family limitation which are only practicable in relatively advanced and prosperous communities. However, the universal rule of declining numbers in advanced civilizations dates back long before the discovery of artificial means of bringing it about, and we must not overlook the possibility that those qualities leading to success in man may have become genetically correlated with relatively low fecundity, and there are some *a priori* arguments in support of such a view.

Under most conditions high fecundity has a clear selective advantage in itself quite apart from any other qualities with which it may be associated, but the less fecund lines will not survive unless they have other hereditary qualities of high survival value to offset the selective disadvantage of low fertility. It is obvious that a man with a dozen children, however ill-favoured, has a better chance of leaving grandchildren, as unpleasing but as fecund as their parents than his neighbour with one plain daughter; but an exceptionally good-looking and intelligent young woman has little difficulty in finding a husband, even though she may lack brothers and sisters. Brains and beauty, virtue and sex-appeal, wealth and social position—that does not exhaust the list of attributes that may influence a man in the choice of his bride before he considers her capacity to present him with a dozen children.

Francis Galton once showed that, in the British peerage, wealth in women was correlated with infertility. An heiress by definition comes of an infertile family, for otherwise there would be many to share her wealth, and many noble families have become extinct through the love of heiresses whose riches were matched by their infertility. We may now put forward another rule, that not only wealth but also nubility in women is likely to be associated with infecundity. Attractive girls will usually marry, and the fecund will have large families while the less fecund will do their best and will certainly leave some descendants in future generations. Unattractive but highly fecund girls will be less likely to marry; but those that do will have plenty of children so that, as a group, the unattractive but fecund will also leave descendants. However, the group that is both unattractive and infecund will be at a double disadvantage and so will tend to be under-represented in future generations. Consequently in each generation, owing to the elimination of this last group, we would expect to find that the mean fertility of nubile and attractive mothers should be below that of the less attractive. This proposition cannot easily be proved. There seems to have been a regrettable lack of research on nubility in women; but as an illustration of what is meant we may consider the breeding record of King Louis XV of France and Mme. de Pompadour, the subject of a recent biography by Miss Nancy Mitford. The King took as his wife the Princess Maria Leczinska of Poland, aged about sixteen and probably deliberately selected for dynastic reasons on account of the splendid record of fertility in her family. She developed into a plain, healthy and rather dull woman who enjoyed the King's not undivided attentions until, at the age of twenty-seven, her reproductive career ended with ten children of whom six survived to maturity. Mme. de Pompadour then took over the far from nominal duties of *maîtresse en titre*, which she performed to general satisfaction for nearly twenty years. She was aged twenty-three when she met the King and had had one child who died young; but though she is said very much to have wanted children by the King, and had several miscarriages, she had no further living children; the King himself left plenty of evidence elsewhere of his own continued fecundity. Mme. de Pompadour, who was considered one of the most attractive, intelligent and accomplished women of her time, came of a bourgeois family that had risen in the world to a position of considerable affluence, and her own mother, married at an early age and renowned more for her beauty than her virtue, herself had only two children. The contrast in fertility between the nubile mistress and the unattractive Queen is striking.

Using similar arguments we would expect that most other human characteristics leading to success in life will become genetically associated with lower fecundity, quite apart from the fact that in more advanced communities low fertility in itself usually results in a higher standard of living.

We know that in animals and plants genetic characters are usually only maintained at the highest level if they are subject to continuous selection, and that there is a loss of fitness as soon as selection pressure is relaxed; this process has been called 'genetical erosion' by Prof. S. C. Harland. There is probably an example of this effect in man with milk yield. A considerable number of civilized women are unable to feed their own babies, although in more primitive races mothers seldom have this difficulty, so long as they are adequately fed. The easier life of civilized women is unlikely to be the direct cause of their inability to produce sufficient milk; but, since artificial feeding is now perfectly satisfactory, selection against low milk yield has ceased. In less advanced peoples, on the other hand, the only children to survive infancy are those whose mothers did have an adequate milk flow. In domestic cows milk yield has been greatly increased in a few generations by deliberate selection, and in civilized man the reverse seems to have happened, also in quite a short time, as soon as selection was relaxed. So also, if selection for the highest fecundity is relaxed, we would expect to find a fall in the average fecundity of the population, as is in fact seen in advanced races with low mortality.

I have suggested that, in man, the more desirable qualities are likely to become genetically associated with lower fecundity, and that there is good evidence that man is genetically heterogeneous for factors affecting fertility. It is likely that this heterogeneity will be maintained by a balance of advantage between higher fecundity on one hand and other qualities of high survival value associated with lower fecundity on the other. It is indeed hard to see how the observed heterogeneity could exist at all unless there was this compensating factor, for without it the lines of lower fecundity could never survive in the face of natural selection. Any equilibrium of this type will be an unstable one, and will be disturbed if the mortality-rate in early life is altered; if it is lowered the *relative* advantage of high fecundity will be diminished, and so we would expect the lower fertility lines to show a proportionate increase.

All this, of course, is rather speculative, and since experiments are impossible really conclusive evidence one way or the other is very difficult to obtain. It may, however, be instructive to consider the population problems of Ireland, which do suggest that selection against fecundity may have had important results over quite a short period. Before 1750 the native Irish lived in conditions of the direst poverty, and must have had a high infant mortality with correspondingly strong selection in favour of fecundity. The introduction of the potato then raised the standard of living, and there was an extraordinary increase in the population, similar to, but greater than, that occurring at the same time in England and elsewhere. In Ireland, however, the increased population supported itself almost exclusively on this one food crop until in the 1840's, in the words of H. G. Wells, "the weary potato gave way under its burden" and was blighted by disease, with the inevitable result of a disastrous famine followed by disease and emigration. In the normal course the formerly highly fertile population should have replenished itself rapidly and resumed its growth with only a slight check; but this did not happen, and the population of Ireland has continued to decline until now it is barely half of what it was in 1840, though most neighbouring countries have doubled their populations during the same period. A probable explanation of this unexpected decline is that since the famine there has been rather strong selection against large families, though artificial restriction of numbers has probably been less important in Ireland than elsewhere.

In the first place, large families are likely to have been worse affected by the famine than smaller ones; where there were numerous children to share the little food available all would be weakened by starvation and may have died. Secondly, and even more important, emigration will have been selective. An only son who has hopes of inheriting the family farm, however impoverished, will not readily abandon it; but if it is to be shared among half a dozen brothers, most of them will be inclined to seek their fortunes elsewhere when times are bad. By 1850 the population of Ireland would have lost most of its more fecund members, leaving the task of replacement to the genetically less fecund who remained. For various special reasons this process is likely to have been continued. A girl's chances of marriage depended largely on the size of her dowry, and that was inversely proportional to the number of sisters who had to share what could be spared. The peasant economy required that adult children should remain on the family farm as unpaid workers, and this tended to advance the age of marriage and so to reduce the number of children born. That in itself was an important, though not a genetical, factor in limiting population; but it is also likely that the more enterprising and virile young men and the more highly sexed girls will have rebelled against these restrictions and left for abroad. The present low fertility in Ireland seems to be due largely to late marriage and failure to marry rather than to low fertility in those women who do marry young, and it is said that many people in Ireland nowadays are 'not the marrying type'. Their infecundity may be psychological rather than physiological, but it is none the less real, and psychological characteristics can be inherited just like anything else; their preponderance in the population could well be the result of selective emigration of those that *were* 'the marrying type'. This process, once started, will continue, for a girl who wishes to marry but lives among a lot of confirmed bachelors will be all the more likely to try her luck elsewhere. Although economic impediments may be given as the reason for late marriages, they are unlikely to be its primary cause, for a much lower standard of life than that at present enjoyed in Ireland does not prevent marriage and procreation in many other countries, and it was not effective in Ireland before the emigrations. Nor is the influence of the Church to be neglected, the call to the convent or the priesthood will no doubt be all the stronger if there is little in the way of worldly wealth to be left behind, and it would not be surprising to find that the mean number of brothers and sisters to each priest and nun in Ireland was significantly higher than for married people of the same age-groups.

There is another important argument in favour of our suggestion that the selective disadvantage of lower fecundity is compensated by other characters of high survival value associated with it, and that is in the inheritance of intelligence. It is well known that in Great Britain at the present time really large families of ten or so children are often of low quality and below average in intelligence, and it has been suggested that since the less intelligent seem to be the most prolific this means that the average level of intelligence of the population will be falling, and that 'civilization is rotting at the core'. In point of fact the only really large-scale direct observations that have been made, on the intelligence quotient of school children in Scotland in 1932 compared with 1947, failed to show any sign at all of the expected fall in mean intelligence. This has been considered a very puzzling and unexpected result; but it is puzzling only on the assumption that the fact that the largest families are to be found among less-intelligent people means that as a group the less intelligent will leave proportionately more descendants in each generation. This is by no means self evident for, quite apart from possible higher mortality in large families of low quality, the data refer only to the low intelligence of the largest families but give no information about the mean family size of the less intelligent as a group. If intelligent people (though fewer of them have really large families) more often marry and have small families than do the less intelligent, they may well leave as a group as many descendants as the less intelligent, of whom a few have the largest families but a higher proportion leave no children at all. If this really is what happens, the mean level of intelligence of the population should remain constant and the Scottish results are puzzling no longer.

We might be able to get direct evidence of differential survival in high- and low-fertility lines in populations for which statistics are available of the distribution of family size two or three generations back. From these we could derive a figure for the number of great-grandchildren to be expected by women who had families of various different sizes, which could be compared with the number of maternal great-aunts and -uncles actually possessed by a sample of children from the latest generation. If they were below the expected number this would confirm our hypothesis that relative infertility a few generations back had been compensated for by better survival and reproduction among the descendants of the infertile families.

To sum up, we have suggested that human populations are genetically heterogeneous, or polymorphic, for factors affecting fertility, and that this heterogeneity is maintained by a balance of selective advantage of high fecundity on one hand and other factors of high survival value associated with lower fertility, on the other. These other factors are seen to be mainly such qualities as intelligence and nubility, which by increasing the chances of success in life and of marriage should compensate for lower fertility, with the further possibility that better health and lower mortality may also be involved. In addition, the lower fertility lines may have a larger proportion of small families with fewer individuals leaving no children at all, so that the difference in mean fertility will be less than is suggested by a consideration only of the largest families in each group. An objection may be raised here, that there is little reliable evidence of this hypothetical association of desirable qualities with lower fecundity, and that to outweigh the very real disadvantage of low fertility the association should be too obvious to be overlooked. To this I would reply by asking another question. We know that more or less complete sterility is surprisingly common, affecting perhaps 10 per cent of married couples, besides those people who never intend to marry and who must be considered psychologically infecund. Such infecundity is generally intrinsic and not due to injury or disease, and it is therefore likely to be at least partly conditioned by inherited congenital factors. Since selection against infecundity is absolute, and stronger than for many rare and harmful though not actually lethal genes, how could any genes responsible for it possibly occur at anything like their present level in the population unless the lines that tend to produce infecund individuals had some important compensating advantage as compared with other lines in which the incidence of infecundity was lower?

If this genetic heterogeneity is maintained, as I have suggested, by a balance of advantage between high and low fecundity, the balance will be an unstable one, and the lines of high fecundity but otherwise of lower quality will be especially favoured in dense populations where mortality from disease is high and indiscriminate, and where small families may be entirely wiped out by disease before benefiting from their presumed greater intelligence or nubility. Such conditions have been experienced by man only during the past few thousand years, so that in many parts of the world at present the mean fecundity of the population is likely to be disproportionately high, compared with our more remote ancestors who lived a healthier life in which strength, and intelligence, rather than mere fecundity, had a higher survival value. Now that disease is being mastered and early mortality is becoming negligible, even though we continue to live in dense communities, families of lower fertility but otherwise of good quality will survive so that they can take full advantage of these better qualities in competition, and the balance of advantage should shift away from the lines of highest fecundity but otherwise of lower quality. It is to be expected, therefore, that at first when new medical techniques are introduced into formerly disease-ridden and fecund populations there should be a rapid rise in numbers; but as the less fecund lines begin to benefit from the new situation, and increase, the mean fertility should fall and the population should taper off to a new position of equilibrium at a much higher level of numbers and, perhaps, with a higher level of intelligence and other desirable qualities.

Sir Charles Darwin, in his stimulating and provocative book "The Next Million Years", adopts the Malthusian argument that, in the long run, human population must always be limited by food supplies, and there will always, or at any rate usually, be a large "starving margin", and he concludes with the challenge that "Anyone who disagrees with my forecast must try to get beyond a vague optimism. . . . In particular he must find a really solid reason which shows how the threat of over-population will be avoided . . . or else he will find that his imagination has gone so far out of the realms of reality that it contradicts the physical or the biological laws of nature".

I have tried to show that there may be, if not really solid reasons, at least plausible arguments not inconsistent with the biological laws of Nature, on the basis of which we may question the fundamental Malthusian assumption that human fecundity has some constant and rather high mean value which could only be altered by artificial means. It is at least conceivably possible that prosperity may provide its own solution to the problem by being the cause of a natural lowering of the rate of increase of the population. Whether my arguments have carried conviction, or whether we continue to believe in the essential correctness of Malthus's analysis, our actions at least will remain the same. No one seriously believes that we can or should deliberately limit increases in world food supplies, nor that we should withhold medical discoveries from over-populated regions, however much many may fear that the benefits they bring will in the end prove illusory. Nor does anyone doubt that these benefits will be the cause of an immediate and, in some parts of the world, at least, an undesirable increase in the present population, which should be restricted by all legitimate means, however much opinions may differ as to what means are legitimate. All I am suggesting is that it is just possible that what we are in any event bound to do may, if we do it in time, not lead our descendants inevitably to disaster.

EFFECTS ON AGRICULTURE OF CHANGES IN THE BALANCE OF NATURE

THE morning session on August 31 of Section M (Agriculture) of the British Association during the Sheffield meeting was devoted to effects on agriculture of changes in the balance of Nature. Mr. E. M. Nicholson, director-general of the Nature Conservancy, opened the session with a paper on "Ecological Research and Farming". He emphasized the common interest of the farmer, forester and nature conservationist in an adequate and well-directed programme of fundamental research into the basic processes of Nature, including soil building, the balance of supply and demand for water, erosion, and the natural control of animal populations. Successful management of Nature, whether for food-growing, timber-growing or conservation, is dependent on a greatly improved knowledge of such processes, which may prove the key to an increase in the rate of formation of natural 'capital' and thus raise the potential 'income' in the form of renewable resources, including vegetation and water. The Nature Conservancy's researches on woodland soils, for example, include studies of the role of different tree species as soil improvers and soil impoverishers, and comparisons of productivity under different species of hardwood trees and conifers compared with weight increases shown by sheep on identical plots scattered within the same experimental area. Other factors being measured include the amount of water used by plantations of trees which would otherwise be available for stream-flow and for water-supply undertakings. It is possible to measure the potential yield of water supply under alternative land uses and to analyse the parts played by, for example, evaporation and transpiration. The Nature Conservancy is now recording potential evapo-transpiration daily in both the east and the north-west Scottish Highlands and in Wales and the Pennines, with results differing considerably from those which had been theoretically predicted.

The maintenance and enhancement of natural 'capital' involve studies now in progress at Moor House Field Station on the management of peat moors and the part played by different types of land management and land use in causing or preventing erosion, which is occurring at a formidable rate, for example, in the Trough of Bowland. Tree stumps and cattle horns of prehistoric age are found even above the 2,000 ft. contour, far above the level at which either exists to-day, and there is little doubt that trees of some sort, if only rowans, alders and willows, could under suitable land management cover some of those areas again, interspersed with improved herbage. In some areas fertility might be raised by making good the chance absence of some soil-improving animal or plant, such as the small hardy strain of wild white clover adapted to high altitudes and heavy rainfalls which has recently been found in North Wales (cf. *Nature*, 176, 596; 1955).

In discussing the balance of Nature, Mr. Nicholson emphasized that it must be remembered that every natural event, whether or not caused by human interference, opens certain doors and closes others. Civilization, unfortunately, closes many doors permanently by excessive inroads into dwindling residues of so-called waste lands which are the last remaining reservoirs of irreplaceable stocks of genes evolved over millions of years.

Mr. Nicholson criticized popular attitudes towards pest control and quoted results obtained during nearly thirty years showing that the population of the heron in England and Wales has without control measures been effectively held at between 4,000 and 4,700 breeding pairs by ecological limitations. On the other hand, the wood pigeon has been greatly favoured by the systematic killing of its predators, such as sparrowhawks, and by the additional cover provided for breeding in young plantations. Control measures would be extremely difficult in face of these ecological stimuli to expansion. Rabbits became a major pest directly owing to human encouragement, and future rabbit populations will depend mainly on whether we have the will to prevent them, as we can, from returning to former levels.

Nature and its study should be regarded as intimately concerning farmers and foresters, who should aim at understanding and working with Nature, rather than using too many mechanical and chemical short cuts. A moralizing attitude towards our fellow predators on the Earth is out of place, and more understanding should be shown of their important role. As the fine and all-embracing tradition of the great estates has lost its impetus, ecological research may become the basis of a new and equally fruitful outlook, reconciling needs for growing food and timber with the need to keep the country worth living in for all its creatures, including people.

Dr. I. Thomas, of the Ministry of Agriculture, Fisheries and Food, read a paper on the "Natural and Artificial Control of Vertebrate Pests of Agriculture". He referred to that widely used and dangerous expletive, 'vermin', and gave illustrations of the different categories in which predators must be placed according to whether the point of view is that of growing crops or preserving game. In discussing the economic balance-sheet in Britain for the rabbit, he pointed out that while on the credit side rabbits have been estimated to yield products valued at £15 million annually, probably less than £2 million of this accrued to agriculture. On the debit side, estimated losses before myxomatosis ranged between £45 and £60 million. Rabbit trapping had, especially in its early stages, killed large numbers of predators, including foxes, weasels, stoats and polecats, and some of these predators had been exterminated over certain areas, thus helping greatly to enable the rabbit population to get out of hand. Dr. Thomas gave figures showing that the disappearance of rabbits has not greatly affected either the numbers of foxes or their depredations on livestock.

Dr. Thomas said that where rabbits have been seriously reduced, wood pigeons are now perhaps the farmer's greatest vertebrate pest; yet man has created the conditions for pigeons to multiply. Increased acreages under brassica and pea cultivation have provided much additional attractive food, and it is difficult to protect these crops by methods which are free of risk of killing game such as pheasants. More than 2½ million wood pigeons were reported to have been shot in England and Wales in 1955 and 445,000 during the first quarter of 1956. In this quarter alone, the cartridges probably cost more than £28,000, and 50 per cent of this sum could be claimed in subsidy. Adding this to the agricultural damage (which is very heavy also on, for example, clover leys), wood pigeons are costing Great Britain large sums of money. Dr. Thomas pointed out that while rabbits can be controlled estate by estate, relief from wood pigeon damage requires control over the whole national pigeon population. There is, therefore, little ground for optimism on this problem.

In a paper on "Insect Pest Balance in Agriculture", Mr. A. H. Strickland, of the Plant Pathology Laboratory, Harpenden, Herts, referred to the difficulty of relating the mathematical theories put forward by Lotka, Volterra, Nicholson and Bailey regarding growth and decline of populations to biological data so far available. Proponents of the probabilistic school have suggested, for example, that plagues of a grasshopper *Austroicetes cruciata* would occur in certain favourable areas five or six times in a century, but there is no way yet of forecasting when a plague will occur. Little work has been done so far on natural populations in the field; but ten years ago the National Agricultural Advisory Service Conference of Entomologists started routine assessments of the annual peak population densities of about a dozen insect pests throughout England and Wales, and six years ago the scheme was widened somewhat in scope to include detailed work on population density in relation to economic damage. In 1946 an 'Extensive Survey' was begun of the cabbage aphid (*Brevicoryne brassicae*), based on an annual random sample of about a hundred unsprayed brussels sprout crops throughout Britain. From 1951 this was supplemented by field-plot experiments set up in commercial sprout fields in the main sprout-growing areas. The results to date show that damage by cabbage aphid to brussels sprouts alone is equivalent to 4,500–10,500 acres a year, the average annual financial loss over the past ten years having been £868,000. Organo-phosphorous insecticide spraying, wherever economically justifiable, might have reduced this loss to about £500,000.

Ten years extensive survey has also been made of frit fly (*Oscinella frit*) infestation at harvest, and yield samples are being threshed at Rothamsted for the fifth season. Four experimental treatments have been tested. It appears that, on average in England and Wales, about 3 per cent of oat shoots are killed and about 5 per cent of oat grains are damaged by frost and second-generation larvæ respectively. This implies losses of 1·8 cwt. per acre from shoot destruction and a further 3·5 cwt. per acre from grain damage. The frit flies are thus estimated to cost farmers in England and Wales some £10 million annually. Complete frit control could raise the average national oat yield from 18·6 to about 24 cwt. per acre.

Mr. Strickland emphasized that toxic chemicals are at best palliatives, and are unlikely to provide a permanent solution, which must be sought by changes in agricultural practice leading to conditions less favourable to a high rate of increase of the pest. He cited A. Milne's recent findings that the sheep tick (*Ixodes ricinus*) can be largely controlled by minor alterations in flock management reinforced by re-seeding of old moorland pastures, while the wheat bulb fly *Hylemyia coarctata* can also be affected by suitable rotational and cultural practices. Aphid infestations can be shown to be less severe on fields of five acres than on larger fields, and even drilling a few rows of a cereal at appropriate intervals can mitigate losses from aphids. Finally, Mr. Strickland referred to the recent eradication of the screw worm *Callitroga hominivorax* in Curacao by releasing 16 million pupæ sterilized with gamma rays so that the normal females with whom the sterilized males mated laid sterile eggs. He concluded that further advances in understanding the environmental factors which prevent insect pests from increasing to an unlimited extent depend largely on development of co-operative field-work on the lines recently adopted in Britain.

There was an interesting discussion on a wide variety of topics arising from the papers. Mr. Cook (Ceylon) described difficulties met in coconut research from an even larger pest, the elephant, breaking into seed gardens despite deep trenches, powerful electric fences and other obstructions which were easily circumvented. Noise and the smell of burning rubber tyres appeared the best deterrents. Cattle had been induced to cease eating experimental plants by adding a special food supplement to their normal grazing diet.

Several speakers expressed concern over the problems of reconciling current game preservation patterns with agricultural needs, and asked that the subject should be explored.

This experiment in bridging gaps between the ecological and agricultural approaches was regarded as well-worth while, and the convergence of the views expressed from such different angles by the three speakers was remarkable, especially as regards the need for studying pest and other problems from an environmental or ecological point of view, rather than seeking chemical or mechanical magic wands.

SHEFFIELD LABORATORIES OF THE BRITISH IRON AND STEEL RESEARCH ASSOCIATION

OPEN DAYS

THE Sheffield laboratories of the British Iron and Steel Research Association are concerned mainly with research on steelmaking, metal working and ferrous metallurgy and are also a base for a section which deals with technical inquiries and investigations on the uses of iron and steel. They form one of the Association's five establishments: research on ironmaking, engineering, metal surfaces and coatings, with supporting departments of physics, chemistry and operational research, is done in London, Swansea and Middlesbrough, and the administrative headquarters are in London.

Open days were held at the Sheffield laboratories during September 6–7, when the opportunity was taken by a large number of visitors to view the work going on there. In the same building, and sharing the Association's general services, are three autonomous co-operative research organizations: the Cutlery Research Council, File Research Council and the Coil Spring Federation Research Organization.

Steelmaking

The Steelmaking Division is concerned with the hot metal when it leaves the blast furnace and until it has been turned into ingots. Current researches deal with the operation of open-hearth furnaces and electric-arc furnaces, the chemistry of steelmaking in each, and the problems of ingots and ingot moulds. Considerable emphasis is placed on the combustion problems of open-hearth furnaces, which produce about 90 per cent of steel in Great Britain. Research in the Association has shown what are the essentials of good burner design, and this knowledge is being widely used in the industry. Sulphur pick-up from the fuel and heat transfer are being studied on a 1/12 scale open-hearth furnace model.

The melting shop at the Association's laboratories houses a 10-cwt. basic electric-arc furnace, which has been used for studying the effects of different power inputs, changing the diameter of the electrodes, the height of the furnace, etc. Other work is concerned with desulphurization and close contact is kept with the more fundamental work on slag-metal reactions in the electric process, which is being carried out in London. The way in which mould dressings work has been observed by high-speed photography through a 'Pyrex' plate let into the side of a mould, and the properties needed in a mould dressing to give a good surface to the ingot have been determined.

During recent years, processes for continuous casting have been developed rapidly, and at least four experimental plants are working in Britain, two of which use a method patented by the Association. Research on the continuous-casting plant at the Sheffield laboratories includes the effects on quality of cooling-rate and of speed and temperature of casting.

Metal Working

The Mechanical Working Division is concerned with forming processes by which the ingot is made into a finished product. The processes comprise rolling, forging, extrusion, wire drawing and sheet metal working. The research also covers the plant and tools of metal working, and the mechanical properties of the products. Among recent and current work, prominence has been given to lines of research of immediate interest to the industry, and some important practical achievements are already claimed.

In rolling, much of the research has been, and is being, devoted to the automatic control of the thickness of strip being rolled. The Association holds several patents in this field, and last year the first industrial installation of its 'setting' method of automatic control of strip gauge was put into operation on a reversing cold-strip mill at the Lancashire and Corby Manufacturing Co. by the Davy and United Engineering Co.; several other installations at home and abroad are in hand. Current research is devoted to the operation of 'tandem' mills used, for example, in the manufacture of tinplate and motor-car bodies; a model three-stand mill has been built for the purpose, with some novel features incorporated.

Investigations of the reheating of ingots and billets for forging have led to significant improvements of present practices in heating. For example, cast ingots of high-speed tool steel can now be heated in an hour or less, as against overnight heating hitherto practised. Among results of recent industrial applications of this are a 25 per cent saving of fuel, a 50 per cent reduction of scale loss, and the elimination of decarburization. Attention is now being given to the mechanization of forging and the improvement of the control of forging plant. The 200-ton laboratory press has been fitted with a position-control system developed by the Association whereby forging is made more speedy and accurate.

In wire drawing, an invention by Prof. D. G. Christopherson of a method for inducing hydrodynamic lubrication has been adapted by the Association to conventional soap-powder lubrication. Full-scale trials in wire mills are more than fulfilling expectations, since dies last twice to ten times as long as previously. In another method, the wire is electroplated during drawing with a thin film of lubricant, which is transparent so as to preserve the high finish required for some applications.

Many other investigations are in progress. The stress–strain characteristics of a dozen steels at high temperatures and rapid rates of deformation have been determined for the calculation of rolling loads in hot rolling. Small steel bars are rolled experimentally as part of investigations into the mechanics of the rolling of sections. The causes of stretcher-strain markings and the mechanisms of their suppression by temper rolling, roller and stretch-levelling have been studied and are now understood more completely. The Swift test of the suitability of sheet metal for drawing and pressing has been further developed. The influence of tool geometry on the mechanical properties of finished forgings has been studied. Experimental investigations have been made of die pressure and drawing force, and of the temperatures in the interior of the die at the interface between the die and wire.

Metallurgy

The Metallurgy (General) Division deals essentially with the treatment, properties and uses of iron and steel. A considerable amount of the work is done extra-murally in university and government laboratories, or collaboratively in the works and laboratories of member firms, but specialist teams in the Divisional Laboratory deal with particular aspects of the work.

Theory suggested that stretcher-strain markings on steel sheet, when deep-drawn or pressed, were produced by the diffusion of nitrogen and carbon through the material. Experiments have confirmed the theory, and have shown that nitrogen has a worse effect than carbon. Transformer laminations are usually made of iron containing 3–4 per cent of silicon. Its magnetic properties are seriously affected by small amounts of impurities, particularly nitrogen. Reducing the nitrogen content of very pure silicon-iron from 0·007 to 0·004 per cent saved rather more than 10 per cent of the total losses, and the effects of additions of nitrogen are much the same in commercial material. The strength, energy and mobility of grain boundaries, which control such properties as brittleness, transformations and recrystallization of metals, are being explored by measurements of internal friction. Work is being done to improve the structure of high-speed tool steels.

Fatigue research was undertaken to determine statistically the variation in fatigue properties of wrought material from different ingots and from different parts of the same ingot for two different casts of steel. Statistically significant variations in properties have been found, but these are not thought to be of practical importance. Further work is in hand with a very-high-tensile steel. Increasing importance is being given to the production, in large quantities, of mild steel having a high resistance to brittle fracture. The effect of variations in rolling conditions, such as variation in the finishing temperatures of rolling, rolling schedules, etc., is being studied.

The analytical section provides a service to the whole Association and also undertakes analytical research. Special methods have often to be developed, for example, for the determination of trace elements, or when only very small samples are available. The characteristics of spectrographic source units and the sensitivity and reproducibility of analysis under various arc-like and spark-line conditions have been studied for a large number of elements normally present in steels.

Steel Users

The Steel Users Section of the Association is mainly responsible for answering technical inquiries on the uses of steel, undertaking *ad hoc* and short-term investigations concerning uses of steel and maintaining contact with the smaller member firms of the Association. Typical work concerns the establishment of the optimum heat-treatment procedure for the manufacture of specific products, investigations of obscure difficulties, and advice on matching the performance of components with steel specifications.

Associated Research Councils

The Cutlery Research Council is an autonomous and independently financed co-operative research organization formed in 1951 to work for members of the Sheffield Cutlery Manufacturers' Association. Its work is organized and controlled by the cutlery industry, but its staff are in close and constant collaboration with the British Iron and Steel Research Association, which provides services, background information on steels, and general assistance. At present the main research projects of the Council are: to improve methods for the production of blanks; to study cutting edges; and to study the grinding and polishing processes used in finishing cutlery. There is also a technical inquiry service, which gives confidential technical assistance to individual manufacturers on application.

The File Research Council is another autonomous and independently financed co-operative research organization formed in 1955 to work for members of either the File Trade Association or the File Manufacturers' Association. The unit is controlled by its member firms, but there is close collaboration with the British Iron and Steel Research Association, which provides services, background information on steel and general assistance. In addition to confidential technical inquiry facilities the Council has begun work on the metallurgy of file steels with particular reference to methods of heat treatment and on testing methods for both saw and engineers' files. The shapes of file teeth and methods of producing a desired shape are also being studied.

The Coil Spring Federation Research Organization has only recently taken over laboratory space at Sheffield; it is in the process of being equipped and expects to undertake active research work in the near future.

OBITUARIES

Prof. Walther Kossel

Walther Kossel, who died after a long illness on May 22, was one of Germany's outstanding physicists, both as a theorist and as an experimenter. He was born on January 4, 1888, into a family that included many men distinguished for their learning. In particular, his father, Albrecht Kossel, was a famous physiologist, long professor at Heidelberg. A students' torch-light procession in his honour, on the occasion of his being awarded the Nobel Prize in Physiology and Medicine, was one of the events during the time when Walther was working for his doctorate in Lenard's laboratory at Heidelberg.

After taking his doctorate in 1911, Kossel moved to Munich, where the University and Technische Hochschule numbered many names renowned in the physical sciences: men such as Arnold Sommerfeld, Max von Laue and Jonathan Zenneck, as well as the world-famous Röntgen. In this stimulating atmosphere he produced work of prime importance on the electronic structure of the nuclear atom, which was then in active development. In particular he dealt with the theory of X-ray emission and absorption, explaining for the first time the mechanism of excitation of the different series and the fine structure of the absorption edges in terms of the Bohr atom. Equally important was his work on valency and molecular structure in terms of complete electron groups, work which was fundamental for later developments. Together with Sommerfeld he put forward in 1919 the so-called displacement rule for optical spectra. Thus by the time he was in his early thirties, Kossel was known for basic discoveries in quite different fields of atomic theory. At the same time he learnt with Zenneck the latest developments of high-frequency electric waves and took part, during the First World War, in the development of electronic valves.

In 1921 he went as professor of theoretical physics to Kiel, which had a fine tradition, Lenard and Dieterici having held chairs there. Here he continued his work on valency and published a second edition of his "Valenzkräfte und Röntgenspektren", the title of which summarizes his work so far. In 1927 he gave evidence of his devotion to a new subject in his first work on crystal growth, in which he dealt with simple structures only, but in a way that lies at the basis of much recent work. In 1932 he followed his old Heidelberg friend Ramsauer by being appointed to a chair at the Technische Hochschule at Danzig; this time as professor of experimental physics, evidence of the range of his activities. Among his most important work here was the discovery of the interference effects produced by the characteristic Röntgen rays excited in a single crystal, in the first case a copper single crystal, the so-called Kossel effect, first announced in 1935. He also carried out distinguished research on the interference of electrons. The significance of his work was recognized by the award of the Max Planck Medal in 1944.

At the end of the War in 1945, Kossel escaped with his family from Danzig, leaving practically all his possessions there, and started again. After a troubled time he was in 1947 appointed professor at Tübingen, the charming town in Württemberg which had escaped undamaged from the war. Here he had an excellent laboratory and a most agreeable residence in the Physics Institute. A great variety of work was here accomplished under his inspiring guidance. Results were produced in the field of the diffraction of electrons and of light, electrical discharges in gases and in the subject of crystal structure, for which he made use of large spherical single crystals of metal, of the kind first produced by his old Heidelberg friend Wilhelm Hausser.

In 1953 his life was saddened by the loss of his beloved wife, who had shared all his troubles with never-failing courage and gaiety and who was always ready for work or play, as occasion demanded. He was already suffering from the illness that ultimately caused his death, so that his last years were in many ways clouded. But he was mentally clear and active until the end, and his plans for future work showed his old powers. He lectured by special invitation in Paris, for example, in 1955.

Kossel was a physicist whose work was throughout marked by clarity and imagination. The fundamental concepts for theory or experiment were simple and original, and they were carried out with remarkable thoroughness and closeness of reasoning. He was an excellent exponent and devised striking lecture experiments. Personally he was a man of great uprightness and warm affection, whose public life and family life were alike admirable. His loss will be widely deplored.

E. N. da C. Andrade

Dr. E. M. Lourie

Chemotherapy and tropical medicine have suffered loss by the sudden death on August 11 at Geneva of Dr. Emanuel Mannie Lourie, chief of the Section of Biological Standardization of the World Health Organization. He was born in Johannesburg on February 18, 1904, and studied medicine at University College Hospital, London, qualifying M.B., B.S. in 1928. He took the D.T.M. & H. of the London School of Hygiene and Tropical Medicine in 1930 and the D.P.H. in 1934; and he was elected M.R.C.P. in 1948. After qualifying he worked for various periods in Palestine, at the Liverpool School of Tropical Medicine and at Chicago with Prof. W. H. Taliaferro. In 1934 he returned to the Liverpool School as a Beit Memorial Fellow to work in close association with Prof. Warrington Yorke on the chemotherapy of trypanosomiasis. After the death of Yorke in 1943 Lourie was appointed as the first director of the Department of Chemotherapy of the Liverpool School of Tropical Medicine. During his whole association with the School he was one of its chief scientific ornaments, and in 1945 he was awarded the Chalmers Gold Medal of the Royal Society of Tropical Medicine and Hygiene. In 1948 he left the Liverpool School and after a short period in the Department of Pharmacology at Oxford he joined the World Health Organization, in which his work and his personality were highly appreciated.

Lourie's scientific work covered a wide field; but his main contributions were made in the chemotherapy of tropical infections. In the four years before the Second World War, he and Warrington Yorke discovered the diamidine compounds as a cure for trypanosomiasis and other infections. One of these compounds, pentamidine, was later found to have a prolonged prophylactic action, so that a single intramuscular injection is sufficient to protect against trypanosomiasis for more than six months. This compound has been used prophylactically on a wide scale in Africa and has made a large contribution to the conquest of human sleeping sickness there. Lourie took a major part in developing these compounds, both in Britain and in Africa. In 1943 he discovered that the new antibacterial agent, penicillin, was also very effective in curing mice infected with *Spirochaeta recurrentis*, the organism of relapsing fever. This finding obviously suggested that penicillin would probably be effective also against the organism causing syphilis, and Lourie in collaboration with others showed that this was in fact the case. His important discovery was, however, overshadowed by the simultaneous publications of American workers, and so it did not receive the recognition which was its due.

After the War Lourie showed that the newly discovered antimalarial compound proguanil ('Paludrine') would induce drug-resistance in the malaria parasite of chickens, *P. gallinaceum*. He also studied the melaminyl series of arsenical compounds and promoted the further investigation of these compounds in the field in Africa.

One of Lourie's later contributions to knowledge has only recently been properly appreciated. In 1950 he showed that the acidic compound, suramin, formed complexes with the basic compound pentamidine, such that the toxic action of the two was diminished but the prophylactic action against trypanosomes was greatly prolonged. Recently

Williamson and other workers of the West African Institute for Trypanosomiasis Research have extended this principle to other antitrypanosome compounds, for example, ethidium; compounds of this type will probably be very valuable in controlling the trypanosomiasis of cattle and in opening up for grazing large areas of Africa infested with tsetse flies.

In character Lourie was modest, quiet and reserved; he was a persistent and careful worker and showed great generosity to his junior scientific colleagues. He leaves a wife and one son. His loss will be felt by many friends throughout the world.

F. Hawking

Mr. Llewelyn S. Lloyd

Llewelyn S. Lloyd, who died on August 14, was one of the small band of able Civil Servants Sir Frank Heath brought with him from the Board of Education to help in the foundation in 1916 of the Department of Scientific and Industrial Research. Until his retirement in 1943 Lloyd faithfully served the Department, first as an assistant secretary and later as a principal assistant secretary, and there is no doubt his work contributed very largely to its survival as an efficient organization through the succession of economic blitzes of the years between the Wars. He disarmed the critics by keeping costs low, particularly those of administration, and by encouraging directors to obtain contributions from outside sources towards as many items on their programmes as possible. Though these policies were probably right in the particular circumstances of the time, he was perhaps inclined to carry them too far as the climate for research improved.

Possibly, for one in his position, Lloyd was apt to pay too great attention to administrative details. This, however, made him a most successful trainer of junior staff. To the auxiliary staff he often seemed something of a martinet; but even the most timid registry clerk found, in the end, that his bark was much worse than his bite. Although to his colleagues some of his own letters sometimes appeared too long, his insistence on clear thinking and its expression in forthright English led to his Department achieving a reputation for efficient administration.

The lines Lloyd laid down for dealing with Treasury officials have stood the test of time. "The Treasury," he would say, "can certainly require D.S.I.R. to reduce its demands for money and it must always be satisfied that our estimates are drawn as carefully and closely as possible, but it is not for the Treasury to criticise the scientific aspects of a project or the priority D.S.I.R. attaches to it. These matters have been considered by the Advisory Council whose advice has been accepted by the Lord President."

Lloyd had many interests outside his official work. These included gardening, golf and music. In his later years he was much attracted by the relation between music and science. He embodied his ideas on the subject in a volume entitled "Music and Sound", and spent much time in his retirement in developing them.

Probably few people saw eye to eye with Lloyd all the time; but his was a most endearing personality and those who knew him best count it a privilege to have worked with him. He gave the best years of his life to the Department of Scientific and Industrial Research, which owes him an enduring debt.

O. F. Brown

NEWS and VIEWS

Metallurgical Education in Texas: Prof. E. H. Bucknall

Up to the present, the metallurgical courses offered in the College of Engineering in the University of Texas have been somewhat limited in scope and number, being in the main optional subjects for students in mechanical or chemical engineering. With the recent great influx of industry to Texas and the prospect of intensive developments in the atomic-energy field, an increasing demand is being felt for engineers with a grounding in physical metallurgy, as well as for specialists in this subject. Under the inspiration of Dean W. R. Woolrich, who was for a time scientific attaché at the U.S. Embassy in London, it has been decided to expand the metallurgical content of the undergraduate engineering courses, to institute a master's degree in metallurgy and to sponsor metallurgical research. To carry through this programme, the University has appointed E. H. Bucknall as visiting professor of metallurgical engineering and he will shortly take up his duties at Austin. Prof. Bucknall, who was formerly connected with the National Physical Laboratory and with the Research and Development Laboratories of the Mond Nickel Co., Ltd., has recently returned from India, where he spent three years as director of the National Metallurgical Laboratory and ex-officio director of inspection (metals).

Messrs. Macmillan regret to announce that, as from the issue dated January 5, 1957, the price of *Nature* will be 2s. 6d.

British Iron and Steel Research Association

Mr. C. N. Kington has resigned his post as group manager of the Sheffield Laboratories of the British Iron and Steel Research Association, director of research of the Cutlery Research Council and research superintendent of the File Research Council, on appointment as chief mechanical and electrical engineer of Husband and Co., consulting engineers and architects, of Sheffield, London and Ceylon. Mr. Kington, who is a graduate of the University of Birmingham, received his early training in sound broadcasting and telecommunications. He served throughout the War in the Technical Branch of the Royal Air Force. Dr. J. Pearson, assistant director of the Association, will take charge of the Sheffield Laboratories. At the same time, he will remain head of the Steel-making Division; but he will relinquish control of the Chemistry Department, for which Mr. E. W. Voice, head of the Ironmaking Division, will become responsible. Mr. R. Mayorcas has been appointed deputy head of the Steelmaking Division. Mr. E. O. Oldfield has been appointed senior research officer of the Cutler Research Council in succession to Mr. Kington; and Dr. J. Pearson has been appointed consultant to the File Research Council, with Mr. R. H. Hancock continuing as senior investigator. Mr. J. G. Wistreich, who has been head of the Metal Working Laboratory in the Sheffield Laboratories, will become head of the Mechanical Working Division in succession to Mr. W. C. F. Hessenberg, deputy director of the Association, who is relinquishing control of the Division in order to devote the whole of his time to his other duties. Mr. S. S. Carlisle, head of the Association's South Wales Laboratories, becomes deputy head of the Division.

Biochemical Principles in Pharmacy

PROF. K. BULLOCK, in the chairman's address on September 3 to the British Pharmaceutical Conference, discussed "Biochemical Principles in Pharmacy". His survey covers enzymology, chemotherapy and disinfection, the relationship between dehydration and life processes and the architecture of living cells. He has achieved a valuable synopsis which presents a balanced account of important principles relevant to his subject and to hypotheses which appear promising. The historical approach and his sequences of discovery and thought, whereby knowledge has grown, are stimulating—the divergencies from one's own sequences can be intriguing. It is an unavoidable penalty to which even excellent surveys must submit that the illustration of a principle may over-simplify the explanation of cause and effect without consideration of every alternative. For example, the phenomena whereby bacteria can utilize a substrate which at first they could not attack, by enzyme induction, is real enough; but in some instances the phenomena can occur where the enzyme involved is constitutively present but inactive because of coenzyme deficiency. The presence of metal ions—including the monovalent ions—may also affect the activity of some of these enzymes, as the recent symposium of the Biochemical Society shows. Does the reference to the known relationship between the bactericidal properties of the sulphonamides and their antagonism to paraminobenzoic acid exclude other possibilities for sulphonamide action? These comments cannot detract from the value of this extensive and profitable review. When Prof. Bullock dealt with dehydration and life processes, he was in his own chosen field. Does he move almost imperceptively from a position of acquiescence in faith to one of faith in experience?

Engineering Studies in the U.S.S.R.

A BRITISH engineering delegation is to visit the U.S.S.R. this month to study engineering education and training. The nine members of the group were nominated by the Joint Committee of the Institutions of Civil, Mechanical and Electrical Engineers and the visit will take place under the auspices of the Soviet Relations Committee of the British Council. A return visit to the United Kingdom by a group of Soviet experts is under consideration. The group will leave London by air on September 16, returning probably on September 28. The programme in the U.S.S.R. will include visits to higher technical education establishments in Moscow and Leningrad. The group will be led by Prof. E. Giffen, professor of civil and mechanical engineering, Queen Mary College, University of London. Other members are: Mr. W. K. Brasher, secretary of the Institution of Electrical Engineers; Dr. B. N. Cole, Department of Mechanical Engineering, University of Birmingham; Mr. H. E. Dance, H.M. Inspector of Schools (Technical Branch); Dr. H. L. Haslegrave, principal of Loughborough College of Technology; Mr. G. S. C. Lucas, director and chief electrical engineer, British Thomson-Houston Co., Ltd., Rugby; Mr. P. E. Sleight, head of the Civil Engineering Department, Brighton Technical College; Mr. E. G. Sterland, principal, Apprentices' School, Bristol Aeroplane Company; Prof. A. S. T. Thomson, Department of Mechanical, Civil and Chemical Engineering, Royal Technical College, Glasgow.

Supply and Training of Teachers for Technical Colleges

A COMMITTEE, nominated by the chairman of the National Advisory Council on the Training and Supply of Teachers and the chairman of the National Advisory Council on Education for Industry and Commerce, has been set up to advise the Minister of Education urgently upon the recruitment and training of teachers for technical colleges. Its terms of reference are: "To consider in the light of the White Paper on Technical Education (Cmd. 9703) the supply and training of full-time and part-time teachers for technical colleges, and to make recommendations", and it is constituted as follows: Dr. Willis Jackson (*chairman*), director of research and education, Metropolitan-Vickers Electrical Co., Ltd.; Councillor R. McKinnon Wood (*vice-chairman*), London County Council; Dr. F. Briers, principal, Norwich City College and Art School; Sir Hugh Chance, chairman, West Midlands Regional Advisory Council for Technical, Commercial and Art Education; Alderman C. B. Jones, Yorkshire Council for Further Education; Mr. D. R. Mackintosh, Shell Petroleum Co., Ltd.; Miss Anne Shaw, director, The Anne Shaw Organization; Mr. J. G. Docherty, principal, North-Western Polytechnic, London; Mr. A. E. Evans, technical adviser, Association of Teachers in Technical Institutions; Mr. H. Wyn Jones, secretary, Welsh Joint Education Committee; Prof. R. A. C. Oliver, Sarah Fielden professor of education in the University of Manchester; Mr. E. W. Woodhead, Chief Education Officer, Kent; Mr. A. Maclennan, principal, Training College for Technical Teachers, Huddersfield.

Birlec Ltd. Apprentice Training Centre, Birmingham

BIRLEC LTD., furnace manufacturers, of Birmingham, have been training apprentices in their works for some considerable time; but in view of the company's plan for expansion and the need to ensure a continuing supply of trained men of the highest calibre, a new apprentice scheme has been launched and a new Apprentice Training Centre has been built specially. Four full-time instructors have been appointed, two of whom have held lecturing posts in the Birmingham College of Technology and the National Foundry College, Wolverhampton, respectively. It is anticipated that the new scheme will cost approximately £20,000 a year. The new Centre is accommodated in single-story buildings and occupies about 10,000 sq. ft. of floor space, with workshop, drawing office and lecture room facilities.

Two main courses are provided, 'technical' and 'craft', each of not less than five years duration. All trainees spend their first year on preliminary courses in the Centre to find the direction in which their abilities lie, and to give them an insight into the fundamentals of engineering with particular reference to those branches with which the Birlec Co. is concerned. After this probationary period, training is then continued in appropriate departments for the remainder of the five-year period, selected apprentices returning to the Centre for advanced instruction at an intermediate stage. All trainees are also required to attend suitable courses at local technical colleges for at least one day a week. Selected apprentices may be offered the opportunity of attending sandwich courses of four to five years at a college of technology, leading to qualification for membership of the appropriate professional engineering institution. There are at present about sixty apprentices in the firm, some forty of whom were recruited this year.

Swiss Society for Natural Sciences

THE 136th annual meeting of the Swiss Society for Natural Sciences will be held during September 22–24 at Basle. The opening address by the president, Prof. A. Werthemann of Basle, is on "Pathology of Embryonic Development". Dr. A. Wettstein of Basle will speak on "Aldosteron and Other Suprarenal Hormones", Prof. J. Piveteau of the Sorbonne on "Recent Progress in Human Palæontology in France", and Prof. E. Hadorn of Zurich on "Hereditary Constitution and the Formation of Characteristics". At a joint symposium, the Societies for Medical Biology and for Genetics will discuss "Malformation of the Gonads and Genetic Sex". The Society for the History of Medicine and Science will hold a symposium on "Medicine at Basle in the Baroque Period". A public session of the Swiss Community for Educational and Scientific Research Films will be addressed by Dr. G. Wolf, of Göttingen, and biological and medical films will be shown.

The meeting will be held in fifteen main sections. Foreign contributors include C. E. Tilley (Mineralogy and Petrography) and P. Tschumi (Zoology and Entomology) of Cambridge, and several from the East European Universities of Poznan (Anthropology), Budapest and Greifswald (Chemistry). In the Geophysical, Meteorological and Astronomical Section, Prof. J. Lugeon of Zurich will report on "The World Comparison of Radiosondes at Payern", and on "Measurements of the Electric Potential Gradient and the Conductivity of the Air by Radiosondes", and J. Häfelin and R. Lotmar of Zurich on the "Determination of Weather Effects on Skin Permeability (Experiments on Rabbits)". Prof. H. Hadwiger of Bern speaks in the Mathematical Section on "Selected Problems of Combinatory Geometry in Euclidian and Spherical Space". The Section for Logic and Philosophy lists four prominent speakers, Profs. Paul Bernays of Zurich ("From Syntax to Philosophy of Science"), Emil Walther of Zurich ("The Problem of Direct, Phenomenological Thought"), Felix Fiala of Neuchâtel ("Methodological Notes on Formalism") and François Bonnet of Geneva ("Irreversibility, Disorder and Chance"). The Society announces as the new topic for the one thousand francs Schläfli Prize (open only to candidates of Swiss nationality, closing date April 1, 1959): "Researches on the Distribution of Polyploid Plant Species in Switzerland".

Zoological Nomenclature

As from January 20, 1957, the International Commission on Zoological Nomenclature will start voting on the following cases involving the possible use of its plenary powers for the purposes specified against each case, full details of which have already been published (*Bull. Zool. Nom.*, 12, Pts. 4 and 5; July 20, 1956): (1) *depurator* Linnaeus, 1758 (*Cancer*), interpretation of, by neotype designated for (cl. Crustacea, order Decapoda); (2) *Cherax* (emend. of *Cheraps*) Erichson, 1846, and *Palinurus* (emend. of *Pallinurus*) Weber, 1795, validation (cl. Crustacea, order Decapoda); (3) *ferox* Gmelin, 1771 (*Accipiter*), suppression (cl. Aves); (4) *Maja* Lamarck, 1801, validation of and designation of type species for (cl. Crustacea, order Decapoda); (5) *Sao* Barrande, 1846, and *Ellipsocephalus* (emend. of *Elleipsocephalus*) Zenker, 1833, validation (cl. Crustacea, order Stomatopoda); (6) *Heteralocha* Cabanis, [1851], validation (cl. Aves); (7) *Acrodytes* Fitzinger, 1843, *venulosa* Laurenti, 1768 (*Rana*) and *tibiatrix* Laurenti, 1768 (*Hyla*), suppression (cl. Amphibia, order Salientia); (8) *Palaeophonus* (emend. of *Palaeophoneus*) Lindström and Thorell, 1884, validation (cl. Arachnida); (9) *Actinocrinus gilbertsoni* Phillips, 1836, interpretation of, by neotype (cl. Crinoidea). Comments should be sent as soon as possible to the secretary to the Commission, Francis Hemming, 28 Park Village East, Regent's Park, London, N.W.1.

Museum of Applied Science of Victoria, Melbourne: Report for 1954–55

THE annual report of the Museum of Applied Science of Victoria, Melbourne, for the year ended June 30, 1955 (pp. 17; 1956), records major steps in the general building programme which should go a long way to ease congestion. A special exhibit of a demonstration model of the Lurgi plant for the production of gas from the extensive brown-coal deposits in the Latrobe valley has been installed in the main entrance to the Museum. This semi-diagrammatic model was constructed by the staff of the Museum and shows each unit in section, starting with the high-pressure reaction unit and proceeding to the final gas-purification tower from which it will be piped to Melbourne. Each stage of the process is explained by a panel of text, which is illuminated in sequence by an automatic time-switch.

Extension to the Rowett Research Institute

THROUGH the generosity of the Wellcome Trust, the Rowett Research Institute, Aberdeen, is now able to go ahead with the erection of a building to house the special equipment for research in animal nutrition which the Rockefeller Foundation was prepared to grant to the Institute if a suitable building were put up for it. These awards by the Wellcome Trust and the Rockefeller Foundation—up to £5,000 and £4,900 respectively—will now permit the staff of the Institute to isolate and prepare, in larger quantities than can at present be achieved in its laboratories, microbial, plant and animal constituents for further identification, analysis and *in vivo* testing.

The Library Association

THE annual conference of the Library Association will be held at Folkestone during September 18–21, under the presidency of Mr. Edward Sydney. The programme includes papers on international librarianship (Dr. H. Coblans, head of the Information Service of the European Organization for Nuclear Research), libraries in colleges of technology (Mr. L. L. Ardern, librarian of the College of Technology, Manchester), libraries of the learned societies (Mr. K. D. C. Vernon, librarian of the Royal Institution), and on "Science, Humanism and Libraries" (Mr. D. J. Foskett, librarian and information officer of the Metal Box Co., Ltd.). There will also be an exhibition of books and library equipment. Further information can be obtained from the Secretary, Library Association, Chaucer House, Malet Place, London, W.C.1.

Ministry of Agriculture Postgraduate Awards

THE Ministry of Agriculture, Fisheries and Food has awarded the following postgraduate research and training scholarships in agricultural economics, agricultural engineering, husbandry and farm management, tenable in the first instance at the university or institute shown for periods of up to two years: *Agricultural Economics:* M. J. Dorling (Oxford), B. B. Perkins (Manchester), Miss P. M. Prosser (Reading), P. F. Romney (University College of Wales, Aberystwyth); *Agricultural Engineering:* T. H. E. Harrison, S. Moore and M. R. Potter (King's College, Newcastle upon Tyne); *Husbandry:* D. M. Allen (Nottingham), G. W. Arnold (Wye College), W. J. M. Black (King's College, Newcastle upon Tyne), M. W. Case (Long Ashton Research Station, Bristol), D. C. Dalton (University College of North Wales, Bangor), J. L. Hammerton (University College of Wales, Aberystwyth), B. Roscoe (King's College, Newcastle upon Tyne), P. J. M. Sale (Reading), D. B. J. Thompson (Reading), L. J. White (Wye College); *Farm Management:* D. Hardy (Reading), P. M. Harris (Leeds), D. Wilman (Leeds).

As part of the Conditional Aid Programme, the Ministry of Agriculture, Fisheries and Food announces that the following postgraduate scholarships have been awarded in farm management, tenable at the universities shown for a period of one year: B. J. F. James (Oxford), G. J. Tyler (London).

The Nature Conservancy: Awards for 1956

THE Nature Conservancy announces the following awards of research studentships for postgraduate training in ecology, tenable for periods up to three years at the universities shown: *Botany:* C. D. K. Cook (Cambridge); K. A. Kershaw (University College of North Wales, Bangor); A. Pettet (Southampton); Miss P. J. Warwick (Birmingham). *Zoology:* B. C. Clarke (Oxford); O. W. Heal (Durham); Miss J. Kear (Cambridge); G. H. Manley (Oxford). *Geology:* M. P. Kerney (London).

Physical Society: Awards and Officers for 1956–57

THE Council of the Physical Society has made the following awards for the year 1957: *Guthrie Lecture,* Prof. H. C. Urey; *Charles Chree Medal,* Sir Edward Bullard; *Duddell Medal,* Dr. C. E. Wynn-Williams; *Charles Vernon Boys Prize,* Dr. L. Essen.

The following have been elected officers of the Society for the session 1956–57: *President,* Prof. N. F. Mott; *Vice-Presidents,* Dr. A. B. Wood, Prof. S. Devons, Prof. F. Llewellyn Jones, Prof. H. Jones; *New Members of Council,* Dr. V. E. Cosslett, Dr. D. Gabor, Mr. E. S. Shire; *Honorary Secretaries,* Dr. C. G. Wynne and Dr. H. H. Hopkins; *Honorary Foreign Secretary,* Prof. E. N. da C. Andrade; *Honorary Treasurer,* Mr. A. J. Philpot; *Honorary Librarian,* Dr. R. W. B. Pearse.

Announcements

MR. A. L. BACHARACH has retired after more than thirty-six years on the staff of the Glaxo organization. His services in a consultative capacity are being retained for continued editorial work on "The Glaxo Volume" and on papers written by members of the Company's scientific staff for publication in scientific and medical journals.

THE Ministry of Supply announces the following appointments at the Royal Aircraft Establishment, Farnborough: Mr. E. C. Cornford, to be head of the Guided Weapons Department; Mr. D. J. Lyons, to be senior superintendent, Ballistic Missiles Division of the Guided Weapons Department; and Mr. P. A. Hufton, to be senior superintendent, Supersonics Division of the Aerodynamics Department. Mr. Cornford, Mr. Lyons and Mr. Hufton have all been promoted to the grade of deputy chief scientific officer on taking up their new appointments.

THE Institution of Electrical Engineers is arranging a convention on "Ferrites", which will be held in London at the Institution during October 29–November 2. The topics to be discussed will be the theory, preparation and properties of ferrites; microwave applications; square-loop applications; radio and television applications; and carrier-frequency applications. More than fifty papers will be read. Delegates will be attending from France, Germany, Holland, Sweden, the United States and, it is hoped, from the U.S.S.R. Further information can be obtained from the Secretary of the Institution at Savoy Place, London, W.C.2.

THE Clay Minerals Group of the Mineralogical Society is holding a meeting in London on November 2, at which "Clay Minerals and Soil Mechanics" will be discussed. Civil engineers and geologists will be particularly welcome at this meeting. Offers of papers and inquiries should be sent to the secretary of the Group, Dr. R. C. Mackenzie, at the Macaulay Institute for Soil Research, Craigiebuckler, Aberdeen.

THIS year's Convention of Chemical Sciences of the Société de Chimie Industrielle will take place in Paris during November 18–December 3 and will include a number of meetings (to be held during the dates indicated): an international congress of industrial chemistry (November 18–24); a European congress on corrosion (November 18–24 and on December 3); a European conference on chemical engineering (November 22–24); the Paris technical meetings of the Society (November 26–30); and a chemical, rubber and plastics exhibition (November 22–December 3). The first two will be at the Maison de la Chimie, and the others in the Palais des Congrès and the Parc des Expositions at the Porte de Versailles. Further information can be obtained from the Société de Chimie Industrielle, 28 rue Saint-Dominique, Paris 7e.

MESSRS. Oliver and Boyd have written pointing out that the price of "Physiology and Biochemistry of Lactation", by Dr. S. J. Folley, is incorrectly given in their advertisement in *Nature*, September 1, supp. p. iv, as 63*s.*; it should read 18*s.* 6*d.*

ERRATUM. In the communication on "Relationship between the Amine Contents of the Two Adrenal Glands of the Cat" by Drs. K. R. Butterworth and M. Mann in *Nature* of August 18, p. 363, legend to Fig. 1, for "hatched" read "clear".

THE ROCKEFELLER FOUNDATION

GRANTS made by the Rockefeller Foundation for the second quarter, 1956, have recently been published. The following are some examples of work being supported by the Foundation to a total of nearly seven million dollars.

For the first time a high-powered nuclear reactor will be equipped with a special opening to provide streams of energy solely for medical and biological research. The design of the new 1,000 kilowatt nuclear reactor now under construction by the Massachusetts Institute of Technology is being altered to include an extra port on one of its faces. The Rockefeller Foundation has appropriated 250,000 dollars for the addition of this special medical facility.

Research on low-cost, protein-rich foods to improve the diets of food-deficient populations will be the object of two projects which the Rockefeller Foundation will assist during the next three years. A grant of 250,000 dollars to the U.S. National Research Council will be used for studying the nutritional value of proteins in products available in under-developed countries. The London School of Hygiene and Tropical Medicine in England will use a grant of £17,000 for research on the biological value of proteins in tropical foodstuffs.

The Rockefeller Foundation has renewed its aid to the Rural University of the State of Minas Gerais, Brazil, with a grant of 200,000 dollars for the further development of its School of Agriculture and Agricultural Experiment Station during the next three years.

To support a programme of research on plant and animal genetics, under the leadership of Profs. H. J. Muller, T. M. Sonneborn and R. E. Cleland, the Rockefeller Foundation has made an outright grant of 350,000 dollars to the University of Indiana—an important centre for genetics research. The grant will enable Prof. Muller to continue his research on the modifications of individual genes. Prof. Sonneborn has developed an almost uniquely personal field of study by utilizing the rapidly reproducing *Paramecium* to show that inheritable characters depend not only upon chromosomal structures within the cell nucleus, but also upon elements which may be found in the cytoplasm and which behave in part like genes and in part like viruses. This discovery may have an important bearing on research in the heredity of mammalian cancer. Prof. Cleland, applying the genetic theory to the evolution of plants, has shown how a stable recombination of genes can be selected by environmental pressures to produce entirely new species. The work of the Indiana group is also being supported by the Atomic Energy Commission, the National Science Foundation and the American Cancer Society.

A 260,000-dollar grant will be used over the next three years for purchasing basic research equipment for two newly created science institutes at the University of Copenhagen. New buildings now under construction will house the institutes. The Institute of Biology's new building will permit expansion of existing departments of the Faculty of Science and the creation of new ones. The Marshall Plan, the Carlsberg Foundation, industry and the Danish State have combined to furnish funds for construction. The Institute of Experimental Medicine and Surgery, where research is concentrated in areas of medicine between the purely basic sciences and clinical fields, will also have new quarters. Danish insurance companies contributed a major share of the building fund, which was augmented by a government grant of land and money. Danish botanists, who have made significant contributions in the study and cultivation of arctic plants, will also have a new cold house where meteorological conditions in Greenland can be approximated. A portion of the current Rockefeller grant will be matched by funds from Danish sources for construction of the cold house as an adjunct to the Institute of Biology.

Of the many research laboratories which are making rapid advances towards an understanding of the nature of viruses, one of the most prominent is that of Prof. Barry Commoner at Washington University, St. Louis, Missouri. For general support of Prof. Commoner's research programme, the Rockefeller Foundation has appropriated 165,000 dollars, available during the next four years.

The collaborative biological and biochemical researches in genetics, cytology and evolution at the Johns Hopkins University, an integrated programme of the Department of Biology and the McCollum-Pratt Institute, will be supported by an outright Rockefeller Foundation grant of 100,000 dollars. Prof. W. D. McElroy, director of the Institute and newly appointed chairman of the Department of Biology, will lead the consolidated research programme. Prof. B. H. Willier, distinguished embryologist and recently retired chairman of the Department of Biology, will continue to be active in research.

Support for an unusual biological research programme in a liberal arts college setting will be continued by an outright Foundation grant of 100,000 dollars to Amherst College. Inaugurated at Amherst in 1934, the research activity is concentrated in genetics and embryology. Under the leadership of Prof. Harold H. Plough, chairman of the Department of Biology, the work has resulted in a substantial increase in the number of students entering on careers in the biological and medical sciences.

The molecular mechanisms by which fungicides produce their effects in controlling plant diseases will be studied intensively in a new research project at the Boyce-Thompson Institute for Plant Research, Yonkers, New York, directed by Dr. George E. McNew. A grant of 105,000 dollars from the Rockefeller Foundation will give partial support to this project over a five-year period.

To further the development of agriculture in Puerto Rico, the Bureau of the Budget of the Commonwealth will review the organization and administration of insular agricultural agencies through a survey to be supervised by Dr. José Noguera, director of the bureau. The Rockefeller Foundation has appropriated 85,000 dollars to the Commonwealth of Puerto Rico to assist with the expenses of the survey during the next two years.

As part of its world-wide programme to investigate and assist investigations of arthropod-borne virus diseases, the Rockefeller Foundation has appropriated about 73,800 dollars, available over the next five years, to the University of Malaya, Singapore, to aid further research on Japanese *B* encephalitis and other virus diseases by the Department of Bacteriology.

In support of basic research on the nature of viruses, the major effort of the Walter and Eliza Hall Institute of Medical Research, Australia, an eight-year grant of 60,000 dollars has been made by the Foundation. The programme dealing with various phases of virus research is under the supervision of Sir Macfarlane Burnet, a leading investigator of the biology of viruses and director of the Institute, whose studies on the genetics of influenza viruses have resulted in a series of highly important findings.

Two Rockefeller Foundation grants totalling 80,000 dollars have been made to Balwant Rajput College in India to aid rural students and to promote the development of an agricultural training centre on a new 436-acre experimental farm. An outright grant of 10,000 dollars will provide a scholarship and revolving loan fund for local students. The second Rockefeller appropriation of 70,000 dollars will be used over a three-year period for building and equipping classrooms, laboratories and a library at the new site of the College of Agriculture. The College, affiliated with Agra University, is successfully bridging the gap between agricultural theory and local practice in its efforts to improve rural life.

The biochemical research of Dr. J. H. Quastel, director of the Institute of Special Research in Cell Metabolism in Montreal, will be aided by a new five-year grant of about 56,650 dollars to McGill University. The work of Dr. Quastel has been supported by the Foundation since 1936, when he held a medical sciences fellowship. Dr. Quastel will conduct a new series of laboratory studies of the effects on the processes of cell metabolism of tranquillizing and other drugs used in the treatment of mental illness. One of the first biochemists to apply modern biochemical methods to study of the brain, he will return to this field of his earlier interest in view of important recent clinical findings on drug therapy and psychosis. His early discovery of the mechanism of action of barbiturates in depressing brain metabolism formed the basis of much of the later work done in this area. More recently, Dr. Quastel has been working with intermediate carbohydrate metabolism, certain aspects of protein synthesis, and the relation between proteins and fats.

A national survey of the attitudes of newspaper and magazine readers toward science and science news, sponsored by the U.S. National Association of Science Writers, will be financed by a 70,000 dollars grant from the Rockefeller Foundation. Available over an 18-month period, the grant will make possible a 2,000-person poll to be conducted by the Survey Research Centre of the University of Michigan. The grant will be administered by New York University.

An interdisciplinary research project on the relationship of cultural patterns and personality, at the Nagoya University, Japan, will be financed in part by a 60,000-dollar grant, available over a three-year period, from the Rockefeller Foundation. Prof. Tsuneo Muramatsu, professor of neuropsychiatry at Nagoya Medical School, will direct the study.

A research and training programme in Middle Eastern economic and cultural geography will be established by the University of Durham, to enable a group of scholars to study in the Middle East. In support of the project during a five-year period, the Rockefeller Foundation has appropriated £16,925 to provide a series of postdoctoral and junior fellowships. Prof. W. B. Fisher, head of the Department of Geography, will direct the programme.

The University of Cambridge will inaugurate a research programme in experimental animal psychology with partial aid from a Rockefeller Foundation grant of £15,000, available during the next five years. The new programme will be developed as the primary research interest in the Department of Experimental Psychology under the direction of Prof. Oliver Zangwill.

A new method of analysing changes in the birth-rate, the cohort system, will be used for assessing the main factors influencing population growth in the United States by the Scripps Foundation for Research in Population Problems at Miami University, Oxford, Ohio. Dr. P. K. Whelpton, director, will conduct a two-year study with Rockefeller Foundation support of 40,000 dollars. The cohort system uses groups, or 'cohorts', of women born in the same year and follows their child-bearing experience during the course of their reproductive life. Analyses based upon the cohort tables together with other data will be used by the Scripps Foundation group to prepare new and more accurate estimates of future population growth in the United States.

The deterioration of stored grain, a food problem of world-wide importance, and the basic chemical changes occurring in seed under varying storage conditions, will be studied by a group at the Kansas State College led by Dr. Max Milner, a distinguished cereal chemist. The three-year project will be financed by a 36,000-dollar grant.

Research equipment for a new laboratory of biochemistry at the University of Ferrara, Italy, will be provided over the next three years by a grant of 40,000 dollars from the Rockefeller Foundation. The new laboratory is under the direction of Prof. Enzo Boeri.

The School of Medicine of the University of Wisconsin will institute a research programme in medical genetics with partial support from a three-year, 25,000-dollar grant from the Rockefeller Foundation. Dr. Newton Morton, formerly a member of the Atomic Bomb Casualty Commission in Japan, will direct the programme.

Among other awards are: a total of 950,000 dollars to three Indian medical schools; a total of 365,000 dollars to three Brazilian medical schools; a grant of 290,000 dollars to a Japanese medical school; a grant of 250,000 dollars in support of the programme in international student exchange of the Institute of International Education, New York; a grant of 111,600 dollars to the American Library Association for the maintenance of an overseas library planning and development office.

Other grants have been awarded to institutes and individuals in the United States, Canada, Latin American countries, most European countries, Iraq, India, Pakistan, Thailand, Australia, Japan and the Philippines.

One hundred and thirty-one fellowships were awarded by the Foundation during the second quarter of 1956. These were distributed as follows: agriculture, 31; biological and medical research, 17; humanities, 31; medical education and public health, 41; social sciences, 11.

GRASSLAND AND THE FEEDING OF LIVESTOCK

THE Nutrition Society held a meeting in Reading on July 20 which took the form of a symposium on "Grassland and the Feeding of Livestock", a subject of major importance in relation to the improvement both of the efficiency of animal production and of human nutritional status. Prof. H. D. Kay (Shinfield) was in the chair.

The first contributor was Dr. William Davies (Hurley). In an introductory paper he laid emphasis on the unstable nature of the grassland sward, ever changing in one direction or another in response to environmental changes. Following the destruction by man of the primeval forests which at one time covered the greater part of the present cultivable area of Great Britain and his subsequent agricultural efforts, several types of grassland of different botanical composition and of differing agricultural value developed. These can be conveniently divided into six major types, from the ryegrass–white clover pasture at the better end to the *Molinia-Nardus* pasture at the poorer. Far from stable, the poorer types can be improved under suitable management—including fertilizer treatment and grazing—or the better types can deteriorate when improperly managed. In one recorded trial, for example, fertilizer (calcium, nitrogen, phosphorus and potassium) treatment of a mainly *Molinia* hill pasture not only completely changed the botanical composition of the sward in a few years but also gave nearly ten times the yield of herbage (measured in lb. of dry weight per acre per year). Even grazing alone (without added fertilizer) of such a pasture more than doubled the yield of dry matter per acre in less than ten years. One of the effects of the fertilizer treatment was to bring in species, such as rough-stalked meadow grass and white clover, which were not present at all in the original sward. Good pasture management and knowledgeable fertilizer treatment not only give greatly increased yields of consumable grass, but also extend the normal grazing season into the autumn and spring.

Prof. W. Holmes (Wye) discussed the so-called law of diminishing returns in relation to the application of increasing quantities of nitrogenous fertilizers to crops and grass. For cereal and root crops the response curve is logarithmic; thus, it has been found that for cereals each successive fertilizer dressing of 28 lb. of nitrogen per acre increases (on the average) the yield by 53 per cent of the previous increment. For leafy crops such as kale, the response is much greater, 28 lb. of nitrogen per acre increasing the yield by 78 per cent of the previous increment. For grassland the percentage response is greater still; given suitable temperatures and water supply, it is almost linear up to an application of 300 lb. of nitrogen per acre. Application of nitrogen also increases the efficiency with which water is used by the growing grass. A further factor arises when grass is grazed—namely, the return of nitrogen and other grass nutrients in the form of dung and urine; in effect, some of the fertilizer nitrogen is used more than once. Response to nitrogen treatment depends on climate, water supply, season and frequency of application. The situation is complicated since, owing to its content of legume, the normal clover–grass sward derives directly or indirectly substantial quantities of nitrogen from the clover (of the order of 150–250 lb. of nitrogen per acre per year). Application of small amounts of fertilizer nitrogen in spring is very harmful to the clover and gives, therefore, poor total response; but heavy dressings give good responses in terms of total yields per acre, since grass is greatly stimulated though the clover is suppressed.

The capacity of grass to respond to large amounts of nitrogen is outstanding, and from the point of view of farm economics, very cheap cattle food may be produced by the skilful use of nitrogenous fertilizers. Provided there is also mastery of the technique of the utilization of grass by cattle, the results in animal production may be very profitable. This latter aspect was dealt with by Mr. A. S. Barker (London), who, in his paper on fertilizer nitrogen and milk production from grassland, emphasized the great importance of skilled management in making optimum use for grazing animals of the increased production of grass. Taking one year with another, the joint effect of fertilizer plus management can be measured in a dairy herd by the output of milk per cow per year or per acre of grassland per year. Given appropriate grassland and livestock management, it has been shown in a series of trials on farms that the application of increasing quantities of nitrogenous fertilizer from 23 lb. of nitrogen per acre in steps of 23 lb. up to 115 lb. will increase the output of utilized feed at the rate of about 2–3 cwt. of 'starch equivalent' per acre for each increment of 23 lb. of nitrogen, and that at a practically linear rate. Mr. Barker stated that, from the profit-and-loss point of view, at prices current during the past two years, £1 spent on fertilizer has given a considerably greater return in milk production than £1 spent on purchased food.

Mr. W. F. Raymond (Hurley) spoke on the measurement of pasture output. Most systems of pasture evaluation take little account of two of the main characteristics of pasture output—namely, that it is made up of a number of harvests in any one year, and that management in one year affects yields and persistence in subsequent years. Optimum management methods vary with different pastures. The total annual yield is of less importance practically than the distribution of that yield between different months of the year, while such herbage characters as persistence, palatability and winter greenness are also of major importance in relation to the evaluation of any particular sward for stock. Pasture investigation requires measurement of effective output from a pasture over a relatively short period; some techniques which have apparently been valid for assessing output over a whole grazing season are inadequate when applied to short grazing periods. As a yardstick, live-weight gains, at least over short periods, are not very helpful; milk production is a rather more sensitive reflexion of pasture output than live-weight gains, but is even more dependent on management. Two methods of assessing pasture intake are being investigated, involving herbage cutting or fæcal measurements with an indigestible tracer such as chromic oxide for determining the quantity of fæces voided, and analysis of the amount of lignin in the fæces to determine the digestibility of the herbage, with the aid of a 'fæcal index' based on indoor experiments on digestibility.

Dr. M. J. Head and Mr. J. A. F. Rook (Shinfield) discussed certain effects of spring grass on rumen digestion and the metabolism of the dairy cow, particularly in relation to hypomagnesæmia. Heavy dressings of nitrogenous fertilizer in early spring produce a rapid growth of succulent herbage containing a high percentage of crude protein. If this herbage is grazed by dairy cows as their sole diet, it provides an unbalanced ration containing excess of protein equivalent. The effect of the sudden change from the winter ration to such an unbalanced diet in the spring is not infrequently to induce severe hypomagnesæmia and 'tetany'.

Rumen fermentation of such spring herbage has been shown to lead to increased production of ammonia; the ammonia is absorbed from the rumen into the blood stream and can be demonstrated in the portal vein and sometimes in the peripheral blood. This production of ammonia in the rumen can be depressed by feeding starch. Ammonia in the circulating blood may be toxic in relatively low concentrations.

Hypomagnesæmia in the cow in spring is due in part to the low availability to the animal of the magnesium in spring herbage, and in part to the relatively low daily intake of magnesium in the grass diet in comparison with the intake from winter feed. The hypomagnesæmia is most severe in those cows with the highest levels of ammonia in the blood. If the ammonia concentration in the rumen of a cow is artificially raised, the magnesium-level in the blood is depressed. On the other hand, low level of magnesium in the blood induced by feeding young spring grass may be raised again by feeding maize starch, which at the same time causes a drastic reduction in ammonia-levels in the rumen.

The final paper in this symposium, by Dr. W. A. McGillivray (Palmerston North, New Zealand) and Dr. S. Y. Thompson (Shinfield), was concerned with the influence of pasture on the vitamin A and carotene in the milk of cows. Calculation shows that, in the average human diet in Britain, cows' milk contributes about 20 per cent of the daily requirements of vitamin A. Three factors influence the vitamin A content of cows' milk, as follows: stage of lactation—colostrum and very early lactation milk are richer in both carotene and vitamin A than milk secreted during the rest of the lactation period; hormonal influences—the thyroid plays a part in carotene metabolism in the cow; and feed of the cow—the major factor. The cow converts carotene inefficiently into vitamin A. Intake of carotene is, however, probably quite sufficient on pasture to produce butter with high vitamin A potency; but on a winter diet this potency diminishes markedly. In New Zealand, where cows—predominantly Jerseys—are fed outdoors on pasture throughout the year, a uniformly high vitamin A potency in milk fat might be expected. In fact, the potency depends in large part on the botanical composition of the herbage, less carotene being absorbed and utilized on a pasture containing much clover than on one containing little clover. The tocopherol content of milk fat is likewise decreased on a high-clover pasture. There are probably two forms of carotene in blood plasma, one which contributes little to milk-fat-carotene levels and is associated with vitamin A alcohol, and the other which is present on a carotene-containing diet and is associated with vitamin A ester and dietary fat in the chylomicrons, taken up directly by the mammary gland to contribute to the synthesis of milk fat.

Quickly growing, 'improved' pasture produces a number of metabolic disturbances in sheep and in cows in New Zealand. Muscular dystrophy is found in young sheep (though there is adequate tocopherol in the pasture). There seems to be an anti-vitamin D factor in pasture, producing rickets in young lambs. Bloat in cows is a serious problem in New Zealand—drenching the cows with oil appears to be an effective treatment. Facial eczema in sheep, associated with lush pasture, also causes serious losses in some years; its cause is not yet understood.

Each paper in the symposium was followed by a short but lively discussion; from these discussions it is clear that two of the present urgent needs in relation to the feeding of farm livestock on pasture are: first, more knowledge of those constituents of rapidly growing herbage which at times upset the metabolic balance of grazing ruminants; and second, how such upsets can be most conveniently prevented in practice on the ordinary farm, without diminishing the advantages of modern methods for improving the efficiency of grassland production.

H. D. Kay

THE 1956 CAMBRIDGE SUMMER SCHOOL IN PHYSICAL CHEMISTRY

THE rate at which modern science advances continues to increase, and most scientists, though confining their activities within narrow channels, find themselves incapable of synchronizing with the acceleration. One way of contending with this situation is by means of the refresher course, where a small number of lecturers who have paid special attention to certain selected subjects give brief reviews on recent developments, stressing general theoretical principles rather than detailed experimental technicalities. With this object in mind, the Department of Physical Chemistry of the University of Cambridge has arranged summer schools, at intervals of three years, since the end of the Second World War.

This year's summer school, held during August 18–25, began with an inaugural lecture on Saturday night by the head of the Department, Prof. R. G. W. Norrish, who outlined briefly the history of the University of Cambridge and in particular of the origin and growth of its scientific departments. Prof. Norrish is particularly well qualified for such a lecture, being a Cambridge man in every sense of the word; he was born in the City, and, before entering the University, was educated at the Perse School, the ancient hall of which is now one of the most attractive features of his Department. The lecture, though full of fact, was interspersed with adequate humour, and helped to create an atmosphere of welcome to the 116 visitors who attended the school. The first real mingling of the visitors among themselves and with many Cambridge dons began in a garden party held on Sunday in the pleasant grounds of Sidney Sussex College.

The scientific course, which started on August 20, consisted of a course of fourteen lectures devoted to two broad topics, both of which are rapidly developing, namely, the applications of spectroscopy to chemical problems and the application of intermolecular force theory to the study of fluids. The first lecture was given by Prof. H. C. Longuet-Higgins on the nature of intermolecular forces and the properties of imperfect gases. Direct electrostatic, induction and dispersion forces play a part in determining intermolecular potential energies, and must be supplemented by repulsive forces, which predominate when molecules get very close together. This led naturally to a treatment of the liquid state of matter, which was given by Dr. E. A. Moelwyn-Hughes. Theories of free space, moving holes and anharmonic oscillators were reviewed, and new data presented on the heat capacities of liquids at constant volume. Both these lecturers spoke later, and from different angles, on current theories of solutions of non-electrolytes. Longuet-Higgins showed how the thermodynamic properties of regular solutions could be derived on a statistical basis, while making a small number of assumptions concerning the form and relative magnitude of the three interaction-energy terms. Dr. Moelwyn-Hughes explained how the theories of van Laar, Hildebrand and Scatchard can be derived in terms of a simple model of a solution and of the partition function to which it leads. Dr. J. N. Agar gave two lectures on selected topics dealing with solutions of electrolytes. He dealt with heats and entropies of hydration of ions, with the limitations of Born's theory, and with a new hypothesis on solvation which can explain the magnitude of the ionic activity coefficient in quite strong solutions. Mr. R. P. Bell, of Oxford, one of the visiting lecturers, spoke on the hydrogen bond and the very wide range of phenomena connected therewith. The hydrogen bond deserves to be treated as distinct from other types of bonds. Our knowledge in this field began with the study of the interaction of two carboxylic acids, and now extends to the interpretation of the so-called anomalous properties of hydroxylic liquids and solutions.

The discussion on modern developments in spectroscopy was opened by Mrs. D. M. Agar, who gave an account of infra-red and Raman spectra, with their application to such problems as rotational isomerism and forbidden transitions. There followed a lecture by Prof. W. C. Price, of King's College, London, the second visiting lecturer, on observations made in the visible and ultra-violet regions. Electronic spectra and ionization potentials of polyatomic molecules are now telling us much about the pattern of electrons in molecules and of their energy states, just as atomic spectra long ago provided Rutherford and Bohr with a picture of electronic arrangements and energies in free atoms. The nature of the chromophoric group in the normal and excited states of the molecule can be understood in terms of a fairly simple free-electron theory. Among the more spectacular spectroscopic developments of the past decade are those associated with the production of free radicals under the influence of an intense flash and with their characterization during their transient existence. The first lecture on this subject was delivered by Prof. Norrish, who first described in general terms the methods of kinetic spectroscopy and their application to isothermal reactions of free radicals. Among the many problems which have been tackled by the new method are the rates of combination of free atoms, the mechanism of the interaction of carbon monoxide with various gases and the conversion of the vibrational energy of the oxygen molecule into energies of other forms. The marked advances made in radio-frequency spectroscopy, and the related topics of nuclear magnetic resonance, were treated in two lectures by Dr. T. M. Sugden. Moments of inertia, intermolecular distances, valency angles and dipole moments are among the molecular properties which can be measured by the radio-frequency method. Dr. Sugden's third lecture dealt with the applications of spectroscopy to the study of flames. The concentration of free electrons in flames can now be determined fairly accurately, and the results can be applied to estimate the energy required to dissociate molecules into radicals, and complex radicals into simpler ones. Values of the bond energies thus found have been confirmed by other means. The course concluded with a lecture by Prof. Norrish on the study of explosions by means of kinetic spectroscopy. The mechanisms of the reaction between hydrogen and oxygen and of the oxidation of hydrocarbons have been studied by the new method, which has served also to throw light on the nature of the knock and anti-knock effects met with in combustion.

Each lecture was followed by discussion, and the two morning lectures at 9.30 and 11.15 were separated by an interval when discussions continued over coffee. One cannot attend lectures and take part in discussions the whole day through, and the organizers of the summer school had wisely provided amenities to fill in the leisure hours. Most of the men attending the school were housed in Corpus Christi College and Pembroke College, and the five women were accommodated in the Corpus Christi College Hostel. There was a reception in the Guildhall on August 21, when scientists forgot that they were scientists and relaxed in dancing or sipping wine under the influence of pleasant music. Mr. Hugh J. McLean gave an organ recital in the chapel of King's College on August 23, when the visitors had an opportunity of listening to some of the fugues and voluntaries of Orlando Gibbons, a chorister of the College in 1596, and of Bach, Mozart, Franck and Willan. Those who attended the school were also entertained by Prof. and Mrs. Norrish at their home and by the senior members of his staff at evening parties given at their homes or in their colleges. On August 24 the school and a number of guests dined in the hall of Pembroke College under the presidency of Prof. Norrish, with Sir Owen Wansbrough-Jones, chief scientist of the Ministry of Supply, as principal guest.

Most of those attending the school were research workers or those engaged in teaching physical chemistry. Fifty-four came from industrial research establishments, which included Bakelite, British Celanese, British Rayon, Bush, Boake Roberts, Courtaulds, Distillers, Dow Chemical Co., Esso, J. Lyons, Imperial Chemical Industries, Laporte, Monsanto Chemicals, Metropolitan-Vickers, Philips (Eindhoven), Pilkington's, Rolls-Royce and Shell. There were thirty-two academic scientists from the Universities of Belfast, Berlin, Columbia, Copenhagen, Delft, Geneva, Glasgow, Göttingen, Hong Kong, Leyden, Liège, London, Marburg, Moscow, Prague, Southampton, Texas, Tokyo, Virginia and Warsaw. There were nine representatives of research and development establishments of the various Ministries of the Crown and six teachers from public and grammar schools.

It is almost impossible to over-rate the importance of the contacts established in such a gathering. The great number of questions put to the lecturers in private conversations proved that the topics dealt with were of immediate interest and value. The lecturers themselves have also learnt much of what is happening in wide fields of research enterprise outside their own university. Ideas were freely exchanged and, like the poet's joy, improved on being poured from one vessel to another. There was a refreshing frankness in all the school's deliberations, and there was a free trade of thought.

No account of the physical chemistry summer school at Cambridge would be complete without some reference to the happy human relationships which were established, and in many cases strengthened, between academic research workers and industrial research workers, and between British scientists and foreign scientists. Politicians have yet to learn that scientists are men who are kindly disposed towards one another, have a common faith and interest in their subject and desire nothing more than freedom to study Nature and to subjugate her to the benefit of mankind. A gathering of this kind can be lightly described as just another conference, conducted with evident pleasure, and not unprofitably. On the other hand, its consequences are incalculable. To bring industrial and academic research workers together is a vital step in furthering the national economy. To bring foreign scientists from all over the world—including that part which lies beyond the 'iron curtain'—into harmonious contact with British scientists is to increase the volume of international goodwill, in an age when that commodity is none too abundant, and when the contribution of the scientists to it is paramount. E. A. MOELWYN-HUGHES

GLAZED FROST IN ENGLAND OF JANUARY 1940

GLAZED frost, the phenomenon of rain or drizzle falling on a frozen earth and covering everything with a layer of clear ice, is not of very frequent occurrence in Britain and, when it does occur, it is usually short-lived and quickly followed by an influx of air warm enough to melt the ice. In the United States it is sufficiently common and severe to be called an ice storm. The main economic effects are severe disturbance of transport by the very slippery roads and paths and destruction of overhead telegraph and power lines. The precipitation falls from clouds at a temperature above freezing point through a low-lying layer of air at a temperature below freezing point. The supercooled droplets freeze on striking the ground, trees, telegraph wires and so on, forming a coating of clear slippery ice. Usually the phenomenon is transitory because it is produced by the fairly fast-moving warm front or warm occlusion of a winter depression.

During January 25–February 4, 1940, however, as is described by Dr. C. E. P. Brooks and Mr. C. K. M. Douglas in Geophysical Memoir No. 98 of the Meteorological Office, entitled "Glazed Frost of January 1940"*, intense persistent glazed frost formed over much of England south of a line from the Humber to the Mersey except East Anglia. It was especially intense along a wide belt from North Wales to Kent. The ice formed cylinders up to 2½ in. in diameter on telegraph wires, twigs, etc., and a coating an inch thick on the ground. Telegraph poles and trees collapsed in large numbers under the weight of the ice. The memoir contains some vivid photographs of the ice which the authors describe as probably unequalled, certainly in at least a century, for extent and persistence in Great Britain.

The meteorological circumstances producing the ice are fully described. At the time there was an anticyclone over Scandinavia and a depression south-west of Iceland. Between these systems a very cold south-easterly wind blew across most of the British Isles with temperatures between 25° and 30° F. inland. Two warm fronts moved successively early in the period from the south-west across Ireland, south-west England and Wales and then oscillated slowly backwards and forwards over the mouth of the Channel and south-west England, bringing the rain which fell through the cold surface air to produce the glazed frost. Finally, on February 3, the warm air swept northwards, displacing the cold south-easterly current over the country and melting all the ice. The chief technical meteorological interest lies in the motion of the fronts, which over a considerable period departed widely from that given by the components of geostrophic wind normal to them.

The differences were abnormally large. One warm front over south-west England on January 28, which should, on the geostrophic basis, have moved at the rate of 15 m.p.h. to the north-east, moved at 5 m.p.h. south-west. The differences between actual and geostrophic wind are too large to be accounted for by accelerations associated with pressure changes, and the best suggestion is that of a departure caused by turbulent friction in the frontal zone in which the wind changed rapidly in direction. This friction introduces a term in the hydrodynamic equations proportional to the coefficient of turbulence, multiplying the second differential coefficient with respect to height of the wind component parallel to the front. It is shown in the memoir that this would have the right order of magnitude.

THE BUKIDNON OF MINDANAO

PROF. FAY-COOPER COLE'S recent field-work monograph on the people of one of the larger islands of the Philippines, entitled "The Bukidnon of Mindanao"*, is an unusual publication. Had it been written by an anthropologist as a result of recent field-work, it is doubtful whether there would have been any justification for having it published. But the field-work dates from 1910, and the author is a professor of anthropology (emeritus) writing in 1956. The situation has its possibilities, and on commencing to read the monograph one wonders whether the author will succeed in producing a work of contemporary interest on foundations that are left over from a different period. The answer is, unfortunately, no.

It would, of course, be unfair to take the author to task for not having had 1956 in mind in 1910; but it is obviously true that he has been unable to decide what to do with the material himself, and, as a result, the book is concerned with everything in general, but nothing in particular. There are good illustrations of material objects, houses and dress, all of which are interesting, but within the scope of a hundred-odd pages the text rushes through chapters with such diverse titles as "Making a Living"; "The Life Cycle, Social and Political Organization"; "The Spirit World"; "The Ceremonies"; "Music and Dancing"; "Celestial Bodies"; "Stories and Legends".

Prof. Cole seems to have had no concern for kinship, at least in 1910—which is a pity; for the Bukidnon appear to have a system of bilateral kinship on the Iban pattern, but there are scarcely any asides in that direction. The remarks on marriage are more tantalizing than illuminating, and social and political organization—including such headings as crime and law (four paragraphs) and slavery (two paragraphs)—merits only ten pages.

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* Air Ministry: Meteorological Office. Geophysical Memoir No. 98: Glazed Frost of January 1940. By Dr. C. E. P. Brooks and C. K. M. Douglas. Pp. 40+10 plates. (M.O. 584f) (London: H.M.S.O., 1956.) 7s. 6d. net.

* *Fieldiana*: Anthropology. Vol. 46. "The Bukidnon of Mindanao". By Prof. Fay-Cooper Cole. Pp. 140. (Chicago: Chicago Natural History Museum, 1956.) 4 dollars.

It is not that the author has no interest in the problems of social anthropology; for example, he reports the notable phenomenon—recorded also in other areas—that as the "aggressive intervention" (*sic*) of the authorities (in this case the American Governor) increased in the daily life of the people, and as they were forcefully moved into "model villages", there was a "withdrawal into the old ways in religion". With the decline of the political importance of the local headmen, the influence of the "mediums" and their ceremonies became more powerful "to the extent that they dominated the social and religious life" of the Bukidnon. But all this is merely stated and not followed up. There are, instead, descriptions of ceremonies concerned with ritual healing and with the fertility of the crops, and there are discussions on the concepts of the supernatural. However, the author seems to have worked through interpreters, and what with the unclear social background and without the backbone of a theory to give the material some coherence, these pages remain unrewarding.

The conclusion strikes a different vein. For, when the author is left with two pages, he reveals that he had in mind all the time "the attempt to account for the peopling of Central and Southern Mindanao": this aim is certainly not disclosed earlier on, nor is it pursued with much vigour. NUR YALMAN

VOLTA RIVER PROJECT IN THE GOLD COAST

THE report of the preparatory commission on the Volta River Project set up in 1953 by the United Kingdom and Gold Coast Governments was published on July 27 as a non-parliamentary paper, and the Secretary of State for the Colonies, Mr. A. T. Lennox-Boyd, said in a written answer in the House of Commons on that day that the report provides evidence of an extremely thorough examination of all the problems to be solved in a project of this magnitude. The main conclusions of the commission are that the project is technically sound and could be carried out successfully; it is not capable of significant improvement from an economic point of view, but the greatest return would be derived by achieving maximum production as soon as possible. The commission further concludes that the project should be competitive in relation to other schemes, provided that the time-table of construction is observed, a sound policy adopted in the employment and provision of living conditions for the labour force, economic stability maintained in the Gold Coast, and that the aluminium companies are satisfied that the internal cost of operating the smelter would be acceptable. The report also considers such factors as the co-ordination of the future development plans of the Gold Coast Government, the maintenance of adequate administrative and technical services, and the level of future world demand for aluminium and future developments in the generation of power from nuclear energy.

As a result of its investigations, the commission considers that the scheme, based on two stages of aluminium production, would cost £184·9 million (with a capacity of 120,000 tons a year), rising to a total of £231·3 million (with a capacity of 210,000 tons a year) compared with the estimates of £116 million and £144 million in 1952 but including also certain additional work. The commission suggests that it would be prudent to allow for a further increase of 40–50 per cent so as to obtain a realistic appreciation of the finances that might be required for the project, which would take about eight years to bring to production. This increase should not make the project less attractive provided world prices move upwards at roughly the same rate. The United Kingdom and the Gold Coast Governments and the aluminium companies have each re-affirmed their interest in the project, though none of them is yet committed to participation. They have agreed that, because of the substantial increase in the estimated capital cost, it is necessary to review both the framework and the method of finance; as the next step, the International Bank is being asked to make a general assessment of the project and to indicate the extent to which it would be willing, in principle, to participate if the two Governments and the aluminium companies reached agreement on the framework.

POLLEN CHEMISTRY

R. LUNDÉN, with the citation of some eighty-one references, has given a useful résumé of the literature of pollen chemistry (*Grana Palynologica*, 1, No. 2, 3; 1956). The protein and amino-acid content of different pollen grains has long been of special interest and practical importance, on one hand, to apiarists in search of a pollen substitute in the rearing of bees, and, on the other, to medical investigators interested in the active principle in pollen allergy.

With the development of partition chromatography, considerable advances are now being made in ascertaining both qualitative and quantitative facts regarding the amino-acid content of grains; indeed, all the common amino-acids have now been found to be present in pollens, either bound to protein or in the free state, though some important deficiencies have been reported. As the carbohydrate content of pollen grains is considered to be of less importance from the point of view of bee nutrition, this aspect of pollen chemistry has received rather less attention; but analytical data have been given for the starch, cellulose, pentosan and reducing sugar contents of the pollen of a number of species. Lipides have also been examined.

Studies of the vitamins and hormones of pollen grains have shown that, in general, they are rich in the vitamins of the B group but low in fat-soluble vitamins; some quantitative information relating to a considerable number of vitamins is now available for several species. The evidence indicates pollen to be an exceptionally good source of water-soluble vitamins, for example, of thiamine, riboflavin, pantothenic acid, nicotinic acid and ascorbic acid. Œstrogenic substances have been detected in certain pollens, and also plant growth regulating substances. Pollen enzyme chemistry likewise promises to be a particularly rich field for research. Reference is also made to the pigments, which are chiefly flavonols and carotenoids, and to the inorganic and various miscellaneous constituents.

A VIRUS RESEMBLING RUSSIAN SPRING–SUMMER ENCEPHALITIS VIRUS FROM AN IXODID TICK IN MALAYA

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A VIRUS (*TP*21) serologically resembling that of Russian spring–summer encephalitis has been isolated from a pool of hard ticks, *Ixodes granulatus* Supino, from forest rats caught near Kuala Lumpur. The probable importance of this finding is two-fold. First, the distribution of viruses resembling Russian spring–summer encephalitis may be wider than was previously known. Russian spring–summer encephalitis, transmitted apparently by *I. persulcatus*, occurs in widespread areas of the U.S.S.R.[1], Czechoslovakia, Slovenia and Austria[2]. The virus cannot be distinguished from that of louping ill[2], which is an encephalomyelitis mostly of sheep, but occasionally of man, transmitted by *I. ricinus* in Scotland. Russian spring–summer encephalitis in Europe and North Asia has apparently a widespread reservoir mainly in rodents and is only occasionally transmitted to man. The only obvious common factor between these areas and Malaya is the presence of *Ixodes* species, which suggests the possibility that *Ixodes* species in many parts of the world may be the vectors of Russian spring–summer encephalitis or antigenically related viruses, some if not all of which may be capable of causing disease in man. Secondly, although *I. granulatus* has not yet been recorded biting man in Malaya, it has a wide host-range, and, as planters and troops are frequently bitten by ticks, we should be alert to recognize human disease caused by this virus.

The relevant technical details are as follows: twenty-four female and one male *I. granulatus* from one *Rattus mülleri validus* (Miller) and one *R. sabanus vociferans* (Miller) were ground up and treated with antibiotics and by high-speed centrifugation. Intracerebral inoculation into day-old suckling mice (*DDM* strain) caused paralysis on the fifth day after inoculation. Passage of bacteriologically sterile brain material from these caused paralysis in adult mice on the fifth day, and in sucklings on the third day. Re-isolation in adult mice from the tick suspension was successful. Using adult mice, one hour incubation of serum–virus mixtures at 37° C. and intracerebral inoculation of ten mice per 10-fold dilution of virus, *TP*21 was tested by neutralization test against antisera to Russian spring–summer encephalitis (I am indebted to Dr. W. L. Pond for this antiserum), Japanese encephalitis, and dengue-1 viruses, of which the last two have been isolated in Malaya. The Russian spring–summer encephalitis antiserum used was the same serum pool as was used by Pond *et al.*[2,3] in their studies of Russian spring–summer encephalitis and related viruses. The latter was suspected because of the high pathogenicity of *TP*21 for adult mice, its lethality by intraperitoneal route, and because it came from *Ixodes* ticks. *VR*4609 and *VR*4610 were sera of two wild-caught *R. rajah surifer* (Miller) which had hæmagglutinin-inhibiting antibody to *TP*21. Clearly (Table 1) there was significant neutralization only by Russian spring–summer encephalitis and the *R. rajah* sera. As no other virus has so far been described with such a close antigenic relationship to Russian spring–summer encephalitis, *TP*21 must be closely related to it if not identical. The neutralizing antibodies in the two *R. rajah* probably indicate natural infection with *TP*21.

Table 1. IDENTIFICATION OF *TP*21 BY NEUTRALIZATION TEST IN MICE VERSUS SPECIFIC IMMUNE ANTISERA

Antisera	*LD*50 titre (negative log) after incubation of virus–serum mixtures	Neutralizing index	Homologous titre of antiserum
Russian spring–summer encephalitis	4·1	790	6,300
Japanese encephalitis	6·9	1	2,500
Dengue-1	6·6	3	250
*VR*4609	4·0	1,000	
*VR*4610	4·0	1,000	
Normal rabbit } controls	7·1 } 7·0		
Normal mouse } controls	6·9		

Table 2. *p*H AND TEMPERATURE CHARACTERISTICS OF FRESHLY PREPARED *TP*21 HÆMAGGLUTININ

*p*H	Reciprocal hæmagglutinin-inhibiting titre at temperatures indicated		
	4° C.	27° C.	37° C
5·6	< 50	< 50	< 50
6·0	< 50	< 50	< 50
6·4	< 50	100	50
6·8	> 6,400	3,200	3,200
7·0	1,600	800	3,200
7·2	< 50	< 50	3,200
7·6	< 50	< 50	< 50

Apart from a passing and incomplete reference by McLean[4], there is no published account of the preparation of a chick-cell hæmagglutinin from Russian spring–summer encephalitis or a related

Table 3. DISTRIBUTION OF HÆMAGGLUTININ-INHIBITING ANTIBODIES TO JAPANESE ENCEPHALITIS AND *TP* 21 IN A VARIETY OF MALAYAN SERA

	No. of sera tested	No. containing hæmagglutinin-inhibiting antibody to		
		*TP*21 only	Jap. enceph. only	*TP*21 and Jap. enceph.
Forest animals				
Ground rats	51	6	0	0
Tree rats	4	0	0	0
Squirrels	3	0	0	0
Birds	2	0	0	0
House pests				
Rats	6	0	0	0
Civets	2	0	0	0
Domestic animals				
Cattle	5	0	3	0
Buffaloes	27	0	0	0
Goats	2	0	1	0
Pigs	10	0	0	0
Humans				
PUO (pairs showing rise in titre)	8	0	0	0
Sera for heterophile antibody tests				
Asian	24	0	7	10
European	9	0	1	8

Table 4. Hæmagglutination Inhibition Tests with *TP*21 against Hyperimmune Mouse Sera

Immune mouse serum pools	Reciprocal hæmagglutinin-inhibiting titre with indicated antigens															
	Jap. enceph. : units				Dengue-1 : units				Dengue-2 : units				*TP*21 : units			
	1	2	4	8	1	2	4	8	1	2	4	8	1	2	4	8
Jap. enceph.	160	160	80	40	640	640	320	320	160	160	80	20	640	320	80	40
Dengue-1	< 10	< 10	< 10	< 10	160	80	160	80	20	10	< 10	< 10	320	160	40	20
Dengue-2	320	320	80	40	320	320	80	40	160	160	40	20	40	20	< 10	< 10
'Normal'	< 10	< 10	< 10	< 10	20	20	20	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10

agent, which is inhibited by immune sera. However, a hæmagglutinin was prepared from *TP*21 by the method of Chanock and Sabin[5], and its *p*H and temperature characteristics when freshly prepared are shown in Table 2. Third-passage material gave a titre of 1/200,000 at *p*H 6·5 and 4° C. Using this system and acetone-extracted sera[3], a variety of sera were tested for hæmagglutinin-inhibiting antibodies to *TP*21 and Japanese encephalitis (Table 3). Six sera, all from forest ground-rats (*R. sabanus*, *R. rajah*, and *R. mülleri*), were positive only against *TP*21, but a proportion of the human and domestic animal sera which had antibody to Japanese encephalitis also had antibody to *TP*21—this probably indicates cross-reaction between *TP*21 and Japanese encephalitis, as all these sera had higher titres versus the latter than *TP*21. None of the nine pairs of acute- and convalescent-phase sera from cases of pyrexia of unknown origin, nor of the thirty-four sera received for heterophile antibody tests, showed evidence suggestive of previous *TP*21 infection.

*TP*21 was also tested by Dr. B. L. Elisberg of the U.S. Army Medical Research Unit stationed at the Institute for Medical Research, Kuala Lumpur, in a hæmagglutinin-inhibition test against hyperimmune mouse sera prepared by the method of Casals and Brown[6] and his results are shown in Table 4. These results confirm that *TP*21 is antigenically related to Japanese encephalitis and the dengue viruses (that is, it belongs to Casals' *B* group of viruses[6]), but that its behaviour differs from each of them.

*TP*21 inoculated subcutaneously into two macaque monkeys caused fever between the tenth and fifteenth day in one; similar inoculations into albino rats, and wild-caught *R. bowersi*, had no detectable effect. One of two guinea pigs inoculated intracerebrally died, but virus could not be found in its tissues; two inoculated intraperitoneally were unaffected. Adult mice were only moderately susceptible by intraperitoneal inoculation—only four out of six were killed by 10^6 intracerebral *LD*50 doses.

The implication of this very limited study is that infections with *TP*21 may be common and probably often symptomless in forest rats, and that *I. granulatus*, which is common and widespread on ground- and tree-living small mammals in the Malaysian forests, extending northwards to India, may be a vector. Neutralizing antibodies to Russian spring–summer encephalitis virus were found in a few individuals from north-west India by Smithburn *et al.*[7], and work by Pond and his colleagues of the U.S. Army Medical Research Unit (to be published) suggests that such antibodies may also occur in Malaya.

This preliminary report is submitted because, owing to the known laboratory hazards of Russian spring–summer encephalitis virus, work with *TP*21 has been suspended until its identity has been established by a reference laboratory.

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POSSIBLE CATION-CARRIER SUBSTANCES IN BLOOD

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THE existence of carrier molecules responsible for the transport of specific ions across cellular membranes has long been postulated, but no substances with the necessary chemical characteristics to fill the role have yet been recognized in biological material. As a consequence, the combination of alkali cations with molecules that are found in living matter is of particular importance to the problem of transport of ions across cellular membranes. Lipide binding of cations has been studied by Christensen and Hastings[1], Folch[2], and Baer, Buchnea and Newcombe[3]. Pyridoxal has been suggested as a carrier by Christensen[4], and the relevance of polyphosphate cation-binding to the carrier problem has been put forward by Steinbach[5]. In the case of the red cell, Solomon[6] has put forward the hypothesis that the complex of sodium and potassium ions with carrier, or carriers, should be lipide-soluble, non-dissociable in lipide, but dissociable in water solution. Thus the cation would be carried through the lipide portion of the membrane as part of a soluble carrier complex.

Human blood and plasma have both served as starting materials. Samples of whole blood were incubated at 37° C. for periods of one hour or more with potassium-42, using the techniques previously described[6]. At the close of the incubation, the blood was frozen and dried under vacuum. 0·5 gm. aliquots of the dried material were then extracted for 15 min.

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Table 1. EXTRACTION OF POTASSIUM FROM BLOOD BY VARIOUS SOLVENTS

Solvent	Potassium extracted (m.mole/l. blood)
Diethyl ether	0·003
Benzene	0·004
Chloroform	0·009
Hot 2 : 1 chloroform–methanol	0·429

by shaking with 10 ml. of each of a variety of organic solvents, including chloroform, a hot 2 : 1 mixture of chloroform–methanol (Folch *et al.*[7] have shown that chloroform–methanol is effective in removing lipide from brain tissue, in which it is found in association with proteins), acetone, benzene, diethyl ether, *iso*-propyl ether, and petroleum ether. It can be seen from Table 1 that the chloroform–methanol mixture extracted much more potassium from blood than benzene, ether and chloroform, the behaviour of which was typical of the other solvents studied.

It was necessary to rule out the possibility that the results in Table 1 could be ascribed to the solubility of the inorganic salts of potassium-42 directly in the chloroform–methanol mixture. For this purpose, an additional step was added to the procedure. The filtered chloroform–methanol extract was evaporated to dryness. The dry material was then taken up in chloroform (which had been dried over calcium chloride), filtered, transferred to a counting planchet and dried once more. The potassium content in the final chloroform solution was calculated as millmoles potassium in chloroform solution per litre of material extracted. From Table 1 it can be seen that chloroform by itself extracts only a negligible quantity of potassium-42 from blood. To confirm this point, the usual inorganic buffer solution used in potassium transport studies (ref. 6, Table 1), which simulates the ionic composition of plasma, was dried and subjected to the extraction procedure described above. The potassium uptake (uptake is used in the special sense of cation solubility in chloroform) was 0·0008 m.mole/l. buffer, which is to be compared to values of 0·532 m.mole/l. blood, and 0·221 m.mole/l. plasma when blood and plasma were extracted under the same conditions. From these results it was concluded that a material capable of carrying cations into non-polar solvents, such as chloroform, could be extracted from plasma and blood.

The uptake of potassium by plasma extracts was compared with that of sodium. The potassium ion concentration in plasma was raised to an average of 11·9 m.moles/l. plasma by the addition of the potassium-42; the sodium concentration was 144·0 m.moles/l. plasma. In ten experiments, the average potassium uptake was 2·51 ± 0·62 μmoles/gm. dried plasma; and in six experiments, the average sodium uptake was 11·28 ± 2·24 μmoles/gm. dried plasma. If the uptake is directly proportional to plasma cation concentration, it would be expected that the sodium uptake would be 12·1 times greater than the potassium. The fact that the observed uptake was only 4·5 times greater suggests that the extracted material discriminates between these two cations, potassium being taken up in preference to sodium. The difference in uptake between the cations is expressed in terms of a potassium/sodium competition factor which is defined as (K uptake/Na uptake)/([K]/[Na]) and is equal to 2·7 in this case. If there are saturation effects, a more complex expression will be required.

Experiments were next carried out to see whether the chloroform-soluble material would give up the extracted cation to water. For this purpose, a volume of chloroform extract was shaken with an equal volume of water for 10 min. At the end of this period, 31 per cent of the activity was found in the water solution. The water solution was then shaken again for 10 min. with an equal volume of fresh chloroform, and no potassium-42 was taken up by the chloroform. Thus the material initially responsible for taking potassium ions into the chloroform solution is no longer present in the water phase, and has apparently dissociated, releasing its potassium to the water phase.

Studies were also initiated to determine the extent to which purified lipides might possess the power to combine selectively with sodium and potassium ions. Lipide samples (for which we are indebted to Drs. Manfred L. Karnovsky, Jordi Folch-Pi, Gerhardt Schmidt and James Garvin) were emulsified with buffer solution (sodium chloride and potassium chloride concentrations modified as shown in Table 2) and incubated separately with sodium-24 and potassium-42 ions. The results of these experiments are presented in Table 2. It will be seen that sphingomyelin, phosphatidyl-serine and acetal phosphatide showed characteristic uptakes of sodium and potassium, potassium being taken up preferentially (see Table 2, col. 6). Cholesterol, which has no phosphate or other charged groups, was ineffective in taking potassium and sodium into solution.

Table 2. UPTAKE OF POTASSIUM AND SODIUM IN CHLOROFORM EXTRACTS OF PURIFIED LIPIDES

Lipide	Concentration (m.mole/l.)		Uptake m.mole/m.mole lipide		K/Na competition factor
	Potassium	Sodium	Potassium	Sodium	
Phosphatidyl-serine	4·28	132·8	0·664	1·50	14·2
Sphingomyelin	4·64	132·8	0·645	2·57	7·5
Acetal phosphatide	4·28	132·8	0·386	1·40	8·9
Cholesterol	2·4	64·0	0·005	0·02	6·7

The problem of cation binding has been approached in the present study specifically with the intention of finding a material suitable for transporting cations across the red-cell membrane, and thus of giving support to the carrier theory of ion transport. In this respect, it now appears that a heterogeneous material can be extracted from blood that has the requisite characteristics, namely: (1) it can discriminate between sodium and potassium ions, preference being given to the latter; (2) it is soluble in lipide solvents; and (3) it dissociates in water. It seems likely that the material is lipide in character and possibly contains phosphatides. Whether the material plays a part in cation transport has yet to be established, and experiments covering this aspect of the problem are now in progress.

The present studies have been supported in part by the Atomic Energy Commission. We wish to thank Drs. F. R. N. Gurd, Oscar Hechter, M. L. Karnovsky and F. M. Snell for many stimulating and informative discussions during the course of these experiments.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Observation of Magnetic Domains in Electron Shadow Photographs

During a study of the magnetic effects produced on a fine electron beam by an unmagnetized single crystal of hexagonal cobalt, an effect was found which shows the existence of domains in a particularly vivid manner.

A small aperture of 12μ close to the crystal surface is used to limit the electron beam of a conventional electron diffraction apparatus. This aperture produces, in addition to the main beam, a diffuse electron beam which gives a magnified shadow photograph of the crystal on the photographic plate (Fig. 1). The electron beam is almost parallel to the prism face of the crystal, the direction of the beam being nearly parallel to the hexagonal axis. The horizontal edge of the crystal, appearing in the photograph as a succession of small cusps, is normal to the hexagonal axis and forms part of the prism face. This face is nearly normal to the plane of the photograph. The main beam strikes the crystal surface and does not appear in the photograph.

The explanation of these cusps appears to lie in the action on the electrons of the magnetic leakage field near the surface of the cobalt. It is known[1] that at room temperature the domains in hexagonal cobalt have a preferred axis parallel to the hexagonal axis, that the leakage field is very strong close to the hexagonal face (of the order of 10,000 oersteds)[2] and that it dies off to relatively small values at about 40μ [3]. In an investigation of the fields at an edge of the hexagonal face of a cobalt crystal, Marton, Simpson and Lachenbruch[4] find a value of 100 oersteds at about 40μ.

Using the main beam from the aperture as a probe, the magnetic fields leading to the formation of the cusps were investigated. If the effects on the edge of the hexagonal face of the cobalt crystal are studied with electrons of energy 46 keV., it is found that the cusps are formed from electrons passing at a distance between 70μ to 120μ from the edge, where the average value of the magnetic field is of the order of 100 oersteds. Those electrons which pass closer to the edge are deflected by larger amounts and form part of the general background.

The cusp shape must evidently follow from the character of the multipole field produced by oppositely magnetized domains. In order to explain in a simple manner the formation of the cusps at the edge of the hexagonal face, we take a cross-section through the crystal parallel to the hexagonal axis. This cross-section showing the magnetic domains, and the associated leakage field in this plane, are represented diagrammatically in Fig. 2. We first consider the effect of this field on a parallel electron beam of rectangular cross-section, indicated by the shaded area, which cuts the plane of the figure at a certain average distance from the edge. The deflexions of the electrons in the beam on passing through various parts of the field have been indicated by arrows. These deflexions are shown again in the top diagram, which also shows the resultant effect on the beam, that is, the formation of the cusps. In particular, it will be seen that the distance between successive cusp tips (*a*–*b*, *b*–*c*) is equal to the sum of the widths (*D*) of neighbouring domains of opposite polarity; this sum ($\bar{L}$) we will term 'domain spacing'. Instead of the parallel beam, we can now consider a part of the divergent beam produced by the small aperture, this part having the same cross-section as the parallel beam. Similar cusps will be produced, which will appear highly magnified if photographed at a distance which is large compared with the distance between the aperture and the edge of the crystal.

We next consider the case in which a beam, of the same cross-section as before, is approximately parallel to a prism face and in the direction of the hexagonal axis (as in Fig. 1). The leakage field responsible for the formation of the cusps in this case is produced by the same domains as in the previous case. We consider the field in a plane situated close to the edge and at right-angles to the plane of Fig. 2, if this is taken to be the prism face; it has approximately the same form as the field represented in this figure. A similar analysis again shows that the electron beam is distorted into a succession of cusps. The cusps are observed in both cases discussed, and in other cases in which the beam is not parallel to the hexagonal axis. The illustration (Fig. 1) was chosen because it shows in addition a corner of the crystal.

Measurements of 'domain spacing' have been made in the two cases mentioned above. The magnitude of the 'domain spacing' varies from 40μ to 240μ, the most frequent value lying between 100μ and 160μ. Values of the 'domain spacing' found from published photographs of Bitter figures on the prism face of hexagonal cobalt[1] vary from 40μ to 170μ, which are similar to those found in our experiments.

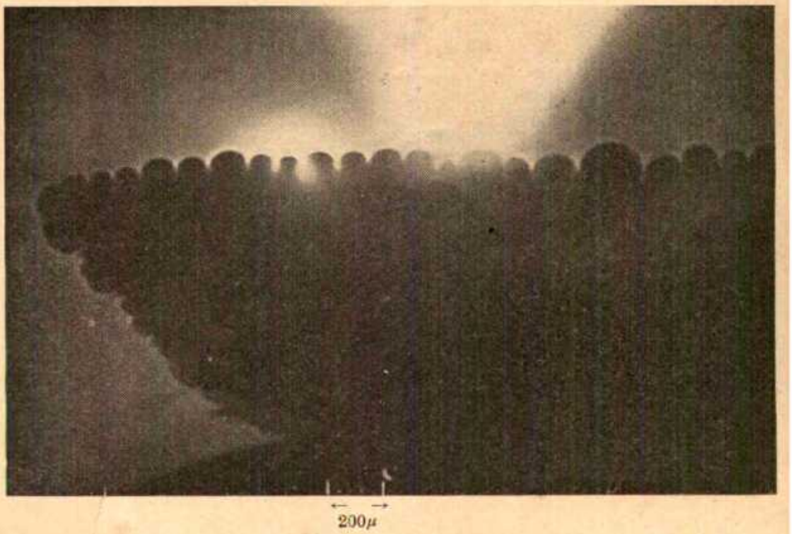

Fig. 1. Shadow photograph of an unmagnetized crystal of hexagonal cobalt, showing domain effects

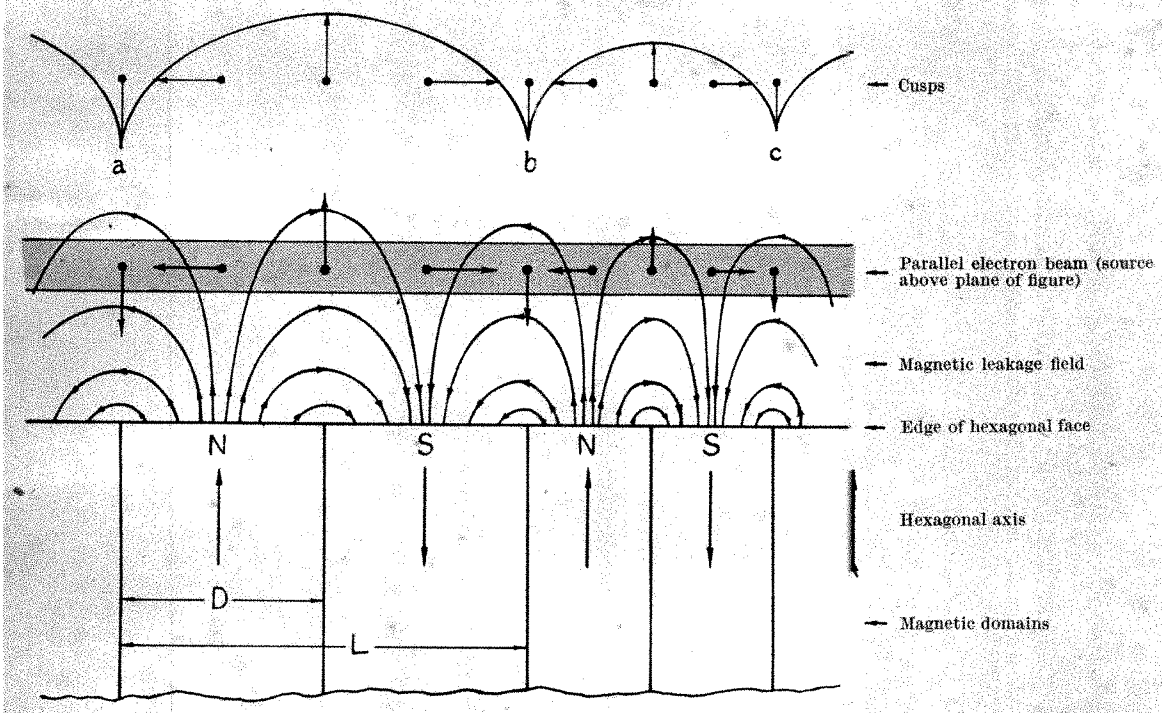

Fig. 2. Illustration of the formation of cusps

A detailed account of these and other magnetic effects will be published shortly. We are indebted to Dr. R. S. Tebble and Prof. E. C. Stoner, of the University of Leeds, for the cobalt crystals. One of us (E. G.) is indebted to the British Council for a scholarship and grant, which have enabled him to take part in this research.

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Vertical Eddy Diffusion in Deep Water

The equilibrium of the uranium series in sea water is interrupted by the removal of ionium (thorium-230)[1]. The efficiency of the removal seems, according to investigations by Koczy, Picciotto, Poulaert and Wilgain[2], to be higher than 98 per cent. This means that the ionium in solution is almost completely precipitated, and the radium content of sea water must be renewed from radium produced in the sea floor by the decay of precipitated ionium. The amount of radium supplied to the ocean by river water seems to be only a few per cent of that necessary to keep the radium content of sea water at its average value of 8×10^{-17} gm. per ml. The radium is transported by currents and eddies in the deep water and is moved upwards by eddy-diffusion. The distribution of the radium in the deep water should, therefore, enable the eddy diffusion to be estimated.

As a first approximation, it is assumed that the sea floor delivers per square metre and year the same amount of radium throughout a large region of the deep sea floor, that the advection is zero, and that the distribution of radium is stationary. Then, if the decay of the radium during its transport is also taken into consideration, the following equation is obtained:

$$\frac{\partial}{\partial t}\left(\frac{A}{\rho}\,\frac{\partial c}{\partial t}\right) - \lambda c = 0$$

where c is the radium content, λ is the decay constant of radium and t is the height above the bottom or the zero-level. This equation solved in respect to A gives:

$$A(\xi) = A(0)\left(\frac{\partial c}{\partial t}\right)_{t=0} \Big/ \left(\frac{\partial c}{\partial t}\right)_{t=\xi} + \lambda\rho \int_0^{\xi} c\,(t)\,dt \Big/ \left(\frac{\partial c}{\partial t}\right)_{t=\xi}$$

In order to estimate the variation of $A(\xi)$ with depth, the eddy-diffusion at a reference-level must be known. This may be obtained if it is assumed that the eddy diffusivity in the thermocline is near zero; moreover, the eddy diffusivity must not show negative values. The derivatives are read from the smoothed curve of the distribution of radium with depth, and the integral value is also obtained by graphical evaluation.

During the Swedish Deep-Sea Expedition (1947–48), a series of radium determinations was carried out[3]. This series demonstrates that the radium content in the ocean is generally lowest at the surface and rapidly increases in deep water with decreasing stability. At two stations in the Atlantic, the distribution of radium with depth shows a more complex structure. This may be explained by the existence of the North

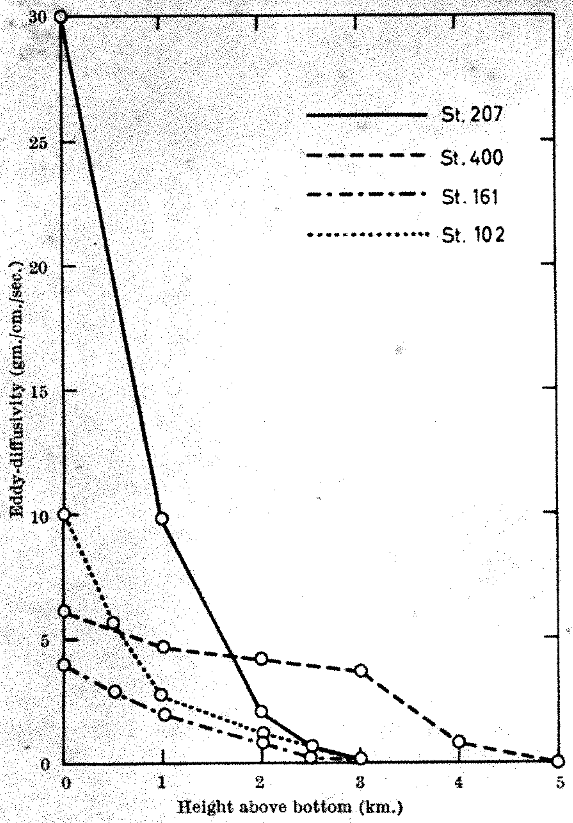

Fig. 1

Atlantic water, whereas a corresponding water mass originating in the Arctic region is absent from the other oceans. The distribution of radium in the deepest layer of the Mindanao Trench does not conform with the general pattern. For our calculations four stations were selected, one in the Atlantic, one in the Indian Ocean and two in the Pacific Ocean. Their geographical position and the total depth are as follow:

	Lat.	Long.	Depth
Station 102	13° 25′ S.	149° 30′ W.	4,630 m.
161	5° 10′ N.	127° 53′ E.	8,200
207	0° 01′ S.	88° 18′ E.	4,486
400	43° 04′ N.	19° 40′ W.	5,990

As zero-level the depth of the deepest-water sample was generally taken at a distance of about one hundred metres above the sea floor. But at Station 161 in the Mindanao Trench the mean depth of the Pacific Ocean was chosen as zero-level. The results from the calculation are given in Fig. 1.

The eddy-diffusivity near the bottom varies between 4 and 30 c.g.s. units and decreases with distance from the sea floor. The values obtained by this method are not as high as the values obtained by Wüst[4] from a dynamical calculation. One reason for this may be that the variance of the eddy-diffusivity is so high that values of 70 c.g.s. may also be obtained in certain places by our method. On the other hand, the eddy-diffusivity should always be lower than the eddy-viscosity. It must be pointed out that the lowest values of the eddy-viscosity are about a power of ten higher than our lowest value for the eddy-diffusivity.

The amount of radium given off from 1 sq.m. of the sea floor per year is given by:

$$\varphi = 3{\cdot}16 \times A(0)\left(\frac{\partial c}{\partial t}\right)_{t=0} \times 10^{11}\ \text{gm./m.}^2\text{/year}$$

The figures obtained at the four stations vary between 120 and 180 × 10^{-12} gm. radium/m.^{2}/year. The same result has been found by a different method[5] based on the total geochemical balance of the radioactive elements in the hydrosphere.

Details of this work will be given in the Reports of the Swedish Deep-Sea Expedition. I wish here to thank Östen Carlsson, of the Chalmers Technical Highschool, who has kindly carried out the calculations.

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Lattice Magnetostriction in Spinel-Type Iron Chromites

Several accounts have previously been given from these Laboratories of the lattice dilatation effects that occur when monoxides and other compounds of the transition metals are cooled through their paramagnetic–antiferromagnetic transition temperatures.

Two instances of structural deformations at low temperatures in spinel-type oxides have also been reported. Thus Tombs and Rooksby[1], using X-ray powder methods, showed that in magnetite (Fe_3O_4) a rhombohedral deformation takes place below − 160° C., and Rooksby and Willis[2] found that at − 180° C. the structure of cobalt ferrite is tetragonally deformed. The rhombohedral nature of the magnetite structural change was later critically investigated by Abrahams and Calhoun[3] by magneto-X-ray single-crystal methods. Although they found some fine detail not detected in the powder work, and suggested that the true low-temperature structure is of orthorhombic or lower symmetry, the rhombohedral interpretation appears to be valid to a first approximation[4].

Besides the observations of distortions in such sodium chloride-type and spinel-type structures, measurements on ferric oxide[5] and chromium oxide[6] have disclosed lattice dilatations associated with antiferromagnetic transitions. Consequently there seemed to be grounds for predicting that lattice magnetostrictive effects similar to those already observed in in Fe_3O_4 and $CoFe_2O_4$ might occur at low temperatures in chromium-substituted cubic iron oxides, that is, in solid solutions of the general form $FeFe_{2-x}Cr_xO_4$. Confirmation of this prediction has recently been obtained by X-ray powder studies of several such iron oxide/chromite preparations, using liquid air-cooling and gas-cooling techniques.

When observations are made at − 180° C., for compositions in which the value of x in the solid solution lies between 0·2 and 0·8 the structural deformation established as characteristic of Fe_3O_4 becomes vanishingly small. At $x = 1{\cdot}0$, however, a new tetragonal-type distortion becomes evident at liquid-air temperature, and for $x = 1{\cdot}2$ the

Table 1. X-Ray Data for Iron Oxide – Iron Chromite Solid Solutions of Composition $FeFe_{(2-x)}Cr_xO_4$

Composition x	Cubic at 20° C.		Tetragonal at − 180° C.	
	a_0 (A.)	a_0 (A.)	c_0 (A.)	c/a
1·0	8·396	8·384	8·392	1·001
1·2	8·405	8·369	8·410	1·005
2·0	8·377 (± 0·001)	8·454	8·187	0·968

magnitude of this distortion has increased appreciably, as shown in Table 1.

The results obtained for the solid solutions led us to believe that with pure ferrous chromite, $FeCr_2O_4$, an even larger lattice dilatation effect might be obtained at liquid-air temperature. Examination disclosed that, although the tetragonal deformation was indeed larger in magnitude, there was a change in its sense. The tetragonality observed was the result of a relative contraction, instead of expansion, in one of the [001] directions, so that the axial ratio was less, not greater, than 1·0 (see Table 1).

It will clearly be of considerable interest to examine the low-temperature behaviour of compositions between $x = 1{\cdot}2$ and $x = 2{\cdot}0$. X-ray studies are now being carried out on several solid solutions lying in this range, and it is hoped to present all the results in detail elsewhere.

The mechanism by which the structure cell of spinel-type oxides of this type deforms from its room-temperature cubic symmetry on cooling through a certain critical temperature is not yet properly understood. It would appear likely, however, that the lattice dilatation effects are linked with alterations of the magnetic dipole alignments such as have been discussed by Li[7] in connexion with simple anti-ferromagnetic monoxides and other compounds. It is possible that an extension of Li's arguments on spontaneous magnetostriction to the spinel-type compounds will explain all the various structure changes that have been described above.

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Ductility in Chromium

Much recent work has been carried out on the preparation and properties of pure chromium with the aim of establishing chromium base alloys as engineering materials. The obstacle to this, the room-temperature brittleness, has naturally attracted great attention. It has been suggested that the brittleness of chromium is promoted by nitrogen content above 20 p.p.m., by rough surface condition and by recrystallization. It had been found previously that the greatest lowering of the ductile/brittle transition temperature in chromium is obtained in polished pieces which have been worked below the recrystallization temperature. Complete recrystallization in rolled chromium raises the transition temperature so that there is usually no bend ductility at room temperature, although pieces in this condition showing ductility have been produced[1].

Recently, we have found that the main source of nitrogen in electrolytic chromium is the presence of nitrates in the electrolyte of a conventional hexavalent chromium bath and that nitrogen in other forms such as ammonia or air has no appreciable effect on the composition of the deposited metal.

We have also found that chromium produced by the lubricated extrusion of sheathed, compacted flakes can show ductile behaviour in bend tests, even though the nitrogen content is as high as 900 p.p.m. An electro-polished piece made in this way, and having an insoluble content of 1·25 per cent and a nitrogen content of 0·091 per cent, showed ductile bend behaviour at a temperature of − 30° C., but broke in a brittle manner at − 50° C. Charpy-type impact tests on a low-nitrogen piece of this extruded chromium gave results of 2·17 ft.lb. at room temperature and 5·74 ft.lb. at 250° C. using machined, unnotched specimens of 1 cm. square cross-section. These figures can be compared with corresponding values of 0·4 and 0·6 ft.lb. respectively for tests on similar-sized chromium bars made by sintering chromium powder in purified hydrogen. X-ray diffraction examination of the extruded chromium showed it to be in a fully recrystallized condition.

It therefore appears that the extrusion method indicated above has an effect of increasing ductility and lowering of the transition temperature which over-rides the opposing effect of nitrogen content and recrystallization. Clearly a measure of preferred orientation may be produced by the extrusion and this may be playing an important part in the effect. This is being investigated.

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Application of the Schlieren Technique to the Study of Ripples

In the simplest form of ripple tank demonstration, a 'point' source of light placed below the tank is used for casting 'shadows' of the ripples on a screen. The ripples have a complicated lens action on the light, so that the relation between the pattern of ripples on the water surface and the pattern of light and shade on the screen is not necessarily a simple one: caution must be exercised in interpreting the finer details of the pattern observed. In more complicated forms of the apparatus, a lens is used above the tank for projecting on to the screen a real image of the ripples; but the same difficulty arises. If the water surface is in sharp focus, the ripples are almost invisible. The lens must be raised so that it focuses the focal lines of light produced by the ripple crests. Now the distance of these focal lines above the surface of

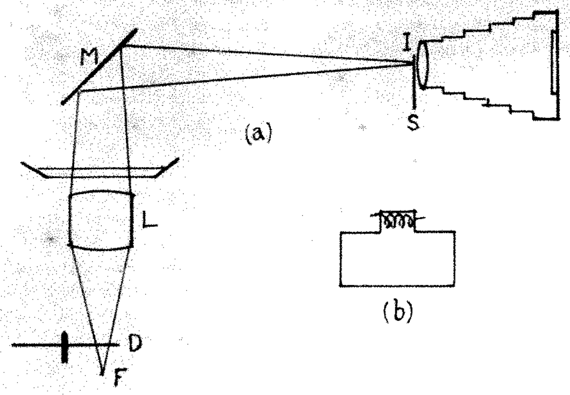

Fig. 1

the water depends on the curvature of the ripples, and since this varies with the attenuation of the waves, it is impossible for the pattern to be in sharp focus over the screen, while obstacles introduced into the tank to produce reflexion, refraction or diffraction are always out of focus.

The schlieren technique, normally used for revealing regions of varying refractive index in a gas, appears to offer a solution of the problem. In the arrangement (Fig. 1) used for obtaining the accompanying photographs, an epidiascope lens *L* of 4 in. aperture was mounted, with axis vertical, immediately below the tank. The source was a micro-projector lamp, *F* (30-W., filament size 3 mm. × 2 mm.), placed so that the lens focused its light through the tank to form a real image 9 mm. × 6 mm. For convenience, the axis of the beam is made horizontal by the surface-silvered mirror *M*. The image of the filament is thus focused at *I* in front of the camera lens and the camera itself is focused on the surface of the water. The image *I* is intercepted by the screen *S*. (The shape of *S*, with image *I* superimposed, is shown at Fig. 1*b*.) The field of view on the camera screen thus becomes uniformly dark. Any disturbance on the surface of the water which deflects light upwards or sideways will appear bright on the screen and the ripples are thus made visible. The lens of the camera should be used at full aperture, with the shutter open, and an exposure made by uncovering *F*.

The photographs (Fig. 2) show: (*a*) partial reflexion, refraction and interference of linear waves originating in deep water and impinging on the apex of a triangular patch of shallow water; (*b*) passage of waves from shallow into deeper water, with total internal reflexion and interference; (*c*) interference of light from two point sources.

The ripples were produced by a vibrator driven from 50 ~ supply, and a stroboscopic disk was used at *D*. The exposure was about ¼ sec. Work is now in progress on ciné-photography of the ripples.

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X-Ray Hazard in Sputtering Apparatus

In a paper to be published in the *Proceedings of the Physical Society* on the "Bombardment of Various Elements by Hg$^+$ and A$^+$ Ions", we have described sputtering experiments with low-pressure gas discharge tubes where an appreciable intensity of X-radiation was observed. It has been pointed out to us that, whereas the hazards of X-rays in magnetrons[1], gas-filled[2] and vacuum valves are well known, the indirect production of X-rays during sputtering at high voltages would be generally unsuspected, and that the matter should be given wider mention.

The discharge tubes used in these experiments had each an oxide-coated flat nickel-strip cathode and an 'Armco' iron anode. The discharges were formed in argon or mercury vapour at currents ranging from 0·1 to 15 amp., with a cathode-to-anode voltage drop of about 20 V. The targets were attached to side arms sealed to the discharge tubes and were exposed to the discharge plasma. Negative potentials of up to 20 kV. were applied to the targets so that they were bombarded by positive ions drawn from the discharge. The target currents depended on the experimental conditions and ranged from 0·1 to 10 m.amp. With the various targets studied, including carbon, iron and uranium, copious secondary electron emission by positive ion bombardment was found at the higher voltages. The X-rays observed were shown to arise from the acceleration of these electrons across the positive ion sheath surrounding the target and their subsequent collision with the walls of the discharge tube. At 8 kV. and above, the X-rays were detected by the fogging, within an hour or so, of Ilford dental X-ray film placed about six inches from the tube, indicating radiation intensities at that point of roughly 10^{-5} r./sec., which exceeds the maximum permissible dose-rate.

Thus in similar experiments or industrial processes involving ion bombardment at, say, 10 kV. and

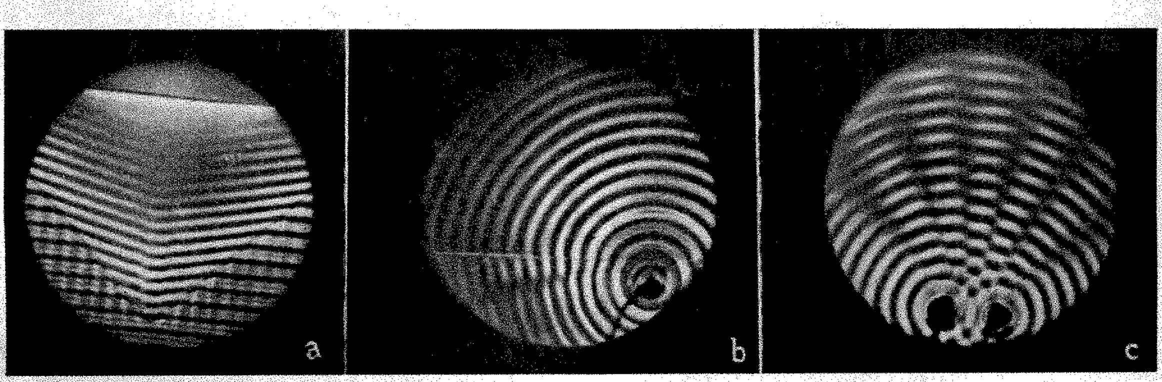

Fig. 2

above, it is essential to test for X-rays, and to shield against them if they present a hazard to personnel.

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Existence of a Non-Electrostatic Stabilizing Factor in Hydrophobic Selenium Hydrosols

It is well known that the stability factor of hydrophobic sols decreases, at first, exponentially with the ionic strength of the solution, and reaches, rather suddenly, its limiting value for a certain concentration C_1 of the coagulating electrolyte[1]. For concentrations lower than C_1 we have the so-called 'slow coagulation'; the interaction energy consists of long-range electrical repulsions, dependent on ionic strength, and of Van der Waals attractions. For concentrations higher than C_1, the electrical repulsions have practically disappeared[2] and we have 'rapid coagulation'.

The kinetics of rapid coagulation have been studied theoretically. Each particle is assumed to be surrounded by a sphere of attraction having a radius r. If the centre of a second particle penetrates into this sphere of attraction, the two coalesce irreversibly. Treating the problem as one of simple diffusion, von Smoluchowski[3] showed that the disappearance of primary particles must initially be a bimolecular process, characterized by a kinetic constant:

$$k_{1\cdot 1} = \frac{4kT}{3\eta} \cdot \frac{r}{a}$$

where k is Boltzmann constant, T is the absolute temperature, η is the viscosity of the medium and a is the radius of the particles.

The ratio r/a must obviously have a value of at least 2, and Hamaker[4] has shown that it should be slightly larger. Experimental values between 2 and 3 have been found in a number of cases.

However, for selenium hydrosols, Kruyt and Van Arkel[5] found very small values ranging from 0·55 to 1·3. With sols prepared in a similar manner, we have confirmed their results, obtaining values between 0·58 and 1·06, as shown in Table 1. It therefore appears that for selenium sols, some repulsive force unconnected with the charge of the double layer must be taken into account.

We have found that the abnormal stability is due to an impurity, probably hydrazine hydrate, which is used as a reducing agent for preparing the sols.

Table 1. Experimental Values for the Ratio r/a, with Non-dialysed Selenium Hydrosols

Sol concentration (No. of particles/cm.^{3})	Diameter of particles (mμ)	r/a
$0\cdot62 \times 10^9$	188	1·06
0·96	168	0·84
3·14	142	0·58
1·57	142	0·62
0·78	142	0·77

Table 2. Variation of the Ratio r/a during Purification of a Selenium Hydrosol

Time of electrodialysis (hr.)	Conductivity of the sol (ohm^{-1} cm.$^{-1}$)	r/a
0	$133\cdot0 \times 10^{-6}$	1·5
22·5	118·0	1·8
29·75	95·5	2·1
46·0	57·0	2·3
71·0	8·8	2·2
78·5	8·0	(3·9)
118·5	6·5	2·1
167·0	4·2	2·2

The numerical data given in Table 2 show clearly that when the colloidal solutions are purified by prolonged electrodialysis, the ratio r/a increases regularly with the purity, as measured by specific conductivity.

In another series, r/a varied from 0·44 to 2·5 during purification.

It must be stressed that the purification has practically no influence on the stability factor in the region of slow coagulation, or on the limiting concentration C_1. Therefore, it does not affect the Stern potential.

A tentative explanation of this behaviour is that each micelle is covered by an adsorbed layer of hydrazine, and this strongly polar substance modifies the local structure of water in the immediate neighbourhood of the colloidal particle. The 'hydration' shell may cause a repulsive action of entropic origin—a steric hindrance.

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Synthesis of 4-Methylumbelliferone β-D-Glucuronide, a Substrate for the Fluorimetric Assay of β-Glucuronidase

At the present time there is considerable demand for a suitable synthetic substrate for the routine assay of β-glucuronidase. The most common assay method employs phenolphthalein glucuronide isolated from rabbit urine[1]. However, the preparation of 4-methylumbelliferone glucuronide from rabbit urine and its use in the fluorimetric assay of β-glucuronidase have been recently described[2]. This substrate promises certain advantages over phenolphthalein glucuronide, and it is easy to synthesize, by the method previously employed for (−)-menthol[3] and phenol[4] β-D-glucuronides.

4-Methylumbelliferone β-D-glucoside hemihydrate[5] (1·5 gm.) in 60 ml. water was maintained at 90° C. and vigorously stirred. Oxygen was passed into the solution through a sintered glass disk, and freshly reduced platinum catalyst[3] (0·4 gm.) was added. The pH was kept between 7 and 9 throughout the oxidation by the addition of 0·5 N sodium bicarbonate. After 1 hr., more catalyst (0·2 gm.) was added, and the reaction was complete 30 min. later, with an almost theoretical uptake of alkali. The filtered solution was reduced to half volume, treated with charcoal, and made acid to congo red with hydrochloric acid. The hydrated glucuronide was filtered off and recrystallized from 50 per cent (v/v) aqueous ethanol and then from water : yield 0·95 gm. (54 per cent). After drying at 105° over phosphorus pentoxide, the hemihydrate[2] had corrected and mixed melting points with a biosynthetic specimen of 139–140°, and $[\alpha]_D^{22}$ $-119°$ in water (*c*, 0·25) : on acid hydrolysis 4-methylumbelliferone was obtained, melting point and mixed melting point 187–188°. Mead *et al.*[2] give a melting point of 139–140° (decomp.) for the hemihydrate of the biosynthetic glucuronide, and $[\alpha]_D^{23}$ $-105°$ for the completely hydrated compound.

Grateful acknowledgment is made to Prof. R. T. Williams and Dr. D. Robinson for specimens and unpublished results.

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Phase-Change in 1,2,4,5-Tetrabromobenzene investigated by Pure Quadrupole Resonance

It is the purpose of this communication to mention a result of a type which we believe to be hitherto unreported, which we obtained when the temperature dependence of the bromine-81 pure quadrupole resonance at about 240 Mc./s. in 1,2,4,5-tetrabromobenzene was investigated. Here, on raising the temperature above 20° C., there is as usual a linear decrease of frequency. However, a very sudden discrete drop occurs at 46·5° C., after which there is again a linear decrease. On then reducing the temperature, the increase of frequency is linear as far as 33·5° C., where there is a sudden discrete rise, the frequency returning to the original line and completing a hysteresis loop.

The experimental results are shown in Fig. 1. The temperature coefficients of frequency are $-3·9 \times 10^{-5}$/deg. C. and $-5·9 \times 10^{-5}$/deg. C. for the upper and lower straight line portions respectively. The frequency jump is of the order of 1·5 parts in 10^3. It is interesting to note that the temperature coefficient at temperatures above the discontinuity is of the order usually found in compounds where bromine is attached to the benzene ring, while that at temperatures immediately below is about 35 per cent lower.

The resonance was obtained by means of an externally quenched frequency-modulated super-regenerative oscillator using a cathode-ray oscillograph display. A push–pull arrangement was used employing type 955 'acorn' triodes, the sample being placed in a tuned coil at the far end of the anode lines. A simple oven surrounds the specimen. Comparison between frequency measurements made with slowly rising and slowly falling temperatures indicates that the error of temperature measurement is ± 0·2° C.

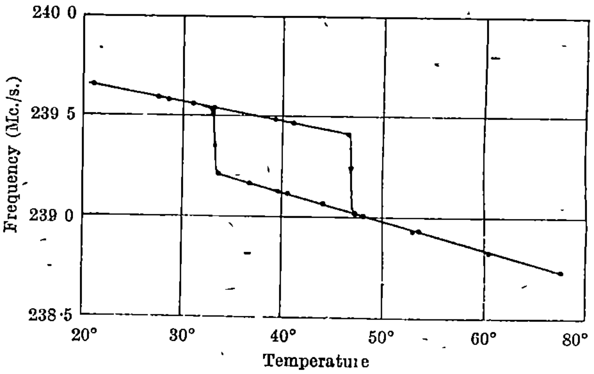

Fig. 1. Frequency of bromine-81 pure quadrupole resonance in 1,2,4,5-tetrabromobenzene as a function of temperature

Frequency measurements were made by adjusting the amplitude and frequency of quench so that the resonance appeared as a single peak. This was then located at the centre of the cathode-ray oscillograph display. The sweep- and quench were then switched off, and the frequency of the oscillator measured by obtaining zero beat with a harmonic of a calibrated wave-meter, type *BC*-221-*C*, detected by means of a G.E.C. very high frequency panoramic receiver, type *BRT*-652. The calibration of the wave-meter was set for each reading by means of the 2 Mc./s. crystal incorporated in the receiver. This was, in turn, checked against a B.B.C. transmission at 94·3 Mc./s., which afforded a sufficiently accurate standard at a convenient frequency. This system of measurement gives an error of about ± 5 parts in 10^5, which includes that of setting the oscillator exactly upon the quadrupole frequency.

Thanks are due to Mr. D. Pardy for carrying out the measurements.

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Factors affecting the Permanency of Paper : Tests with Labelled Sulphur

Papers of good quality and high alpha-cellulose content can be kept under suitable storage conditions for several centuries. There are, however, differences of opinion on factors affecting storage, and a recent investigation by Langwell[1–5] claims that even good-quality papers can become brittle at the edges. He stated that this attacked portion of the paper in old documents and books has a scorched appearance resembling the product of the reaction between cellulose and strong acid. Analyses of these old papers reveals a high sulphate content indicative of attack by sulphuric acid from the atmosphere.

The concentration of sulphur dioxide in industrial atmospheres is of the order of 0·5 part per million[6], and Langwell has suggested that catalysts in the paper accelerate the conversion of this sulphur dioxide to sulphuric acid. By exposing paper, usually under damp conditions, to atmospheres containing about 0·5 per cent sulphur dioxide, that is, 10,000 times that in an industrial atmosphere, Langwell measured the increase in sulphate in the paper by extraction with water and precipitation as barium sulphate. The uptake of sulphur was correlated with catalysts present in, or added to, the paper, and ron was found to be an important catalyst for the conversion of sulphur dioxide to sulphate under these conditions.

His work was limited by the sensitivity of the precipitation method. One of us had found, in another connexion[7], that sulphur-35 could be used very effectively in paper for studying migration by autoradiographs or counting. We therefore decided to repeat some of Langwell's experiments using sulphur labelled with sulphur-35. W. H. Langwell, imself, kindly supplied us with the same papers that he had used in studying the effect of catalyst nhibitors[4].

Detailed results will be published elsewhere, when hey are complete, but some new information has een found already. Using a wet atmosphere and 0·5 per cent sulphur dioxide the uptake of sulphur dioxide could be detected with a Geiger–Müller ounter after 2-hr. exposure only, and after 24-hr. exposure the papers tested could be shown to fall in general into the order already found by Langwell using a seven-day exposure.

Some labelled sulphur was burned in a desiccator o give a concentration of 1 per cent sulphur dioxide under normal dry conditions (about 50 per cent elative humidity). When papers were exposed to his the uptake of sulphur dioxide could be detected n 3 hr., and after 24 hr. the papers again fell into the order obtained by Langwell.

It was necessary to expose all papers to atmosphere efore counting to allow gaseous sulphur dioxide to diffuse out; but a steady counting-rate was obtained after 4 hr.

The labelled paper samples after exposure to ulphur dioxide under both wet and dry conditions were placed between X-ray film for three weeks and hen developed. The autoradiographs showed some general take-up of sulphur; but they also showed a andom distribution of intense black spots with dark areas spreading from them. The paper itself was now developed with acid potassium ferrocyanide and it was found that the dark areas corresponded to iron, and in some cases, bronze spots in the paper. The take-up of sulphur dioxide is, therefore, partly general and partly localized.

One of us (W. D. M.) holds a George Rackley scholarship provided by the Northern District of he British Paper and Board Makers' Association.

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Detonation Phenomena in Homogeneous Explosives

In their discussion of certain detonation phenomena in homogeneous explosives, Campbell *et al.*[1] describe a curious effect obtained by lining the container of an explosive with metal foil. They state that very thin metal foils, of the order of 0·001 in. thickness, can reduce quite considerably the diameter at which failure of detonation of nitromethane occurs.

In considering the effect of the container on the detonation of an explosive charge, the natural impulse is to look for an interpretation of the phenomenon in terms of confinement, by which is usually meant the resistance offered by the envelope to the lateral expansion of the detonation products. It is known, however, that the initial mass movement of the products, or 'streaming velocity', is forward, from which it may be deduced that the early stages of detonation are more likely to be influenced by resistance to forward, rather than to lateral, movement. This suggests that frictional resistance at the surface may be a more potent factor initially.

That this effect exists is indicated by the fact that detonation in a gaseous explosive is established sooner in a tube with a rough interior than in one which is smooth. Also, detonation sets in earlier in a narrow tube than in a wide one[2]. These facts show that the onset of detonation is governed by conditions at the surface and that the roughness of the surface is involved. The inference is that frictional resistance at the surface, which is a tangential force and so does not oppose lateral movement, is a significant factor in the development of detonation.

In detonation, very high pressures and velocities are involved and, as violent friction causes abrasion and erosion, the surface material is reduced and is able to mix, and possibly react chemically, with the products of detonation, much as coal dust is raised and consumed in a mine explosion. The violent explosions which have occurred in oil-contaminated compressed-air lines[3], the independent propagation of detonation in tubular cavities in high-explosive cartridges[4], and the low-velocity detonation regime in cartridges of granular explosive[5], are probably further instances of surface films taking part in high-velocity explosive reactions. Thus the action of the surface layer can be chemical as well as physical.

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Activation of Phospholipid Thromboplastin by Lecithin

This communication is prompted by the recent report of Newlands and Wild[1] that a preparation of soybean phospholipid can serve as a useful source of platelet factor for the thromboplastin generation test. We have been trying in this laboratory for several years to define the phospholipid structures responsible for thromboplastic activity. Reports have been limited to preliminary communications[2-4] because the degree of purity of the active fractions does not permit a rigorous correlation of structure with activity, although the evidence suggests that the essential structural requirement is the presence of a serine or ethanolamine base in a glycerophospholipid molecule. It should be noted that the activity discussed in this communication is acceleration of the conversion of prothrombin to thrombin in the presence of calcium and a suitable (glass) surface in mammalian coagulation systems. Phosphatidyl serine, which has a higher activity per unit weight than thromboplastic protein in accelerating prothrombin conversion in the rabbit system[2], is without effect when studied with avian plasmas.

The discovery of the activating effect of lecithin arose from two observations. The first was that individual fractions of cephalin, precipitated from methanol according to Maltaner[5], did not show greater activity as their content of amino-nitrogen containing phospholipid increased. The second was that the step in which crude cephalin is precipitated from an ether extract of brain by the addition of ethanol according to the method of Folch[6] led to a loss of 90 per cent of total activity. The activity could be recovered if the fractions were recombined in an organic solvent before the lipid was suspended in aqueous medium for testing. The major component of the less active, ethanol-soluble fraction was lecithin. While the addition of an aqueous suspension of lecithin had no effect, or was at most slightly inhibitory, when added to an aqueous suspension of phospholipid thromboplastin[3], the prior combination of the two in organic solvents had not been tried.

In the present experiments thromboplastic activity was determined as previously described[2]. The source of lipid thromboplastin was a cephalin fraction of beef brain prepared by Maltaner twenty years ago[5] and stored under ethanol. It was as active as fresh preparations, attesting to the exceptional stability of the active component. Analysis of this material showed phosphorus, 3·7 per cent; nitrogen, 1·59 per cent; and serine, 11·4 per cent. Three lecithins were studied: a highly purified egg lecithin, dipalmitoleyl lecithin from yeast and beef heart lecithin (the major component of which was recently shown to be phosphatidal choline, a choline-containing plasmalogen). The lecithins had no thromboplastic activity. The phosphatidyl serine fraction in toluene was combined with a solution of lecithin in toluene. The organic solvent was completely removed under reduced pressure and the lipid suspended in saline. The curves in Fig. 1 show the dependence of clotting time on the logarithm of quantity of cephalin for this preparation of beef brain phosphatidyl serine by itself and in the presence of a two-fold quantity of lecithin. It is apparent that the lecithin–cephalin mixture is ten times as active as the cephalin alone, when comparison is made in the optimal region of the curve (that is, where clotting time reflects most sensitively changes in quantity of active substance and is still sufficiently short to permit sharp endpoints of 50–100 sec.). This represents an increase greater than three-fold based on total weight of combined phospholipids. A smaller activation was obtained when the phosphatidyl serine preparation was combined with either an equal quantity of lecithin or five times the quantity of lecithin, indicating that the activation phenomenon is characterized by optimal proportions and cannot therefore be considered to result entirely from enhanced solubility of lipid through mixed micelle formation. A ten-fold quantity of lecithin was inhibitory. It has not been possible to substitute synthetic saturated phosphatidyl ethanolamine or phosphatidyl choline for the natural products, which may be attributed to the difficulty of preparing suitable aqueous suspensions. The phenomenon described here recalls the activation of lipid antigens by lecithin and cholesterol[7], and suggests that the biological properties of phospholipids must be considered in relation to lipid–lipid interactions rather than as discrete functions. Thus identification of 'active lipid' either associated with protein (for example, thromboplastic lipoprotein, lipoprotein antigens) or free, becomes a much more complex problem. With respect to the substitution of lipid thromboplastin for platelet factor in the thromboplastin generation test, the finding that lecithin activates the thromboplastic properties of cephalin should permit a product to be formulated with any desired degree of activity, rather than leaving to chance the isolation of suitable material.

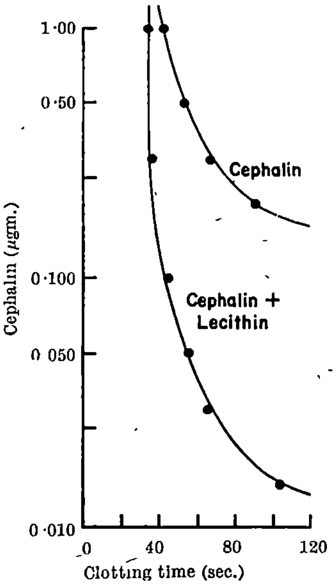

Fig. 1

I wish to thank Dr. Liselotte Graf, Mr. Nicholas Alonzo and Mr. Bernard Lerner for their co-operation and analytical assistance. I am also indebted to Dr. Donald J. Hanahan for the specimen of dipalmitoleyl lecithin and to Dr. Erich Baer for the synthetic phospholipids.

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Isolation of (−) S-Methyl-L-Cysteine from Beans (*Phaseolus vulgaris*)

THE recent isolation[1,2] of S-methyl-L-cysteine sulphoxide from two crucifers, turnips and cabbage, and the chromatographic evidence[3] for its occurrence in many related plants suggested the possibility that methyl cysteine should also occur in plants. In addition, preliminary evidence has clearly indicated that the turnip can readily form the sulphoxide from methyl cysteine. A careful examination[3] of the protein and non-protein fractions of several crucifers revealed no methyl cysteine. Previous work[4] on the non-protein amino-acids of bean seeds showed a ninhydrin-reactive spot which gave an iodoplatinate test[5] indicative of the sulphur amino-acids. This material was found on a two-directional chromatogram (phenol : butanol–acetic acid) in a position corresponding to that of methyl cysteine and close to that of γ-amino-butyric acid. This compound has been isolated and identified as (−) S-methyl-L-cysteine.

Dry kidney bean seeds were ground and extracted with 50 per cent alcohol. The extract was treated with mercuric acetate, and the resultant precipitate was separated and decomposed with hydrogen sulphide. After removal of mercuric sulphide, the solution was passed through a column of sulphonic acid ion exchange resin ('Dowex 50-*X*4') in the acid form and the column was washed. The amino-acids which were retained by the resin were fractionated by displacement chromatography with 0·10 *N* ammonia[6]. The fractions containing the unknown material were contaminated with glutamic acid and asparagine. These three compounds were separated by chromatography on a paper roll[7] using 70 per cent ethanol. The unknown material was purified by three crystallizations from 95 per cent ethanol. Approximately 150 mgm. were obtained from 5 kgm. of beans. The isolate was found to be identical with synthetic (−) S-methyl-L-cysteine with respect to infra-red spectra, optical rotation $[\alpha]_D^{25^\circ} = -26^\circ$ ($c = 2{\cdot}5$), decomposition point (about 220° C.), and paper chromatography in phenol, butanol–acetic acid and collidine–lutidine ($R_F = 0{\cdot}71$, $0{\cdot}27$ and $0{\cdot}38$, respectively). The elementary analysis of the isolate was C, 35·6 ; H, 7·0 ; N, 10·2 ; S, 23·5. The calculated values are C, 35·6 ; H, 6·67 ; N, 10·37 ; S, 23·7.

The presence of methyl cysteine in legumes and its sulphoxide in crucifers suggests that these two related compounds may have a widespread occurrence in plants. This possibility, coupled with the preliminary evidence of their interconversion, may foreshadow an interesting metabolic role for the methyl cysteine–methyl cysteine sulphoxide system in plants.

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Malate Synthesis in a Cell-free Extract from a Crassulacean Plant

EXTRACTS of spinach leaves[1] and of wheat germ[2] contain a phosphoenolpyruvic carboxylase which, in the presence of magnesium or manganese ions, catalyses the reaction:

$$\text{phosphoenolpyruvate} + \text{CO}_2 \rightarrow \text{oxalacetate} + \text{orthophosphate} \quad (1)$$

In the presence of reduced diphosphopyridine nucleotide and malic dehydrogenase, the oxalacetate is reduced to malate :

$$\text{oxalacetate} + \text{DPNH} \rightarrow \text{malate} + \text{DPN} \quad (2)$$

The linked reaction,

$$\text{phosphoenolpyruvate} + \text{CO}_2 + \text{DPNH} \rightarrow \text{malate} + \text{DPN} + \text{orthophosphate} \quad (3)$$

may then be followed spectrophotometrically by measuring the decrease in absorption at 340μ caused by the oxidation of reduced diphosphopyridine nucleotide.

It has been suggested that phosphoenolpyruvate carboxylase may function in the synthetic accumulation of dicarboxylic acids in plant tissues and especially in those of the Crassulaceae[2,3]. This communication reports that the leaves of *Kalanchoë crenata* and two other Crassulacean plants contain this enzyme. Extracts of *Kalanchoë* leaves known to contain malic dehydrogenase brought about a rapid oxidation of reduced diphosphopyridine nucleotide in the presence of phosphoenolpyruvate and magnesium or manganese ions. Phosphoenolpyruvate could not be replaced by pyruvate and adenosine triphosphate. There was no appreciable decrease in absorption when reduced triphosphopyridine nucleotide was substituted for reduced diphosphopyridine nucleotide.

Pre-incubation of phosphoenolpyruvate with the leaf extract and magnesium ions caused increases in the initial rate of oxidation of added reduced diphosphopyridine nucleotide. A two-stage reaction is implied by the fact that, within limits, the initial rate of oxidation was directly related to the length of the pre-incubation period.

Production of malate during the course of the linked reaction (3) has been shown chromatographically and the hydrazone of oxalacetic acid prepared, and separated, from reaction mixtures containing no reduced diphosphopyridine nucleotide. Labelled malate and labelled oxalacetic hydrazone have been similarly prepared by adding radioactive bicarbonate to the appropriate reaction mixture. This is believed to be the first demonstration of malate synthesis *in vitro* catalysed by a cell-free preparation from a Crassulacean plant.

Bandurski[3] has reported a stimulation of phosphoenolpyruvic carboxylase by carbon dioxide. This has been confirmed by Brown[4] and by myself, who found a linear relationship between the reciprocals of reaction-rate and the reciprocals of (low) concentrations of both phosphoenolpyruvate and carbon dioxide. Between 0·1 and 10 per cent the rate of the linked reaction was affected only slightly, rising gradually below 0·5 per cent and then declining. Above 10 per cent this decline became pronounced, and the reaction was almost completely inhibited in 70 per cent carbon dioxide (that is, in a solution containing the bicarbonate calculated from the Henderson Hasselbach equation[5] to be in equilibrium with an atmosphere containing 70 per cent carbon dioxide). As malic dehydrogenase was not depressed by carbon dioxide, it is presumed that reaction (1) was inhibited. There is a strong parallelism between this behaviour and the effect of carbon dioxide on dark acidification in the intact leaf[6]. This is consistent with the view that phosphoenolpyruvic carboxylase is the enzyme which actuates such acidification *in vivo*.

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Net Synthesis of Lecithin in an Isolated Enzyme System

WORK in this Laboratory[1] has shown that the biosynthesis of lecithin and of phosphatidyl ethanolamine involves the intermediary formation of cytidine diphosphate choline and cytidine diphosphate ethanolamine. The enzymatic synthesis of lecithin is described in the following simplified scheme:

$$\text{Cyt-P-O-P-O-P} + \text{P-choline} \longleftrightarrow \text{Cyt-P-O-P-choline} + \text{P-O-P} \quad (1)$$

$$\text{Cyt-P-O-P-choline} + \text{D-}\alpha,\beta\text{-diglyceride} \longleftrightarrow \text{Lecithin} + \text{Cyt-P} \quad (2)$$

Previous experiments on the biosynthesis of lecithin in isolated enzyme systems have required the use of isotopic tracers, since the amounts of newly formed phospholipid were too small to be detected by conventional chemical methods. In such experiments, it was impossible to rule out the occurrence of reactions by which the labelled compound exchanges with the phospholipid in the enzyme preparation, bringing about an incorporation of the isotope without a net increase in phospholipid.

It has now been found that isolated mitochondria, incubated with cytidine diphosphate choline and D-α,β-diglyceride, catalyse the net synthesis of lecithin (Table 1). During the course of incubation with the complete system, the amount of phospholipid is almost doubled. Synthesis falls to a low level if the diglyceride is omitted, and no synthesis occurs if the cytidine diphosphate choline is omitted. It is necessary to carry out the reaction in the presence of small amounts of a surface-active agent such as 'Tween-20' (polyoxyethylene sorbitan monolaurate) in order that the diglyceride may penetrate to the site of enzymatic synthesis. There is good agreement when the synthesis as measured by the incorporation of radioactive choline from the cytidine diphosphate choline is compared with the net increase in lipid phosphorus.

Table 1. THE NET SYNTHESIS OF LECITHIN IN AN ISOLATED ENZYME SYSTEM

Additions	Lipid phosphorus (microatoms)	Δ Lipid phosphorus (microatoms)	Total counts incorporated
1. None	1·19	—	—
2. Cytidine diphosphate choline	1·23	0·04	960
3. D-α,β-diglyceride	1·17	0	—
4. Cytidine diphosphate choline + D-α,β-diglyceride	2 25	1·06	13,375

Each tube contained 20 μmoles magnesium chloride, 10 μmole cysteine, 40 μmoles tris(hydroxymethyl)aminomethane buffer o pH 7·4, 2 mgm. of 'Tween-20' and 8 mgm. of mitochondria from chicke liver in a final volume of 1 ml. Cytidine diphosphate choline (3 μmoles labelled with choline-1,2-^{14}C (14,000 counts/μmole/min.) was adde where indicated. D-α,β-diglyceride (4 μmoles), prepared from eg lecithin by the action of lecithinase from *Clostridium perfringens*, wa also added to some tubes as shown. The tubes were incubated at 37 for 2 hr. The lipid fraction was isolated, counted and analysed fo total phosphorus as described in ref. 4.

Work in several laboratories[2] has led to the discovery in liver and brain of enzyme systems which rapidly synthesize phosphatidic acids. However, phosphatidic acids do not occur in appreciable concentrations in these tissues. Considerable speculation has therefore arisen as to the role of phosphatidic acids in the metabolism of lipids. It has now been found that mitochondria and microsomes from rat liver catalyse the reaction:

$$\text{Phosphatidic acid} \rightarrow \text{D-}\alpha,\beta\text{-diglyceride} + \text{inorganic phosphorus} \quad (3)$$

The dephosphorylation is inhibited by magnesium ions and 'Tween-20'. Therefore, if phosphatidic acid is added to enzyme systems such as shown in Table 1, which are synthesizing lecithin in the presence of magnesium ions and 'Tween-20', no stimulation of synthesis occurs. If the phosphatidic acid is preincubated with the enzyme, and then 'Tween-20', magnesium ion and labelled cytidine diphosphate choline are added, a stimulation of synthesis is observed (Fig. 1) which is proportional to the time

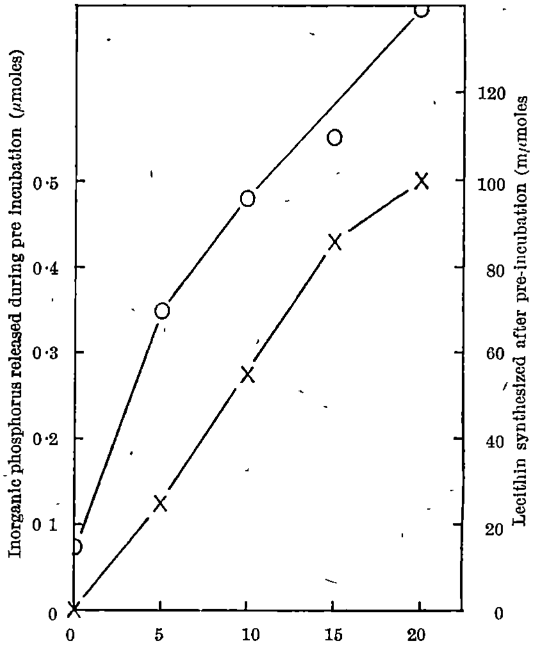

Fig. 1. 4·0 μmoles of phosphatidic acid were pre-incubated at 37° with 50 μmoles of tris(hydroxymethyl)aminomethane buffer of pH 7·4 and 2 mgm. of microsomes from rat liver for the time intervals shown. One set of tubes was then analysed for release of inorganic phosphate. To the other set, 5 mgm. of 'Tween-20', 20 μmoles of magnesium chloride and 1 μmole of cytidine diphosphate choline labelled with choline-1,2-^{14}C (56,000 counts/μmole/min.) were added and the incubation continued for another 2 hr. The release of inorganic phosphorus during pre-incubation (crosses) is plotted against the left-hand scale, and the synthesis of lecithin (circles) against the right-hand scale

of pre-incubation and to the prior release of inorganic orthophosphate.

These results indicate that phosphatidic acids may act as precursors of D-α,β-diglycerides *in vivo* and thus furnish the glyceride moiety of glycerophosphatides, and also show that the biosynthesis of phospholipids and neutral fats are intimately related processes.

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Polynucleotide Phosphorylysis and Synthesis by Lysed Cells of *Micrococcus lysodeikticus*

AQUEOUS extracts of *Micrococcus lysodeikticus* possess a highly active enzyme capable of polymerizing mononucleotides reversibly[1]. In addition, the bacterial ribonucleic acid is readily phosphorylysed by this enzyme in the presence of inorganic phosphate. Because of these facts, we have attempted in a few preliminary experiments to evaluate the part this enzyme system may play in modifying the properties or content of bacterial cell ribonucleic acid during lysis of the cells and extraction procedures. In these experiments we have measured the acid-insoluble and acid-soluble fractions extractable from the cells during and after lysis in *tris* buffer, phosphate buffer, and in the presence of adenosine diphosphate in *tris* buffer, all experiments at *p*H 9·5. The cells were harvested from submerged 48-hr. cultures[2] and washed three times in 0·5 per cent sodium chloride. The concentration of cells was selected empirically by choosing a value which would, after complete lysis, yield an optical density of approximately 1·0 at 260 mμ for the acid-insoluble material when dissolved in 3 ml. of *tris* solution, *p*H 8·0, 0·1 *M*.

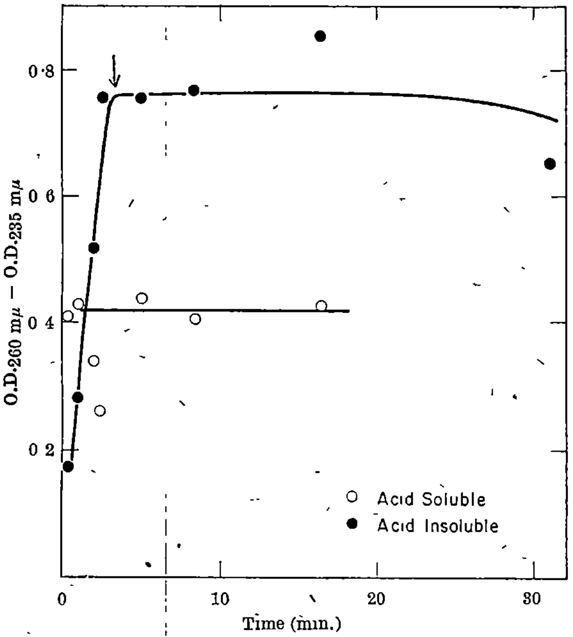

Fig. 1

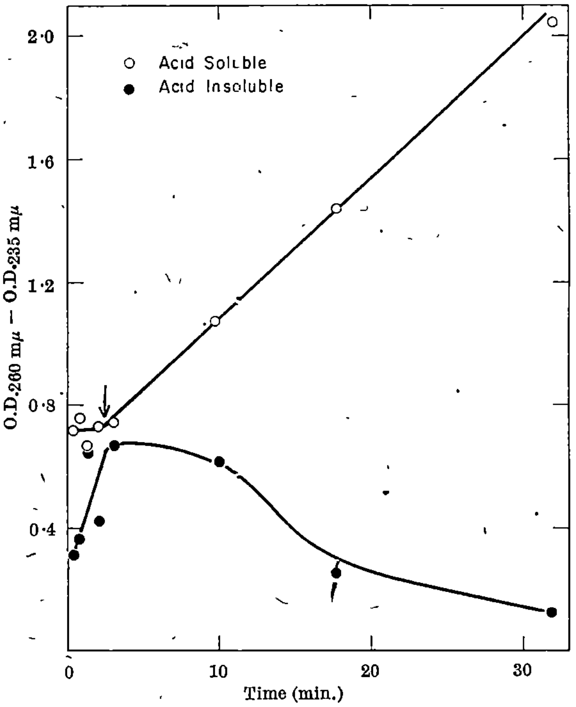

Fig. 2

In the first experiment (Fig. 1) 8 ml. of cells were mixed with 3 ml. of 0·1 *M tris* buffer and 5 ml. of 0·1 per cent lysozyme (Worthington crystalline enzyme). The suspension was incubated at 37°, and at periodic intervals 2 ml. aliquots were removed and added to 2 ml. of 5 per cent perchloric acid. The resulting precipitate and lysed cells were centrifuged down and the optical density of the supernatant measured at 235 mμ and 260 mμ. The sediment was washed once with 5 per cent perchloric acid, twice with 95 per cent ethanol, and finally dissolved in the *tris* buffer at *p*H 8·0. The optical densities were recorded as above. Plotted in Fig. 1 are the differences in optical densities at 235 mμ and 260 mμ, corrected for a 3-ml. sample. We observe that except for some scatter the acid-soluble fraction remains constant. The acid-insoluble fraction increases linearly until lysis is complete (vertical arrow), at which point this fraction, too, remains constant. The sensitivity of the method employed has not been developed to the point where we might detect transient changes in the acid-soluble fraction during the initial period of lysis. However, in view of the fact that the acid-soluble material is apparently easily extracted from intact cells, we do have a reliable indicator of any change in the concentration of the acid-soluble material should it occur. The linearity of the acid-insoluble curve suggests that the rate of lysis of the cells may be easily measured by this technique.

In the second experiment (Fig. 2) *tris* buffer was replaced by dipotassium phosphate. We observe

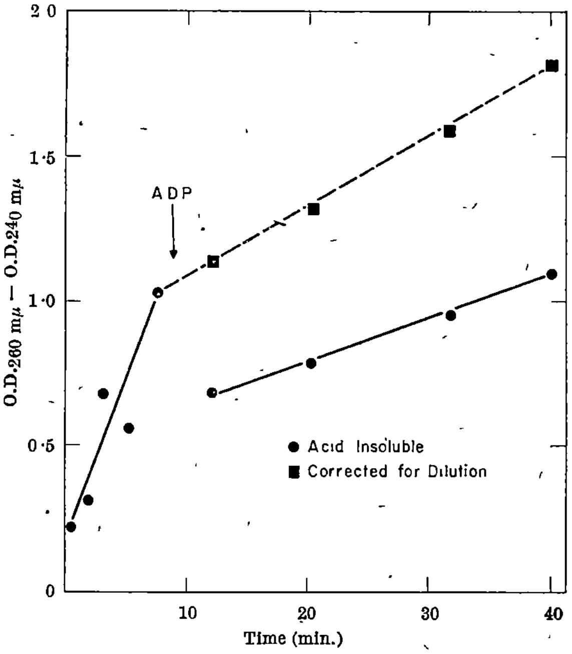

Fig. 3

the same initial increase in acid-insoluble material followed by a rapid drop. The acid-soluble material, after an initial lag, shows a remarkably linear increase. This experiment clearly demonstrates the phosphorylysis action of the lysed cells.

In the third experiment (Fig. 3) 4 ml. of cells were mixed with 2 ml. of *tris* buffer, 1 ml. of $6 \times 10^{-3} M$ magnesium chloride, and 1 ml. of 0·1 per cent lysozyme. 1-ml. aliquots were removed, added to 2 ml. of 5 per cent perchloric acid and the acid-insoluble material was determined as above. In this instance the differences at 240 mμ and 260 mμ were recorded. After 10 min., lysis was complete. 2 ml. of $10^{-2} M$ adenosine diphosphate were added. Additional 1-ml. aliquots were removed and measured for acid-insoluble material. In Fig. 3 we observe first the rapid increase in acid-insoluble material followed by a drop after dilution with adenosine diphosphate and a linear increase thereafter. The rate corrected for dilution effects is also given. This experiment clearly demonstrates the polymerase action of the lysed cells. Indeed, the rate of synthesis by unfractionated lysed cells is sufficiently great to permit one to assay the cells for enzyme content using the previously described method of assay[1].

The relationship of these findings to the *in vivo* status of ribonucleic acid is not clearly defined by these experiments. We may state that possibly the ribonucleic acid of the intact cell exists in an equilibrium with the inorganic phosphate and diphosphate mononucleotides as it certainly does in the lysed cell. However, a very difficult practical problem is suggested by these findings. The presence of an easily displaced equilibrium in the lysed cells indicates a high turnover of ribonucleic acid and mononucleotides. In other words, although the amount of ribonucleic acid and mononucleotides as indicated in Fig. 1 may remain constant, the exchange between the mononucleotides and nucleic acid may be very large, particularly if the enzyme system is very active. Therefore, the specific structure of the ribonucleic acid may vary from moment to moment, the size of the nucleic acid molecules may decrease or increase, and, in general, the state of ribonucleic acid after lysis of the cell may bear no relationship to what actually exists in the cell. The remarks can also apply to ribonucleic acid isolated from other bacteria and yeast. We conclude, therefore, that such parameters as molecular weight, mononucleotide sequence, and *in vitro* determinations of amounts of ribonucleic acid extracted from bacteria and yeast can have no important biological significance unless one has carefully ruled out the role of polynucleotide phosphorylase in the procedures adopted for disrupting the cell walls and extracting the nucleic acid.

This investigation was performed in the Division of Biochemistry, Massachusetts Institute of Technology, Cambridge, Mass., and was supported by Research Grant C-2550(*C*) from the National Cancer Institute, National Institutes of Health, U.S. Public Health Service. I wish to thank Mrs. G. Olson for her assistance in these studies.

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Peroxide Formation in Bacteriological Media

It has been observed that small inocula of *Mycobacterium tuberculosis* grow poorly in synthetic media unless certain additions (serum fractions, hæmoglobin, cobalt, charcoal) all of which are peroxide-destroying agents are made. Highly isoniazid-resistant strains of *M. tuberculosis* (which are much more sensitive to hydrogen peroxide than isoniazid-sensitive strains) show a greater demand for such peroxide destroyers, especially when manganese is present in the medium[1]. Consequently, it has been suggested that these media contain traces of peroxide, although this had not been confirmed chemically.

We have examined Proskauer and Beck-type media and have shown that, as prepared in these laboratories, they contain 1–10 μgm./ml. of hydrogen peroxide. All the media investigated contained citrate. When citrate is autoclaved with manganese salts, substantial quantities of hydrogen peroxide are formed. For example, a 0·25 per cent solution of sodium citrate in phosphate buffer, *p*H 7, containing 1 μgm./ml. manganese (added as manganous chloride), autoclaved at 10 lb. for 10 min., contained about 7 μgm./ml. hydrogen peroxide. No peroxide was produced in the absence of manganese; but exceedingly small concentrations of manganese were effective. Thus about 1 μgm./ml. hydrogen peroxide was formed when 0·01 μgm./ml. manganese was autoclaved with citrate under the above conditions. Such traces of manganese were usually present in the asparagine used in these media, but occasionally were present in other constituents also.

No measurable peroxide production was observed from manganese and citrate at room temperature; at 37°, peroxide was formed slowly. A 0·25 per cent solution of sodium citrate produced 1·5 μgm./ml. hydrogen peroxide when incubated with 1 μgm./ml. manganese for three days at 37°.

The presence of peroxide was shown by liberation of iodine from potassium iodide, reaction with potassium permanganate, oxidation of benzidine in the presence of peroxidase, luminescence with luminol, and formation of 'pertitanic acid' with titanic sulphate. The last method was usually employed for quantitative determination. We did not show for certain that the peroxide formed was hydrogen peroxide; but peroxide-destroying agents of widely different type and activity—hæmin, serum, cobaltous ions, cupric ions, ferrous and ferric iron, activated carbon, Adams catalyst, sodium hydrosulphite, reductone, pyruvic acid, ascorbic acid and cysteine—all removed this peroxide from media at the same rate as they removed added hydrogen peroxide.

Hydrogen peroxide is very stable in Proskauer and Beck-type media. In glycerol-buffer it is rapidly destroyed; but citrate or asparagine greatly reduces the rate of destruction, so that in the full medium hydrogen peroxide has a half-life of more than a month, when kept at room temperature.

It has been known for a long time that light can bring about the formation of peroxide in certain other bacteriological media[2,3]. Light is not necessary for its formation from citrate and manganese, however. The mechanism involved resembles rather the well-known phenomenon of 'autoxidation', by which certain substances in the presence of oxygen and water produce hydrogen peroxide. Classical examples are the oxidation of phosphorus, lead, zinc and turpentine, while there are references also to hydrogen peroxide production from isoniazid[4], hydrazine, ascorbic acid and some heterocyclic substances.

Peroxide formation thus appears to require a reducing system which will transfer hydrogen atoms (or electrons) to oxygen. With many reducing agents the peroxide formed would be further reduced to water. In some cases, however, this further reduction does not take place, or takes place more slowly than the peroxide is formed, so that peroxide accumulates. Citrate is not readily oxidized, and requires manganese as a catalyst and raised temperatures before it reduces oxygen to hydrogen peroxide.

A wide range of other reducing agents has been investigated for ability to produce peroxide when autoclaved in the presence of manganese. Although quite a number of substances produced very small traces of peroxide, only reducing sugars and some hydrazine derivatives gave levels comparable to those obtained with citrate. Some hydrazine derivatives were particularly strong peroxide formers with manganese at 37°—thus more than 200 μgm./ml. hydrogen peroxide could be obtained with isoniazid (conc. = 2 mgm./ml.).

The formation of peroxide from citrate appeared to be catalysed specifically by manganese. Silver, aluminium, arsenic, boron, barium, calcium, cobalt, chromium, copper, iron, mercury, magnesium, nickel, chromium, lead, tin and zinc under similar conditions failed to give measurable peroxide production when autoclaved with citrate. However, the possibility cannot be excluded that there are reducing systems with which metal ions other than manganese will function catalytically, leading to the formation of peroxide. Such reducing systems may be operative in the formation of hydrogen peroxide in types of media other than those which we have investigated. For example, cuprous salts (or metallic copper) will form traces of peroxide in the presence of water and oxygen—though this peroxide does not accumulate owing to the further action of copper salts in catalytically destroying hydrogen peroxide. But these traces may explain the results of O'Meara and Macsween[5] on the effect of small amounts of copper salts on the growth of a number of pathogens. It would appear that when copper was added to their peptone media, cuprous salts were formed during sterilization, which on exposure to air formed hydrogen peroxide, thus inhibiting the growth of the inocula.

It is interesting to note that Seigel and Galston[6] have shown that manganese stimulates the formation of peroxide in plant tissues, and have suggested that if the same phenomenon occurs in bacteria it may explain the mutagenic effect of manganese on them.

Grateful acknowledgment is made to Prof. R. A. Q. O'Meara for stimulating discussions, and to Arthur Guinness, Son and Co. (Dublin), Ltd., for financial assistance.

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Nucleic Acid Turnover Studies in Human Leukæmic Cells and the Function of Lymphocytes

THE experiments described here were undertaken to ascertain the pattern of purine utilization and turnover in the nucleic acids of different types of leukæmic leucocytes. The results indicate that leukæmic lymphocytes survive longer than leukæmic granulocytes. The results also direct attention to the possibility of re-utilization of large fragments of nucleic acids by lymphocytes, and invite speculation on the significance of this process as an explanation of the problem in long-term immunity of how formation of antibody continues long after the limited contact between tissues and antigen.

Adenine-8-carbon-14 (200 μc.) was given intravenously once to two patients having chronic lymphatic and to two having chronic granulocytic leukæmia; in the lymphatic leukæmia patients the predominant cell type was the small-lymphocyte and in the granulocytic leukæmia patients the leucocytes were polymorphonuclears. Pentose nucleic acid and deoxyribose nucleic acid were isolated from leucocytes collected afterwards. In leucocytes from the first two patients the radioactivities of the separated individual purines were determined, and, for the other patients, the radioactivities of the pentose nucleic acid purine nucleotides and of the deoxyribose nucleic acid purines.

Representative data on the incorporation of adenine into deoxyribose nucleic acid purines of granulocytes and lymphocytes are shown in Fig. 1; for simplicity, data on pentose nucleic acid are not shown in the figure but will be described in the text.

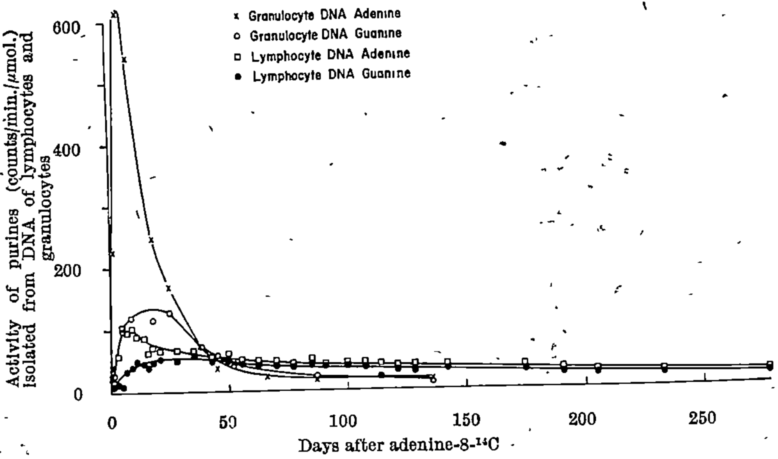

Fig. 1. Incorporation of adenine-8-^{14}C into DNA lymphocytes and granulocytes in chronic lymphatic and granulocytic leukæmia

In granulocytes, adenine as such was incorporated into deoxyribose nucleic acid; there was also extensive transformation of adenine into deoxyribose nucleic acid guanine. The curves of incorporation and transformation of adenine into polynucleotides of pentose nucleic acid and deoxyribose nucleic acid as a function of time were similar; as were also the retentions of isotope in the adenine and guanine of pentose nucleic acid and deoxyribose nucleic acid. A similarity of incorporation and turnover in pentose nucleic acid and deoxyribose nucleic acid of granulocytes is also found in intestine and bone-marrow—all of which are rapidly dividing tissues.

In lymphocytes, the incorporation of adenine into pentose nucleic acid and its transformation into pentose nucleic acid guanine resembled that in granulocytes (that is, the early portions of the curves were similar to granulocyte deoxyribose nucleic acid adenine and guanine); in contrast, the incorporation of adenine into deoxyribose nucleic acid and transformation of adenine into deoxyribose nucleic acid guanine were less extensive than the incorporation and transformation of adenine into pentose nucleic acid. In lymphocytes, then, contrary to much present belief, the lesser metabolic activity, as deduced from turnover data of deoxyribose nucleic acid compared with pentose nucleic acid, is characteristic of slowly dividing tissues such as liver.

In contrast to granulocytes, in which significant radioactivity was not demonstrated beyond 140 days, there was prolonged retention of isotope in both pentose nucleic acid and deoxyribose nucleic acid of lymphocytes; radioactivities in the deoxyribose nucleic acid purines gradually surpassed those in pentose nucleic acid. Although the initial portions of the pentose nucleic acid curves in lymphocytes were similar to the initial portions of the deoxyribose nucleic acid curves for granulocytes, in their later portions, as mentioned, they resembled the deoxyribose nucleic acid curves for lymphocytes.

The decline in activities of both pentose nucleic acid and deoxyribose nucleic acid purines of lymphocytes fell into two phases: an initial rapid decline, followed by a slow decline having a half-time of the order of 300 days.

The results suggest that the survival time of leukæmic granulocytes is less than that of leukæmic lymphocytes. If the assumption is made that deoxyribose nucleic acid once formed in a cell is stable for the life of that cell, analyses of the deoxyribose nucleic acid data permit calculations of the average survival time of each cell type (for example, by the solution of the Volterra integral equation of the first kind); this procedure is analogous to that used by Shemin and Rittenberg for the life-span of the red cell[1]. It was thus estimated that leukæmic granulocytes survive on the average for 23 days, and calculations based on the first part of the lymphocyte curves give an average survival time for leukæmic lymphocytes of 85 days. The present evidence does not permit decision whether the prolonged retention of isotope in the pentose nucleic acid and deoxyribose nucleic acid of lymphocytes (and not found in granulocytes) represents the survival of some cells for very long periods, or a specific re-utilization by lymphocytes of large fragments of nucleic acid or nucleoproteins of their progenitors.

Other kinds of evidence are in favour of the second interpretation. The phagocytosis of lymphocytes by reticulum cells in lymph nodes and the differentiation of these reticulum cells into new lymphocytes have been repeatedly observed[2]; cells have been described that are intermediate between these reticulum cells and large lymphocytes which still contain pyknotic fragments of lymphocyte nuclei (personal communications from Trowell, O. A., and from Dempsey, E. W.). Such observations suggest that there is re-utilization of large fragments of lymphocyte nucleic acids or nucleoproteins by phagocytosis.

Recognition that lymphatic tissue is an important site of protein synthesis—as indicated by antibody production—has been obscured by an inability to differentiate between the roles of lymph nodes and of the mature lymphocyte. The mature lymphocyte is little more than a nucleus, and this fact plus the re-utilization of lymphocytes by phagocytosis suggest that lymphocytes may function primarily as a store of deoxyribose nucleic acids. This hypothesis would afford an explanation of the ability to transfer immune reactions by the use of lymph nodes or lymphocytes[3]. Exposure of the embryo to antigens might result in the loss of specific deoxyribose nucleic acids responsible for the production of homologous antibodies, possibly by an absence of the conservation mechanism of phagocytosis and re-utilization in the embryo; the adult exposed as an embryo to an antigen would thus have lost the ability to respond[4]. Since antibodies are incapable of self-replication in later life[5], the process of phagocytosis with re-utilization of nucleic acids allows for the selective preservation of necessary templates for the production of specific antibodies, and might account for the continued formation of antibody long after the apparently limited contact between tissues and antigen. A fuller account of these studies will be published elsewhere[6].

I wish to thank Dr. C. C. Stock for encouragement and facilities, Dr. G. B. Brown, Dr. M. E. Balis and Dr. A. Bendich for helpful advice about technical methods leading to this work, Dr. S. Schuster and Mr. M. Berman for much discussion and assistance in the mathematical analyses, Dr. M. E. Balis for supplying part of the adenine-14-carbon, and the Chemotherapy Service, Memorial Center, for their co-operation. The work has been aided by grants from the National Cancer Institute of the United Public Health Service C-1813 and from the Commonwealth Fund.

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Proteolytic Enzymes in *Entamoeba histolytica*

THE presence of proteolytic enzymes in *Entamoeba histolytica* has been suspected for many years and he extracellular secretion of these enzymes has been put forward by many authors as an explanation of the mechanism of tissue invasion by this parasite[1]. Experimental evidence of their occurrence in *E. histolytica* has been presented by several authors[2], though a detailed study of them has not been made.

The proteolytic enzymes of *E. histolytica* (strain $P + A^1$) were investigated by making an extract of amoebae grown *in vitro* in association with *Escherichia oli*. The amoebae were collected in suspension from the culture medium (solid egg base covered with dilute horse serum, supplemented with rice starch) and washed with Tyrode solution. The amoebae were re-suspended in a volume of Sørenson's phosphate buffer, pH 7·2, to give a calculated concentration of 5 million amoebae/ml. The amoebae were then frozen overnight. After thawing, the rice starch and debris were removed by centrifuging and the supernatant was shaken with a few drops of chloroform to inhibit the growth of bacteria. Excess chloroform was removed by centrifuging. Extracts prepared in this manner from strain $P + A^1$ were sterile.

The extract was incubated at 37° C. with casein olution as substrate and with ammonia – citric acid buffer to give a range of pH from 4·0 to 8·5. After ncubation, the reaction was stopped by the addition of trichloracetic acid. The degree of hydrolysis of the casein was determined with Folin–Ciocalteau phenol reagent, and expressed as μgm./ml. of tyrosine. The method is similar to that described by Holter and Løvtrup[3].

The extract showed high activity from pH 6·5 to 8·5 with a maximum at pH 7·9–8·0. When the extract was incubated with the substrate at the optimum pH, the amount of hydrolysis increased linearly with time up to the end of 2 hr.; thereafter he rate of hydrolysis decreased. The activity was not potentiated by cysteine or inhibited by iodoacetate.

The proteolytic enzymes in extracts of strain $P + A^1$ also dissolved formalin-denatured gelatine and reduced the viscosity of gelatine solutions.

Extracts of the associated strain of bacteria, *Escherichia coli*, showed no proteolytic activity on the casein substrate, nor did they affect the viscosity of gelatine solutions.

Other strains of *E. histolytica* are being examined by this technique and all show some proteolytic activity. Further details of experiments showing the correlation of virulence and proteolytic activity will be published elsewhere.

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Disomic and Tetrasomic Inheritance in a *Solanum* Hybrid

IN the course of a cytogenetic study of the nature of differentiation of diploid species ($2n = 24$) of the section Tuberarium, genus *Solanum*, the mode of inheritance of three loci could be followed in a cross between *S. macolae* and *S. simplicifolium*, two species of the series Tuberosa occurring in Bolivia and Argentina. The *simplicifolium* parent used in the cross had simple leaves, a prominently winged stem and white corolla, in contrast to the compound leaves, rudimentary stem wing and purple corolla possessed by the *macolae* parent. Except for corolla colour in *macolae*, the two species bred true for their characters. The *macolae* parent was found to be heterozygous for P, a dominant factor necessary for the formation of purple colour in the corolla.

Meiosis was regular in the F_1 plants, and the plants set berries with viable seeds. These plants had compound leaves and prominently winged stems. There was segregation for corolla colour; six plants had purple and four plants had white corollas. In F_2 progenies from F_1 plants with compound leaves, prominent stem wing and purple corolla, there was monogenic segregation for all the characters. In backcrosses between the F_1 and recessive and dominant parents, 1 : 1 and ∞ : 0 segregations respectively were obtained. Thus, the genotypes of the *macolae* and *simplicifolium* parents were determined as $LLwwPp$ and $llWWpp$ (L, for compound leaf; W, for prominent stem wing and P, for purple corolla) respectively. There was no evidence of linkage among factors L, P and W in the F_2 and backcross data.

Seeds from the initial cross were treated with colchicine, and tetraploid hybrid plants were thus obtained. At first metaphase in the doubled hybrid, there was a mean frequency of 1·19 quadrivalents 0·095 trivalents, 21·025 bivalents and 0·905 univalents per cell. The number of quadrivalents per cell ranged from 0 to 4. The tetraploid plants were fertile. When the C_2, C_3 and C_4 plants (corresponding to the F_2, F_3 and F_4 plants of the diploid hybrid) were grown in following years, it was found that all

Table 1. INHERITANCE OF LEAF-TYPE IN *S. macolae* × *S. simplicifolium*

Material	Genotype	Segregation				Deviation	
		Observed		Expected			
		L	*l*	*L*	*l*	X^2	*P*
F_2 progeny	*Ll* × *Ll*	45	16	5	1	0 0492	0 9–0·8
F_1 × *simplicifolium*	*Ll* × *ll*	52	44	1	1	0·6666	0 5–0 3
C_2 progeny	*LLll* × *LLll*	87	2	35	1	0 0920	0·8–0·7
C_3 progenies i. C_2 206 self	*Llll*	18	4	3	1	0·5454	0 5–0 3
ii. C_2 203 × 205	several possibilities	132	0	*X*	0		
iii. C_2 211 (compound) × C_2 198 (simple)	*LLll* × *llll*	73	19	5	1	1·0464	0·4–0·3
iv. C_2 198 self	*llll*	0	28	0	*X*		
C_4 progeny	*LLll*	39	1	35	1	0 0112	0·95–0·9

the plants in the different generations had broad stem wings like the C_1 and *simplicifolium* parents. Since the C_1 plants would have had the genotype *WWww* for stem wing character, the lack of segregation in subsequent generations would mean that the *simplicifolium* chromosomes carrying factor *W* were pairing preferentially at the tetraploid level. The segregation ratios for leaf type, however, were typical of tetrasomic inheritance; simplex and duplex genotypes were identified by the 3 : 1 and 35 : 1 ratios obtained on selfing C_2 plants (see Table 1) and a 5 : 1 ratio was observed on backcrossing a duplex to a nulliplex type. The chromosome numbers of the simple leaf plants in C_2, C_3 and C_4 were determined to make sure that the simple leaf character in them is not due to the loss of chromosomes carrying the *L* factor. The number in all the plants was $2n = 48$, and it is thus clear that the locus *L* in tetraploid *macolae* × *simplicifolium* segregates tetrasomically.

For colchicine treatment, seeds from the initial cross-had been used, and consequently there was segregation for corolla colour in the C_1 plants (three coloured and two white). In the C_2 progeny grown from a sib-cross between two C_1 plants, one with coloured and another with white flowers, the forty-three plants which flowered all had coloured corollas. Two C_3 progenies were raised: one from seeds of a C_2 plant selfed and another from a C_2 sib-cross. Both segregated for corolla colour in the ratio 3 coloured : 1 white (observed: 29 : 11 and 12 : 5 respectively). The genotypes of the C_1 plants with purple and white corollas would be *PPpp* and *pppp* respectively, and the ratios suggest that the chromosomes in which the *P* locus is situated pair preferentially at the tetraploid level. From the data concerning the inheritance of factors *L*, *W* and *P* in the diploid and tetraploid populations of *macolae* × *simplicifolium*, it can be concluded that the quadrivalents and bivalents observed in the tetraploid are not formed in a random manner but result from pairing among specific chromosomes. These observations thus lend support to the inference drawn earlier from cytological studies[1] that cryptic structural differentiation of chromosomes has played an important part in the origin of species differences in the section Tuberarium.

This work was begun at the Laboratory of Genetics, Wageningen, Holland, in 1950, with material kindly supplied by Dr. H. J. Toxopeus, and was continued at the Plant Breeding Institute, Cambridge, and the Department of Genetics, University of Wisconsin. My thanks are due to Prof. R. Prakken, Dr. H. J. Toxopeus, Dr. H. W. Howard and Dr. R. W. Hougas f facilities and advice.

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Chelating Agents as Growth Substances

SINCE the article[1] under the above title wa published, we have obtained further biologic evidence bearing on the mode of action of auxi We carried out two root-growth experiments exactl similar to those of 23.3.56 and 21.4.56 (Tables 4 and *loc. cit.*) but using 8-hydroxyquinoline and ethylenediaminetetra-acetate instead of 3-indolylacetic aci and ethylenediaminetetra-acetate. Essentially simila results were obtained, that is, the inhibition of ro growth caused by 10^{-5} *M* 8-hydroxyquinoline o 10^{-5} *M* ethylenediaminetetra-acetate alone was largel prevented by the presence of 10^{-11} *M* ethylenediaminetetra-acetate in the former case or of 10^{-11} 8-hydroxyquinoline in the latter.

In a further similar root-growth experimen 2-hydroxyquinoline, a non-chelating analogue o 8-hydroxyquinoline, and ethylenediaminetetra-acetat were used. Again, a most remarkable interactio was obtained; but the roles of the two substance were no longer mutually interchangeable. Thus th inhibition due to 10^{-5} *M* ethylenediaminetetra-acetate alone was considerably less in presence o 10^{-11} *M* 2-hydroxyquinoline; but the rather sma amount of inhibition caused by 10^{-5} *M* 2-hydroxyquinoline alone was made very much more sever by 10^{-11} *M* ethylenediaminetetra-acetate.

We have also extended the investigation of th growth responses of coleoptile sections to includ supraoptimal concentrations of the agents, and so fa the picture is essentially like that for inhibition o root growth in intact plants. Using concentration of zero, 10^{-9}, 10^{-7}, 10^{-5} and 10^{-3} *M*, we have foun with 3-indolylacetic acid and ethylenediaminetetra-acetate that a 10^{-9} *M* concentration of either agen greatly reduces or prevents the inhibitory or harmf effect of a 10^{-3} *M* concentration of the other. (A intermediate concentrations significant stimulation o course occurs, unlike the root-growth results.) Th same type of mutual antagonism has been found in similar experiment using 3-indolylacetic acid an 8-hydroxyquinoline and also in another using th latter and ethylenediaminetetra-acetate. Wit 2-hydroxyquinoline and ethylenediaminetetra-acetat the former shows only inhibitory effects; 10^{-9} 2-hydroxyquinoline slightly increases the inhibitio due to 10^{-3} *M* ethylenediaminetetra-acetate, wherea 10^{-9} *M* of this agent to some extent removes the harmful effect of 10^{-3} *M* 2-hydroxyquinoline. Here th roles of the two agents are reversed as compare with their effects on root growth (see above). Wit 2-hydroxyquinoline and 3-indolylacetic acid, th former again shows inhibitory effects throughou but either agent at 10^{-9} *M* shows a small tendenc to increase the inhibition due to a 10^{-3} *M* concentration of the other. (Two out of three roo growth experiments which were carried out usin these two agents, at the usual concentrations zero and 10^{-11} to 10^{-5} *M*, also showed no tendenc for a 10^{-11} *M* concentration of one to prevent the inhibition caused by a 10^{-5} *M* concentration of the other; the third experiment gave an aberrant result.)

Table 2. Effect of Pre-drying after Harvest on the Percentage Germination

Treatment	No. of samples grouped according to percentage germination									
	0–10	11–20	21–30	31–40	41–50	51–60	61–70	71–80	81–90	91–100
10 days at 16°–18° C.	—	1	2	3	17	10	8	10	11	—
and 3 days at 40° C. 7 days at 16°–18° C.	—	—	—	—	—	—	—	1	4	57

The extraordinary mutual antagonism described has in fact always been found (and, with the exception of the single aberrant experiment mentioned, only been found) in experiments with two known chelating agents or with 3-indolylacetic acid and a known chelating agent; the substitution of a non-chelating analogue for one of the agents destroys the symmetry of the interaction or entirely prevents either agent at low concentration from reducing the inhibition caused by a high concentration of the other. The fact that 3-indolylacetic acid interacts with known chelating agents in the same remarkable and symmetrical way as these interact with each other in affecting the growth of roots and of coleoptile sections would seem strongly to support the hypothesis that it is here itself acting as a chelating or complex-forming agent. On this hypothesis, however, there is no reason why 3-indolylacetic acid should interact with the non-chelating 2-hydroxyquinoline in the same way as does ethylenediaminetetra-acetate if the latter interaction is not due to chelation.

Although the biological evidence for chelation or complex-formation by 3-indolylacetic acid appears to us convincing, we have not so far been successful in attempts to obtain direct chemical evidence. The difficulty experienced here may perhaps be due to 3-indolylacetic acid only forming complexes with one or a few metals and (or) within a narrow range of conditions; this might well be biologically advantageous to the plant.

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Effect of Desiccation on the Dormancy of Barley

In certain seasons the condition of dormancy in barley is prolonged and the delayed germination of a proportion of the grains has an adverse effect on its use for malting[1]. Observations over a number of years have indicated that this condition is more marked when atmospheric humidity is high before harvest. The effect of desiccation has therefore been investigated, as it is also an important factor in the maturation of wheat[2]. During ripening, transfer of material to the endosperm ceases at a moisture content of about 42 per cent, and the grain then undergoes rapid drying[3]. The final moisture content is determined, however, by the atmospheric humidity and the degree of desiccation therefore depends on the weather conditions before harvest.

Table 1. Effect of Desiccation on Percentage Germination, (*a*) During Ripening, and (*b*) at the Harvest-ripe Stage

Moisture content (per cent fresh weight)		Percentage germination After 10 days at 16°–18° C.	After 3 days at 40° C. and 7 days at 16°–18° C.
(*a*)	40–45	6	95
	29–35	10	94
	16–20	44	96
(*b*)	17·4	44	99
	18·1	72	99
	16·9	82	100
	12·7	99	—

The percentage germination was determined at intervals during the final stages of ripening by removing undamaged grains from the ear and placing them either directly in damp sterile sand, at 16°–18° C. for ten days, or after pre-drying for three days at 40° C., which reduced the moisture content to 7 per cent.

The effects of natural and artificial desiccation are shown in Table 1. About half the grains acquired ability to germinate as soon as the moisture content fell during ripening from 40 to 16 per cent, and the majority of the remainder did so later without any further desiccation. Complete germination did not, however, take place until atmospheric conditions allowed the moisture content to fall to 12·7 per cent, although it was obtained after pre-drying at each stage. Full maturity was thus eventually attained by natural desiccation, and although individual grains differed in their response to the same degree of desiccation at the harvest-ripe stage, these differences were removed by additional desiccation. There was no evidence that the dormant condition developed at the time of harvest, as suggested by Bishop[4].

When the dormant condition persists after harvest, it can also be successfully eliminated by additional desiccation. This is shown, in Table 2, by the increased germination after pre-drying obtained with sixty-two samples of commercial malting barley tested between August and October 1954.

It therefore appears that a varying proportion of grains may fail to reach maturity because of insufficient desiccation before harvest; but this can be corrected by artificial drying during subsequent storage.

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June 29.

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An Instance of Delayed Communication in Solitary Wasps

The eumenid *Rygchium foraminatum* (de Saussure) and the sphecid *Trypoxylon clavatum* Say are common solitary hunting wasps which nest in hollow twigs, making the burrows septate with cross-walls of mortar so that a linear chain of cells is formed. Each brood cell, when first made, contains a single egg along with paralysed prey sufficient for full growth of the young hatched larva to the adult wasp. Generally the provisioned cell is only somewhat larger than the wasp which will mature within it, and indeed may be too small in diameter to permit the adult wasp, once formed, to reverse its direction within it. The oldest wasp larva of necessity lies innermost at the blind end of the burrow, while the youngest occupies the cell nearest the sole exit from the nest. When nests are constructed in burrows 4–6 mm. in diameter and 150 mm. long, each mother wasp may provision from 1–10 cells per burrow, most nests having 4–6 provisioned cells.

If a nest is split lengthwise after feeding, cocooning and pupation are completed, the pupæ which lie lengthwise in their cells are regularly found to face the sole exit of the nest. Orientation of a pupa toward the blind end of the burrow occurs, but is relatively rare and has serious consequences—especially in nests with minimal diameters. Ordinarily, emergence from linear nests is in reverse order to actual age, so that the wasp from the last egg to be laid is first to emerge from the nest, the next youngest wasp second to emerge, and so on. Misoriented wasps work their way, when they can do so, to the blind end of the burrow, generally resulting in the death of sibs older than themselves, and almost invariably in their own death as well. On the average, then, if misorientation is rare and random with respect to cell order, reversal of a single pupated wasp may be expected to result in the death of more than one nest occupant.

Since larvæ within their cells neither have nor can attain direct knowledge of the location of the exit from the burrow, and since larvæ may take any position within their cells during feeding, a highly efficient substitute for direct knowledge must be provided in the nest. Experiments have shown that the location of the egg, disposition of prey, possible asymmetric marking of the cell by the occipital glands of the mother, gaseous diffusion, and so on, at most play negligible parts so far as orientation of the larvæ at pupation is concerned. But if each cell's mud walls are reversed in position by rotation 180° about a diameter, care being taken to minimize breakage, then the enclosed larvæ pupate in reversed direction, that is, facing the blind end of the burrow.

The information acted upon by each pupating larva lies in the geometry and texture of the surfaces of the anterior and posterior cell walls. It can be shown that the information provided is redundant. A scanning comparison of two surfaces is not necessary to bias markedly the orientation of a pupating larva, nor indeed is a natural cell-wall necessary. A sandpaper disk placed transversely across a burrow, for example, is adequate to cause a larva to pupate facing the grit in the preponderance of cases. Furthermore, *Trypoxylon* larvæ, transferred to *Rygchium* nests, and vice versa, pupate with correct orientation toward the exit of the foreign nest. The informational signals of these remotely related wasps are thus similar.

The female wasp makes these cell walls asymmetric in relation to the nest's sole exit. In turn the larva responds to the asymmetry by orienting towards the nest's exit on entering the pupal state. In effect the mother wasp acts as an information source and transmitter, the mortar of the cell wall serves as a communication channel, and the geometry and texture of the walls as signals. The information is stored, then, in digital form in an artefact. The receiver and destination of the message is the fully fed larva, the highly regular response of which is in turn a measure of the singular effectiveness of the communication system.

Haldane and Spurway[1] and Haldane[2] have given analytical and interpretive summary accounts of animal communication that should do much to enliven research and discussion of this topic. The wasps discussed above provide a new and novel example of animal communication, for not only is the signal produced within a complete artefact, but also the stored signal serves as a message between parent and young, members of two generations that ordinarily do not overlap in contact. A detailed account of this work will be published elsewhere.

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---

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Regenerative Capacity of Tadpoles inhibited in Growth and Development

As shown previously, 20-day old tadpoles of *Xenopus laevis* exhibit, after removal of the telencephalon and plexus chorioideus of the third ventricle, complete inhibition of development and almost complete cessation of growth[1]. In the course of recent experiments, we tested the regenerative capacity of these partially decerebrated experimental animals, operated on 2, 5 or 18 months before the amputation of the tail. As controls, we used tadpoles of the same length as the experimental ones. We were also able to compare regeneration in animals deprived of the telencephalon for two months with that of normal tadpoles of the same age, the development of which was delayed by the action of a lower temperature.

In spite of the inhibition of growth and development, the experimental animals retained the ability to regenerate amputated tail-tips. Whereas the first phases of the regenerative processes, that is, the covering of the wound surface with epithelial cells, proceeded at the same rate and in the same manner in experimental and in control animals, the visible regeneration of the axial organs appeared 2–3 days later in experimental tadpoles. The same result was obtained whether the tadpoles were operated on 2, 5 or even 18 months before the amputation of the tail.

In order to find out whether the inhibition of growth and development in experimental animals is in any way correlated with a decrease in mitotic activity, we determined the mitotic frequencies of the epithelial cells in mounted preparations of the tails. In every tail, we counted 6,000–10,000 cells in a series of fields, and expressed in percentages the number of dividing nuclei ranging from prophases to telophases.

In control animals, on the average, 1·3 per cent of mitotic nuclei were found, while two months after operation 0·4 per cent and 18 months after decerebration only 0·1 per cent mitotic nuclei were present. It seems, therefore, that the inhibition in growth observed in tadpoles after the excision of the telencephalon and plexus chorioideus on the twentieth day after hatching is due to a decrease in mitotic activity.

If, however, in inhibited tadpoles the tail tip is amputated and the regenerative processes set up, the number of dividing cells increases. Six days after amputation of the tail, we found 0·8 per cent of dividing nuclei in tadpoles decerebrated two months before amputation. A similar increase was observed in regenerating animals operated on five months before amputation. The increased number of dividing cells in regenerating experimental animals is probably induced by stimuli originating in wounded tissues after the initiation of regenerative processes. We had previously found a similar effect in regenerating tadpoles treated with nitrogen mustard[2], and Lüscher described an increase in mitotic activity on the third to the sixth day after amputation of the tail of *Xenopus laevis* tadpoles[3].

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May 27.

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Adrenaline and Noradrenaline in Adrenal Autografts

BOTH cortical and medullary cells survive in adrenal grafts months after transplantation into the anterior chamber of the eye[1]. It is, however, not known whether the two medullary hormones, adrenaline and noradrenaline, are present in the grafts. Moreover, all previous work has been without regard to the fact that there are two different types of cells in the adrenal medulla[2]. A substantial body of evidence is now available indicating that one of these cell types contains and secretes adrenaline, and the other noradrenaline[3,4]. It seemed therefore to be of interest to investigate adrenal grafts by chemical and histochemical methods which differentiate between adrenaline and noradrenaline.

Adult Wistar rats were used. The left adrenal of each animal was removed, and a piece of the medulla was inserted into the anterior chamber of the left eye. Five months later the animals were killed and the grafts removed.

The adrenaline and noradrenaline contents of some grafts were estimated chemically after separation of these amines by ascending paper chromatography, using a mixture of phenol and 0·1 *N* hydrochloric acid[4]. Both adrenaline and noradrenaline were detected in the grafts (Fig. 1). The adrenaline content was 5–10 times the noradrenaline content.

Other grafts were plunged into a 3·5 per cent solution of potassium dichromate to produce the chromaffin reaction, or into a saturated solution of potassium iodate to demonstrate the noradrenaline-containing cells[3]. These grafts were afterwards fixed in formalin and cut with a freezing microtome at 50µ. Some sections were mounted unstained in glycerol, others were stained with hæmatoxylin and sudan red to facilitate the detection of adrenocortical cells.

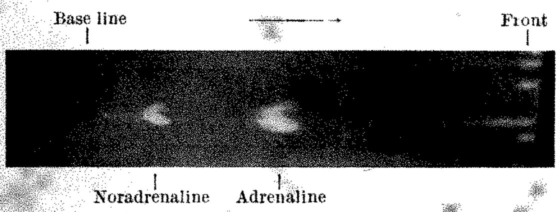

Fig. 1. Chromatogram of an adrenomedullary autograft smeared directly on the base line of the paper (Whatman No. 1). Phenol and hydrochloric acid were used for development, and the strip was sprayed with potassium ferricyanide to develop fluorescence in the adrenaline and noradrenaline spots. Fluorescence photograph

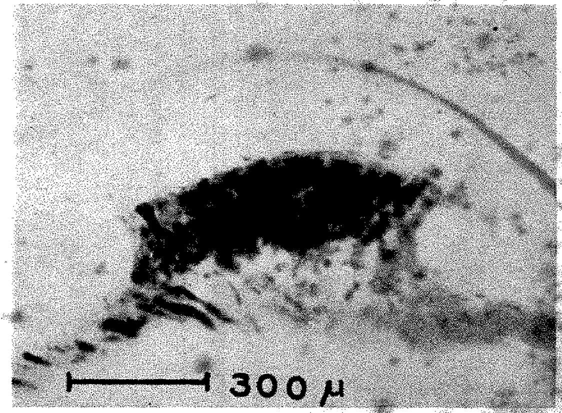

Fig. 2. Unstained frozen section of an adrenomedullary autograft in the anterior chamber of the eye. The graft is attached to the cornea (above) and the iris (below). Chromaffin cells are brown after dichromate fixation. Red blood cells in the vessels of the iris (lower left corner) are also brown

Fig. 2 shows a typical graft, mainly composed of strongly chromaffin cells, and attached to both the cornea and the iris. The chromaffin cells were closely packed together in the grafts. However, regular cell acini, such as can be always seen in the normal adrenal medulla, were replaced by irregular groups of cells. This may be indicative of cellular migration within the graft.

The iodate reaction, which stains the noradrenaline-containing cells brown[3,4], was positive in some graft cells, which were usually solitary and randomly distributed in the graft. The majority of graft cells, although chromaffin, remained colourless after iodate treatment. This is in good agreement with the chemical observations made, and suggests that the grafted adrenomedullary cells have retained their ability to make and secrete the same catechol amine which they were making and secreting in the adrenal before grafting.

Although efforts had been made to include only medullary tissue in the grafts, typical sudan-positive cortical cells were detected in all grafts which were examined histologically. The cortical cells were fewer than the medullary ones and usually apart from these. It is therefore most likely that cortical hormones were equally available to both the iodate-positive, noradrenaline-secreting cells and the adrenaline-secreting cells of the graft, in which the two types of cells were present in proportions similar to those in the normal rat's adrenal medulla. If cortical hormones really have a specific influence on the quality of the secretory products of the adrenomedullary cells, as has been claimed[5], such an influence could not be observed in the present study.

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May 25.

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FORTHCOMING EVENTS

Wednesday, September 19

Institute of Petroleum (at 26 Portland Place, London, W.1), at 5.30 p.m.—Dr. W. T. Lyn: "Diesel Combustion Study by Infra-Red Emission Spectroscopy".

Thursday, September 20

Oil and Colour Chemists' Association (at University College, Gower Street, London, W.C.1), at 10.30 a.m.—Symposium on "Some Implications of Colour".

Physical Society (in the Lecture Theatre of the Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Prof. J. G. Daunt (Ohio State University): "The Magnetic Refrigerator for Temperatures below 1° K." (Duddell Lecture).

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Chemist (with a first- or good second-class honours degree in chemistry, or equivalent qualification, at least three years experience, and preferably a knowledge of liquid fuels and lubricants), at the London Transport Central Laboratory, Chiswick, London—The Recruitment and Training Officer, London Transport, 55 Broadway, London, S.W.1, quoting F/EV.597 (September 20).

Lecturer in Applied Mathematics—The Registrar, The University, Liverpool (September 20).

Senior Lecturer (with high academic and research qualifications) in Organic Chemistry, and a Lecturer (able to teach their branch of chemistry to special (honours) degree standard) in Inorganic and Physical Chemistry—The Clerk to the Governors, Woolwich Polytechnic, London, S.E.18 (September 21).

Assistants (3), Grade B (for physics, general chemistry and mathematics), in the Science Department, Birkenhead Technical College—The Director of Education, 63 Hamilton Square, Birkenhead (September 22).

Lecturer and Assistant Lecturer in Physics at the University College of the West Indies—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (September 29).

Lecturer or Assistant Lecturer (with special interests in general, inorganic or physical chemistry) in Chemistry—The Registrar, The University, Sheffield (September 29).

Lecturer, Grade II, in Physiology at the University College, Ibadan—The Secretary, Senate Committee on Colleges Overseas in Special Relation, University of London, Senate House, London, W.C.1 (September 29).

Federal Information Officer (with considerable experience of information service work, preferably in the Caribbean area), to plan and build up the Information Service of the Federal Government and to serve as Executive Head of the service stationed initially in Barbados—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.148/500/01 (September 30).

Lecturer (with a good degree in economics, commerce, administration or some branch of technology, with managerial experience in industry and preferably with some research experience in any of the above fields) in Industrial Administration, to deal with management subjects from a general management viewpoint and to undertake research—The Registrar, College of Science and Technology, Manchester 1 (September 30).

Junior Research Fellow, Research Fellow and Senior Research Fellow (with a good honours degree in economics and an interest in economic analysis) for the Research Staff of the Institute of Social and Economic Research, University College, West Indies, for investigations which may be made in any part of the British Caribbean territories—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (October 1).

Lecturer or Assistant Lecturer (with a good degree in science or applied science, and research experience in general ceramics, refractory materials or related fields, preferably with some industrial experience) in Ceramics and Refractory Materials—The Registrar, The University, Leeds 2 (October 1).

Statistician (with an honours degree in economics or commerce, able to give close attention to detail and to write clearly) in the Area Statistician's Office, Eastern Gas Board, Tottenham, London, for work concerned partly with the compilation of statistics and partly with the preparation of statistical reports for the guidance of the management—The Secretary, Eastern Gas Board, 2 The Abbey Garden, Great College Street, Westminster, London, S.W.1 (October 6).

Senior Lecturer in Aeronautical Engineering at the University of Sydney, to work in the field of aerodynamics—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (October 8).

Senior Lecturer or Lecturer in Physical Chemistry or Inorganic Chemistry at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (October 12).

Lecturer in Botany at the University of Natal—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (October 15).

Lecturer or Assistant Lecturer (graduate, with experience and/or special interest in surveying and tutorial mapwork) in Geography at the University of Malaya—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (October 15).

Lecturer or Senior Lecturer (with qualifications in economic geography) in Geography at the Canberra University College, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (October 15).

Lecturer (graduate in chemistry with a knowledge of modern synthetic resins and rubbers) in the Department of Leather Industries, to give instruction in, and to investigate the application of synthetic resins and rubbers to various leathers—The Registrar, The University, Leeds 2 (October 15).

Director of the Computing Unit—The Secretary of Faculties, University Registry, Oxford (October 30).

Lecturer or Senior Lecturer in Fluid Dynamics at the University of Tasmania—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (October 31).

Assistant Conservators (with a university degree in forestry) of Forests in British Guiana—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.61/30/02.

Cyclotron Engineer or Physicist (graduate in light electrical engineering or physics) at Hammersmith Hospital, to work on the cyclotron, with opportunity to gain experience in engineering mechanics including cyclotron beam measurements, high vacuum work, target design and ion sources development—The Senior Cyclotron Engineer, Medical Research Council, Hammersmith Hospital, Ducane Road, London, W.12.

Fisheries Officer (with an honours degree in natural science with emphasis on zoology, preferably with a knowledge of French and experience of work at sea and the handling of nets) for the Western Region of Nigeria, to develop inshore fishing and fish culture—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.461/410/03.

Geologist (with a first- or second-class, upper division, honours degree in geology, preferably with experience in an alluvial diamond field) with the Government of Sierra Leone, for the geological examination and mapping of the diamond deposits of Sierra Leone, together with special reference to the areas now being opened up under the Diamond Licensed Mining Scheme, to describe these areas and to prepare a report and eventually a bulletin on these deposits—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.105/15/01.

Graduate in Biological Science in the Department of Zoology, to assist in research on mass culture of marine algae—Professor of Zoology, The University, Southampton.

Health Physicist (with a degree in physics and some experience in nuclear physics and electronics, and an interest in biophysics, physiology or biology, preferably with a knowledge of French) with the European Organization for Nuclear Research, Geneva, to take charge of a small team entrusted with the physics measurements pertaining to all radiation protection in all CERN laboratories, and to develop measuring techniques in an unusually high energy region (up to 600 MeV. protons)—The Ministry of Labour and National Service, Employment Services Department (AS.12), 26 King Street, London, S.W.1.

Junior Scientific Officer (with an honours degree in science, pharmacy or biology), for technical work in the Blood Transfusion Service Laboratories—The Director, Blood Transfusion Service, Roby Street, Manchester 1.

Scientific Officers (3) (with first- or second-class honours degrees in civil engineering, economics or statistics, or equivalent qualification) in the Colonial Section, Road Research Laboratory, Department of Scientific and Industrial Research, for duties concerning road materials and methods of construction, soil mechanics, traffic engineering, road safety and economics of roads and road transport—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting E.384/6A.

Technician (with a good knowledge of electronics and experience in the construction and maintenance of electronic apparatus) in the Department of Applied Electrophysiology—The Secretary, The National Hospitals for Nervous Diseases, Queen Square, London, W.C.1.

Training Officer (with an engineering or science degree and training and organizing experience) in the Public Works Department, Government of Western Nigeria, to be responsible for training junior grades of a large Government Department and to correlate training facilities to ensure the fullest use is made of existing educational and technical establishments—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.112/410/018/T.

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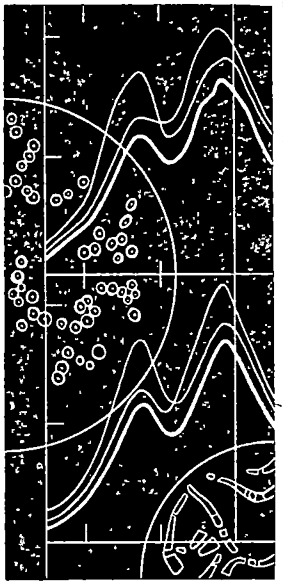

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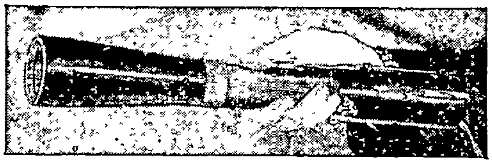

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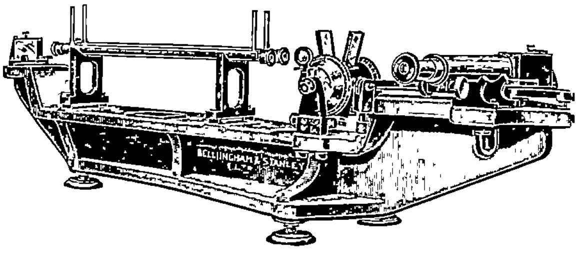

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WORLD POWER IN THE NUCLEAR AGE

WHEN the Chancellor of the Exchequer made his statement about economies in Government xpenditure on June 26, he pointed out that the aving of £36·5 million on the defence estimates did ot reflect any change in the size or shape of the rmed Services. The savings, of which about £11 illion is on the Navy estimates, nearly £17 million n the Army estimates and about £8·75 million on he Air estimates, arise mainly from abandoning or eferring orders, from increasing the use of existing ocks and from expediting the disposal of surplus ocks. Mr. Macmillan referred to the review of efence policy which the Prime Minister had underken, and gave the assurance that any major ecisions in this field would be taken only after nsultation with our allies.

This assurance, which the Prime Minister repeated the House of Commons on July 23, was needed, r the Government, as two recent debates on scientific search and on technical education have shown, is xposed to a continuous clamour to reduce expendiure on defence quite regardless of the consequences. here is, however, a further principle that needs to enunciated more clearly at a time when the overnment is being pressed with perhaps more al than foresight to reduce its expenditure on efence. If we are to get the best results in up-toate mobile joint defence at the lowest expenditure, will only be by proceeding hand in hand and step step with the United States. It is right to point t that Britain's position in the world has changed d that there are limits to the expenditure which e can wisely incur on defence—in terms of manwer, finance or economic resources; and it must recognized that changes in policy and in disposition n only be made in agreement with our allies.

It is, of course, the uncertainty as to the effect on efence of nuclear warfare that has been responsible r many dubious proposals, and such books as dmiral Elis Biörklund's "International Atomic licy during a Decade, 1945–1955"* and Prof. E. W. tterton's "Facing the Atomic Future"†, are inluable in promoting public understanding of the nitations, as well as of the dangers, of nuclear arfare. Moreover, the *Bulletin of the Atomic ientists*, which has initiated a symposium on Science and the Affairs of Man" to continue through t the tenth anniversary year of the *Bulletin*, after article in the April issue by R. Aron, discussing e possibility of half a century of limited war, has voted its May and June issues to a special discussion science and military strategy.

Admiral Biörklund reviews the decade in two ctions, the second of which is concerned essentially with the hydrogen bomb. Then he attempts, in two successive chapters, appreciations of the views of the Western Powers and the Eastern Powers on problems which nuclear weapons present, before considering briefly the technical development of such weapons. His own conclusions as to the possibility of international control are set forth in the following chapters, and the most important of these conclusions is the rejection of the theory, with which he started, that all nuclear weapons should be controlled. He now believes that the manufacture of nuclear weapons could never be effectively controlled, and that they should accordingly be ignored from this point of view and included with conventional armaments. Further, he insists on the importance of restricting control to what really can be controlled, and exercising this control in a way that does not so seriously infringe the autonomy of a State as to increase political uneasiness. Accordingly he suggests that the supervision of mines, transport and laboratories should be relinquished because of the consequent large reduction in the need of permanent control in favour of unexpected flying visits by groups of inspectors with permanent authority and guaranteed freedom of movement and entrance to atomic factories, atomic piles, reactor stations, experimental stations and testing grounds. These visits of inspection, moreover, should extend to any places where there is reason for suspecting that a breach of a treaty may occur or be prepared.

Admiral Biörklund believes that a reasonable control organization could be established, and that international negotiations for an agreement to reduce or stop production of cobalt, large hydrogen and atom bombs and also long-range robots should be made. Success in such a restricted task, which in itself may be difficult enough, would assist, he thinks, in the gradual solution of the other more complicated problems when the situation improves. He would model his control organization on that of Western European Union, making use of the foreign military attachés stationed in the respective countries and appointing atomic attachés. In his view, by stopping the production of the large hydrogen and atomic bombs, though existing stocks are kept for the time being and prohibition of their use is conditional, these weapons become a powerful deterrent against aggression, alike for the Western and the Eastern Powers. Moreover, his proposal, by retaining the present balance of power, on which also an agreement can be based, does not require the Western Powers to give up their essential margin of security.

Admiral Biörklund is convinced that, for the sake of humanity, a solution must be found, and he believes that encouraging the development of nuclear energy for peaceful purposes is likely to decrease world tension and enable the Great Powers to satisfy the demands of peace at the expense of those of war.

While Prof. Titterton's survey is rather more comprehensive than that of Admiral Biörklund, he does not attempt to suggest any solution or particular method of control. Until disarmament proposals for weapons of all types, with adequate safeguards of inspection and policing, have been implemented, freedom and survival, he remarks, will depend upon preparedness and strong defence forces. He gives indeed an admirably concise review of Western policy and recent discussions on the control of weapons, and his final two chapters on planning for survival and the steps ahead give a clear indication of the kind of thinking and preparation that are required—thinking of which Mr. Hugh Gaitskell's speech in the House of Commons on July 24 contained more than a hint.

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* International Atomic Policy During a Decade: an Historical-litical Investigation into the Problem of Atomic Weapons During Period 1945–55. By Admiral Elis Biörklund Translated by ert Read.) Pp. 148. (London: George Allen and Unwin, Ltd., 56.) 15*s*. net.

† Facing the Atomic Future. By Prof. E. W. Titterton. Pp. xi+ +6 plates. (London: Macmillan and Co., Ltd.; New York: Martin's Press, Inc., 1956.) 21*s*. net.

Mr. Gaitskell rightly insisted that whatever new policy we adopt in regard to defence should be hammered out jointly with our friends and allies, and not adopted as each country thinks independently on its own. There is solid truth in his suggestion that the North Atlantic Treaty Organization and the Atlantic Alliance seem unable to decide jointly on the implications of the new situation and that, instead, different countries each say aloud what they expect to do in the circumstances.

The House of Commons debate did not, however, bring out the vital point which Prof. Titterton stresses. It was admitted by Mr. Gaitskell and others that democracies tend to drift apart unless the threat of war is imminent; but the corollary was not faced. If the democracies are to be kept together in the Anglo-American alliance and the North Atlantic Treaty Organization, as Mr. Gaitskell, no less than the Prime Minister, believes they must, more than words are required. A new kind of defence effort is needed in which the public co-operates; and the task of public education that is the first step is only possible if the major political parties co-operate in that task, and cease to make party capital out of even legitimate differences of opinion. Perhaps the biggest problem of defence is that of education—of giving all the people some understanding of the conditions of survival.

Prof. Titterton's book is first and foremost an effort to help in that direction—to help the reader to appreciate those basic facts of the present technological age which every citizen must understand if he or she is to have any influence on the future. That, of course, is also a matter of time, and our second urgent need is accordingly to buy the time in which to achieve the re-orientation of outlook so necessary to a satisfactory solution of the problems of defence. Here Prof. Titterton agrees with Admiral Biörklund as to the need for maintaining world peace through strength, and he considers that with balanced forces at its disposal the West can now meet each type of military threat with an appropriate defence. It is no longer necessary to rely entirely on nuclear bombs, although integration of tactical weapons could greatly strengthen the defence. Thirdly, it is necessary to pursue all possible avenues towards a just settlement of international differences. Mankind can no longer afford the luxury of warfare; fission and fusion weapons have rendered it obsolete as a method of settling international differences. We have still far to go in learning to live together in th changed world; patience, wisdom and human unde standing are still needed, and statesmanship of a hig order. Nor can we count on rapid progress; but peace can be preserved through strength and withou sacrifice of freedom, the chance of establishing a ne order free from fear, and in which full advantage ca be reaped from the possibilities of improved livin offered by nuclear energy to all men, is not t remote.

No less clearly than Admiral Biörklund and Pro Titterton, contributors to the symposium on scien and the affairs of men in the *Bulletin of the Atom Scientists* stress the need for seeing clearly th dangers and tasks of the present. Straight thinkin and a readiness to prepare and adopt radical solutio for the appropriate moment are essential conditio of survival, and the half-century of limited war whi Raymond Aron forecasts could well afford our childr the opportunity to achieve a century of peac Moreover, this clear thinking that is required mu be uninhibited and penetrating, considering n simply the place of science in war but also th implications of science for the relations betwe States in peace as well as in times of tension. Indee the symposium itself offers sufficient evidence of th wide differences in opinion that are likely to be m and the slow rate of progress.

Thus, in the discussion on science and milita strategy, while several contributors agree that nucle and thermonuclear weapons are about to become th mainstay of military planning of the major Power and that their removal from national arsenals is no unlikely, C. W. Sherwin and W. Amster welcome th approaching state of 'mutual deterrence'. The believe that when the two opposing major Powe are demonstrably capable of destroying each other economy and population but demonstrably unab to prevent retaliation, stable peace will result. C the contrary, from the same set of facts, Col. R. Leghorn and D. Inglis reach the radically differe conclusion that the United States and Soviet Russ should arrest the arms race before this ultimate sta of mutual deterrence is achieved. They regard a international agreement to stop further nuclear a thermonuclear tests and to halt the development intercontinental ballistic missiles as our last chanc Stopping at the present level of development thermonuclear weapons and missiles, they believ will preserve a situation which will permit a mo back towards real disarmament when internation relations have improved enough to make extensi international control and inspection feasible. Perha the most convincing argument which Leghorn an Inglis develop for this freezing of nuclear weapons the predicament into which both major Powers cou be put by the acquisition of nuclear weapons b several other smaller Powers. The capacity the two blocks to avoid the outbreak of major war which neither of them wants ma thereby be badly crippled. Furthermore, lil Admiral Biörklund's proposals, those of Legho and Inglis can be enforced without extensi inspection.

It may be that the ideas advanced by Col. Leghorn nd Mr. Inglis have already been judged by official dvisers as technically impossible or coming too late; ut while differences of opinion between technical nd scientific experts are unavoidable, it is not npossible or impracticable to make those differences ntelligible to the layman. Indeed, it is an important art of the task of public education that the reasons r such differences should be explained and made nown to the public. In the radical revision of efence which the British Government is quite rightly ontemplating, it is extremely difficult to make the ght decisions and only too easy to make the wrong hoice. Moreover, such economies as are possible in oncert with our allies cannot do more than enable s to make the best use of our limited resources and void placing an intolerable burden on our economy. hey can do nothing to make for more comfortable ving or lighter taxation, unless we are prepared to bandon all pretence of being a great Power and ccept the incalculable political and diplomatic as ell as economic consequences. There is no escaping therwise the enormous and increasing expense of hermonuclear weapons as the deterrent on which e at present propose to rely.

So long as Britain proposes to share in the strategic eterrent, it cannot escape that cost; and the ientist and technologist as such will have some ontribution to make towards the wise selection and isposition of our resources for that purpose. They n help also in making clear the implications of lternative policies, both for materials and for ientific man-power; and there are scientific and chnical factors which should be taken into account n deciding just what Britain's share in the nuclear eterrent should be. Probably, however, their most nportant contribution will be to the task of public ducation to which Prof. Titterton refers. They can elp to see that misleading statements are duly orrected—that the Chancellor of the Exchequer's uggestion that we might come down to an expenditure of only 5 per cent of our national income on efence is seen as an impossibility. Beyond that, hey can play their part, as the Geneva Conference n the Peaceful Use of Atomic Energy last year has emonstrated, in promoting greater understanding nd unity across national frontiers.

If we can gain time for this task of education, it ay well be one of the most important ways in which ience can contribute to world peace. In an article n "Science as a Force of Unity among Men" contributed to the *Bulletin of the Atomic Scientists* of une, Pierre Auger, arguing that the great task of ur time is to create unity among the peoples of the orld, refers to the great human value of such nternational institutions as the European Council of Nuclear Research. Developments along such lines, e believes, would greatly assist unity and undertanding.

While British scientists should not neglect their opportunities for contributing to international undertanding in such ways, in the field of defence their main responsibility at present is in the task of promoting the formation of a sound public opinion; above all in regard to the implications of nuclear weapons and particularly for our research effort and the distribution of scientific and technical man-power. Even the radical change in strategy and tactics which is involved in any fundamental revision of defence policy in Britain has implications for scientific and technical man-power which need to be considered and explained. If the right decisions are to be reached, it is important that there should be as much informed discussion as possible. If, when the decisions are taken, they are to be firmly executed and faith maintained with our allies, it will be no less important that all that is involved is clearly and fully explained to the public, so that policy enjoys the assured support of an informed and understanding public opinion no matter what political party may be in power.

THE BRITISH FLORA IN RETROSPECT

The History of the British Flora

A Factual Basis for Phytogeography. By Dr. H. Godwin. Pp. viii+384+26 plates. (Cambridge: At the University Press, 1956.) 90*s*. net.

THE foundations of the history of the British flora were well laid when Clement Reid at the end of the nineteenth century published his pioneer work on "The Origin of the British Flora", largely based on seed material which he and his wife collected and identified. But the frequency of such macroscopic specimens as seeds and leaves is poverty compared with the wealth of pollen grains often preserved; it was Von Post who so ably demonstrated this to be a most valuable means of tracing vegetational changes, and his methods were applied in Britain by Woodhead and Erdtman in the middle and late 1920's. From the middle 1930's onwards, Dr. H. Godwin and his associates have exploited this field of study, and the present work is a valuable summary of the rich harvest of their results.

The resistance of pollen grains to decay and their generic and even specific distinguishability render their occurrence of great importance, provided adequate caution is used for guarding against the obvious sources of error. Undoubtedly the most important part of this book is the section devoted to the records of species and genera, which occupy more than half the text and which deal with more than five hundred kinds of plants, fully documented as to the sites from which they have been obtained. Here, for example, the reader can assess the extent of the present evidence for the national status of box, the ancient occurrence of *Lythrum hyssopifolium* or the shrunken distribution of *Polemonium coeruleum*; or again, by reference to *Trapa natans* and *Naias flexilis*, he can envisage some of the evidence for a post-glacial climatic amelioration leading to a climatic optimum in the first half of the Atlantic period.

The text begins with an account of the collection and identification of plant remains, followed by a consideration of Quaternary chronology in which the author provides a tentative scheme of the main vegetational changes from 12,000 B.C. to the present time. Following the plant records already referred to, the author discusses what is termed the pattern of change in the British flora. Here it is apparent, as the author is at pains to emphasize, that, despite the accreted knowledge of the past quarter of a century, there remains a wealth of ignorance and speculative conjecture which only the assiduous collection of further material can remove or justify.

The interplay of climatic, edaphic and historical factors can only be significantly assessed in the light of a far more detailed knowledge than we at present possess of the autecology of individual species and, in particular, of their major physiological responses; never forgetting that, within the same morphological taxon, races of widely differing physiological response may occur, such as the differing photoperiodic response of strains of *Arabidopsis* or alternative reproductive tolerance, as where a species in one climatic complex reproduces by seed and in another by vegetative exuberance.

On the path of his own speciality, we can follow Dr. Godwin with confidence; but when he strays towards the edge his guidance is less reliable. In common with some other phytogeographers, Dr. Godwin appears loth to admit that plant dispersal, although naturally varying in effectiveness with the species and conditions of the habitat, is not infrequently highly successful—perhaps because this introduces an element of uncertainty that is difficult to assess. Thus Dr. Godwin naïvely accepts the increased occurrences of *Himantoglossum* in Britain between the two World Wars as possibly related to climatic conditions and ignores the fact that after the First World War there was a considerable importation of lizard orchids for garden culture. That the plants often seeded freely is a fact, and millions of seeds must have been widely dispersed. The importation is believed to have ceased before the Second World War, and no additional records have in recent years been added. This may be mere coincidence; but on present evidence the facts are at least equivocal. Again, on p. 342 Dr. Godwin states that it can scarcely be doubted that *Bromus secalinus* is a weed, although chess in primitive times, as to-day, was probably cultivated as a crop plant.

But if here and there one feels that judgments have been made on too narrow a consideration of the relevant facts, one cannot doubt that this book is not only a major contribution to this topic, but will also serve as a valuable foundation upon which future work can be based. E. J. SALISBURY

TECHNIQUES AND THEORY OF MOLECULAR BEAMS

Molecular Beams

By Prof. Norman F. Ramsey. (International Series of Monographs on Physics.) Pp. xii+466. (Oxford: Clarendon Press; London: Oxford University Press, 1956.) 75*s*. net.

THERE can have been no more elegant developments of technique in recent years in any field of physics than those that have taken place in the study of beams of neutral atoms and molecules. By combining the techniques of radio-frequency and ultra-high-frequency oscillations with those developed earlier for the production and detection of molecular beams, Rabi and his associates introduced the molecular-beam resonance method which has made possible the measurement of magnetic and electric moments, both of nuclei and of molecules, with an astonishing precision.

In nuclear physics such measurements have been of great significance in the development of current ideas of nuclear structure. In molecular physics they have enabled precise determinations of molecular constants and have contributed to the study of polymerization. But perhaps most important of all has been the contribution of measurements of this kind to the deeper understanding of electron and radiation physics. Precise determinations of atomic magnetic moments established the existence of an anomaly in the magnetic moment of the electron. Using a rather different beam resonance method, Lamb and Rutherford, in their now classical experiment, established the splitting of the $2s_{1/2}$ and $2p_{1/2}$ atomic states of hydrogen and measured it with great accuracy. The remarkable agreement between the calculated values of the anomalous electron magnetic moment and the Lamb–Rutherford shift with the measured values constitutes to-day the most impressive evidence in support of quantum electrodynamical theory and of the essential validity of the mass renormalization methods used in its application to specific calculations.

In this book the techniques of these and many other types of experiment using molecular beams, together with the results obtained and their significance, are described for the first time in a full-length monograph by Prof. N. F. Ramsey, who has himself contributed very much in this field. One has the impression that the author is equally at home whether discussing the finer points of experimental detail or the theoretical bases necessary for the interpretation of the experiments.

Although most of the volume is devoted to the measurement of magnetic and electrical moments, a short early chapter on gas kinetics serves as a reminder that molecular-beam techniques have a considerable importance also in low-energy atomic and molecular physics and in the physics of surfaces. This is followed by a chapter in which the basic expressions for the multipole expansion of the electrostatic and magnetic interactions are set out in a clear and useful form. Then, after a chapter on measurements of the earlier Stern–Gerlach type most of the remainder of the book is devoted to a comprehensive discussion of magnetic and electric molecular-beam resonance methods and their application to the study of nuclear magnetic moments and electric quadrupole moments, the radio-frequency spectroscopy of molecules, the anomaly in the magnetic moment of the electron and the Lamb–Rutherford shift. The interesting possibilities of the development of an atomic-beam clock capable of measuring time-intervals with an accuracy of 1 in 10^{13} and of a molecular microwave amplifier (the 'maser') are discussed briefly. The last two chapters are devoted to the principles used in the design of molecular-beam experiments and to a detailed discussion of the experimental techniques of molecular beam physics.

The large number of carefully chosen figures, the comprehensive tables of data on nuclear moments and molecular constants obtained using molecular-beam methods, and the useful set of appendixes, add greatly to the value of the book, which is likely to remain the standard work in this field for a long time to come. But the book is much more than a description of investigations carried out using molecular-beam methods and a compilation and discussion of the results obtained. By its clear definition of important lines of future development, it should stimulate research in this field, and by its meticulous attention to experimental detail, it should make easier the task of new research workers who may be attracted to such work. E. H. S. BURHOP

DIFFUSION AS A MATHEMATICAL PROBLEM

The Mathematics of Diffusion

By J. Crank. Pp. vi+347. (Oxford: Clarendon Press; London: Oxford University Press, 1956.) 50*s*. net.

THIS book has been written by a mathematician who has worked on diffusion for a number of years and has compiled many of the available solutions of the diffusion equation. It is a book on applied mathematics in which the problems are stated with the minimum of physical description, the main interest being in the method of solution and in tabulating generalized results. The style of presentation is to be recommended to all those who write for non-mathematicians. The discussion is always closely related to the physical problem in hand, particular examples as well as generalized solutions are given, and purely mathematical questions such as uniqueness of solutions, existence theorems and convergence, except where this concerns numerical calculations, are excluded.

The first six chapters, which treat the case of constant diffusion coefficient, form a counterpart to "Conduction of Heat in Solids", by Carslaw and Jaeger (Oxford, 1947). At first glance it would appear that this earlier book covers the subject adequately, it being necessary merely to replace thermal diffusivity by diffusion coefficient. However, many results have been given since 1947, the problems being dictated by the boundary conditions of particular experiments on diffusion rather than heat conduction.

In the present work there are two chapters on the related topics of diffusion with a moving boundary, and absorption with chemical reaction. The latter might well have been expanded; for example, nothing is said about absorption with second-order chemical reaction, a problem of physical importance which presents difficulties of a purely mathematical kind.

The remainder of the book deals mainly with variable diffusion coefficients and with numerical methods. These chapters are rather badly arranged, so that chapters on analytical and numerical solutions with variable diffusion coefficients are separated. There is a useful account of methods of finite differences, in which the brief mention of digital computing machines might have been expanded. A valuable chapter deals with the definition and measurement of diffusion coefficients. Here the author restricts himself to a mathematical discussion, the object being to use the analysis to extract the maximum of information from the experimental data. Such discussion is not out of place in this kind of book, but a little more experimental detail would be helpful, since the analysis available, and the type of experiment which is actually carried out, are interdependent.

The primary value of the book will be to research students beginning the study of diffusion. The earlier chapters will also be useful for advanced undergraduate teaching, while the established research worker will welcome the book as a comprehensive survey of the mathematical literature on diffusion during the past ten years.

It is interesting to note that the author is employed in an industrial laboratory. Until quite recently, theoretical books of this kind were always written by academic workers. Presumably industry is at last realizing the value of advanced mathematics, and it is to be hoped that more theoretical workers in industry will have time to write books of this quality. J. F. DAVIDSON

EARLY CIVILIZATION IN MESOPOTAMIA

From the Tablets of Sumer

Twenty-five Firsts in Man's Recorded History. By Dr. Samuel Noah Kramer. Pp. xxv+293 (40 plates). (Indian Hills, Colorado: Falcon's Wing Press, 1956.) 5 dollars.

FOR more than half a century the Sumerians have held an honoured place in history as the creators of urban civilization in the plains of southern Mesopotamia; but it is only during the past two decades that their highly developed poetical literature has become available in translation, and for this we are indebted first and foremost to the labours of Prof. Samuel Noah Kramer. Others had indeed paved the way by the elucidation of the grammar of the Sumerian language—a language unrelated to any known linguistic group—and by the publication of some of the tablets. However, these tablets, most of which were excavated as long ago as the 1890's, were found broken into many fragments, and at the conclusion of the excavations the fragments were divided between the Museum of the Ancient Orient at Istanbul, the University Museum at Philadelphia, and other collections, before any serious attempt had been made to effect joins. As a result, the fragments copied by scholars over a period of some thirty years were rarely large enough to yield intelligible sense.

The great achievement of Prof. Kramer has been due to his recognition that the most urgent need was the reconstruction of the texts of these compositions. With the support of several American learned societies and institutions, he has devoted all his energies to this task, travelling to Europe and Asia, copying unpublished fragments, and identifying those which belong together. The result has been the rediscovery of a lost literature, which deserves to be made known to a wider public than that reached by the learned journals where the first translations have usually appeared.

This is the main purpose which Prof. Kramer has set himself in this book. However, he has not, as in his earlier work, "Sumerian Mythology" (1944), confined himself to a straightforward presentation of the texts. Rather, he has used the texts to illustrate twenty-five different features of Sumerian civilization, each of which is represented as the earliest known occurrence of a phenomenon familiar in the modern world. These are his "Twenty-five Firsts in Man's Recorded History"—an expression with an oddly academic ring to British ears. Some of these chapter-headings are merely descriptions of actual texts, such as "The First Love-song", "The First Proverbs and Sayings", "The First Tale of Resurrection", "The First Library Catalogue". Others are aspects of Sumerian society deduced from incidental references in one or more texts, such as "The First Bicameral Congress", "The First Experiment in Shade-Tree Gardening", "Man's First Cosmogony and Cosmology". The strange theocratic world-view of the Sumerians is well illustrated by the document translated under the heading "The First Historian". Another text reveals their quaint analysis of their own culture into more than one hundred elements (ranging from institutions like "kingship" to abstractions like "justice" and "terror"), which can be loaded into a boat and carried from one city to another. The remarkably human essay quoted under the title "The First Case of Apple-Polishing" gives a vivid impression of the life of a Sumerian schoolboy; and in the chapter entitled "Man's First Heroic Age", Prof. Kramer draws some far-reaching conclusions about Sumerian origins, which will doubtless not remain unchallenged.

This is a thoughtful and scholarly book, despite the colloquial tone sometimes adopted, particularly in the opening pages. The occasional glimpses of moments in the life of a Sumerologist and his search for 'joins' provide an attractive background to the description of the literature. O. R. GURNEY

EVOLUTION OF MAN

The Fossil Evidence for Human Evolution

An Introduction to the Study of Paleoanthropology. By Prof. Sir W. E. Le Gros Clark. (The Scientist's Library—Biology and Medicine.) Pp. x+181. (Chicago: University of Chicago Press; London: Cambridge University Press, 1955.) 45s. net.

IF Pierre Charron in his "Treatise on Wisdom" was himself wise, the true science and study of man is man. Things, of course, were easier in the sixteenth century when fossil men were not in the laboratory or the study. How much happier we might be to-day if the wisdom of Charron had been coupled with the earlier wisdom of Job, who inquired: "What is Man, that thou shouldest magnify him ?".

Alas, in recent years the study of man has been attempted and magnified by all classes and conditions of men: geologists and palæontologists; anatomists and anthropologists; statisticians and geneticists; blood-group specialists and geochronologists; and adventurers and plain unvarnished liars. Many of the results have added to a confusion that Pope might well have had in mind when he wrote of the "Sole judge of truth, in endless error hurled".

There are, however, ways in which the judges can review the evidence and determine the end of error-making. It may be said that in this slim and elegant volume of a new and enterprising series in "Biology and Medicine", Sir Wilfrid Le Gros Clark has made a brilliant start. This is not easy to do. Man has the palæontological misfortune to be represented fairly generously in the Pleistocene and thus shares in the general regard for antiquity with the taxonomic confusion due to an almost super-abundance of contemporary specimens of the same animal. To all, ancient and modern, a generous amount of anthropomorphization is applied on the lines most familiar to the particular writer.

The answer to the question "What is Man ?" is thus both complex and unsatisfying. It is hard to separate the basic facts from a mass of observation and opinion and from an immense literature. Sir Wilfrid recommends the study of genetics, and rightly so. In "Genetics and the Races of Man" W. C. Boyd in 1950 forecast that more and more attention would become directed to blood-groups; and since he wrote, well over a thousand papers have been published on the subject—a sobering thought on the evolutionary picture. The strongest possible support must be given to Sir Wilfrid's plea that the student of human evolution should have a much closer acquaintance with the facts of functional anatomy. Without this and the assurance it gives for critical appreciation of structural analysis, all the highly important new work on the dating of the Pleistocene will be much reduced in value and the evolutionary pathways indubitably obscured.

The accumulation and recognition of a total morphological pattern is not simplified either when, through lack of anatomical knowledge, the desire to create new genera or species on every fragment of hominid bone persists. The current value of human remains is sometimes to be assessed by the value the observer places upon his observation rather than upon the intrinsic characters of the specimen.

It is of paramount importance that Sir Wilfrid here approaches the subject from the point of view of the scientific palæontologist and examines each piece of evidence as if it belonged to some anima other than man. He pays primary attention to the morphological and phylogenetic problems in taxonomy in relation to hominid evolution. This leads to a sound taxonomic system based on comparative anatomy, and placed on a background of geologica time, that enables the distinction of hominid and pongid radiations to be made.

In the major portion of the book he follows the story of man's evolution in the logical way—from the known to the lesser known, the unknown and the postulated. In this route he recognizes taxonomic categories for *Homo sapiens*, *Homo neanderthalensis* *Pithecanthropus* and *Australopithecus*.

Each of these sections ends with a diagnosis of the genus concerned and a discussion of its relationship with the other genera. The final chapter is on the origin of the Hominidae.

So far, the author says, no undoubted hominids have been found of an antiquity clearly older than the Early Pleistocene, and so far no fashioned implements have been proved of any greater antiquity. The relics of Pliocene hominids have yet to be discovered, though there is no doubt that such hominids existed.

It is thus all the more important to be able to be precise about the characters that these may have possessed and which will serve to distinguish them from the ten (at least) genera so far described o anthropoid apes of Pliocene and Miocene age.

The text is well illustrated by line-drawings, and there is a long and useful list of references. As a whole, the book will be of great interest to the anthropologist and quite invaluable to the student Not the least of its appeal to vertebrate palæontologists is the fresh draught of common sense tha the author lets in on the nomenclatural fog. Thi is a wise and valuable addition to the library of th palæontologist and physical anthropologist, and i can also be read by the layman.

W. E. SWINTON

Arabic Astronomical and Astrological Sciences in Latin Translation

A Critical Bibliography. By Francis J. Carmody. Pp. vi+193. (Berkeley and Los Angeles: University of California Press; London: Cambridge University Press, 1956.) 21*s*. net.

THE purpose of this bibliography is to present in a co-ordinated form all known translations into Latin of Arabic works on astronomy. Most of the known Arabic works were translated into Latin during the medieval and renaissance periods by scholars who were specialists. In these translations they were able to exert a marked influence on European thought. The translations are of use to a far greater number of scholars than the Arabic originals would be; moreover, many of the original Arabic texts have not survived.

This bibliography has been prepared with great care by co-ordinating and corroborating the various editions and manuscripts. Several hundred manuscript texts have been examined at first hand. Works on astrology have been included as many of them contain technical information on such matters, for example, as planetary theories and improvements in astronomical constants. Mathematical works have also been included where they touch on the borderline of astronomy and deal with such matters as optics or the astrolabe.

A chronological arrangement of authors has been followed. Some brief notes about each author are given, followed by lists of editions and of manuscripts and some idea of the reliability of each. The contents of each work are described and an estimate of its significance is given. The locations of the several manuscript copies believed to be suitable for research are listed.

The preparation of this bibliography has evidently entailed an immense amount of research. It will provide an invaluable reference source for all students of Arabic astronomy. H. SPENCER JONES

Unione Internazionale di Chimica Pura e Applicata

Simposio Internazionale di Chimica Macromolecolare, Milano–Torino, 26 Settembre–2 Ottobre, 1954. (Supplemento a *La Ricerca Scientifica*, Anno 25.) Pp. xix+954. (Roma: Consiglio Nazionale delle Ricerche; New York: Interscience Publishers, Inc.; London: Interscience Publishers, Ltd., 1955.) 12,000 lire; 19.20 dollars.

THIS volume comprises some 106 papers contributed to the International Symposium on Macromolecular Chemistry, which was held under the auspices of the International Union of Pure and Applied Chemistry, in Milan and Turin, during September 1954.

The editors and printers have carried out their difficult and laborious task well, and the result is a substantial volume which gives an excellent permanent record, not only of the papers contributed, but also of the discussion remarks. The majority of papers are in English or French; but in all cases a lengthy résumé is given in Italian, French and German; so that the volume as a whole is a very valuable contribution to the international literature on this subject; it is clearly a necessity for the libraries of all institutions and laboratories concerned with macromolecular chemistry. It is only unfortunate, but quite understandable, that so much time should have elapsed between the conference and the volume. The subjects of the discussion were: (1) building reactions of macromolecules; (2) transformation reactions of macromolecules; (3) block polymers and graft polymers, preparation and properties; (4) cellulose and derivatives; (5) molecular weight determination and distribution; (6) branched polymers; (7) fibre-forming high polymers; (8) crystallization and transitions; (9) proteins; (10) general properties of polymers. J. A. V. BUTLER

Welt, Ich und Zeit

Nach unveröffentlichen Manuskripten Edmund Husserls. Von Gerd Brand. Pp. xviii+1012. (Den Haag: Martinus Nijhoff; London: B. T. Batsford, Ltd., 1955.) 9.50 florins.

THIS scholarly volume deals with the unpublished Husserl manuscripts. They represent the state of affairs existing at the end of the philosopher's life, and comprise his heroic attempts (never perhaps, in his estimation, wholly successful) to set phenomenology fairly and squarely upon an irreproachable methodological basis. Thus is explained the division of the work into two parts. In the first, no more than a general introduction to the subject is achieved, whereas in the second Husserl brings to bear his constitutive analysis with that particular brand of rigour which impelled him to regard phenomenology as a portion of a living science.

So, his meditations upon the return to experience occupy about one-third of the book, and his concept of temporality as fundamental for such experience the remaining two-thirds. The contrast is between occasional truths—with which we have to be satisfied in everyday life—and final validity. Observed historically, this means that the choice for Europe (as Husserl saw it) is between decay into barbarism or the rebirth of a spirit of philosophy in which objectivity would play a major part. It seems safe to deduce from these pages that something less violent than the "Enlightenment" of French savants is envisaged, but at the same time a system capable of eliminating the crudities of a merely pragmatic theory of knowledge. F. I. G. RAWLINS

The Theory of Differential Equations

By Dr. J. C. Burkill. (University Mathematical Texts.) Pp. ix+102. (Edinburgh and London: Oliver and Boyd, Ltd., 1956.) 8*s*. 6*d*. net.

INCE'S volume in the "University Mathematical Texts" gave an account of standard forms of explicit solution of ordinary differential equations. Dr. Burkill's companion volume takes this material as known, and proceeds to discuss conditions under which the existence of a solution may be proved, and those properties of the solution which may be deduced from the nature of the differential equation. The theory of the linear equation is concisely but thoroughly developed, an introduction to the Sturm–Liouville theory is given, solutions by means of infinite series and by contour integrals are carefully discussed. Chapters on the Legendre and Bessel functions serve as illustrations of general methods, and there is a brief introduction to asymptotic series. To cover this ground in a hundred small pages demands expository skill of no mean order, and it is a measure of the author's mastery to find a lucid account, easily intelligible to any good honours student, in so small a compass. Both as a text in itself, and as an introduction to more comprehensive treatises in this field, this book is a worthy member of the excellent series to which it belongs.

T. A. A. BROADBENT

ZOOLOGICAL RESEARCH AND ANIMAL LEARNING

ON the first day of the recent meeting of the British Association at Sheffield, the presidential address by Dr. W. H. Thorpe to Section D (Zoology) (see *Nature*, September 1, p. 473) was followed by a series of papers on "The Contribution of Zoological Research to Theories of Animal Learning".

Dr. Peggy E. Ellis (Hope Department of Entomology, Oxford) opened with an account of some experimental work on gregariousness in the desert locust (*Schistocerca gregaria*). Locusts reared in the laboratory in company with other individuals started to form groups some hours after hatching. When ten such individuals were tested under standard conditions in a ring-like cage, 70–80 per cent formed groups by the end of the first day, and the proportion remained more or less constant on the following days. Locusts reared in isolation and afterwards placed in crowded conditions, however, at first tried to escape from aggregations, and became gregarious only after several hours. When such individuals were tested in the ring-like cage, at first only 45–55 per cent formed groups, though the proportion rose to 70–80 per cent during the first day. Once the locusts had learned to aggregate, the behaviour seemed to be fixed. Thus insects kept under crowded conditions for three days, and then isolated for several days, did not lose their gregarious tendency.

From such experiments it seems that positive gregariousness depends on a learning process which resembles 'imprinting' in being rapid, irreversible and in involving a learning of 'supra-individual' characters. It differs from imprinting in that there is no sensitive period—individuals reared in isolation can learn to become gregarious at any age. Dr. Ellis related her experiments to the behaviour of hoppers in the field and her lecture was illustrated by a colour film taken in Ethiopia.

Dr. S. A. Barnett (Department of Zoology, Glasgow) then presented a paper on "Animal Motility and Learning". Early scientific work on animal movement was concerned primarily with the control of orientation and directed movement, the approach being narrowly mechanistic. Later, the importance and role of appetitive behaviour were appreciated, and investigators were concerned with the initiation as well as the orientation of the movement. Dr. Barnett used the term 'appetitive behaviour' only for behaviour which is (*a*) specifically motivated and (*b*) related to a consummatory act, and pointed out that some variable movement is not appetitive in this sense. Thus 'exploratory behaviour' is widespread among animals but does not lead to any specific act. Appetitive and exploratory behaviour are important in that they provide opportunity for learning—exploratory behaviour, in particular, makes possible topographical learning. Such learning is independent of the satisfaction of a particular need—a fact surprising to the learning theorist accustomed to manipulate motivation in experiments on learning, but not to the zoologist, who thinks in terms of survival value. In its independence of specific needs and acts, exploratory behaviour resembles play; such behaviour is of course of particular importance in the primates and in man.

The first paper in the afternoon, by Dr. R. A. Hinde (Ornithological Field Station, Department of Zoology, Cambridge) was concerned with "The Significance of Imprinting"—'imprinting' being used in its original sense to refer to the learning of the characteristics of their parents by young birds, and especially to the learning occurring when young nidifugous birds follow their parents. Among the characteristics of imprinting and the following-response discussed were:

(*a*) The diversity of objects which can elicit following. This can be understood functionally: responsiveness limited to one or a few stimulus patterns would be too selective, for the juveniles have not yet acquired a sense of constancy of size and shape and might fail to follow the parent when the latter was seen in varying postures and from varying angles.

(*b*) The ambivalence of the young, which tend to flee from their parents as well as to follow. This is a consequence of the selective advantage to adults of caring only for their own offspring and of driving off others.

(*c*) Irreversibility, rapidity and 'the sensitive period'. By virtue of such characteristics Lorenz believed imprinting to be a special form of learning. These characteristics are, however, by no means peculiar to imprinting, and can be found to a comparable degree in other contexts. Furthermore, all are covered by William James's laws of instincts.

(*d*) Imprinting and the parent-offspring relation. For a full understanding, imprinting must be considered in relation to all the behaviour patterns operating between parent and young: it plays an essential part in building up the parent-offspring relationship.

Since the characteristics of imprinting in birds can be understood functionally, learning with similar characteristics can be expected in other contexts with similar functional requirements. Thus the relationship between human mother and baby is built up in a similar way and shows many characteristics in common with the analogous relationship in birds, though the underlying mechanisms are presumably different.

A paper by Dr. I. M. L. Hunter (Department of Psychology, Edinburgh) entitled "'Trial and error' versus Insight" followed. Much of the problem-solving behaviour of animals seems to be 'almost human', and it seems reasonable to suppose that the animal 'understands' the situation. Such a supposition may, however, be wrong, for the animal has had a long learning history during which complex performances may have been developed by a process of trial-and-error learning which in no sense indicates the presence of thinking. In other cases the apparently intelligent behaviour of an animal may even turn out to be devoid of any learning at all: thus some of the strikingly purposeful behaviour of insects has been found to be instinctive, depending on a complex behaviour pattern which is, as it were, built into the organism.

The question whether animals think is thus more difficult to answer than it might appear. We need to know whether animals, whose past history is known in detail, can reorganize their past and present experiences to produce an anticipation of truly novel relationships within the problem situation. Only if this is so is it justifiable to speak of 'thinking' in animals. However, within the past ten years this has been actually demonstrated. In chimpanzees, kept under continuous observation from birth, familiar material may suddenly and adroitly be used in a genuinely novel way as, for example, when a T-shaped stick is used to rake in food which lies out of manual reach beyond the bars of the cage. In white rats, certain types of maze experiment—the so-called reasoning and latent-learning experiments—have shown that these animals can make inferences about the spatial characteristics of certain situations, since they can run deftly from one place to another by paths which they have never before traversed. These and other findings lead to the conclusion that thinking exists not only in humans but also in animals, at least within the mammalian range.

Dr. Hunter suggested that the importance of such experiments not only demonstrates the existence of animal thinking but also contributes to the understanding of human thought processes. They have shown, for example, that thinking occurs only when the animal has had certain appropriate experiences in the past, experiences which contribute to thinking by furnishing, as it were, the raw material out of which a new response pattern can be formed. The experiences of early life seem to be especially important in this respect. Because it is easier to control the exact conditions under which animals can be reared (whether, for example, their visual environment is rich or lacking in detail), experiments with animals are particularly suited to yield information on the effect which early perceptual learning has on the emergence of thinking. In this way, animal experiments will supplement the considerable body of work which is currently being done on the nature and development of human thinking, and will provide answers to questions which could not be feasibly tackled at the human level.

Dr. A. J. Watson (Department of Experimental Psychology, Cambridge) discussed " 'Stimulus-response' Theories of Animal Behaviour in the Light of Work on Instinctive Behaviour". He directed attention to three ways in which work on instinctive behaviour could lead to modification in theories of learning as devised by psychologists.

(*a*) Theories of learning are really theories of 'behaviour'—they attempt to predict what an animal will do in a certain range of circumstances. Furthermore, current learning theories are all in a sense stimulus-response theories; that is, given one set of stimulus conditions, and another of response conditions, an attempt is made to unite the two so that the second can be inferred from the first, but nothing is postulated about the actual mechanisms which intervene. Just because the initiating conditions, the final state and the intervening mechanisms are so complex, such attempts at prediction are almost bound to fail. Another type of approach is therefore necessary.

This is provided by instinct theories (for example, McDougall, Tinbergen) which permit distinctions between different 'kinds of responses' in different situations; for example, between appetitive and consummatory behaviour. Such distinctions cannot be accommodated within, for example, the Hullian framework, and permit an analysis of the problem so that it can be studied piecemeal.

(*b*) Instinct theories have emphasized the goal-seeking and directive properties of behaviour, which enter rather as an afterthought into theories of learning. This is related to the concepts of motivation used; in ethological theories the 'drive' selects the stimuli for which the animal searches in its appetitive behaviour, while in learning theory the drive serves only to provide a perpetual internal stimulus which may become linked to responses in the same way as an external cue. Further, the retroactive effect of drive reduction in learning theory is without parallel in instinct theories. The instinct-type theory, involving a 'goal-seeking' system, is superior to a stimulus-response system both because of its simplicity and because it can deal more readily with variable behaviour leading to a constant end. The retroactive effect of drive reduction is an unnecessary postulate, for goal-seeking machines can be made to learn what cues to search for without invoking any such principle.

(*c*) Dr. Watson suggested that instinct and learning theories differ in the nature of the goals which they postulate. While instinct theories have tended to emphasize the importance of acts as goals, psychologists have laid more stress on the perception of stimuli. The evidence is in favour of the latter view, and on this issue, therefore, ethologists seem to be farther from the truth than students of the theory of learning.

Thus ethological studies suggest that the student of the theory of learning should attempt to build a theory of a different logical type—with room for different 'kinds' of behaviour—and that he should modify his treatment of motivation. Ethologists, on the other hand, could usefully study the treatment of consummatory situations by learning theorists.

Finally, Mr. R. L. Reid (Department of Psychology, Aberdeen) spoke on "Avoiding Theory", expressing the view that the study of behaviour might progress more rapidly with fewer theories. Among the types of theory which could, in his view, profitably be discarded are:

(*a*) Escapist theories which attempt to explain a phenomenon away. Thus when a worm learns to turn into that arm of a T-maze in which it is shocked, its behaviour can be explained away by saying that 'worms like electroshock', or by supposing the synapses to be directly affected by shock. The first is mentalistic, the latter a physiological fairy tale, and both are unverifiable: they merely translate statements about behaviour into a different language.

(*b*) Behavioural cosmologies. These are superordinate theories which usually reflect the theorist's values and metaphysical assumptions, but are irrelevant to the practical aim of predicting behaviour. Arguments about holism and analysis or the purposeful nature of behaviour may obscure agreement about facts.

(*c*) Formal theorizing. This results from the use of hypothetico-deductive schemes (for example, Hull) and theoretical models (for example, Estes, Bush and Mosteller). These are unlikely to be fruitful in the study of broad areas of behaviour because of the complexity of the problems involved. Although they may be suitable for exploiting limited areas where the facts are already known, the urgent need —while the gaps in our knowledge are still so great—is for factual survey work. Such formal approaches are inevitably constrictive: although there is room for formal theorizing, the less pretentious inductive approach must not be neglected.

(*d*) Physiologizing. In thinking about complex behaviour it is sometimes disadvantageous even to consider possible mechanisms. Thus the concepts of 'set' and 'attention' were disposed of in the early stages of behaviourism largely because they did not fit in with the picture of the nervous system then held. They have now been restored on the grounds that they are physiologically respectable. Behaviour is as real and as regular as the physiological events underlying it, and reduction from the one realm of discourse to the other is unnecessary.

Mr. Reid concluded by hoping that zoological research will continue to provide empirical studies of learning in a wide variety of animals, and to examine the effects of hitherto neglected variables, rather than indulge in speculative theorizing.

In his concluding remarks, Dr. Thorpe directed the attention of those present to the growth of liaison between psychologists and zoologists studying behaviour. Five years previously they would barely have understood each other's problems, whereas now each has a broad knowledge of the other's work and they are aiming at similar goals. R. A. HINDE

THE PHYSICAL PROPERTIES OF METALS

ALTHOUGH the British Association has no section dealing specifically with metallurgy, it was to be expected that the recent meeting in Sheffield should give prominence to the subject. Thus the morning session of Section A (Physics) on September 3 was devoted to physical metallurgy, and Sir George Thomson, president of the Section, presided. The first paper, "The Physical Approach to Metallurgy", was presented by Prof. A. G. Quarrell (Sheffield) and served as an introductory lecture to the morning's proceedings. It emphasized the complexity of the technology of metals to-day and described how physics has provided not only the techniques for studying metals but also the necessary mental approach to the ultimate nature of metals which is leading to an understanding of their strength and behaviour.

Metallurgy as a science dates from the application of the microscope by Sorby to metal specimens at Sheffield in 1863, and a unique series of ferrous metallographic specimens laboriously prepared by Sorby in 1864 was on view at the meeting. Fortunately, these have been preserved by a cover-glass cemented on each prepared surface, and many may still be examined at high magnification. Sorby realized that the structure visible in polished and etched specimens is characteristic of the metal and the way it has been produced, and some time later it was shown that the appearance is also related to the mechanical properties of the metal.

The maximum magnification with the optical microscope is about × 2,000, but about fifteen years ago the development of the electron microscope led to an increase in the useful magnification up to × 100,000. Unfortunately, direct observation of the metal surface is normally impracticable, and a replica which is transparent to electrons must be examined. The initial unreliability of replica techniques prevented the general acceptance by metallurgists of electron microscopy, but the use of vacuum-deposited carbon replicas during the past two years has completely revolutionized the situation, and the electron microscope is now a most powerful metallurgical tool.

The early optical microscopic examination of metals was soon supplemented by thermal and dilatometric studies, enabling the composition limits of the various metallic phase fields to be determined and constitution diagrams to be constructed. The understanding of the alloy formation, however, had to wait for the technique of X-ray diffraction and for the concept of a metal as an assembly of charged ions surrounded a cloud of the conducting electrons. Hume-Rothery then showed in 1926 that the limiting solubility in monovalent metals such as copper and gold depends on the relative atomic diameters of the metals concerned, and that the structure of the intermediate alloy phases depends on the ratio of valency electrons to atoms in the alloy. These rules unfortunately fail to explain the alloying behaviour of the more complex alloys which are important in modern technology, and the approach to these alloys is still largely empirical.

The appreciation of the crystalline structure of metals has also made possible the study of the factors influencing the strength of metals. However, the theoretical strength of metals calculated from their atomic properties is 100–1,000 times greater than the measured stress required to produce permanent plastic deformation. This weakness is due to imperfections in the lattice, known as dislocations, and since the 'edge' dislocation was introduced in 1934 a complex theory of dislocations and their behaviour in crystal lattices has been developed. It has been calculated that the stress necessary to move a dislocation, if the interactions between the dislocation and the stress fields due to alloying atoms and precipitates are taken into account, is similar to the stress required to initiate slip in practice.

The dislocation theory of plasticity has been developed by theoretical physicists such as Mott and physical metallurgists such as Cottrell, and while strain-hardening, yield-points and crystal growth have been explained satisfactorily, only a beginning has been made towards the understanding of creep, fatigue and brittle fracture.

Creep is an example of a phenomenon of interest to both physicist and metallurgist; it was studied by Andrade in 1910 as a purely scientific phenomenon, but in 1920 Dickinson, in Sheffield, appreciated the importance of creep in steels at high temperatures and carried out the first long-time creep tests. These showed that at high temperatures much lower stresses would cause stretching and failure in the long-time creep test than in the short-time tensile test. The importance of creep in modern engineering has grown enormously in recent years with the trends towards high operating temperatures and pressures, and a large proportion of our metallurgical man-power is concerned with the development of new creep-resistant alloys which, for example, would be expected to last for many years at 570° C. in a modern power station.

Although complex metallurgical problems such as the mechanism of creep and its relationship to structure have not been solved completely by the physical approach, and resort must be made to semi-empirical methods, the major contribution of physics to metallurgy has been to give metallurgists a new mental attitude. Metallurgists are no longer satisfied with *ad hoc* solutions of immediate problems and have become increasingly anxious to provide fundamental explanations of important phenomena.

This truly scientific approach will undoubtedly result in rapid advance of the science of metallurgy.

"The Microstructure of Metals and Alloys" was the subject of a paper by Prof. C. S. Smith (Chicago). At the time of Sorby, the grains visible in metallographic micro-sections were not recognized as single crystals, because the single crystals of minerals in Nature were always expected to be regular polyhedra. However, it is now realized that the requirements of space filling prevent metal crystals in a polycrystalline aggregate from exhibiting regular crystallographic faces, and the geometry of the grains is governed by the condition that the interfaces contribute minimum energy to the system.

The interfaces themselves are of considerable interest as the interface atoms belong to both adjacent crystals. They have abnormal co-ordination with their neighbours, and abnormal spacing from them, making the interface a high-energy region which may be regarded as constituting a thin layer of liquid between the grains. A micro-section is essentially a random two-dimensional section through an aggregate of grains, and in a section the relationship between the number of polygons (P), the number of edges (E) and the number of corners (C) is given by the two-dimensional form of Euler's Law:

$$P-E+C=1$$

This shows that a grain can have any number of sides greater than two, but that hexagonal polygons are the most common.

Although polygons of other than six sides are possible and do occur, the condition of minimum energy in the boundaries invariably results in the grain boundaries meeting in threes at angles of 120°, and such junctions can only be accommodated by curved boundaries. In three dimensions the grain edges meet each other in fours at angles of 109½° to each other at each junction. These four crystal junctions are the only constant unit of structure and may be connected in innumerable ways. A three-dimensional array is thus made up of irregular grains each with approximately fourteen faces, and each face having an average of 5$\frac{1}{7}$ faces.

The arrangement of the grains in beta brass can be revealed by fracturing in the hot-short range and is analogous to that of the bubbles in a soap froth or the cells in human fat, as they are all controlled by the requirement that the interface energy, and hence the area, must tend to a minimum.

Such grains show curved faces, and if a metal is heated to the temperature at which diffusion can occur, the boundaries move towards their centres of curvature and the smaller, convex, cells disappear while their concave neighbours grow. The final minimum-energy state would consist of a single crystal.

In two-phase alloys the same relations between the grains apply, but the dihedral angle between the grains usually differs from 120° as the interfacial tensions are usually different. This angle is often zero for a liquid between two crystals which breaks all coherence, as in brass in contact with mercury or molten solder. In solid two-phase alloys the angle is often between 90° and 100°, showing that the chemically different interface is of lower energy than that between the two crystals of the same phase.

In this treatment it has been assumed that the energy of the interface is independent of the orientation between the grains forming the grain boundary; but this generally correct assumption breaks down at certain critical orientations. Thus the twins and plate-like precipitates which are due to a nucleation and growth processes, orientate themselves to give the lowest possible energy, and this outweighs the spatial improbability of such relationships. The majority of precipitates within the grains of heat-treated structures are of this type, exhibiting an orientated, polyhedral habit.

These general principles of space filling by polyhedra to give the minimum area, and hence minimum energy, of the interface, apply not only to metals but also to other microcrystalline materials such as ceramics and rocks, and all structures and transformations can be classified in terms of the structure of the boundary and the kind of adjustments in composition and position which occur as the boundary moves.

Dr. N. J. Petch (Leeds) spoke next on "Brittle Fracture", a subject he has made peculiarly his own. A fracture is defined as brittle if it is associated purely with elastic deformation and the fractured metal thus shows no evidence of deformation.

The difference between a brittle and a ductile crack is in its method of propagation. In the former case the applied stress required to spread the crack decreases as the crack grows; hence the maximum stress is required initially and catastrophic propagation occurs once the crack is initiated. If the crack is ductile, some energy is expanded in deforming the ends of the crack, and continued straining is necessary to spread the crack.

Although a mild steel may be quite ductile in a tensile test, it may behave in a brittle manner when incorporated into a structure. This difference has become more obvious with the use of all-welded structures, in which a crack, once started, can often travel a very large distance before being arrested by a physical discontinuity. More than one-fifth of the 5,000 ships built under the American emergency shipbuilding programme during the Second World War suffered serious cracking within three years, and eleven had broken completely in half by 1951. Other serious fractures have occurred in bridges and oil-storage tanks, and outstanding fractures a mile long have been reported in 30-in. diameter natural gas pipe-lines in the United States. These fractures travel with speeds approaching the speed of sound in the metal and a mile-long fracture would thus occur in about one second.

It is found that brittle materials exhibit a strength which is approximately one-thousandth of that calculated for a perfect solid, and Griffith laid the foundation of our present understanding of brittle fracture by showing that in glass and silica this weakness is due to minute cracks acting as stress concentrators. The current ideas of metallic fracture regard these stress concentrators as dislocation pile-ups on slip planes blocked by grain boundaries, and the stress concentration of × 1,000 necessary to account for the difference between the observed and theoretical strengths would require a thousand piled-up dislocations. which is not unreasonable. The difference between brittle and ductile materials is in the behaviour at the pile-up; in ductile metals crack formation is accompanied by plastic deformation, so that energy is lost in initiating the new dislocation movements, and the resulting crack is too small to propagate itself; many small cracks are thus formed which eventually join up and cause failure. In brittle failure, the propagation is elastic and no plastic deformation occurs, so that all the energy of the dislocation pile-up goes into the production of the crack and the initial crack is sufficiently long for spontaneous propagation.

Metals are most prone to brittle failure if movement of the dislocations, that is, plastic deformation, is difficult; for example, mild steel shows more brittleness than, say, copper because the dislocations become locked by carbon atoms, and this effect becomes more pronounced the lower the temperature.

The dislocation model also explains why brittle cracking is often observed in structures when a test piece of the same steel is ductile. Notches in the structure cause stress concentrations at their roots at which the rate of strain is high and dislocation movements are not rapid enough to avoid brittle fracture.

In general, the physical explanation of brittle fracture in polycrystalline metals is satisfactory, but the mechanism of the fracture in single crystals is still obscure.

In his paper on "The Metallurgy of Nuclear Energy", Mr. L. Rotherham (United Kingdom Atomic Energy Authority) outlined the metallurgical problems in the design of nuclear reactors. A thermal reactor consists essentially of a lattice of uranium rods surrounded by a moderator, usually of graphite. When a chain reaction is allowed to take place in the uranium, heat is generated and the pile must be continuously cooled. This is accomplished in the Harwell and Windscale piles by the use of air as a coolant and at the Calder Hall power station by carbon dioxide under pressure.

The problems encountered may be divided into those of a conventional nature which might be encountered in general chemical engineering, and those in which radiation effects are important. A typical conventional problem was the construction of the steel pressure vessels at Calder Hall, which are 40 ft. in diameter and 60 ft. long, containing carbon dioxide under pressure to increase its efficiency as a coolant. These vessels were fabricated by welding two-inch thick steel, and to avoid the brittle fracture dangers discussed by Dr. Petch, they were made of special steels.

The fuel elements consist of uranium rods protected by aluminium or magnesium 'cans' to prevent attack by the coolant. Unfortunately, uranium has low crystal symmetry with three markedly differing coefficients of thermal expansion along the three orthogonal crystal axes, and on heating and cooling considerable thermal distortion can occur in polycrystalline material. The effect of irradiation is similar, and considerable dimensional changes can also occur due to the internal strains produced by the fission products, which occupy more space than the parent uranium atoms. This effect is aggravated if atoms of rare gas are produced, which afterwards diffuse into voids and set up a considerable pressure. At 200° C. a single crystal of uranium would approximately double its length after the fission of one in a thousand uranium atoms. Irradiation of cast polycrystalline material produces an orange-peel surface wrinkling, while rolled material may increase its length and decrease its width, or vice versa, according to the rolling temperature. A further complication arises from the phase change in uranium at 650° C., as repeated heating and cooling through this transformation leads to severe distortion and surface roughening. The metallurgists' problem is to minimize these effects by heat-treatment to produce smaller grain-size, to avoid any preferred orientation due to fabrication and to study the effects of alloying which might stiffen the rods and thus help to resist the effects of internal pressure.

It is also possible to prevent distortion of the fuel elements by enclosing them in a rigid can. The Harwell and Windscale reactors employ aluminium cans; but as the fuel elements are discharged for plutonium extraction after relatively short periods in the pile, the distortion problems are not severe. In the Calder Hall reactors, power and not plutonium production is the main objective, and to withstand the severe distortion and growth consequent on a high burn-up of uranium, magnesium was chosen for the canning material. Magnesium has a higher creep strength than aluminium, and as it has a lower neutron absorption cross-section, a thicker and more rigid sheet can be used for the can.

In the future, the higher temperatures of fast reactors as envisaged at Dounreay will preclude the use of aluminium and magnesium as canning materials, and new metals will have to be employed. The choice is limited by the requirement that the metal must have a low neutron absorption, and use must be made of the rarer metals beryllium, zirconium, niobium, vanadium, tungsten and molybdenum. Of these metals niobium perhaps offers the most advantages, in that it is the most resistant to attack by uranium and liquid sodium, it has good high-temperature strength and it is extremely ductile and therefore readily fabricated into cans.

Up to the present, the extraction and properties of the rarer metals have been explored, and future developments will lie in the direction of enhancing the usefulness of these metals by alloying.

R. G. WARD

THE ELECTRICAL CONDUCTIVITY OF THE HEAD-WATERS OF THE WHITE NILE

By R. S. A. BEAUCHAMP

East African Fisheries Research Organization, Jinja, Uganda

FOR many years records have been kept of the levels of the lakes that form the head waters of the White Nile, and estimates have been made of the amount of water discharged from these lakes. Yet some uncertainty still exists regarding the relative contributions made by these various sources. This is not surprising when one considers the extent and complexity of this lake and river system, and the fact that the whole area is subject to high and irregular rates of evaporation and precipitation. The purpose of this article is to indicate the value of keeping, in addition to records of lake-levels and rates of discharge, records of the electrical conductivity of the water at particular points in the system. The electrical conductivities of these lakes and rivers cover a wide range of values. A study of hese values provides information on the amounts of vater derived from different sources.

Lakes Victoria and Kyoga form a major portion f the head waters of the White Nile ; the outlets of hese two lakes give rise to the Victoria Nile, which ischarges into the northern end of Lake Albert close o its outlet. The rest of this system is composed of series of three lakes : Lakes George, Edward and lbert. Values for the electrical conductivity of the vater contained in these five lakes remain nearly onstant and are as follows :

Lake Victoria	100	Lake George	160
Lake Kyoga	330	Lake Edward	910
Lake Albert	720		

The more important rivers in this system are the ictoria Nile, already referred to, the Semliki and he Albert Nile. The Semliki flows from Lake Edward o Lake Albert. The Albert Nile is the outflow from ake Albert.

The electrical conductivity of the Victoria Nile, easured just below the Murchison Falls at Fajao, emains at a nearly constant value of 110 units.

The electrical conductivity of the Semliki varies long its course and at different times of year. The ganda Hydrological Survey Department has on is river three recording stations. The first of these ations is at Ishango, close to the outlet from Lake dward; the second is at Ngamba, about half-way own the river; and the third is at Bweramule, irty miles from Lake Albert. My thanks are due the Hydrological Survey Department for supplying mples of water from these three stations.

At Ishango the electrical conductivity of the water almost constant at 910 units, being undiluted Lake dward water. At Ngamba values recorded range etween 780 and 885 units; at Bweramule they nge between 360 and 800 units (see Fig. 1). The riations in conductivity of the water at Ngamba d at Bweramule indicate that the Semliki at times ceives considerable quantities of water of low nductivity on its way to Lake Albert.

The conductivity of the Albert Nile measured at kwach ranges between values of 160 and 355 (see ble 1). My thanks are due to the Commander-in-arge, Lake Albert, East African Railways and arbours, Butiaba, for samples of water from kwach and from mid-lake. It can be seen that nductivity values at Pakwach are entirely different om the value of 720 recorded for Lake Albert. The bert Nile cannot therefore be considered simply as e outlet of Lake Albert.

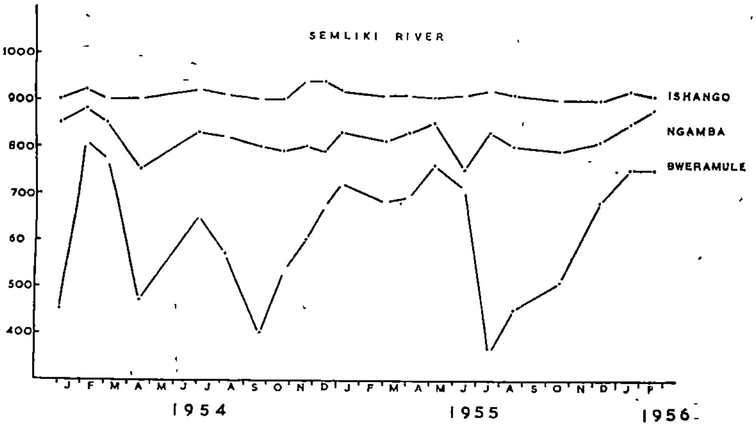

Fig. 1. Values for the electrical conductivity of the Semliki River at three stations

Table 1. VALUES FOR THE ELECTRICAL CONDUCTIVITY OF THE ALBERT NILE AND ESTIMATES OF THE PERCENTAGE OF LAKE ALBERT WATER CONTAINED IN THIS RIVER

Date	Electrical Conductivity Pakwach	Per cent Lake Albert water at Pakwach	Date	Electrical Conductivity Pakwach	Per cent Lake Albert water at Pakwach
25.3.54	310	33	26.8.54	210	16
1.4.54	320	34	2.9.54	190	13
8.4.54	260	24	9.9.54	240	21
15.4.54	300	31	20.9.54	160	8
23.4.54	260	24	7.10.54	185	12
29.4.54	300	31	14.10.54	185	12
2 5 54	300	31	30.10.54	190	13
6 5.54	320	34	25.11.54	355	40
13.5.54	260	24	12.12.54	250	23
27.5.54	295	30	16.12.54	300	31
3.6.54	220	18	23.12.54	250	23
10.6.54	275	27	30.12.54	320	34
13.6.54	200	14	4.1.55	300	31
17.6.54	230	19	6.1.55	300	31
1.7.54	230	19	9.1.55	300	31
8.7.54	290	29	20.1.55	280	28
11.7.54	270	26	23.1.55	290	29
15 7.54	230	19	27.1.55	300	31
22.7.54	270	26	6.2.55	250	23
29.7.54	285	29	10.2.55	340	37
12.8.54	280	28	20.2.55	250	23
19.8.54	205	15	3.3.55	280	28

Samples of water collected along a course running south from Fajao out into Lake Albert show that very little water from the Victoria Nile finds its way into Lake Albert. At a point approximately ten miles south of the Victoria Nile Delta, the water has a conductivity value of 720. It seems, therefore, that nearly all the water in the Victoria Nile travels almost directly into the Albert Nile.

Summarizing the information given above and the data contained in Fig. 1 and in Table 1, it can be said that the waters of the five lakes, which form the head waters of the White Nile, have electrical conductivities which remain constant at values characteristic for each lake, and that the water in the Victoria Nile also has a characteristic and almost constant electrical conductivity. On the other hand, the water in the lower reaches of the Semliki and in the Albert Nile show widely fluctuating values.

The electrical conductivity of natural waters is directly related to the concentration of dissolved electrolytes contained in them, and in normal circumstances a mixture of two samples of water will have a conductivity determined by that of the two samples and the relative amount of each contained in the mixture. Thus, if the conductivity of two confluent waters and that of the resulting mixture are known, it is a simple matter to calculate the relative amounts of water supplied by the two streams.

Calculated values for the percentage of Lake Albert water contained in samples of water from Pakwach on the Albert Nile are given in Table 1. These values indicate that at times the amount of Lake Albert water in the Albert Nile may be as high as 40 per cent and at other times as low as 8 per cent. For the purpose of these calculations the conductivity of the water at Fajao was taken to be 110 units and that of Lake Albert water 720 units. In order to test the validity of the calculations for the percentage content of Lake Albert and Victoria Nile water in the Albert Nile, appropriate mixtures of these two waters were made and the conductivity of these mixtures measured. In all cases the calculated values agreed with the actual values.

For many years estimates[1] have been made of the discharge of water at Fajao and of the amount of water flowing down the Albert Nile. These estimates indicate that the amount of water flowing down the Albert Nile is on the average about 10 per cent more than the flow at Fajao. Although the discharge at Fajao can be measured reasonably accurately, it is, unfortunately, impossible to measure the flow down the Albert Nile with the same degree of accuracy, because the banks of this river are deeply overgrown with papyrus. Considerable quantities of water no doubt flow through this fringing belt of swamp vegetation, but it must be nearly impossible to determine how much. In the circumstances, it would seem to be advisable to consider with some reserve the recorded rates of discharge down the Albert Nile.

The question of how much water in the Albert Nile is derived from the Victoria Nile and how much from Lake Albert has not previously received close attention. The Victoria Nile has usually been considered as a tributary flowing into Lake Albert, without regard to the fact that it enters the Lake so close to the outlet that, as shown above, most of its water passes straight into the Albert Nile. Whether the waters of the Victoria Nile flow directly into the Albert Nile or not may at first appear to be a point of academic interest. However, as it is difficult to estimate accurately the flow in the Albert Nile, any information that may help towards obtaining a more accurate estimate is worth considering.

Although it is not possible to say that all the Victoria Nile water flows directly into the Albert Nile it seems, from the evidence available, that more than 90 per cent of the discharge at Fajao does so. It thus appears that by using the known discharge at Fajao and the conductivity values recorded at Pakwach, an approximate estimate of the amount of water flowing down the Albert Nile could be obtained. This estimate may be at least as, if not more, accurate than the direct measurements made at Pakwach. At a later date it is hoped with the co-operation of the Uganda Hydrological Survey Department and the Egyptian Ministry of Public Works to go into this matter in greater detail.

Apart from the above considerations, records of the conductivity of the water at Pakwach could be of value for other reasons. It can be seen that over quite short periods of time values for conductivity may vary considerably; these fluctuations could be used to estimate the time taken for water to travel downstream, probably at least as far as Bor in the Sudan. J. F. Talling, of the University of Khartoum (*in litt.*), has noted that marked fluctuations occur in the conductivity and chemical composition of the water in the neighbourhood of Bor; he tentatively explained these fluctuations as due to changes in the contribution of water derived from Lake Albert.

In a memorandum[2] addressed to a Commission to consider the question of the salinity of Lake Albert and its bearing on irrigation, H. E. Hurst stated that the proposed regulation of Lake Albert by means of a barrage at Mutir, some miles below Pakwach, would not increase the salinity of the summer water supply to Egypt by an amount which could damage either the cultivation or the land. This may indeed be so, but Hurst assumes that under the new conditions all the water from the Victoria Nile will, as at present, find its way into the Albert Nile. However, the possibility exists that raising the level o Lake Albert may have a very significant effect o the fate of Victoria Nile water. At present this wate travels through more than a right angle in order t reach the outlet of the Lake; it seems that the flo of Lake Albert water across the mouth of the Victori Nile delta brings this about. This deflexion of th Victoria Nile water is no doubt further assisted b the way the delta has been formed.

If the level of Lake Albert is raised, the effect o existing channels in the delta will be largely abolishe and the velocity of the outflow from Lake Alber will be reduced. At present the depth of water acros the outlet is slight. At one point in the channel use by the lake steamer the maximum depth is onl three metres. Raising the Lake by only two metre would reduce the velocity of the outflowing curren very considerably; this current might then not b sufficient to deflect the Victoria Nile waters toward the outlet. The consequence of this would be t allow more Victoria Nile water to flow into Lak Albert. Thus, the outlet from Lake Albert might i the future come to consist mainly of typical Lak Albert water. The introduction of large amounts o Victoria Nile water into Lake Albert and the withdrawal of typical Lake Albert water might have very profound effect on the biology of the Lake b causing a reduction in its salt content and perhap bringing about a reduction in fertility. It is als possible that the new conditions might favour th development of thermal stratification and thus caus great changes in its biological economy. These idea are at the moment rather speculative, but it is hel that more hydrological data should be collected befo proceeding with plans to build a barrage at Mutir.

In the memorandum quoted above, Hurst state that the Semliki River has a salt concentration th same as that of Lake Albert. The data contained i Fig. 1 show that the salt concentration varies ver considerably and is only the same as that of Lak Albert occasionally. These fluctuations in the sa content of the waters of the Semliki merit furthe consideration. They are undoubtedly brought abo by varying amounts of water received from strea running off Mt. Ruwenzori. Unfortunately, there a not adequate data available on the electrical conductivity of these streams to permit an accura estimate to be made of the amount of water receive from these sources. Some samples of water ha been obtained from these rivers; they contain a lo concentration of dissolved salts and their electric conductivity is about 40 units. However, as only few streams have been sampled, no reliable avera value can be given; but if it is assumed that a average value of about 40 units is probable, it appea that at times more than half the water entering La Albert by way of the Semliki is derived from M Ruwenzori.

The Semliki is a large river and certainly influenc the flora and fauna of Lake Albert, both on accou of its chemical composition and its temperatur The chemical and physical condition of this water determined by the relative amounts of water receiv from Lake Edward and from Ruwenzori.

Lake Edward should be considered as contributi significant quantities of dissolved salts to La Albert, and at times plant nutrients which affect t fertility of this lake. The amount of these pla nutrients in the outflowing water at Ishango depen on the hydrological conditions obtaining in La Edward at the time. Lake Edward becomes thermal stratified for considerable periods; at such times plant nutrients in the surface waters are reduced to very low values. However, when thermal stratification is broken down and water from the deeper layers is brought to the surface, high concentrations of nutrient salts are found in this water. It has been shown[3] that in the waters of East Africa sulphates are frequently in short supply; they may therefore be used as a suitable and convenient chemical label or indicator of the potential fertility of the water. At those times when Lake Edward is thermally stratified, sulphates are reduced to one or two parts per million; but after 'turn over', values as high as one hundred and twenty parts per million have been recorded.

It is probable that significant amounts of certain plant nutrients, such as phosphates, are supplied to Lake Albert by the water derived from the Ruwenzoris, but there are few adequate observations on this.

There is little doubt that the water from the Ruwenzori streams is colder than the water from Lake Edward, and that at those times when the Semliki contains a high proportion of water from Ruwenzori, it will be at a lower temperature than when more of the water is derived from Lake Edward. Further observations need to be made, but it seems that the influx of this cooler water into Lake Albert may explain the periodic mortalities of Nile perch in this Lake. This water may be expected to flow into Lake Albert beneath the surface and, while flowing along the bottom of the Lake in contact with the warmer bottom deposits, may become deoxygenated. Fish swimming into this water are likely to be asphyxiated. This hypothesis is discussed in a paper by Fish[4] on the oxygen requirements of certain fish.

It is submitted that further hydrological data collected on the head-waters of the White Nile should include records of the electrical conductivity of the waters of the Semliki and the Albert Nile, as these observations are likely to add considerably to our understanding of the biology of Lake Albert and may also be of great importance with regard to projects aimed at making greater use of these waters for irrigation in the Sudan and Egypt.

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[1] Hurst, H. E., "The Nile Basin". First Supplement to vol. 2, 727

[2] Hurst, H. E., "The Effect of the Salinity of Lake Albert on Future Irrigation in Egypt". Unpublished report (1950).

[3] Beauchamp, R. S. A., *Nature*, **171**, 769 (1953).

[4] Fish, G. R., *J. Exp. Biol.*, **33**, 186 (1956).

OBITUARIES

Mr. L. Bainbridge-Bell

Labouchère Bainbridge-Bell, who died on August 7, interrupted his education at Emanuel College, Cambridge, in 1914 to join the Signals Branch of the Royal Engineers and won the Military Cross in the battle of the Somme. Later he served in Egypt as a wireless officer in the R.F.C. and R.A.F. After demobilization, he spent six years with the Radio Communication Co., and in 1927 joined the Radio Research Station, Slough. In 1935 he became one of the group of scientists working, under the direction of R. A. (now Sir Robert) Watson-Watt, on what is now known as radar. For his part in this development he received an award of £2,400 from the Royal Commission on Awards to Inventors, and it was characteristic of Bainbridge-Bell that he immediately gave the money to charity.

In the first week of the Second World War he was seconded to H.M. Signal School at Portsmouth and shortly afterwards flew to Montevideo, when the German battleship *Graf Spee* was scuttled in the River Plate; after many adventures, he was able to confirm that the enemy was using shipborne radar, and he returned to Britain with invaluable details of the equipment.

After the War, Bainbridge-Bell re-organized the arrangements at the Admiralty Signals Research Establishment for producing technical reports, establishing a system of centralized editing which not only relieved harassed laboratory workers of much paper work but also ensured uniformity of layout, presentation and illustration. He represented the Admiralty on the Glossaries and Symbols Panel of the Armed Services and was also a member of the British Standards Institution committees dealing with graphical symbols and with the glossary of terms used in telecommunications. It was mostly due to his efforts that the Services standard of graphical symbols and the British Standard were each modified so that they became identical, with the logical next step that the Services could cease a separate publication and use the British Standard. Bainbridge-Bell retired from the Royal Naval Scientific Service in August 1953, on reaching the age of sixty, joined the British Standards Institution and became secretary of the committees on which he had served as a member for many years.

Bainbridge-Bell was one of the few men who have combined science with classical scholarship and hence was most valuable on a committee dealing with the definitions of technical terms. At times, his ruthless exposure of false or incomplete reasoning, of lack of precision, or of attempted concealment of ignorance by verbosity, could be embarrassing. Yet he was essentially kind and had the respect and regard of numerous friends for his tremendous energy and enthusiasm.

J. Reading

Mr. J. W. Lester

John Withers Lester, whose death at the untimely age of forty-seven occurred on August 9, was born in Walsall, Staffs, in 1908 and was educated at Wrekin College where, besides taking a prominent part in Rugby football and boxing, he devoted much of his spare time to natural history, either in the field or in reading books on the subject. In fact, from a very early age he displayed an interest in animals, particularly reptiles and amphibians, and even when only five had acquired a sure skill in catching them. This strong interest his parents wisely encouraged, and when during his later school-days the family moved to Cornwall, Jack, as he was known to all, continued his field excursions, becoming in particular very skilled in the hunting of badgers. His early career was with the Bank of British West Africa, and during his six years in Sierra Leone he devoted much of his spare time and energy to collecting animals of all kinds. He sent home many interesting specimens to several zoos, especially that at Primley, Devon, owned by the late Herbert Whitley, and when he resigned from the Bank on his marriage in 1936, he became actively associated with the Primley Zoo, being responsible for the building up of the reptile and tropical house there.

During the Second World War, Lester was an officer in the R.A.F., and then in 1946 he was appointed curator of reptiles at the London Zoological Gardens, where it soon became evident that he was the right man for the job. During the next few years he made several trips to West and East Africa on behalf of the Zoological Society, collecting and bringing back many specimens of mammals, birds and insects, as well as reptiles and amphibians, of interest and rarity. In 1954 he led an expedition to Sierra Leone in conjunction with the B.B.C. Television Service, the outcome of which was the greatly appreciated television series "Zoo Quest", and last year he led a second such expedition to British Guiana.

In January last he was awarded the Zoological Society's Silver Medal. He was a founder-member of the British Herpetological Society.

Throughout his years at the Reptile House of the London Zoo, Lester was unstinting of the time he gave to advising visitors on the care of reptiles, as well as to giving evening lectures to schools and many small societies, and he was always keen to encourage the growth of natural history interests in the young. He made many broadcasts and television appearances. A man of charming, yet unassuming personality, always so willing to share his love of natural history and to help others to that end, his death is a sad loss to his many friends, both at home and overseas as well as to the Zoological Society.

L. C. Bushby

NEWS and VIEWS

Astronomical Society of South Africa: Gill Medal

The Astronomical Society of South Africa announces the first award of the newly established Gill Medal to Dr. Harold Knox-Shaw, "For outstanding services to Astronomy and in particular to South African Astronomy in the successful establishment of the 74-inch Radcliffe Reflector at Pretoria". The Gill Medal commemorates the work of Sir David Gill, one of the most distinguished scientists to work in Southern Africa. Gill was H.M. Astronomer at the Cape during 1879–1907, and is celebrated for his numerous contributions to astronomy, notably his determination of the solar parallax, his leading part in the introduction of photography into astronomy, and his design of the Cape Transit Circle, a model for many later instruments. The Medal, which is in silver, of a diameter of two inches, bears on the obverse a portrait of Gill in low relief, and on the reverse, a representation of Gill's favourite instrument, the 7-in. heliometer. On the same face is the inscription—"Awarded for services to astronomy". The Gill Medal is probably unique among honorary awards by scientific societies in that it was designed by a president of the Society during his year of office, for Dr. Peter Kirchhoff of Johannesburg, the well-known sculptor, is also a keen amateur astronomer, and executed the design during his presidential year. The medal is to be awarded not more than once in any year for services to astronomy, preference being given to services to astronomy in Southern Africa.

Dr. H. Knox-Shaw

Dr. Knox-Shaw was educated at Wellington and Trinity College, Cambridge. He began his astronomical career in 1908 as an assistant at the Helwan Observatory in Egypt. He took charge of the newly installed 30-in. Reynolds reflector and used it to photograph southern nebulæ as far as south declination 40°. In addition to purely astronomical work, his duties covered the usual scope of a government observatory—time service, gravity survey, geodesy, meteorology and the like. In 1913 Knox-Shaw was made director of the Helwan Observatory, and in 1918 also of the Meteorological Service of Egypt and the Sudan. In 1924 he returned to England to become Radcliffe Observer at Oxford. Two pieces of research in this period are especially noteworthy: the determination of the proper motions of more than 30,000 faint stars in the northern selected areas, and the reduction (in collaboration with Dr. J. Jackson) of the meridian observations of Thomas Hornsby, the first Radcliffe Observer, made between 1774 and 1798. The latter part of Knox-Shaw's term of office as Radcliffe Observer was concerned with the transfer of the Observatory to Pretoria, Union of South Africa, and the erection there of the 74-in. reflecting telescope. This change was successfully carried out in face of a long series of obstacles and delays. Knox-Shaw was president of the Astronomical Society of South Africa during 1941–42, and of the Royal Astronomical Society during 1931–33.

Scientific and Technological Man-power in the United States and the U.S.S.R.

Estimates issued by the National Science Foundation, Washington, D.C., on August 3 give the number of graduates in scientific fields in the United States in 1955 as 59,000, or about 20 per cent of those obtaining first degrees, compared with 126,000 in the

U.S.S.R., or 49 per cent of the total graduates; 22,600 of the former and 59,000 of the latter were in engineering, 2,000 of those in the U.S.S.R. being agricultural engineers. The total number of living graduates with first-level degrees, or their equivalent, in the United States is given as 1,536,000, of whom 575,000 are engineers, and 1,158,000 (555,000 engineers) in the U.S.S.R. In the United States there were, in 1955, 114,600 living Ph.D.s, including 61,800 in science and engineering, and 1,360,000 teachers, of whom 181,000 were working in higher educational establishments, and 130,000–140,000 were teaching science and mathematics in high school. The U.S.S.R. had 80,000–85,000 living persons of Ph.D. level and 9,000–9,500 with advanced doctor's degrees, of whom 60,000–68,000 and 6,000–7,000, respectively, were in science, and 1,900,000 teachers at all levels (120,000 in higher educational establishments and 350,000 science teachers in secondary schools). In the United States 2,721,000 students were enrolled in institutions of higher education and 287,000 first degrees were conferred, of which 9,050 were in biological science, 10,516 in physical science, 7,170 in agriculture and 22,589 in engineering. In the U.S.S.R., 1,865,000 students were enrolled at higher educational establishments, and 265,000 graduated at a level equivalent to a first degree in the United States. Of live holders of first degrees, 566,000 were in engineering and 205,000 in agriculture, 240,000 were science teachers and 87,000 were university graduates in science. Dr. A. J. Waterman, commenting on the danger of making comparisons, except in very broad terms, points out that while in the United States graduates in science may not necessarily be employed in the field in which they were trained, in the Soviet Union they are likely to be so employed.

Employment of Coloured Workers in the Birmingham Area

The report of an inquiry initiated by the Birmingham Christian Social Council and undertaken by the Race Relations Group of Fircroft College, Birmingham, into the employment of coloured workers in the Birmingham area, has been published by the Institute of Personnel Management as Occasional Paper No. 10 (pp. 30; 1956; 3*s*. 6*d*.). The inquiry was conducted between May 1954 and July 1955, thirty-five places of employment, covering ninety thousand employees and 2,150 coloured workers, being visited. The report, which is written by Leslie Stephens, deals with the background of coloured workers in Britain, including the reasons which bring them here, and whether they are likely to stay, and discusses national differences between West Indians, West Africans and Pakistanis. There are chapters on employment policies, the attitudes of trade unions and British workers, and on the attitudes of coloured workers themselves. Its concluding chapter, which stresses the need for a good deal more information on the actual experiences of coloured workers at work and in trade unions, suggests that the conditions revealed by the inquiry do not give grounds for very grave concern and contain many hopeful elements, although there is undoubtedly some discrimination in the relations of employers and workers to coloured people. Concrete recommendations include the preparation of something in the nature of a Code of Fair Employment for coloured workers or for immigrants in general. More advice should be available to potential employers of coloured workers, and every effort should be made, particularly in the countries of origin, to press on coloured workers their own responsibilities. In every town with appreciable numbers of coloured workers there should be an officer like the liaison officer in the Town Clerk's Department in the City of Birmingham, and an advisory committee with a special concern for the welfare of coloured workers; to increase the effectiveness and raise the level of work of local authorities and voluntary bodies, the Home Office or Colonial Office should be given an overall responsibility for the welfare of coloured people and other immigrants in Great Britain.

Nok Culture of West Africa

The July issue of *Man* contains a striking illustration of a life-size terra-cotta head in the now familiar Nok style. Bernard Fagg, curator of the museum at Jos, describes the find, which was made in the course of tin mining at Nok itself in southern Zaria Province, Northern Nigeria. The Nok culture is now known to stretch approximately three hundred miles across the Benue-Niger valley from Katsina Ala in Benue Province to Kagara in Niger Province. These artists have made heads that are more beautiful, but few that are as striking as the one here discussed. It must have needed great skill to fire such a large piece with the primitive means at their disposal. The thickness (just under ½ in.) is uniform, and on the top of the head are five bosses probably representing coiled hair. Four of them are pierced, perhaps for the insertion of feathers. Bernard Fagg suggests a date in the first millennium B.C.; but until definite proof from carbon-14 dating comes to hand, there seems little reason why a considerably more recent date might not be postulated.

Underground Storage of Grain

Primitive methods of the storage of grain in underground pits have been practised in the Middle East for many centuries; but not until 1942, when an experimental underground store was built in the Argentine, was any attempt made to develop the idea along scientific lines. These first trials proved highly successful, and, in spite of the hot and moderately damp climate in which they were carried out, wheat and maize remained in excellent condition for up to seven years. The method has been adopted on quite a large scale in several South American countries, the Argentine now having storage for some two million tons of grain. The possible value of similar systems in British Colonial territories has been under investigation during the past three years, and the results of the inquiry are published in a Colonial Office pamphlet, "Underground Storage of Grain" (Colonial Research Studies No. 21. Pp. 27. London: H.M.S.O., 1956; 2*s*. 6*d*. net). Considerable success has been achieved, and it is hoped to construct pit storage for 11,000 tons in Tanganyika and for 10,000 tons in Cyprus in 1956. The efficiency of underground storage systems depends on the fact that virtually air-tight conditions are achieved. Oxygen is sufficiently depleted, and enough carbon dioxide is produced to inhibit further insect development, and often to kill any insects that may be present. No heating of the grain occurs, and external changes of temperature are unimportant owing to the structure of the pit and the large bulk of grain stored. The method has proved cheap and efficient provided the grain is dry (less than 13 per cent moisture), and can now be recommended for the storage of both maize and wheat.

Systematics of the Notostraca

THE Notostraca constitute an order of the Euphyllopod Crustacea that is interesting not only because they are examples of primitive Crustacea but also because of their adaptation to life in temporary pools and practically world-wide distribution, and in "A Review of the Notostraca" (*Bull. Brit. Mus.* (*Nat. Hist.*), 3, No. 1; 1955. Pp. 57; 12*s.* 6*d.*) Alan R. Longhurst has carried out a detailed revision. Careful study of a large amount of material from different countries and museums and from populations reared in the laboratory has shown that a number of the characters that have been used for the erection of species are, in fact, due to differences of age, sex and the number of body segments and appendages as well as the variations that occur naturally in large populations. Only two genera, *Triops* (Apus) and *Lepidurus*, are included in the family and order. Before this revision sixty-nine species and twelve varieties had been included in the order; but Longhurst has reduced that number to nine species and twelve varieties (not the same twelve as previously). The systematic part at the end includes a very clear and straightforward key for the identification of the species of the two genera, and in dealing with each species an indication of the range of variation is given and, where required, the differentiating characters of the varieties. For completeness, this section might have included the name of the family and its definition and definitions of the genera; for example, under *Triops* the only character given is that it is "separable from *Lepidurus* by its lack of a supra-anal plate".

Measurement of High Temperatures by Thermocouples of Noble Metals

THE accurate measurement of high temperatures is a matter of prime importance in many branches of science and technology, and, in particular, the greater control made possible by the use of thermocouples of noble metals has contributed materially to the successful development of improved methods in metallurgical industry and research. An interesting, illustrated survey of methods of high-temperature measurement and of the development of the thermocouple in this connexion is given in a new booklet, entitled "Noble Metal Thermocouples", by H. E. Bennett, which has been issued by Johnson, Matthey and Co., Ltd., of London (pp. 36; 1956). Three topics are dealt with separately: applications of the platinum metal thermocouple, with particular reference to its use in the steel industry; the properties of the platinum-group metals and their alloys; and the principal causes of deterioration of thermocouples under the headings of strain, prolonged heating at high temperatures, and contamination. Various physical properties of the platinum-group metals are listed, together with calibration curves for different kinds of platinum alloys/platinum thermocouples. Information is included of results of experiments conducted by the author, and there are many references to work of other investigators. A bibliography of forty-nine references is appended.

British Standards Institution: Annual General Meeting

AT the annual general meeting of the British Standards Institution on September 4, it was decided to combine the two formerly separate offices of president and of chairman of the General Council. Sir Herbert Manzoni (City Engineer of Birmingham), who is already chairman of Council, was elected the first president under this new arrangement. He succeeds Sir Roger Duncalfe, chairman of British Glues and Chemicals Ltd., who has served the Institution in many offices for the past twenty years. Mr. John Ryan (vice-chairman of the Metal Box Co., Ltd.) was re-elected vice-president. The following were elected, as representatives of the Institution's divisional councils, to serve on the General Council: *Building Division:* Mr. H. A. Pursey (Turners Asbestos Cement Co., Ltd.); Mr. J. C. Tait (Department of Health for Scotland); and Lieut.-Col. E. Vigor (Neuchatel Asphalte Co., Ltd.); *Chemical Division:* Mr. G. J. Cutbush (Metropolitan Leather Co., Ltd.); Mr. G. Dring (Bakelite, Ltd.); and Sir Knowles Edge (W. Edge and Sons, Ltd.); *Engineering Division:* Mr. P. L. Jones (Swan Hunter and Wigham Richardson, Ltd.); Mr. G. L. Newman (Metropolitan-Vickers Electrical Co., Ltd.); and Mr. B. E. A. Vigers (Laporte Industries, Ltd.); *Textile Division:* Mr. H. N. Aitken (British Celanese, Ltd.); Mr. L. F. Cockroft (John Cockroft and Sons, Ltd.); Mr. P. W. Gaddum (H. T. Gaddum and Co., Ltd.); and Mr. E. R. West (Jute Industries, Ltd.).

National Smoke Abatement Society

THE annual conference of the National Smoke Abatement Society will be held in Southport during October 3–5. The programme will include an address by Mr. Enoch Powell, Parliamentary Secretary to the Minister of Housing and Local Government, on the new Clean Air Act, and a session devoted to the Act from the point of view of local authorities. Other subjects to be discussed are the health aspects of the problem, pollution from road vehicles and problems of increasing the supply of solid smokeless fuels for use in smokeless zones and the new smoke control areas. The Des Voeux Memorial Lecture this year will be given by Sir Hugh Beaver, who will speak on "Clean Air: the Next Step". A resolution authorizing a special general meeting in the near future for the purpose of revising the Society's constitution and changing its name to the "National Clean Air Society" is to be considered. Further information can be obtained from the Society at Palace Chambers, Bridge Street, London, S.W.1.

British Institution of Radio Engineers: Awards

THE British Institution of Radio Engineers has recently awarded the following premiums for papers published in its *Journal* during 1955: *Clerk Maxwell Premium* (the senior premium for the most outstanding paper in the *Journal*), to E. M. Bradley and Dr. D. H. Pringle (the theory and design of gas-discharge microwave attenuators); *Heinrich Hertz Premium*, to Dr. R. Filipowsky (electrical pulse communication systems); *Louis Sterling Premium*, to D. R. Coleman, D. Allanson and B. A. Horlock (the development and design of an underwater television camera); *Marconi Premium*, to Dr. Sin-Pih Fan (the magnetron beam-switching tube: its operation and circuit design criteria); and *Leslie McMichael Premium*, to D. J. Fewings and S. L. Fife (a survey of tuner designs for multi-channel television reception).

Courtaulds' Scientific and Educational Trust Fund: Postgraduate Research Scholarships for 1956

THE Courtaulds' Scientific and Educational Trust Fund has recently announced the award of postgraduate research scholarships for 1956. Scholarships in a branch of science related to the textile, plastics and allied industries (maximum of £400 for one year only, but renewable for further periods) have been awarded to the following: E. W. Abel, Northern Polytechnic, London; Miss P. A. Carr, Imperial College of Science and Technology, London; G. Holden, University of Manchester (renewal); W. A. Keith, The Queen's University, Belfast; and M. T. Pope, University of Oxford (renewal). Postgraduate research scholarships in textile technology, tenable for two years (£320 the first year and £360 the second), have been awarded to the following: B. Chalkley, J. D. Johnson, W. G. Kaye (renewal), A. P. Lockett, D. W. Martin, Miss A. J. Soper, P. E. Williams and E. R. Wyke. The holders of these scholarships have all chosen to do their research at the University of Leeds, except Mr. Lockett, who will work at the Manchester College of Technology.

Oversea Service Division, Colonial Office

THE following appointments have recently been made in the Oversea Service Division, Colonial Office: J. C. Collins (chief tobacco adviser, Northern Rhodesia), senior agricultural officer (tobacco), Uganda; H. A. L. Francis (assistant agricultural superintendent, Dominica), agricultural superintendent, Dominica; J. S. Gunn (agricultural officer, Tanganyika), senior agronomist, West African Institute for Oil Palm Research; R. R. Mason (agricultural officer, Fiji), senior agricultural officer, British Solomon Islands Protectorate; W. V. Rose (deputy director of agriculture, Barbados), assistant director of agriculture, Western Region, Nigeria; Song Thian Siang (senior agricultural assistant, Sarawak), sub-assistant agricultural officer, Sarawak; E. R. Watts (rural education officer, Western Region, Nigeria), agricultural officer, Western Region, Nigeria; A. J. Radford (government chemist, Mauritius), geochemist, Geological Survey Department, Tanganyika; C. W. C. Turner (vice-principal) and J. R. Scobie (lecturer in mathematics), to be principal and vice-principal respectively of the Yaba Technical Institute, Federation of Nigeria; R. J. Dewar (assistant conservator of forests, Nyasaland), deputy conservator of forests, Nyasaland; J. S. Smith (conservator of forests, grade A, Federation of Malaya), deputy director of forestry, Federation of Malaya; R. C. Pargeter (senior geologist, Geological Survey Department, Uganda), senior geologist, Geological Survey Department, Federation of Nigeria; Dr. T. Wilson (senior medical research officer, Federation of Malaya), director of the Institute for Medical Research, Federation of Malaya; R. Mather (meteorological officer, Malayan Meteorological Service, Singapore), assistant director, Malayan Meteorological Service, Singapore; J. B. D. Robinson (scientific officer, Kenya), senior scientific officer, Kenya; J. D. Bald (assistant surveyor, Forest Department, Kenya), staff surveyor, Forest Department, Kenya; B. N. Bowden, specialist officer (ecologist), Northern Region, Nigeria; L. H. Collett, soil conservation officer, Barbados; R. I. Green, agricultural officer (soil conservation), Nyasaland; J. F. Harrop, soil survey officer, Uganda; T. G. Stephen, agricultural officer, Gold Coast; P. Blasdale, entomologist, Tsetse Control, Northern Region, Nigeria; C. A. R. Savory, biologist (game officer), Northern Rhodesia; D. Adair, chemist, Leeward Islands; W. R. Day, forest pathologist, Cyprus; F. Endean and K. A. Jenkins, assistant conservators of forests, Northern Rhodesia; J. F. Harris, geologist (mining), Geological Survey Department, Tanganyika; W. A. Fairburn and D. J. Jennings, geologists, Kenya; S. L. Edwards, statistician, East Africa High Commission; J. G. Hare, veterinary officer, Kenya.

Announcements

AT the annual general meeting of the Manchester Literary and Philosophical Society the following officers were elected: *President*, Dr. F. C. Toy; *Vice-Presidents*, Miss A. C. Alexander, Sir Geoffrey Jefferson, Prof. J. Kenner, Dr. Norman Smith; *Hon. Secretaries*, Dr. L. Cohen and F. Willett; *Hon. Treasurer*, H. Hayhurst; *Hon. Librarians*, Dr. W. H. Brindley and P. G. Lucas; *Hon. Curator*, N. G. C. Pearson.

A SYMPOSIUM on the "Direction of Research Establishments" is to be held at the National Physical Laboratory, Teddington, during September 26–29. Among the speakers will be the directors of research establishments in Holland, Western Germany, Canada and the United States as well as Great Britain. Papers and summaries of the discussions are to be published as soon as possible by H.M. Stationery Office. Further particulars about the symposium can be obtained from the Secretary, Department of Scientific and Industrial Research, Charles House, 5–11 Regent Street, London, S.W.1.

WITH the current year, the *Bibliography of Scientific Publications of South and South-East Asia* is being issued as a priced publication, the annual subscription for four quarterly numbers, of which that for April 1956 is No. 1 of Vol. 2, being Rs. 10. The 1955 volume is also being issued as a single number at the same price. An author index is included with each quarterly part.

THE National Institute of Technology, Rio de Janeiro, has published the first part of a "Bibliografia Brasileira de Química Tecnológica" (1, No. 1; 1954; pp. 153), which has recently been received. It contains references to, and short abstracts of, publications on various branches of chemical technology which have appeared in Brazil during the years 1922–53. These are classified under subjects according to the universal decimal system adopted by the British Standards Institution.

THE Chilean Iodine Educational Bureau (Stone House, Bishopsgate, London, E.C.2) has published a book, "Geochemistry of Iodine" (pp. 150; n.p.), which contains an annotated bibliography from 1825 to 1954 and covers publications on the occurrence of iodine in rocks, minerals and soils, as well as flue dusts, meteorites, iron and steel. The occurrence of iodine in waters and the atmosphere is to be dealt with in a later publication. The book is well arranged and is strongly bound in cloth.

SOLUS-SCHALL, LTD., a firm engaged in the whole field of non-destructive testing, has recently started a "Newsletter" in which brief information is given of new equipment available, new techniques and recent results obtained. Issues will be dispatched free at intervals to all interested. The first number (January 1956) contains brief discussions of the non-destructive testing of welds and of the appropriate spheres of use of X-rays and gamma-rays in industrial radiography. There are numerous half-tone illustrations of apparatus, including an ultrasonic flaw-locating rule, a portable radiation meter suitable for radiation monitoring and as a liquid level gauge, and arrangements for fluorescent X-ray analysis and flash radiography.

APPLIED RESEARCH AND DEVELOPMENT WITHIN THE INDUSTRIAL GROUP OF THE U.K. ATOMIC ENERGY AUTHORITY

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WE have previously described[1] the general organization developed for the control of applied research and development within the Industrial Group of the United Kingdom Atomic Energy Authority to provide a development effort for all sanctioned construction projects. The system of organization developed must be integrated with a type of executive management which gives the means of firm direction and control while preserving scientific integrity.

In general terms, the main executive responsibility lies in instituting a type of management which enables a strategic plan of research to be tactically discharged with the necessary standard of scientific and technical excellence. The preparation of appropriate financial and staff estimates, and the maintenance of all records necessary to the forward planning of experimental effort and the periodic reviewing of progress, are essential features.

Allocation of Priorities

The work of the experimental establishments serves both the Engineering and Operations Branches[1]. Broadly, where subject priorities are concerned, it is agreed that existing processes must be kept working before all else; secondly, sanctioned projects must be introduced on time, and thirdly, modifications and refinements recognized as advisable should be added to existing projects as facilities permit. A system of priority classification has been designed to take account of both the subject priority and the latest date before action must be taken by either the Engineering or Operations Branch. Some target dates are irrevocable and must be met; others, if necessary, can be revised as a result of due consideration. Based on an analysis of this sort a decreasing scale of priority can be worked out which introduces the time available for experimental work. Where the importance of the subject justifies it, work required within six months merits the highest priority, for which staff will be made available over all other types of work. The time available for second priority work is arbitrarily fixed, and for third priority work no completion date need be stated.

Some general principle must be accepted for assessing priorities, and those set out above are suitable for some circumstances. The principles must be in conformity with the financial and administrative arrangements, and if this is the case, although they may be arrived at arbitrarily, they can safely be adhered to as a working arrangement. It is useless, however, to have a system of assessing priorities and then to ignore the conclusions reached.

Allocation of Costs

The assessment of priorities provides a convenient method of division into categories so that the costs can be properly allocated.

The cost of development work carried out on behalf of the Operations Branch for the removal of difficulties in, or improvement of, existing processes is borne by the works and recovered as a charge on the finished products. Such investigations, always of a high priority, are undertaken only at the request of, or by agreement with, the works general managers but are never delayed by excessive formality.

The major amount of research and development effort is allocated to work in support of current sanctioned design commitments, and, for such, the charges are borne by the chief engineer of the project. These charges are recovered by an addition to capital charges which are amortized over a period of years. In this category the nature of the problems and the necessary experimental work are discussed thoroughly by the chief engineer, head of the experimental establishment and chief scientist[1], following which an estimate of the cost is returned to the chief engineer without delay so that he can assess whether the cost is in proportion to his need. If he feels that the expenditure is too great and that some engineering solution is both possible and preferable, the nature of the problem will be reconsidered against the general background of reactor development and, if the work is undertaken, it will be as a research and development charge. All long-term research and all work for feasibility and design studies of projects not yet sanctioned are Research and Development Branch[1] charges. Work of this type is carried out by the Research and Development Branch without prior discussion with other branches.

Work Requisition and Initiation Procedure

The implementation of the priority and cost allocation procedure leads to a system of work requisition and initiation designed to ensure that only work is undertaken which is expected to influence the course of development and to prevent the application of effort in directions which, although interesting, would be less profitable. A standard requisition form is the medium by which requests for work are passed from headquarters to the laboratories, or from the laboratories to each other or to headquarters, and copies are sent to any other interested parties. This outlines generally the nature of the problem and gives a brief description of the background to the investigation.

On receipt of the requisition the establishment responsible for meeting the requirements decides the reporting dates, and issues an instruction sheet to appropriate sections. There are cases where reporting dates must be imposed in the requisition to fit in to a programme approved by the Research Board, or to conform to some key design date. In such cases the reason for this is stated in the "Background to the Investigation". If the requisitioned laboratory, in view of its existing commitments, is unable to meet these dates, advice on relative priorities may be obtained from the functional chief scientists, or reference may be made to the Research Board[1].

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Obviously, any system for requisitioning work or for the initiation of new items of work must not interpose delays. This is avoided by an adequate delegation of authority. The head of each experimental establishment is responsible for the use of his staff. He can start work himself, to a cost of £500–£1,000, without reference to anyone. If larger sums are involved, by discussion with other heads of experimental establishments, chief scientists or the director, work can again be initiated without any formality. Afterwards, instruction sheets, requisitions and cost returns will be prepared. Periodic reviews of progress may also be made to see if the original instructions need amendment.

Planning of Experimental Effort

Accurate planning of scientific and experimental effort ultimately depends on accurate records of effort spent on previous comparable work.

The effort available from each person in a particular period is reckoned as the number of normal working days less an average figure computed from his annual leave allowance and other absences. The number of investigations which can be efficiently worked on decreases as the status of the staff decreases. Excessive diversification is undesirable, and when it occurs the research manager, in consultation with the section leader, decides how many days will be devoted to each job. If the estimates of time allocation are realistic, over-planning indicates that overtime should be temporarily worked, and that for the long term, additional staff or reduction in the number of commitments should be recommended. Conversely, under-planning implies that additional commitments can be accepted or staff can be available for transfer.

The main experimental work must be supported by services from chemical analysis, X-ray crystallography, metallography, etc. The indirect effort involved is more difficult to estimate. When adequate records are available, these will indicate the amount of indirect effort appropriate to the type of investigation involved. To integrate this with the main effort so that the latter is not delayed may present such difficulty that the best solution may be to make an arbitrary allocation of service effort to any particular section, leaving it as the section leader's responsibility to utilize this allocation to meet his priorities.

Staff can only be provided without delay if there is spare capacity, which is rarely the case. Normally all staff are fully occupied and examination is made of the priorities of work in hand to see which jobs can best yield staff to the proposed new one, if this is of higher priority. When this fails, target dates for all work show the earliest date on which staff will be available. New recruitment is regarded as an aspect of long-term planning and seldom enters into decisions related to work to be undertaken in the immediate future. It may be necessary to refer the matter to the Research Board to resolve competing priorities or to agree on alternative measures for obtaining experimental capacity.

Costing of Experimental Work

In the compilation of an instruction sheet, the estimated amount of experimental effort is stated in terms of the grades of staff to be used. Scientific and experimental staff fall into the three categories of senior, main, and assistant grades. Taking an average figure for the salaries of the staff, and a factor computed by the accounts branch from all other normal expenses, the cost of any investigation can be calculated from the instruction sheet. If a second instruction sheet arises from the first, the cost of the second would be an abnormal charge on the first. Similarly, abnormal usage of any particularly expensive item (for example, a rare metal) necessary to some job is clearly indicated on the instruction sheet, so that a particularly heavy charge is carried by the specific job.

The estimates of the scientific effort required for a particular job are compared with the actual returns of effort spent. The basic information is obtained from the sections by weekly returns of the effort of staff against the various jobs. These returns are forwarded to the Accounts Branch and are the basis of the cost figures produced by them relevant to each job on the programme. These cost figures are tabled at each meeting of the Research Board and explanations made of significant deviation from the estimates. The cost of any job is thus currently known at every stage so that its economic value to the project can be kept under constant review.

Management

The management structure of each research and development establishment is similar and is based on definite responsibilities. The success with which an establishment is managed is clearly the responsibility of its head, who is the administrative authority responsible for ensuring that the work conforms to the policy and commitments of the Branch. The management proper of the scientific work falls to research managers, the number of whom varies with the size of laboratory. Generally, each will be responsible for the work of a group of between thirty and forty scientific and experimental workers. The distribution of scientific, engineering and experimental strength varies, depending on the type of work. Where the work has a highly scientific character, the ratio of experimental to scientific workers will approach 1. Where the work is highly repetitive, the ratio may exceed 5 To preserve a career prospect within the scientific class, it is recognized that any number settled as a complement may ultimately reach 50 per cent of the highest grade below that of research manager. To ensure that the earliest possible recognition is given to merit, staff reviews are held twice yearly to a common standard throughout the Authority, at which all eligible staff are considered. The principle of recognizing ability and giving responsibility leads to the early promotion of suitable staff.

The head of the establishment retains the responsibility of ensuring that the method of approach to any problem is selected on valid scientific grounds to yield the information required. It is the research manager's responsibility to see that a high scientific standard is maintained in the laboratories. The head of the establishment, through the planning and progress officer, ensures that the necessary reviews are forthcoming to plan, and that they conform to the required standard.

On receipt of an instruction sheet the section leader must plan his work. The first requirement is to isolate the problem requiring attention, so as to avoid unnecessary investigation. Having first done this and then consulted the literature, he must plan the experimental attack. It is particularly important that he compile an equipment schedule indicating the dates when he requires instruments. All instruments are entered on an equipment register which at any moment indicates the job number on which an instrument is being used and the section where it is located. Any instrument not on a job number must be returned to the equipment store. Only by a procedure of this sort can the best use of instruments be assured within any one of the establishments or throughout the whole branch. For the latter purpose a Branch Equipment Register is held of all plant and equipment in the five Laboratories.

Reporting of Work

All work must be reported in one of the Branch's three recognized documents. The overall general structure and form of reports is agreed at the Research Board and is standardized for the Branch.

A 'technical memorandum' quotes factually the results of experiment and gives no opinions or recommendations. No special vetting procedure is necessary to ensure conformity to policy; but each memorandum must be addressed for the attention of an individual or body whose query prompted the exercise, or who can take any consequent executive action.

A 'technical note' gives the results of an investigation required to settle some point of policy or design. Conclusions are reached and recommendations made to guide further policy or design decisions. All technical notes are addressed for the attention of one of the Authority's recognized committees, or working parties. Technical notes likely to influence the policy of the Branch, either in respect of the prosecution of work within it or of the attitude which it will adopt to some proposal arising from other groups or branches, are addressed for the attention of the Research Board. Because of the influence that any technical note can have on policy or design involving the expenditure of large funds, it is the head of the Establishment's responsibility to ensure that the note has been properly vetted.

A full 'report' has all the requirements of a technical note with the addition that it deals with a completed block of work. It should be of the standard of a paper to a learned society.

The experimental worker is of course responsible for reporting on his own work, but his draft is subject to scrutiny particularly in regard to its general form. The section leader ensures that all experimental facts and observations have been used in the compilation, and the research manager makes any necessary comment as a result of his wider knowledge and experience. Full reports and technical notes before issue are finally approved by the head of the Establishment, who must be responsible ultimately for the quality of work from his own laboratory.

Distribution of all papers is subject to a number of provisions, depending on the status of the document in regard to its classification. The minimum standard distribution is agreed by the Research Board for each type of document, and additional distribution requires special authorization, depending on the category.

Conclusions

Particularly with applied research, the best work is based on the maximum of meticulous observation with scientific analysis of the results. Observations are amenable to timing and therefore to planning. The inspiration so necessary to the forward development comes to those suitably endowed, with or without a declared plan.

Scientific staff may fail to understand the need for, and therefore resent, the passage of paper and forms between one office and another. This is almost invariably a sign of bad management. The forms are not used as a discipline of the scientific staff but as a means of passing necessary information between the various sections which are concerned. Applied research is almost always a team endeavour involving many different skills, and it is a convenience to introduce a measure of formality into the administration, provided it is under broad-minded control. The formal organization of the scheme must not involve the scientific staff in more than a minimum of administrative work, and they should recognize it as reasonable. They must be allowed to make the proper use of their intellectual abilities without the need to digress every few days to consider administration. In each establishment a technical planning officer and administration officer with clerical assistance are quite sufficient to administer a scheme such as has been outlined.

It must be clear that in giving this outline of some of the methods used, we have not attempted to give a full picture. Only an indication has been given of the administrative and financial framework within which the scientific work can be carried out. It is pointless to construct such a framework and then not to use it; but its use must be, on every occasion, conditioned by the thought that the ultimate criterion of success of a research and development department is in the scientific and technical quality of the work done. The scientific staff must feel that the framework is provided to assist them in their work and not to divert them by form filling, committee attendances and so on.

During the period in which the development of the system of organization and management has taken place, opportunity has arisen to observe the reaction of the scientific staff. In general, scientific staff with experience of the system favour the control which it imposes, although about 1 per cent of recruits are unable or unwilling to work when so controlled. The main requirement is that in any establishment the system of organization must be devised by scientists and be acceptable to them.

In the development of this type of organization, responsibility has been given to all members of staff capable of accepting it. This has bred a responsible approach at a remarkably early age.

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[1] *Nature*, 178, 524 (1956).

SOCIETY FOR APPLIED BACTERIOLOGY

SUMMER CONFERENCE

MILK and cheese were the main, but not exclusive, topics discussed at the summer conference of the Society for Applied Bacteriology held in Reading during July 16–18. Several of the papers contributed were by members from the University of Reading and from the National Institute for Research in Dairying, Shinfield.

One of the first papers dealing with milk was by D. J. Williams, J. G. Franklin, Miss H. R. Chapman and L. F. L. Clegg (Shinfield), who described a method for assessing the sporicidal efficiency of ultra-high-temperature sterilization. Membrane filters are used for detecting trace contaminations in the large volumes of milk employed. By adjusting the inoculum of bacterial spores appropriately, this technique allows killing-rates of more than 99·99 per cent to be assessed.

Consideration was given by D. G. Griffiths, R. G. Druce and S. B. Thomas (Aberystwyth) to the present microbiological standards and tolerances for raw milks, some of which, they suggested, should be tightened in view of the continuous improvements taking place in the methods of handling, storing and sampling milks on the farm. They thought that the present methods of testing should be retained, but that satisfactory milks should not have a total count exceeding 20,000 organisms per ml. and the V.R.B. coli-aerogenes content should be less than 10 per ml. J. G. Murray (Belfast) compared the coli-aerogenes test at 30° C. with that at 37°, using raw and pasteurized milks, and obtained no false presumptive results in three thousand samples examined. Of the pasteurized samples examined, 33 per cent were positive at 37°, and 67 per cent were positive at 30° but negative at 37°; of the raw milks, the comparative values were 76 per cent and 24 per cent. Bottles and dairy equipment gave similar results, but not dried milks.

Prof. E. L. Crossley and Miss M. Campling (Reading) described their investigations into the survival of *Staphylococcus aureus* in the production of spray-dried milk, in which they demonstrated undoubted proliferation during bulk storage, but a tendency for a decline in numbers during the evaporation stage. The survival-rates of four strains on spray-drying ranged between 0·25 and 3·5 per cent; such values are inexplicably lower than those reported earlier. It was thought that organisms picked up after the evaporation stage were likely to cause most trouble because of their capacity for selective growth.

Turning to the bacteriology of cheese, Miss M. E. Sharpe and Miss J. Naylor (Shinfield) commented on the desirability of adding bacteria to maintain particular flavours, and emphasized the importance of the starter in this respect. They examined the survival of lactic bacteria in Cheddar cheeses over periods up to six months and found that the streptococcal types declined in number but the lactobacilli grew slightly. Of the three media used for isolating the various types, acetate agar was best for the lactobacilli. In a similar vein, and on the assumption that farm-house cheeses have a better flavour than factory-made cheeses because they are made under less rigorously controlled conditions and with less pure cultures, Miss N. J. Hall (Reading) examined the associated growths of *Streptococcus lactis*, an organism found normally in cheese, and *Escherichia coli*, a potential common contaminant. Mixed cultures added to the cheese vats undoubtedly affected the flavours according to the amounts of the cultures used, and fortunately the *E. coli* always died out. In mixed cultures maintained in continuous daily subculture at 30° and 37°, *E. coli* disappeared in a few days, and it was not detected in cheese a few weeks after manufacture. The influence of rennet on bacteriophage multiplication in milk prior to making cheese was discussed by L. J. Meanwell and Miss N. Thompson (London). They found that rennet added to milk within 30 min. of inoculating with a starter culture protects the culture against phage attack by stimulating cell production and suppressing phage multiplication. This prolongs the time before phage numbers equal cell numbers and so allows acid production to continue for some hours.

H. B. Hawley (Yeovil) gave two papers, one of which was in collaboration with G. Bourne (London), on the bacteriological deterioration of processed cheese, and its micro-structure and fat distribution. The papers were well illustrated by slides which clearly demonstrated the effects of different contaminating bacteria on the appearance of the cheese, such as 'eyes' in Cheddar cheese due to propionic acid bacteria and deformation in packet cheeses due to bacterial spores. Histologically, the micro-structure has many resemblances to pathological specimens, and bacteria can be seen associated with the fat globules.

Having disposed of the papers on milk and cheese, the conference heard M. Lev and C. A. E. Briggs (Shinfield) describe their investigations into the establishment of the gut flora in the newly hatched chick. Somewhat surprisingly, they found a balanced flora to be present after two days, and even after 24 hr. the broad groupings are established. Highest counts are found in the cæcum, and the next highest in the crop.

The effect of various detergents on the activities of a number of quaternary ammonium compounds at different temperatures and in waters of different hardness was the subject of a paper by Miss C. M. Cousins and L. F. L. Clegg (Shinfield). In general, lower temperatures meant lower activities, although the temperature coefficients varied with the compounds. Water hardness was very significant, to the extent that a mixture active at 50 p.p.m. in distilled water may not be completely effective in a hard water at 200 p.p.m. The activity of the quaternaries themselves bore little relation to their activities in detergent mixtures.

Another topic discussed was the preservation of organisms of the *Pseudomonas* type under mineral oil. Miss M. E. Rhodes (Reading) emphasized the need for cultures to be totally sealed with the oil to effect preservation and described it as an improved method because only slight changes occurred in the saccharolytic and proteolytic properties of the cultures so treated. She preferred it to freeze-drying. Of 170 organisms examined, only 6 per cent changed their reactions to sucrose and 2 per cent to galactose, whereas those maintained in continuous culture underwent significant changes. W. B. Hugo (Nottingham) described a new, or rediscovered, *Pseudomonas* species which is very similar to, or identical with, *Ps. lemonnieri*. It occurred as a contaminant and was singled out for investigation because it produces a characteristic blue pigment which is different from pyocyanin as shown by ultra-violet absorption spectra. The pigment is protein in nature, insoluble in water, and is only produced aerobically in the presence of carbohydrates.

The last two papers dealt, in effect, with the systems of classification of organisms. S. T. Cowan (Colindale) discussed the biochemical and other characteristics of various members of the coli-aerogenes group of bacteria, showing how irregular are some of the divisions of the different genera. This was illustrated by examples such as *Klebsiella pneumoniae*, *Kl. aerogenes*, *Cloaca* and *Citrobacter* spp. He pointed out that any system of nomenclature depends on the system of classification used, and added that utility is another factor to be considered. In a similar way, Joan Taylor (Colindale) discussed a subject on which opinions have varied from time to time, namely, the pathogenicity of *E. coli*. This organism as an infective agent is essentially confined to babies three to six months old. It is infectious in close communities; but the same serotypes are found universally. These serotypes may differ slightly in their biochemical characteristics; but fundamentally they are all typical *E. coli*. At the same time, they may have serological identities with certain of the *Salmonella* group. So what of their classification ?

These papers will be published in full at a later date in the *Journal of Applied Bacteriology.*

INTERNATIONAL LIGHT METALS CONGRESS AT LEOBEN

THE international Light Metals Congress, held in Leoben, Austria, during June 7–9, was the third such meeting there, the previous ones being in 1934 and 1948, and as on the former occasions, the purpose of the Congress was to give a comprehensive picture of the present state of the light metals industry and to permit informal discussion and exchange of views among the delegates. Organized by the Montanistische Hochschule with the assistance of the Austrian light metals industry, the Congress was attended by more than three hundred and fifty representatives from nineteen countries. The programme included an exhibition of the applications of aluminium, various visits and social functions, and six technical sessions at which more than thirty papers were read. In addition to the usual facilities for lantern slides and films, arrangements were made for the whole proceedings to be televised to a second audience in the overflow meetings.

The opening session was devoted to reviewing the part played by light metals in the economy of the major countries represented, which included Austria, France, Great Britain and the British Commonwealth, Italy, the German Federal Republic, Switzerland and the United States. The papers were contributed by W. C. Binz, R. Carmina, Th. Dirksen, A. Dumas, F. C. Frary, B. K. Klein, G. V. Schulthess and W. J. Thomas, respectively. All told much the same story of rapid post-war growth of the industry, encouraged by the continuing strong demand for light metal products. An interesting fact brought out by these papers is that the present and estimated future demand for aluminium exceeds existing supplies of electrical energy and bauxite—the chief raw materials of the industry—so that attention is being turned to additional sources, notably those in undeveloped areas of western Canada and Africa.

In the session dealing with advances in metallurgy, M. O. Sem (Oslo) described the importance of the Söderberg electrode in modern large electrolytic cells, and P. Gross (Stoke Poges) examined the conditions to be fulfilled in the sub-halide distillation of aluminium. A. Brenner (Lend) gave an account of the production, properties and uses of super-purity aluminium—a material which is of growing industrial importance. The single paper devoted to magnesium was presented by C. J. P. Ball (London); this was a comparative survey of the methods currently used for the extraction of magnesium.

Interest in titanium, the latest member of the light metals family to be used industrially, was evidenced by the five papers dealing with this metal. Two of these described extraction processes: R. Kieffer (Reutte) summarized the present methods of production, with figures illustrating the astonishing growth in output during the past few years, and E. Fitzer, H. Hofbauer and H. Hohn gave an account of a process in which an alkali amalgam is used to reduce titanium tetrachloride to titanium amalgam, the mercury being afterwards removed by distillation. M. Hansen (Frankfurt) dealt with the physical metallurgy of titanium and its alloys.

An encouraging sign of improved international relations was the participation of scientists from the U.S.S.R., who contributed two papers on the metallurgy of titanium alloys, including one by Dr. M. A. Pavlov, of the Moscow Academy of Sciences.

Papers dealing with the technology of light metals included one on foundry practice by Prof. A. von Zeerleder, a pioneer of the light metals industry, who discussed the advances in foundry technique from the historical point of view, with emphasis on recent improvements in gating systems. K. Schneider (Nuremberg) described the methods used in the recovery and treatment of secondary metals, and M. Lamourdedieu (Paris) dealt with current practice in the rolling of light metals. Much interest was aroused by R. D. Hamer's paper on experience with the continuous casting and rolling of aluminium strip, which was supported by a short film depicting the operation of installations at Rorschach and Banbury. During recent years a demand has arisen from the aircraft industry for large structural forgings to replace members which otherwise would be built up from extrusions and sheet, and G. W. Richards and C. Wilson (Birmingham) discussed some of the metallurgical problems which arise in the production of these forgings, particularly the control of internal stresses. An account of recent advances in welding practice, including inert gas welding, cold welding and the high-frequency welding of tubes, was given by E. Zurbrügg (Neuhausen), and G. Luft and F. Sacchi (Novara) read a paper on surface treatment with reference to Italian experience.

Six papers were devoted to topics in physical metallurgy and metallography. R. Mitsche (Leoben) described the effect of superheating on the structure of as-cast metals, while E. M. Onitsch-Modl (Winterthur) surveyed the powder metallurgy of aluminium, magnesium and titanium. P. Brenner (Lend) discussed an urgent engineering problem, that of the fatigue strength of aluminium alloys and its relation to other properties of the material. The connexion between processing conditions and the properties of extrusions was considered by E. Nachtigall (Ranshofen), and G. Siebel (Singen) discussed a perennial production problem—the earing of certain aluminium alloys during deep drawing and the influence of processing variables on this behaviour. E. Schmid (Vienna) contributed a necessarily brief account of the part played by lithium, beryllium, magnesium, aluminium, silicon and titanium in certain applications to physics, with particular reference to nuclear energy.

The final session was devoted to applications of the light metals. The way in which new applications are evolved, developed and finally established was discussed by de Ridder, and M. Langegger (Ranshofen) described the various applications of semi-finished products in Austria. L. Kirste (Vienna) examined the essential requirements to be met for successful light-weight construction, and C. Panseri (Novara) mentioned some of the problems which arise when aluminium is used in architecture; he also described a new magnesium-silicide alloy which has been developed in Italy for spandrel sections. A comprehensive paper on the use of aluminium for transport by land, sea and air was contributed by J. J. Baron (Paris), in which details were given of the various applications. A. Taranger (Oslo) discussed another field of use, that of rigid wall cans for processed foods; he concluded that the technical obstacles to the use of aluminium in canning have been largely overcome, and therefore wider employment is a matter of economics. J. C. Bailey (London) dealt with electrical engineering, a field in which aluminium has made, and is still making, great strides and in which it occupies a favourable economic position.

In addition to the foregoing, the following papers were submitted in summary form: improvements in the quality of aluminium–silicon alloys (W. Thury); reactivity and specific consumption of anode carbon in the industrial electrolytic production of aluminium (A. Vajna de Pava); and chemical background to the wet alkaline process of Bayer for extracting aluminium oxide hydrate from bauxites (F. Heyd).

The full text of all the papers will be published, in German, in the journals *Aluminium* (Aluminium-Verlag GmbH., Düsseldorf) and *Berg- und Hüttenmännischen Monatsheften* (Springer-Verlag, Vienna) this autumn.

THE MEDICAL RESEARCH COUNCIL

REPORT FOR 1954–55

THE report of the Medical Research Council for the year 1954–55* follows the plan used in recent years of giving summaries only of the work of the Council's many research establishments, the main part of the report being devoted to a discussion of selected aspects of the general trend of medical research. As the report emphasizes, every conspicuous advance in medical research depends on a mass of unspectacular work and on team work, to which every individual taking part, whatever his status, contributes essential skill or knowledge.

Among the subjects selected for discussion this year the control of poliomyelitis is of popular interest, and an account is given of the vaccines now in use as prophylactics against this disease. The results of the American trial of the Salk vaccine, so admirably conducted, showed that this vaccine reduced paralytic poliomyelitis among children aged 6–9 years by 28 per cent, the protection increasing with age. After revision of the safety tests, many millions of children in the United States and Canada have been vaccinated. The report describes the work being done in Britain on the manufacture of a somewhat different vaccine and on tests of its safety and on trials of it. It then goes on to discuss the epidemiology of poliomyelitis and the increased risk of development of the disease in children who have recently been inoculated with a combined prophylactic against diphtheria and whooping-cough or who have recently had their tonsils removed.

Other subjects discussed in this part of the report are recent research on influenza, vaccination against tuberculosis, antibody immunity, the mechanism of allergic reactions, the causes and control of œdema due to diseases of the kidneys, human genetics, developments in biophysics and the fallacies of the design of industrial work.

The rest of the report, after outlining the administration of the Council's work, epitomizes its research programme and gives the names of its personnel, summaries of the programmes of the many research units and a list of the many publications reporting the work of the Council's staff and the work of the staffs of the Institute of Cancer Research and the Public Health Laboratory Service. The report is, in fact, a complete guide to the Council's many-sided activities. It would be hard to find anywhere a finer record of the devoted efforts of many people of different skills to better the health of man to-day and to make the world a better place for generations to come.

G. LAPAGE

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* Committee of Privy Council for Medical Research. Report of the Medical Research Council for the Year 1954–55. (Cmd. 9787.) Pp. v+286. (London: H.M.S.O., 1956.) 10*s*. net.

CRYSTALLINE CYTOCHROME C

Preparation of Crystalline Cytochrome c from Yeast

THE first crystallization of cytochrome *c* was reported from muscle of the king penguin by G. Bodo[1]. Cytochrome *c* has been crystallized by us from more convenient sources, such as baker's yeast, beef heart[2] or pig heart[2]. In this communication is reported the isolation from yeast of crystalline cytochrome *c*, which was shown to be a homogeneous protein by electrophoretic, ultracentrifugal and chromatographic criteria[2].

Baker's yeast, treated with ethylacetate (1/7 vol.) for one hour, was twice washed by suspending in tap water (5 vol.) for one hour while keeping the suspension at *p*H 7–8 with ammonia. The washed yeast was twice extracted with 10 per cent ammonium sulphate solution (the same volume as the yeast cake) for fifteen hours. The ratio of extinction at 550 mμ of the reduced pigment to the extinction of 280 mμ of oxidized pigment which is abbreviated to R^{550}_{280} was 0·01. The extract, after being dialysed against tap water for two days, was passed through a column of cation exchange resin, 'Duolite *CS*-101' (buffered at *p*H 7·0), which has a greater capacity for adsorption of cytochrome *c* than the 'Amberlite' *IRC*-50 (*XE*-64) ordinarily used[3-5]. After washing the column with dilute ammonium sulphate solution (0·05 *M*), the cytochrome *c* was eluted with 0·2 saturated ammonium sulphate solution (eluate: $R^{550}_{280} = 0·2–0·3$). The solution containing about 0·05 per cent oxidized cytochrome *c* was saturated with ammonium sulphate at *p*H 5·0 and the resulting precipitate was removed (filtrate: $R^{550}_{280} = 0·4–0·7$). The filtrate was dialysed and cytochrome *c* further concentrated using *CS*-101 as before except that ammonium phosphate buffer solution (1·0 *M*, *p*H 7·0) was used for the elution.

The cytochrome *c* was purified by the method of Margoliash[4] with some modifications in which the resin, *XE*-64, treated with sodium hypochlorite and ammonium phosphate buffer solution (0·4 *M*, *p*H 7·0) was used. The cytochrome *c* eluted in the oxidized form at about four hold up volumes was collected and highly concentrated using a small column of *CS*-101 (eluate: $R^{550}_{280} \doteqdot 1·15$). The solution, containing more than 10 per cent oxidized cytochrome *c*, was nearly saturated (about 0·85 saturation) with ammonium sulphate at *p*H 5·0 and the slight amount of resulting precipitate was removed (supernatant: $R^{550}_{280} \doteqdot 1·2$).

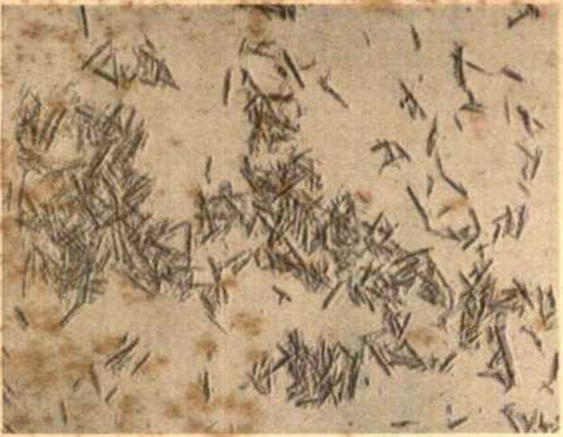

Fig. 1. Crystalline yeast cytochrome *c* (rod form, × 1,500)

The cytochrome *c* contained in the supernatant was reduced with the minimum amount of ascorbic acid, adjusted to about *p*H 9·0 with 30 per cent ammonia (about 1/30 vol.), and then saturated by the addition of finely powdered ammonium sulphate in order to precipitate cytochrome *c*. When the resulting suspension was allowed to stand for 3–5 days, the precipitated cytochrome *c* changed into very small crystals. After centrifugation, the crude crystals were dissolved in the minimum amount of water (about 1/3 vol. of the crystals) (crude crystals: $R^{550}_{280} = 1{\cdot}25$). When finely powdered ammonium sulphate was added to the above solution until it became slightly turbid (about 0·8 saturation), small needle-like crystals appeared after one or two hours and then gradually changed into fairly large needles or rods as shown in Fig. 1 (first crystals: $R^{550}_{280} = 1{\cdot}28$). All the work was carried out at room temperature (10–15° C.). Recrystallization was carried out in the same way; but the purity was not increased.

The crystallization of oxidized cytochrome *c* was performed in almost the same way, and the crystals with the same shape and purity as in the case of reduced cytochrome *c* were obtained. Crystallization was also carried out from a mixture of oxidized and reduced cytochrome *c*. However, it seems to be most convenient to crystallize the protein in its reduced form, since the solubility of the reduced protein in ammonium sulphate solution appears to be somewhat smaller than that of the oxidized form.

This method was quite reproducible and also applicable to the crystallization of the hæmoprotein from dry yeast with a few modifications. The yield of the crystals was about 50 mgm. from 1 kgm. of compressed yeast or 0·3 kgm. of dry yeast.

We wish to express our thanks to the Oriental Yeast Co., Ltd., for the supply of the source material, to the Japan Organo Co., Ltd., for the resin *XE*-64, and to the Nippon Kiko Co., Ltd., for *CS*-101.

BUNJI HAGIHARA
TAKEKAZU HORIO
JINPEI YAMASHITA
MITSUHIRO NOZAKI
KAZUO OKUNUKI

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[1] Bodo, G., *Nature*, **176**, 829 (1955).

[2] See following communication.

[3] Paléus, S., and Neilands, J. B., *Acta Chem. Scand.*, **4**, 1024 (1950).

[4] Margoliash, E., *Biochem. J.*, **39**, 289 (1945).

[5] Minakami, S., *J. Biochem.*, **42**, 749 (1955).

Preparation of Crystalline Cytochrome c from Beef and Pig Heart

CRYSTALLINE cytochrome *c* was prepared from beef and pig heart by a method similar to that used for yeast[1] with a few modifications. Each of these two crystalline preparations was shown to be a homogeneous protein by electrophoretic, ultracentrifugal and chromatographic criteria[2] and to give the highest ratio of the extinction coefficient of the reduced form at 550 mμ to that of the oxidized form at 280 mμ ($R^{550}_{280} = 1{\cdot}29$ in beef, $R^{550}_{280} = 1{\cdot}28$ in pig).

Heart muscle, freed of fat and ligaments and washed with tap water, was minced and then extracted twice with 0·1 saturated ammonium sulphate solution. The residue was removed by filtration through a cloth using a press. In the case of beef heart, the residue was stored as a source of cytochromes *a* and *b*. In the case of pig heart, crystalline fumarase and lactic dehydrogenase were obtainable together with cytochrome *c* from the extract by separating the former two enzymes by a fractionation with ammonium sulphate at 0·8 saturation. In the case of both beef and pig, cytochrome *c* was concentrated by the slightly modified methods of Keilin and Hartree[3,4] from the filtrate from 0·8 saturated ammonium sulphate.

The concentrated cytochrome *c* was dissolved, dialysed against ammonium phosphate buffer solution (0·05 *M*, *p*H 7·0), and then further concentrated using 'Duolite' *CS*-101 as in the case of yeast[1] (concentrate: $R^{550}_{280} = 1{\cdot}1$–$1{\cdot}15$). The procedure followed exactly that used in the preparation of cytochrome *c* from yeast except that when the concentrated cytochrome *c* was chromatographed on *XE*-64 the buffer solution contained 0·25 *M* ammonium instead of 0·4 *M* (main peak: $R^{550}_{280} = 1{\cdot}2$). The cytochrome *c* thus obtained was more soluble in concentrated ammonium sulphate solution than that obtained from yeast, but the shapes of the crystals in various stages of the crystallization were almost identical.

This method was quite reproducible and the yields of the crystals from 1 kgm. of beef and pig heart were about 30 mgm. and 20 mgm., respectively.

The shapes of the cytochrome *c* crystals may be divided into four types: needle, rosette (Fig. 2), leaflet (Fig. 3) and slender rod-like forms. All these types have also been observed in crystals obtained from yeast, though the shape of the second type,

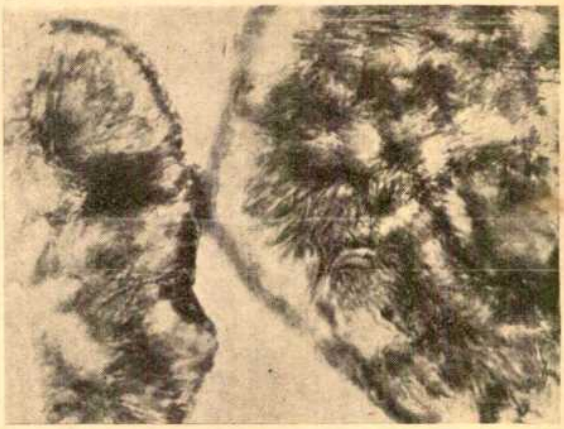

Fig. 2. Crystalline pig heart cytochrome *c* (rosette form, × 1,500)

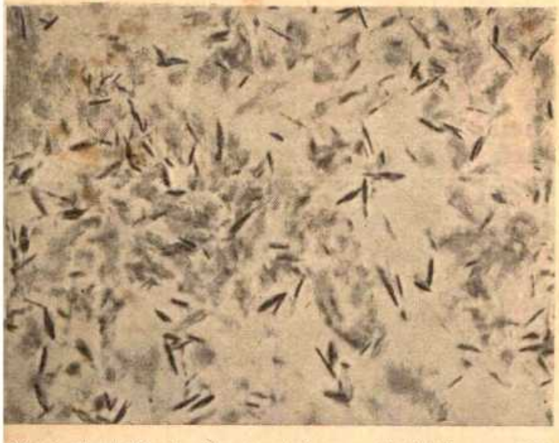

Fig. 3. Crystalline beef heart cytochrome *c* (leaflet form, × 900)

osette, of yeast was somewhat different from the ther. Needle and rosette crystals have usually ppeared in the earlier period in the first crystallizaion and then changed into the leaf-like type which ppeared also in the earlier period of the recrystalzations. These three types have often been changed nto the slender rod-like form by careful recrystalzations and by allowing the suspension of crystals o stand for a very long time. It was supposed from hese observations that the needle type might be a ery small form of the rod type, while the rosette nd leaflet types might comprise grouped forms of he needle. No other shapes of true crystalline cytohrome *c* have yet been obtained from the above hree different sources. These cytochromes *c* have ever been crystallized from a dilute solution, as in he method of Bodo[5] using king penguin muscle, lthough crystals of some other substance with clear dges slightly coloured (presumably by the adsorpion of cytochrome *c*) have sometimes appeared, ogether with an amorphous precipitate of cytohrome *c*, under the conditions used by him.

Bunji Hagihara
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Ichiro Sekuzu
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See preceding communication.
See following communication.
Keilin, D., and Hartree, E. F., *Proc. Roy. Soc.*, B, **122**, 298 (1937)
Keilin, D., and Hartree, E. F., *Biochem. J.*, **39**. 289 (1945).
Bodo, G., *Nature*, **176**, 829 (1955).

Comparison of Properties of Crystalline Cytochrome c from Yeast, Beef Heart and Pig Heart

A few physical and biological properties of the rystalline cytochrome *c* obtained from baker's yeast, eef heart and pig heart by the methods previously escribed[1] are here recorded.

Absorption spectra of the three crystalline cytohrome *c*'s were found in the ultra-violet and visible egions to be practically identical with one another, nd also with non-crystalline samples prepared from orse heart by the method of Keilin and Hartree[2] hrough the visible range. However, in the ultraiolet region at about 280 mμ, a difference was bserved between the crystalline preparations and the non-crystalline preparations (Fig. 4). This suggests the impurity of the latter.

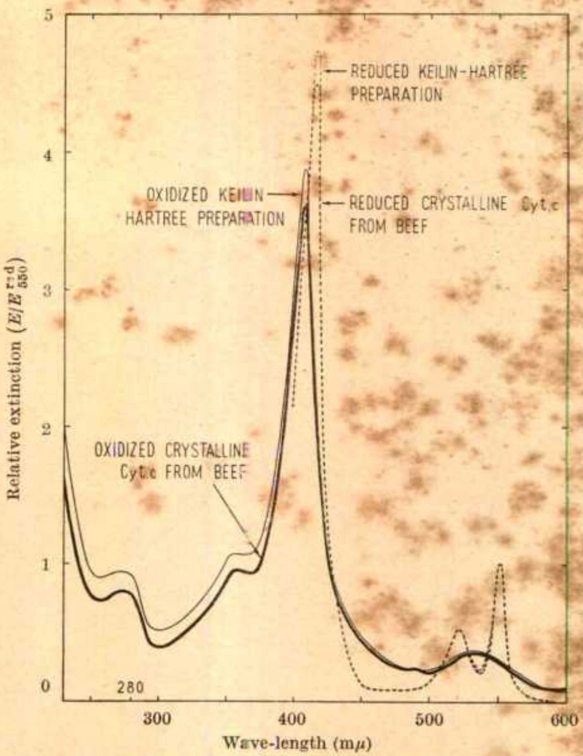

Fig. 4. Absorption spectra of crystalline cytochrome *c* from beef and Keilin–Hartree preparation from horse heart

Electrophoreses were performed at *p*H 9·0 using a sodium glycine–sodium chloride–hydrochloric acid buffer system of ionic strength 0·1. Each of the crystalline preparations in the oxidized form migrated in the electrical field as a homogeneous substance. Further analyses are now in progress under other conditions in order to confirm the homogeneity of these preparations and also to determine their isoelectric points.

Ultracentrifugal experiments were performed by Dr. K. Fukai, of the Institute for Microbial Diseases, University of Osaka, using a 'Spinco' Model-*E*; the runs were carried out in sodium chloride solution of *p*H 6·0 and ionic strength of 0·2 at a protein concentration of 0·5–0·2 per cent. All the above three crystalline preparations showed only one peak in the centrifugal field at 59,780 r.p.m. (Fig. 5).

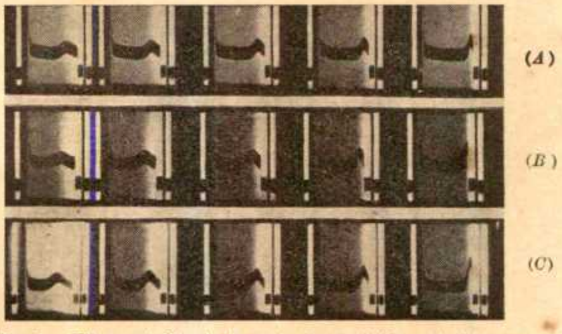

Fig. 5. Ultra-centrifugal diagram of crystalline cytochrome *c* from (*A*) yeast, (*B*) beef heart, and (*C*) pig heart. Solvent, 0·2 *M* sodium chloride; protein concentrations, (*A*) and (*B*) 0·2 per cent, (*C*) 0·45 per cent; 59,780 r.p.m. in a 'Spinco' Analytical *A* rotor with 12-cm. cell; interval, (*A*) 16 min., (*B*) and (*C*) 34 min.

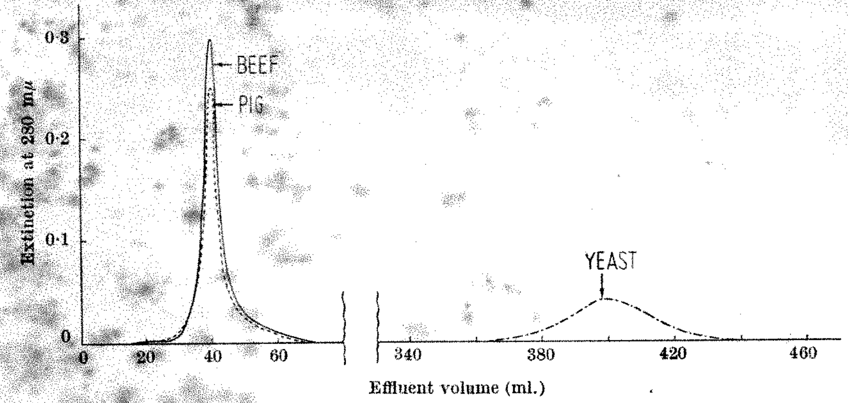

Fig. 6. Chromatograms of crystalline cytochrome *c* from yeast, beef heart and pig heart. Column, 'Amberlite' *XE*-64, 150–300 mesh, 1 cm. × 26 cm.; buffer, ammonium phosphate pH 7·0, 0·3 M ammonium; rate of flow, 10 ml./hr.

Analytical chromatography of the oxidized forms was carried out on a column of ion exchange resin, 'Amberlite' *XE*-64, according to the method of Hirs, Moore and Stein[3], except that resin treated with sodium hypochlorite, and ammonium phosphate buffer solution of pH 7·0 containing 0·3 M ammonium were used. In each case only one clear peak was obtained, though the elution volumes for the yeast preparation were very different from the other two (Fig. 6).

Biological activities of the three cytochromes *c* were tested in the succinic oxidase system and the cytochrome oxidase system prepared from beef heart muscle by the method of Keilin and Hartree[4]. The efficiencies of the three preparations in these systems were almost the same based on the extinction a 550 mμ in the reduced form.

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[1] See preceding communications.

[2] Keilin, D., and Hartree, E. F., *Proc. Roy. Soc.*, B, **122**, 298 (1937).

[3] Hirs, C. H. W., Moore, S., and Stein, W. H., *J. Biol. Chem.*, **200** 493 (1953).

[4] Keilin, D., and Hartree, E. F., *Proc. Roy. Soc.*, B, **125**, 171 (1938).

DETERMINATION OF INTERMEDIARY METABOLITES BY ENZYMIC FLUORIMETRY

By Dr. P. GREENGARD
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WORK now in progress on the metabolism of the peripheral nervous system requires more sensitive methods than are generally available for the assay of various intermediary metabolites. In recent years increasingly widespread use has been made of the difference of ultra-violet absorption properties of oxidized and reduced pyridine nucleotides for the determination of intermediary metabolites. These compounds also differ in their fluorescence properties. Reduced diphosphopyridine nucleotide and reduced triphosphopyridine nucleotide are fluorescent, whereas the corresponding oxidized forms are not. This difference in the fluorescence properties of the reduced and oxidized forms has been used in the determinations to be described as the basis of a direct method for the estimation of intermediary metabolites at levels as low as 2×10^{-10} mole. This is about 100 times the sensitivity of the ultra-violet absorptiometric methods hitherto used for such determinations.

Any of the large number of compounds capable of being enzymatically coupled, by one or more enzymes, either to the oxidation or to the reduction of either of the two nucleotides should be amenable to assay by this method. So far, this fluorimetric method has been found suitable for the determination of a number of compounds, including pyruvic acid, phosphoenolpyruvic acid, adenosine diphosphate, adenosine triphosphate and glucose-6-phosphate. The problem of non-absolute enzyme specificity, such as keto-acids other than pyruvate reacting with lactic dehydrogenase[1] and nucleotides other than adenine nucleotides reacting with 'adenine nucleotide enzymes', are of course, similar to those encountered in the spectrophotometric assay methods.

The measurements reported here were made with a Hilger 'Spekker' absorptiometer modified in this laboratory to serve as a fluorimeter using an *E.M.I* 6097*B* photomultiplier as the light detector.

Pyruvic acid. This compound was estimated, as in the spectrophotometric method of Ochoa *et al.*[2], in the presence of lactic dehydrogenase and excess reduced diphosphopyridine nucleotide. One molecule of the latter is oxidized for each molecule of pyruvate present, according to the following reaction:

$$\text{pyruvate} + \text{reduced diphosphopyridine nucleotide} \rightarrow \text{lactate} + \text{diphosphopyridine nucleotide} \quad (1$$

The disappearance of reduced diphosphopyridine nucleotide, determined by decrease in fluorescence is proportional to the pyruvate present. It can be seen from Fig. 1 that pyruvate can be estimated in amounts of $2{\cdot}5 \times 10^{-10}$ mole in a volume of 1 ml

Although diphosphopyridine nucleotide and triphosphopyridine nucleotide do not ordinarily fluoresce, they can be made to do so by condensation with ketones in an alkaline medium[3]. These condensation products are many times more fluorescent than the reduced pyridine nucleotides, the fluorescence of which is not increased by this treatment. The

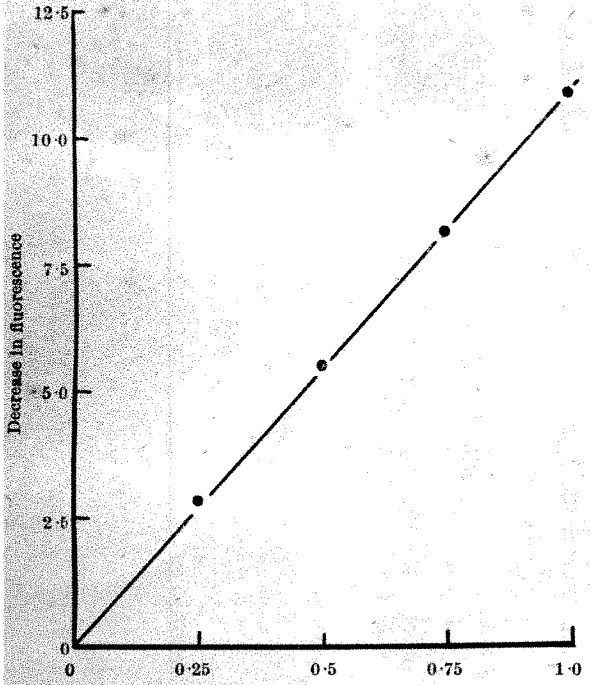

Fig. 1. Assay of pyruvate: Reaction mixture (1 ml.) contained 10 μmol. triethanolamine, *p*H 7·7, 0·5 μmol. ethylenediaminetetra-acetate, *p*H 7·4, 1·6 mμmol. reduced diphosphopyridine nucleotide and indicated amounts of pyruvate. Reaction started by addition of 0·01 ml. (40 Bücher units) of lactic dehydrogenase. Readings taken every minute at room temperature until stable value is obtained. Blank corrections (no added pyruvate) have been applied

combined use of lactic dehydrogenase, excess pyruvate and this ketone procedure was previously employed for the estimation of reduced diphosphopyridine mucleotide[4]. The procedure has now been used for estimating pyruvate by using an excess of reduced diphosphopyridine nucleotide. Following the completion of reaction (1) the diphosphopyridine nucleotide formed is measured by the fluorescence of its ketone condensation product. With this procedure, pyruvic acid was estimated in amounts as small as $2 \cdot 5 \times 10^{-11}$ mole (Fig. 2).

The ten-fold greater sensitivity of the ketone procedure suggests it as the method of choice for the estimation of pyruvate and other compounds when such extra sensitivity is desired. On the other hand, the direct use of reduced diphosphopyridine nucleotide fluorescence for these estimations has certain advantages. One is the greater simplicity of the procedure. Another is that the progress of the reaction can be followed continuously, with the result that the termination of the reaction can be ascertained with greater ease and accuracy. Finally, a second compound can be estimated on a given aliquot (see estimation of adenosine diphosphate and phosphoenolpyruvate).

Adenosine diphosphate and phosphoenolpyruvate. By a simple extension of the fluorimetric method for the assay of pyruvate, either adenosine diphosphate or phosphoenolpyruvate may be estimated at similar low levels. As in the spectrophotometric procedure of Kornberg and Pricer[5], the addition of Mg^{++}, K^{+} and pyruvic phosphokinase to the reaction mixture used for the determination of pyruvate permits the estimation of either of these compounds according to the reaction:

adenosine diphosphate + phosphoenolpyruvate →
adenosine triphosphate + pyruvate (2)

the pyruvic acid formed reacting according to equation (1). In the presence of excess phosphoenolpyruvate, the decrease in fluorescence gives a measure of the adenosine diphosphate present. As shown in Fig. 3, the sensitivity of the method is such as to allow for the estimation of less than 2×10^{-10} mole of adenosine diphosphate in a 1·0 ml. volume. If pyruvate is present, it can be estimated separately as above and the adenosine diphosphate content obtained by difference. Alternatively, pyruvate and adenosine diphosphate can be determined on a single aliquot by first estimating the pyruvate in the presence of lactic dehydrogenase and then adding pyruvic phosphokinase, Mg^{++} and K^{+} for the estimation of adenosine diphosphate. It was found necessary to withhold the addition of Mg^{++} until the pyruvate estimation was completed, since even highly purified samples of lactic dehydrogenase contain small traces of pyruvic phosphokinase and therefore some adenosine diphosphate might be estimated along with the pyruvate.

The same principle when applied to the determination of phosphoenolpyruvate by adding adenosine diphosphate in excess gave a similar sensitivity.

Glucose-6-phosphate and adenosine triphosphate. Glucose-6-phosphate is estimated, as in the spectrophotometric method of Ochoa *et al.*[6], in the presence of glucose-6-phosphate dehydrogenase (*Zwischenferment*) and excess triphosphopyridine nucleotide. One molecule of triphosphopyridine nucleotide is reduced for each molecule of glucose-6-phosphate present according to the reaction:

glucose-6-phosphate + triphosphopyridine nucleotide
→ 6-phosphogluconic acid + reduced triphosphopyridine nucleotide (3)

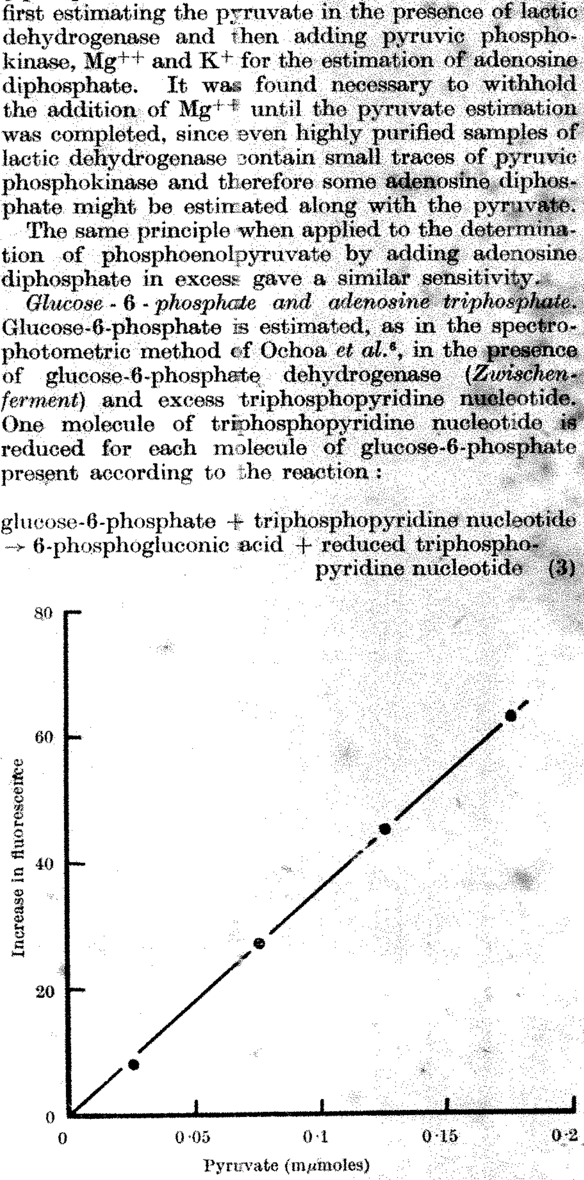

Fig. 2. Assay of pyruvate, ketone method. Reaction mixture (0·5 ml.), containing 5 μmol. triethonalamine, *p*H 7·4, 0·2 μmol. ethylenediaminetetra-acetate, *p*H 7·4, 0·25 mμmol. reduced diphosphopyridine nucleotide, indicated amounts of pyruvate and 40 Bücher units of lactic dehydrogenase, was incubated at 39° for 15 min., followed by addition, with mixing, of 0·2 ml. of 0·0002 *M* manganous chloride in methyl ethyl ketone, 0·2 ml. of 4·2 *N* sodium hydroxide, and, after waiting 5 min., 0·95 ml. of 1·0 *N* hydrochloric acid. Solution boiled 5 min., cooled and readings taken. Blank corrections (no added pyruvate) have been applied

The formation of reduced triphosphopyridine nucleotide, determined by increase in fluorescence, is proportional to the glucose-6-phosphate present.

As in the spectrophotometric procedure of Kornberg[7], the addition of hexokinase and glucose to the reaction mixture used for the estimation of glucose-6-phosphate permits the estimation of adenosine triphosphate according to the reaction:

adenosine triphosphate + glucose → adenosine diphosphate + glucose-6-phosphate (4)

the glucose-6-phosphate formed reacting according to equation (3). This is illustrated in Fig. 4; less than 2×10^{-10} mole of adenosine triphosphate was estimated in a 1·0 ml. volume. If glucose-6-phosphate is present, it can be estimated separately as above in the absence of reaction (4) and the adenosine triphosphate content obtained by difference.

Alternatively, glucose-6-phosphate can be estimated, according to the procedure of Slater[8], in the presence of excess reduced diphosphopyridine nucleotide and adenosine triphosphate using an enzyme system from rabbit muscle. In this procedure, glucose-6-phosphate is measured by the oxidation of reduced diphosphopyridine nucleotide. By measuring the decrease in fluorescence as the reduced diphosphopyridine nucleotide was oxidized, 4×10^{-10} mole of glucose-6-phosphate was readily estimated in a volume of 7·3 ml.

A limitation in the estimation of metabolites at the level of sensitivity potentially available by fluorimetry is the purity of the enzymes used. Among the many substances which should be readily estimated by this fluorescence method are isocitrate, α-ketoglutarate and the triose phosphates, since the respective enzymes catalysing reactions between these intermediates and the pyridine nucleotides have been crystallized.

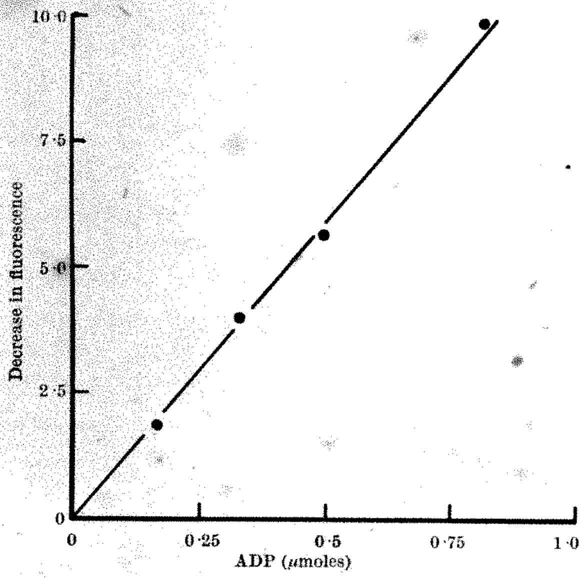

Fig. 3. Assay of adenosine diphosphate. Reaction mixture (1·0 ml.) contained 10 µmol. triethanolamine, pH 7·7, 0·5 µmol. ethylenediaminetetra-acetate, pH 7·4, 1·6 mµmol. reduced diphosphopyridine nucleotide, 20 µmol. magnesium sulphate, 80 µmol. potassium chloride, 1·6 mµmol. phosphoenolpyruvate and indicated amounts of adenosine diphosphate. Reaction started by addition of 0·01 ml. (40 Bücher units) of lactic dehydrogenase and 0·03 ml. (40 Bücher units) of pyruvic phosphokinase. Readings taken every minute at room temperature until stable value was obtained. Blank corrections (no added adenosine diphosphate) have been applied

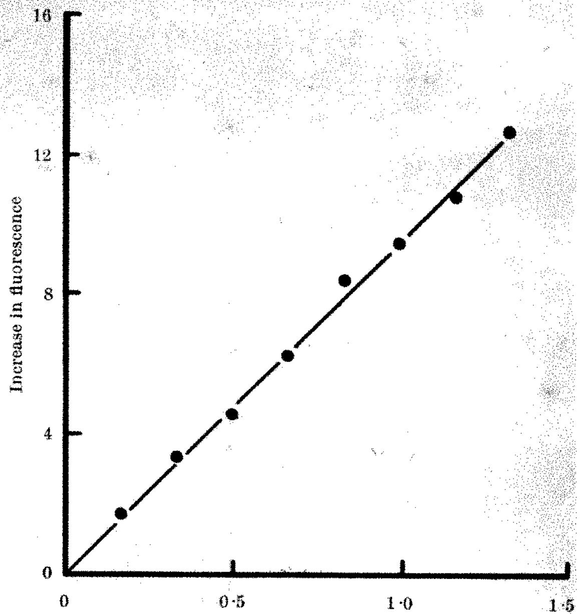

Fig. 4. Assay of adenosine triphosphate. Reaction mixture (1·0 ml.) contained 35 µmol. triethanolamine, pH 8·2, 0·2 µmol. ethylenediaminetetra-acetate, pH 7·4, 2·2 mµmol. triphosphopyridine nucleotide, 5·0 µmol. magnesium chloride, 100 µmol. glucose and indicated amounts of adenosine triphosphate. Reaction started by addition of 0·1 ml. (0·075 Kornberg units) of glucose-6-phosphate dehydrogenase containing hexokinase. Blank corrections (no added adenosine triphosphate) have been applied

Just as the spectrophotometric assay methods have been suitable for the estimations both of intermediary metabolites and of the activities of the related enzymes catalysing the reactions between these metabolites, so the fluorimetric methods described here for the estimation of intermediary metabolites can be used, with slight alterations, for the very sensitive estimation of enzyme activities. In fact, the activities of the enzymes used in this work were usually tested fluorimetrically. Theorell *et al.*[9] have found the sensitivity of fluorescence measurements to be very useful in their study of the reaction mechanisms of pyridine nucleotide enzyme systems.

Note added in proof: Lowry *et al.*[10] have used a similar procedure for the estimation of tissue-levels of glutamic dehydrogenase.

I am grateful to Prof. Th. Bücher for a gift of crystalline lactic dehydrogenase and pyruvic phosphokinase. It is a pleasure to thank Prof. Th. Bücher, Dr. W. Feldberg, Prof. E. C. Slater and Dr. T. S. Work for stimulating discussions. This work was carried out during the tenure of the Doris Duke Foundation Fellowship of the National Paraplegia Foundation, U.S.A.

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LETTERS TO THE EDITORS

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Electron Microscope Observations of Periodicities in the Surface Structure of Tobacco Mosaic Virus

X-RAY diffraction data and chemical evidence suggest that the protein content of tobacco mosaic virus rods is built up of small sub-units[1]. A model has been proposed[2] in the form of a helix of pitch of 23 A. and repeat distance of 69 A.

By electron microscopy using the carbon replica technique[3] we have obtained direct evidence for a structure repeating at 46 A. along the axis of the virus. A longitudinal structure of ridges and furrows has also been resolved which may indicate a polygonal cross-section for the virus rod. This is difficult to reconcile with recent deductions[4] from X-ray diffraction experiments that the virus rod has a hollow centre of radius 20 A. and a concentration of nucleic acid at a radius of 40 A.

A 'type' strain of tobacco mosaic virus was grown in tobacco plants and the virus isolated by the usual ammonium sulphate precipitation procedures. The suspension was dried on carefully cleaned glass surfaces and carbon was evaporated directly on to the preparation at an angle of about 30° from the horizontal. After stripping the carbon from the slide, the replica was placed in $2N$ potassium hydroxide at 60° C. to remove any virus rods remaining attached to the carbon. Finally, the replica was washed using the methods described by Bradley[3]. Direct suspensions shadowed with metal[5,6] and pre-shadowed replicas[7] were not found to be successful for studies at high resolution. Very thin evaporated metal films, normally used in electron microscopy to enhance contrast, are then found to consist of very small particles which confuse rather than reveal much of the fine detail in the specimen. The type of structure produced by shadowing is in agreement with that found by Sennett and Scott[8].

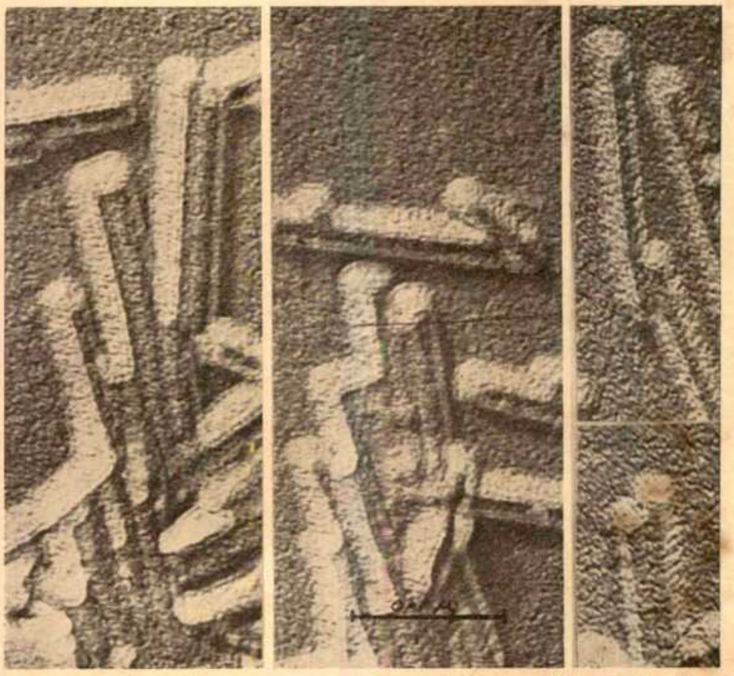

Fig. 2. Carbon replica of tobacco mosaic virus rods lying parallel to the direction of evaporation, showing 'herring-bone' structure and also longitudinal structure. (Original magnification × 40,000; reproduced at × 200,000.) Scale = 0·1μ

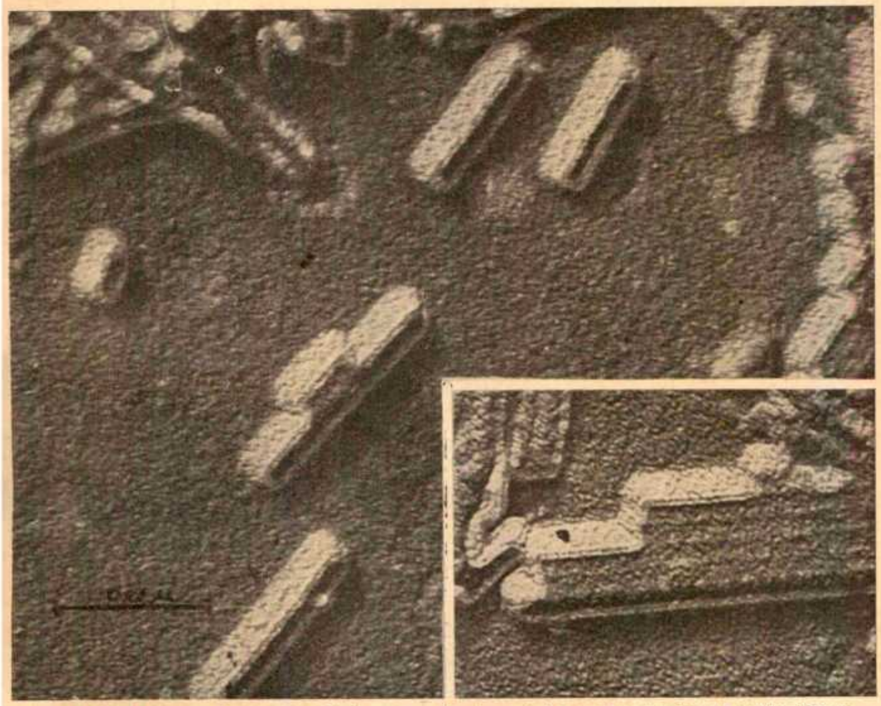

Fig. 1. Single-stage carbon replica of tobacco mosaic virus rods lying across the direction of incidence of the evaporated carbon, showing longitudinal structure along the rods. (Original magnification, × 40,000; reproduced at × 200,000.) Scale = 0·1μ

The replicas were examined in the electron microscope at instrumental magnifications of × 40,000 and × 80,000. In Fig. 1, where numerous rods lie across the direction of incidence of the evaporated carbon, a longitudinal structure is visible running the full length of the virus rod. The same longitudinal structure is also resolved in Fig. 2, in rods lying parallel to the direction of incidence of the carbon. Fig. 2 also shows a 'herring-bone' structure in some of these rods. Measurements made from prints enlarged to × 400,000 gave a mean value of 46 A. for the axial repeat-distance of this structure, which is almost exactly double that of the pitch of the helix deduced from the X-ray data. In the few rods which show evidence of helical structure, the angle of advance was found to be between 80° and 85°, as compared with the value of 82·5° required by the model proposed by Franklin[1]. The width of the rods, measured in regions of close packing, is found to be 150 ± 5 A.

One of the most striking features is the angular appearance of the virus rod in cross-section, suggesting a hexagonal form with a groove at the corners. A series of electron micrographs through the focus has been taken to ensure that the pronounced ridges are not due to electron optical fringe effects. Mixed preparations of tobacco mosaic virus and turnip yellow mosaic virus have been examined under the same conditions. These observations showed that the structures described were confined to the tobacco mosaic virus.

This work has been carried out with the assistance of a grant from the Agricultural Research Council, to which we are indebted. We also wish to thank Dr. R. Markham for supplying some of the tobacco mosaic virus and for several valuable discussions.

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Fine Structure of Tobacco Mosaic Virus

ALTHOUGH tobacco mosaic was one of the first viruses to be examined in the electron microscope, electron microscopy has failed to reveal any fine structure, even though it has been repeatedly looked for[1,2], especially since the introduction[3] of metal shadow casting in 1945.

The present findings result from a study directed at increasing the visibility of macromolecules in the electron microscope, and in particular from evaporating heavy metal at angles (with respect to the substrate) close to 0°.

A sample of the *U*1 strain[4] of tobacco mosaic virus, buffered to *p*H 6·8 in cacodylic acid, was diluted with distilled water to a concentration of 0·005 mgm./ml. and then sprayed on to the collodion-covered convex face of a plano-convex lens of 250 mm. radius of curvature. Thorium was evaporated at a pressure 10^{-4} mm. of mercury from a tungsten filament, the height of the lens being adjusted so as to give grazing incidence of the metal beam near the pole of the lens.

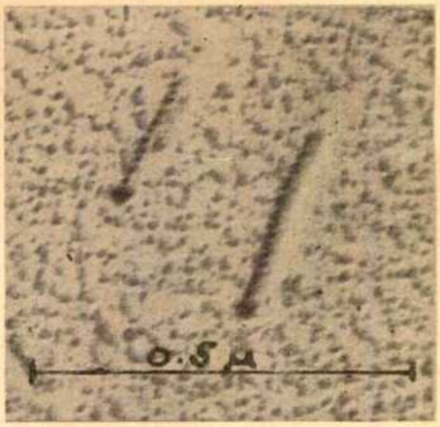

Fig. 1. Electron micrograph of tobacco mosaic virus (*U*1 strain) air-dried on collodion substrate and shadow-cast with thorium at low angle. The direction of shadowing is from lower left. (× 100,000)

The collodion was then stripped from the glass and mounted on 200-mesh copper screens. This technique offered a range of incidence angles in the neighbourhood of 0°, the exact angle depending on the original position on the glass surface.

At angles of incidence near 0°, tobacco mosaic rods which lay perpendicular to the direction of the incoming beam appeared normal, with thorium piling up on the incident side. Rods which lay parallel to the incoming beam, however, showed a periodic density variation along the long axis, in addition to the metal cap on the end which would be expected (Fig. 1). The visibility of the striations decreased as the orientation of the rod varied from parallel to perpendicular. The visibility of the striations was also very sensitive to shadowing angle, the striations disappearing completely for angles greater than approximately 5°.

The period of the density fluctuations along the rod axis, as measured from a number of rods, averaged 136 A. As seen in Fig. 1, the individual striations are not perpendicular to the long axis of the rod, and the net effect is that of a right-handed helix.

Franklin and Klug[5] have recently published X-ray evidence for the existence of a helical groove or helical array of protuberances on the surface of the tobacco mosaic virus rod. The X-ray data can be interpreted as showing a discontinuity 30 A. deep, with the pitch of the underlying protein. While no agreement exists on the value of the pitch, the X-ray value for depth of groove is of the same order as that deduced in this work.

From the variation in contrast as a function of shadowing angle, it can be deduced that the slope of the discontinuity responsible for the deposition of metal must be no more than a few degrees, and the height of the discontinuity is of the order 15–30 A. A simple calculation based on the shadowing angle and the amount of thorium evaporated shows that migration and crystallization of thorium atoms on the rod surface will not account for the observed effect.

Similar results for the *U*2 strain of virus have been obtained, with some differences which will be reported on more fully elsewhere.

I wish to thank Dr. A. Siegel for furnishing the tobacco mosaic virus used in this investigation, which

was supported by the U.S. National Institutes of Health.

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Differences in the Chemical Composition of the Phage Nucleic Acids

IT has been known for some time that the nucleic acids of the coli-dysentery phages, T_2, T_4 and T_6, contain hydroxymethylcytosine and that the composition of their purine and pyrimidine bases is essentially identical[1]. More recently it was found in this laboratory that a hexose is present in T_4 phage[2]. This sugar was identified as glucose and was shown to be a constituent of the viral nucleic acid[3]. It was afterwards demonstrated that T_2 and T_6 nucleic acids also contain glucose and that enzymatic hydrolysates of T_2 and T_4 nucleic acids contain small quantities of the glucoside of hydroxymethylcytidylic acid[4,5]. In the present communication it will be shown that the nucleic acids of T_2, T_4 and T_6 phages differ in their content of glucose and that this hexose is attached to the acid-resistant part of nucleic acid, the apurinic acid.

The wild type (r^+) strains of T_2, T_4 and T_6 viruses were used in this study. They were grown on *E. coli B* in synthetic medium and purified by procedures already described[6]. In order to obtain the viral nucleic acids, aqueous suspensions of the phages were repeatedly frozen and thawed and then deproteinized with chloroform and octyl alcohol in presence of 1 *M* sodium chloride. The nucleic acids were precipitated with ethanol, then dialysed and dried from the frozen state.

The materials thus obtained formed viscous solutions and showed adsorption spectra characteristic of nucleic acid. Their atomic extinction coefficients ($\varepsilon(P)$ at 260 mμ) varied between 7020 and 7280. From Table 1 it can be seen that the nucleic acids derived from T_2, T_4 and T_6 phages differed slightly yet significantly in their nitrogen and phosphorus content. Colorimetric and chromatographic analyses revealed that deoxypentose as well as glucose were components of each. The purine-bound deoxypentose was determined quantitatively with diphenylamine using deoxyribose as a standard. Glucose was determined by means of the anthrone reaction. Since deoxyribose produces a colour with this reagent, absorption was measured at 620 and at 500 mμ and the content of glucose calculated according to the procedure of Knudson, Meloche and Juday[7]. The amount of deoxyribose in the three nucleic acids varied but slightly (18·8–19·8 per cent), whereas differences in glucose content were considerable. The T_2, T_4 and T_6 nucleic acids were found to contain 6·7, 8·4 and 12·0 per cent of glucose respectively. Thus, for each mole of phosphorus there was present 0·14 moles of glucose in the T_2 nucleic acid, 0·18 moles in the T_4 nucleic acid and 0·28 moles in the T_6 nucleic acid. Since each nucleic acid contained approximately 0·17 mole of hydroxymethylcytosine per mole of phosphorus[1] it is evident that the amount of glucose in the nucleic acids derived from T_4 and T_6 exceeds that of the pyrimidine. In the case of T_2 nucleic acid this amount is less.

Table 1. CHEMICAL COMPOSITION OF THE NUCLEIC ACIDS AND THE APURINIC ACIDS OF T_2, T_4, T_6 VIRUSES

	N (per cent)	P (per cent)	Glucose (per cent)	$\frac{[\text{Glucose}]}{[\text{P}]}$
T_2 nucleic acid	14·1	8·4	6·7	0·14
T_4 ,, ,,	13·8	8·0	8·4	0·18
T_6 ,, ,,	12·8	7·4	12·0	0·28
T_2 apurinic acid	5·9	9·8	7·9	0·14
T_4 ,, ,,	5·7	9·7	9·9	0·18
T_6 ,, ,,	5·2	9·0	14·0	0·27

In order to gain some information concerning the nature of the glucose linkage in the viral nucleic acids, the latter were hydrolysed with dilute sulphuric acid at *p*H 1·6 and at 37° C. After dialysis to remove purine bases, the apurinic acids were recovered by lyophilizing the residues[1].

The three viral apurinic acids showed typical absorption spectra when measured at *p*H 6·8, with maxima at 267–68 mμ and minima at 235–38 mμ; their atomic extinction coefficients ($\varepsilon(P)$ at 260 mμ) varied from 4050 to 4280. Chemical analyses revealed that each contained considerably less nitrogen and more phosphorus than the intact nucleic acids from which they were derived. The low molar ratio of N/P (1·3) indicated that on hydrolysis the bulk of the purines was split off. The content of deoxyribose and glucose was increased to 23·0–23·8 and 7·9–14·0 per cent respectively. The molar ratios of glucose to phosphorus were similar to those found in the viral nucleic acids themselves. This fact indicates that glucose is attached mainly to the acid-resistant part of the nucleic acid molecule.

From the data which have been presented, it is apparent that the nucleic acids of T_2, T_4 and T_6 phage differ from the usual nucleic acids in that they contain not only hydroxymethylcytosine but glucose as well. The amount of this saccharide in the three viral nucleic acids appears to be different. The evidence at hand indicates that glucose is bound to the apurinic part of the molecule, probably in the form of a glucoside of hydroxymethylcytidylic acid. Where more glucose than hydroxymethylcytosine is present, it is apparent that part of the sugar must be linked to the pyrimidine in a different manner, perhaps as a disaccharide. The confirmation of this must await further experimentation.

Since this communication was submitted for publication, a report describing variations in the glucose–deoxyribose ratio in r^+ and r variants of *T*-even phages has appeared[8].

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Physical Basis of Insect Repellency

The physical basis of insect repellency being unknown, the search for new repellents has had to be conducted on an essentially hit-or-miss basis. With the accumulation of evidence that the odours of substances may be correlated with the low-frequency, fundamental vibrations of their molecules[1], it seemed worth while to examine the absorption of some typical insect repellents in the far infra-red part of the spectrum.

The following commercial insect-repellent substances were available: dimethyl phthalate, indalone, 2-ethyl hexanediol-1,3, benzyl benzoate, *n*-propyl-N,N-diethyl succinamate and butoxy propylene glycol. In order to increase the statistical weight of the results, additional substances were chosen on the basis of ready availability from the extensive list of repellent chemicals published by Morton, Travis and Linduska[2].

These workers tested 6,241 chemicals as mosquito repellents. The tests were made by covering the forearms of test subjects from wrist to elbow with the chemical or with a treated cloth, and then exposing them in cages containing some thousands of unfed mosquitoes (*A. aegypti*). The substances were graded on the basis of the duration of protection they afforded, the most effective substances being placed in group 4 and the least effective in group 1. This method of screening could only have been approximate, and individual substances may now and then have been wrongly classified (benzyl benzoate, for example, was placed in group 1 and has since found application as a repellent); yet a random selection of compounds from group 4 may be expected to consist mainly if not entirely of repellents, and a similar selection from group 1 will be mainly non-repellent.

Fourteen substances showing grade 4 repellency were collected from available chemical stocks to give a test set of twenty repellents altogether. A control group of twenty non-repellent (group 1) substances was also assembled from available chemical stocks. Infra-red absorption curves were recorded in the region from 700 to 400 cm.$^{-1}$ using a Perkin-Elmer Model 21 infra-red spectrophotometer equipped with a potassium bromide prism and a linear wave-number cam. Liquids were examined as received. Solids were usually examined as mulls in 'Nujol' (which is transparent in this region) or, in a few cases, as compressed films with potassium bromide.

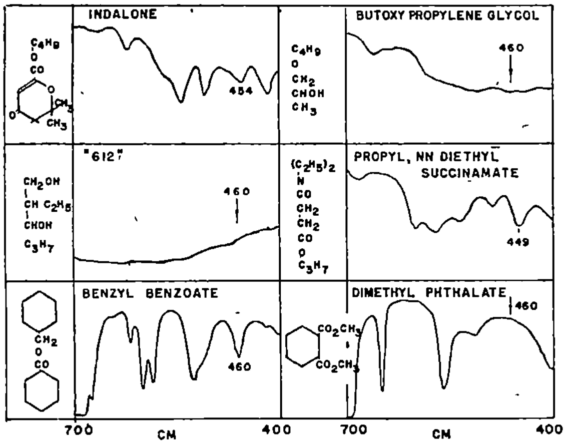

Fig. 1

The absorption curves of the six commercial repellents are shown in Fig. 1. The results exhibit a striking correlation in the part of the spectrum near 460 cm.$^{-1}$. Of the whole group of twenty repellent substances, thirteen have peaks between 449 and 471 cm.$^{-1}$, three of the remainder show strong continuous absorption in this region, and three have nearby broad bands which overlap this region. Of the non-repellent substances, only one has a peak between 449 and 471 cm.$^{-1}$ and the rest with few exceptions show very little absorption in the neighbourhood of 460 cm.$^{-1}$.

The only marked exception in the repellent group is dimethyl phthalate, the repellent properties of which are well known; it has no absorption peak near 460 cm.$^{-1}$. This substance is, however, one of the few members of the repellent group the structure of which is sufficiently symmetrical for certain vibrational modes to be inactive in the infra-red. It may be significant that the Raman spectrum of this substance[3] has a line at 230 cm.$^{-1}$.

Thus the conclusion seems inescapable that the physical basis of mosquito repellency is a molecular vibrational mode capable of giving rise to infra-red absorption or Raman scattering near 460 cm.$^{-1}$ (or 21·7μ). Whether other species of insect are repelled by molecules exhibiting this or some other characteristic frequency is not yet known. The practical value of these results in screening new substances for mosquito repellency will be evident at once. Their bearing on the general problems of olfaction is to lend support to the hypothesis that the low-frequency vibrations of molecules provide the physical basis of their odours. A discussion of the mechanism whereby such vibrations may be able to trigger nerve discharges will be published elsewhere.

I thank the Van Ameringen Co., Firmenich, Inc., and Dr. Hubert Martin for the gift of samples.

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Effect of Fungicides on Fungus Enzymes

Evidence has already been obtained to show that an important mechanism of the toxic action of fungicides is the inhibition of fungus enzymes. Copper and mercury are known to inhibit different systems, including those concerned with carbohydrate metabolism[1]. Rich and Horsfall[2] have investigated the action of phenols and quinones upon polyphenol oxidase, while Owens[3] has examined the effect of organo-sulphur compounds, phenols, quinones and metal compounds upon amylases, polyphenol oxidase and catalase. Attention has been given to the mode of action of different types of derivatives of thiocarbamic acid. Weed, McCallan and Miller[4] found that ferbam (ferric dimethyldithiocarbamate) inhibited urease, whereas nabam (disodium ethylene bisdithiocarbamate) had little effect. Sisler and Cox[5] attribute the toxicity of thiram (bis(dimethylthiocarbamoyl) disulphide) largely to the inhibition of the enzyme triosephosphate dehydrogenase. The activity of 8-hydroxyquinoline has been ascribed[6] to chelation with metal ions essential for enzyme action. Owens[7] has shown that captan (N-trichloromethylthio-*cyclo*hex-4-ene-1,2-dicarboxyimide) prevents the assimilation of inorganic phosphate, and Hochstein, Cox and Sisler[8] have reported that this compound affects cellular metabolism by blocking key decarboxylation reactions.

We have examined the effects of four fungicides upon enzymes of *Sclerotinia laxa* Aderh. and Ruhl., the fungus responsible for the blossom wilt disease of fruit trees. The fungicides used were captan, copper (as sulphate), lime sulphur and *o*-phenyl phenol. Cultures of the fungus were grown on dextrose–peptone–phosphate liquid medium, in which the fungicides were incorporated in amounts found by trial to produce approximately 50 per cent inhibition of growth after incubation at 25° C. for seven days. The fungus felts were washed with water and frozen at −17° C. for 12 hr. or more before grinding them with three times their weight of cold 0·1 *M* phosphate buffer, *p*H 7·5, in a mortar and then in a Ten Broeck glass macerator at 0° C. The homogenate was centrifuged at 2,000 *g* for 10 min. at 4° C. The cell-free extracts were dialysed for 12 hr. against the buffer in which they were prepared, so as to reduce the endogenous rates of the enzymes examined. The following enzymes were determined in 'phosphate' extracts: catalase, peroxidase, cytochrome *c* oxidase and reductase, diphosphopyridine nucleotide oxidase (diaphorase), succinic, *iso*citric and glutamic dehydrogenases, fumarase and polyphenol oxidase. Tris(hydroxymethyl)aminomethane (0·1 *M*, *p*H 7·5) extracts of the felts were used for the determination of hexokinase, aldolase and alkaline phosphatase.

Protein was determined in the extracts by the method of Folin, and enzyme activities were expressed in units per milligram protein (specific activities). The results are shown in Table 1.

Lime sulphur markedly depressed the iron enzymes, but showed little further effect beyond a stimulation of aldolase. Copper treatment appreciably reduced aldolase and fumarase and stimulated diphosphopyridine nucleotide oxidase and hexokinase. Treatment with captan enhanced diphosphopyridine nucleotide oxidase and depleted glutamic dehydrogenase. *o*-Phenyl phenol depressed the flavoprotein diphosphopyridine nucleotide oxidase system.

It is interesting to note that while copper depressed cytochrome *c* oxidase, it exerted a compensating effect by stimulating the alternative diphosphopyridine nucleotide oxidase system for electron transport. The reverse, however, is seen with *o*-phenyl phenol, where a reduction in the activity of diphosphopyridine nucleotide oxidase was accompanied by an increase in that of cytochrome *c* oxidase.

Table 1. EFFECT OF FUNGICIDES ON ENZYMES OF *S. laxa*

Enzyme	Captan	Copper	Lime sulphur	*o*-Phenyl phenol
Catalase	+	−	− −	−
Peroxidase	−	0	− −	−
Cytochrome *c* oxidase	0	− −	− −	+ +
Cytochrome *c* reductase	+	−	− −	+
Diphosphopyridine nucleotide oxidase	+ +	+ +	+	− −
Succinic dehydrogenase	0	0	−	−
*iso*Citric dehydrogenase	−	−	−	0
Glutamic dehydrogenase	− −	−	+	0
Hexokinase	0	+ +	−	0
Aldolase	−	− −	+ +	0
Alkaline phosphatase	0	0	−	0
Fumarase	−	− −	−	0
Polyphenol oxidase	−	−	0	+

−, Some depression; − −, marked depression; 0, no effect; +, some stimulation; + +, marked stimulation.

Further studies may lead to a more rational selection of toxicants for the control of pathogenic fungi. The work is being extended to include other fungi and fungicides.

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Antibacterial Substances in Seeds

WHILE investigating the physiology of germination, it was noted that micro-organisms occurring on the seeds of certain species proliferated rapidly during germination, whereas the seeds of some other species, germinating under the same conditions, remained sterile. It seemed obvious that certain seeds must contain and release—during germination—compounds that are able to inhibit the growth of certain micro-organisms. In order to examine this hypothesis, the antibacterial effect of seeds of several species and varieties of plants has been investigated.

To carry out these examinations the agar-diffusion method[1] seemed to be the most adequate. In a Petri dish fresh bacterium suspension was run on to a solid, 5 mm. thick bouillon agar-plate, containing 2 per cent agar at *p*H 7. After removing the excess and having dried the surface, the experimental seeds were sunk into the culture medium. As the micro-organisms to be tested have been selected from the rapidly proliferating species, a previous disinfection of the seeds that might dissolve the antibacterial compounds was unnecessary. The time of incubation was 20 hr. at 30° C. The clear zones occurring during this time indicated the presence of antibacterial compounds and their size gave information about the intensity of the effect.

Whole seeds were examined, as the natural process of germination was considered to be of chief importance. The only exceptions were the species of *Fraxinus*, the seeds of which, cut transversely, were placed on the agar plate in order to see whether the compound within the seeds inhibiting the germination[2] inhibited growth of the bacteria as well.

The behaviour of seeds not more than a year old of four hundred species and varieties of higher plants belonging to seventy families has been observed by the method above described. In every case eight bacterial strains were used as test micro-organisms. Gram-positive: *Bac. cereus* var. *mycoides*, *Bac. megatherium* 208, *Bac. subtilis* var. *panis*, *Staphylo-*

coccus aureus; and Gram-negative: *Aerobacter aerogenes*, *Erwinia carotovora*, *Shigella flexneri VI* and *Xanthomonas malvacearum*.

The seeds of thirty-six species of plants yielded positive results. In most cases the effect was selective, the diffusing compounds inhibiting the increase of only the Gram-positive bacteria. The inhibitor of the *Fraxinus* species proved effective also against most Gram-negative test micro-organisms. The effect on the Gram-positive bacteria was of similar intensity.

With *Bac. cereus* var. *mycoides*, clear zones of a diameter of more than 1 cm. were produced by the seeds of the following species: *Abies alba*, *Aristolochia clematitis*, *Geranium silvaticum*, *Hypericum elegans*, *Juniperus chinensis*, *Kniphofia aloides*, *K. hybrida*, *K. praecox*, *K. tuckii*, *K. uvaria*.

Zones of 5 mm. diameter or more: *Aristolochia fimbriata*, *Atriplex hortensis*, *A. nitens*, *Cannabis sativa*, *Chenopodium polyspermum*, *Consolida ajacis*, *C. orientalis*, *C. regalis*, *Fraxinus excelsior*, *F. pennsylvanica*, *Maclura aurantiaca*, *Pinus strobus*.

Zones of less than 5 mm.: *Amaranthus ascendens*, *Chenopodium album*, *Ch. bonus*, *Ch. urbicum*, *Kochia scoparia*, *Picea alba*, *P. excelsa chlorocarpa*, *Pinus nigra*, *Pseudotsuga douglasii*, *P. taxifolia*, *Stachis annua*, *Verbena canadensis*, *V. officinalis*.

Certain seeds—generally known to contain antibacterial compounds (*Gynocardia*, *Hydnocarpus*[3], Cruciferae[4–6])—gave no positive results in the present study. The reason is that the active compounds are located in the inner parts of these seeds and are, as a rule, released only by ferments[5,6].

The diffusing compounds observed in the present cases, except the inhibitor of the *Fraxinus* species, are localized in the seed-coat. The active substance of the seeds of *Kniphofia* species has been isolated. Isolation of active substances from other seeds has been started. The detailed results will be dealt with elsewhere.

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Alternaria within the Pericarp of the Wheat Seed

In 1951, Miss Hyde[1] obtained from the basal internode (about 1–2 in. long) of flowering stems of Barsée wheat and from stems immediately below the inflorescence, under aseptic conditions in culture plates, *Alternaria tenuis* in 40 and 43 stems out of 70. In 1953, I[2] published a note on the apparent symbiotic nature of *Alternaria tenuis* within the pericarp of some local wheat seeds. Since then, in the winters of 1953 and 1954, I carried out aseptic culture of our common wheat seeds within two sterilized glass chambers where aseptic seedlings from malt agar tubes were planted on sterilized manured soil, making provision for circulation of pure air which was sucked through cotton-wool in glass tubes by means of a water tap suction pump, and sterilized water, passing through a horizontal glass tube inserted through an air-tight hole on the chamber wall, dropped direct on the seedlings half an hour every day for two and a half months from early November. The two glass chambers were quite similarly fitted. In one glass chamber aseptic seedlings were prepared in the following way: wheat seeds were surface-sterilized with 0·1 per cent mercuric chloride for six minutes, washed three times in sterilized distilled water and planted in malt-agar tubes where they germinated into seedlings in the course of four days. In the other glass chamber, *Alternaria tenuis* was eliminated from the aseptic seedlings in the following way: wheat seeds in sterilized water in a test-tube were exposed to a temperature of 53·5°–54° C. in a water-bath for ten minutes to kill *Alternaria* within the seed coat; they were then cooled, surface-sterilized with 0·1 per cent mercuric chloride for six minutes as before, washed three times in sterile distilled water and planted into malt-agar tubes for germination into seedlings. The temperature of two glass chambers was 10–15 degrees higher than that of the laboratory and they were usually in a very humid condition during the experiment. In the course of a month and a half it was found that the growth of plants and number of tillers under sterilized conditions in the glass chamber where *A. tenuis* was not eliminated were more vigorous and more numerous than those of the plants in the chamber where the *Alternaria* was eliminated by hot water treatment. Thus, the presence of *Alternaria tenuis* within the wheat plants in this case seems distinctly helpful.

Discussing the black point disease of wheat in the United States, Hansen and Christensen[3] in 1953 held from replicated tests that "*Alternaria* infection does not cause any appreciable reductions in stand or any seedling blight and that *Alternaria* has little, if any, deleterious effect on the value of the infected grain for seed". Their final conclusion was that "*Alternaria*, although the most prevalent fungus, was either non-pathogenic or weakly pathogenic and never caused seedling blight of wheat in the greenhouse or field".

But in February 1955 there was a report[4] of severe leaf spot disease of 'durum' wheat by an *Alternaria* sp. from Cuttack (Orissa), Central Rice Research Institute; the brown spotting on leaves, which from a distance looked like rust, was so extensive that ultimately the yield was considerably reduced, leading to almost a complete failure of wheat crop. In this case the disease was strictly confined to 'durum' wheat and common varieties of wheat were free from it. A similar outbreak of severe leaf spot disease of 'durum' wheat by *Alternaria* sp. was noted by Mehta[5] in 1950 from the Research Farm of Kanpur, Uttar Pradesh of India. He established the parasitic nature of that *Alternaria* sp. by inoculation experiment on 'durum' variety with pure culture of his isolation of *Alternaria* from leaf-lesions of the wheat. Mehta held that the disease was seed-borne. Some data, however, are lacking, if the seeds sown in the field in both cases originally harboured the same *Alternaria* sp. within the seed coat of 'durum' wheat, and the species of *Alternaria* here has not been determined. In this connexion it may be remarked that no sharp lines of demarcation can be drawn between symbiotic interrelationship and antagonistic effects and that symbiosis and parasitism (antagonism) have much in common both physiologically and morphologically; the one may be converted into the other by a comparatively slight change of circumstances.

Studying spore production by *Helminthosporium avenae*, Grainger[6] found "no correlation between spore-liberation and general climatic conditions, i.e., temperature, relative humidity and wind velocity", ontrary to the experience of plant-pathologists in any plant diseases. He suggests that as the factor annot be climatic in this case, "an investigation of onditions within the host plant itself is most likely o provide an explanation". I think in wheat rust imilar study of conditions of growth within the wheat lant may yield some clue to the main problem of radication. So far, at wheat rust study centres no ttention in this direction seems to have been paid.

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Effect of Crowding during the Larval Period on the Determination of the Wing-form of an Adult Plant-hopper

The effect of crowding on the physiological and orphological characters of larvæ or adult has ttracted much attention. Comprehensive reviews ave been published by Allee[1], and recently by hauvin[2]. The latter distinguished two categories in he general effect of crowding, "l'effet de masse" and l'effet de groupe", which had been proposed by rassé. Bonnemaison[3], in his studies on the factors ffecting the appearance of the winged form in phids, and Badonnel[4], working on the complete evelopment of the wings in Psocoptera, found that he most important effect of crowding occurs during he developmental period.

I am investigating the factors determining the ing-form, macropterous or brachypterous, of plant-oppers, and I have found that crowding during he larval period plays an important part in the etermination of wing-form in the brown plant-opper, *Nilaparvata lugens* Stål.

The brown plant-hopper is a serious pest of the ce plant in Japan. The macropterous form has ormal fore- and hind-wings; but the brachypterous rm has the fore-wings of half the normal length d rudimentary hind-wings, and this form conquently cannot fly. Macropterous males and females ppear at first in the paddy fields in early summer. rachypterous females appear afterwards and inrease in number during the summer and autumn. y late autumn, when the rice plants ripen, the acropterous form becomes prevalent again. Brachyterous males appear in late summer and autumn ut are less frequent than females.

Larvæ were put into test-tubes (2 cm. in diameter nd 17·5 cm. in length) within 24 hr. of hatching, ith a leaf blade of rice plant in each for food. A w drops of water were poured into each tube. Food d container were renewed at intervals of 1, 2 and days in each series of density.

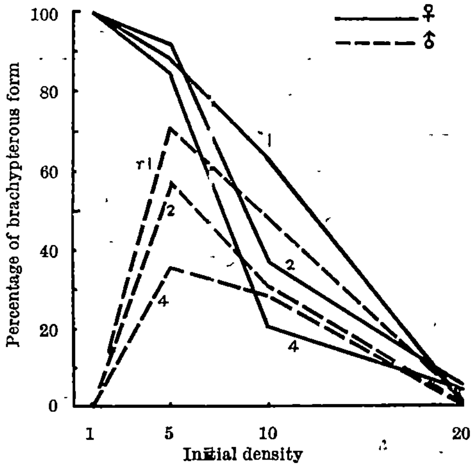

Fig. 1. Percentage of the brachypterous form of both sexes resulting from a breeding experiment in which the initial density and interval of renewal of the food and container were varied

The result is shown in Fig. 1. At the lowest density e figures differ extremely with sex; all emerged males are brachypterous and males are macroterous. With increase of density, the percentage of e macropterous females increases and reaches almost 00 per cent at a density of 20. On the other hand, in the males, the brachypterous form appears in the middle range of density. At greater densities, the macropterous form increases again with the density in parallel with the females. Therefore, the optimal density for the appearance of the brachypterous male can be determined.

On the other hand, the effect of freshness of food and change of container has also to be appreciated. When the interval of renewing food and container is prolonged, the appearance of the macropterous form is accelerated in both sexes. This effect is most clearly shown in the middle range of density. It seems probable that the larvæ are at the critical state for determining their form at that density.

The larval period of the various forms is shown in Table 1; that for the brachypterous form of both sexes is shorter than that for the macropterous form. The former shows a rather constant period even at high densities, whereas that of the latter shows a lengthening effect. Examined in more detail, it is found that at the density of 5 at which the brachypterous male appeared in highest proportion, this form is the group having the shortest period of larval development. This larval period is shorter than that of the macropterous male, which appeared exclusively at a density of 1. This acceleration of

Table 1. Duration of the Larval Development of the Various Forms resulting from a Breeding Experiment in which the Initial Density and Interval of Renewal of the Food and Container are Varied. *B* denotes the Brachypterous Form and *M* the Macropterous Form

Interval of renewal = 1 day

Density / Form and sex	1	5	10	20
B♂		14·2	14 1	
M♂	14·7	14·5	16·1	17·2d.
B♀	15·2	15·5	16·6	18 0*
M♀		15 5	17·5	18·9
r = 2				
B♂		14·2	14·3	
M♂	14 5	14·2	15·2	17·5
B♀	15·3	15 2	15 7	
M♀		16·3	17 4	19·7
r = 4				
B♂		13·8	14 8	
M♂	14·5	14 6	15·4	17·0
B♀	15·1	15·1	16 0	18·0*
M♀		15 4	17 2	18·2

* Only one obtained

Table 2. NUMBER OF ADULTS OF THE VARIOUS FORMS RESULTING FROM BREEDING WITH THE LEAF BLADE IMMERSED IN VARIOUS SOLUTIONS OF SALT. INITIAL DENSITY WAS 5 PER TUBE IN EACH BLOCK

Solution	No. of replicates	No. of adults emerged				
		B♂	*M*♂	*B*♀	*M*♀	Total
Copper sulphate	10	0	0	0	0	0
Ammon. sulphate	10	1	26	3	17	47
Mag. sulphate	10	7	16	15	9	47
Pot. chloride	10	11	16	14	9	50
Control	10	13	13	19	2	47

larval development seems to be due to mutual stimulation among the members in a tube.

Other experiments have shown that the wilting of the host plant produces the macropterous female without the effect of crowding, accompanied by the considerable elongation of the larval period. This fact seems to be responsible for the prevalent appearance of the macropterous female in the field in late autumn.

Various solutions of salts were used instead of water in the test-tubes for examining their effectiveness for the determination of the various forms. The concentration of each solution was 0·05 mol. The initial density used was 5. Food and container were renewed every day and no wilting of the leaf blade was observed, except when copper sulphate solution was used; in that case all larvæ died in a few days (Table 2). These solutions show, more or less, the effectiveness on the production of the macropterous form in both sexes. Parallel decrease in the percentage of the brachypterous form is clearly shown in both sexes, though the absolute figures for the brachypterous females in each treatment always exceed those of males.

The observations lead to the following conclusions.

(1) Low density under favourable conditions of food supply during the larval period is necessary for the appearance of the brachypterous female. On the other hand, optimal density under favourable conditions of food supply produces the brachypterous male. The mechanism of the different responses of the sexes to crowding remains to be found.

(2) Optimal crowding accelerates the development of the larvæ, and this fact seems to be responsible for the mechanism inducing the appearance of the brachypterous male at the optimal density.

(3) Wilting of the host plant, overcrowding, contamination due to crowding and solutions of several salts have the effect of producing the macropterous form, and this effect is followed by lengthening of the developmental period of the larvæ subjected to these conditions.

(4) Factors causing the appearance of the brachypterous form must be studied in parallel with those leading to the appearance of the macropterous form, especially the males, as shown in the present communication.

The advice of Prof. S. Utida of this Laboratory is gratefully acknowledged.

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An Apparent Reaction of Fish to Linear Accelerations

IT has been reported that fish do not appear t react to rectilinear accelerations[1]. However, the have the sense organs to detect such movements ; th otolith organs of the thornback ray are sensitive t linear translations in all three planes of space[2] an teleosts take up compensatory positions when subjected to centrifugal force[3]. Some experiments wer therefore made to re-examine the reactions of fish t rectilinear accelerations, blinded minnows, goldfis and naturally blind cave characins, *Anoptichthy jordani*, being used in the preliminary observation The fish were placed in an enclosed 'Perspex' tank completely filled with water, and mounted on rubber-wheeled chassis. They appeared to turn abou when the tank was accelerated along a bench b hand.

The reactions of blind goldfish were then studie in a more quantitative manner. A fish was introduced into an enclosed 'Perspex' tank, 60 cm. long 30 cm. × 15 cm. in section, which was filled with wate The tank was housed in a welded angle-iron chassi fitted with flat rubber-tyred wheels running on 4-m. long railway made from ¾-in. steel rod firml attached to sleepers. The chassis was attached to rope which ran over two pulley wheels so arrange that the vertical fall of heavy weights would accelera the tank horizontally along the railway. When th weights hit the ground, the forward movement of th tank was checked by a rope attached at one end t a wall and at the other to the tank by a short lengt of rubber tubing. A range of accelerations an decelerations was covered by varying the weight and the forward run of the tank. The movemen of the tank relative to the ground and that of th fish relative to the tank was recorded by a 16-mm ciné camera mounted vertically above the railway Releases were only made when the fish was in mid water and well clear of the sides of the tank, an when it was swimming more or less in a straigh line either with or against the movement of the tank

The results showed that blind goldfish would tur about when suddenly stopped going forward, or whe suddenly started backwards, but not when starte going forwards or when stopped going backwards An analysis of two typical results is given in Figs. and 2. The orientation of the fish is given relativ to the longitudinal axis of the tank, a bearing of 0 indicating that the fish was facing in the directio of the tank's movement. In Fig. 1 the tank wa released so that the fish was accelerated backward and it turned about. When the tank slowed down the fish was decelerated while travelling forwards an turned again. In Fig. 2 there was no reaction to a acceleration when the fish was going forward, bu the fish turned on deceleration. A positive reactio was thus only observed when the otolith organs wer displaced anteriorly, as indicated diagrammaticall in the figure.

The threshold acceleration to induce a reactio was high, positive results being obtained only wit accelerations or decelerations greater than 160-200 cm./sec./sec. In both Figs. 1 and 2 it will b seen that the tank recoiled after its forward movement was checked. In some experiments a fish wa observed to turn both when the tank slowed dow and when the recoil movement slowed down.

While there is an apparent reaction of blind goldfis to linear accelerations, the results do not show con-

Reactions of Blind Goldfish to Accelerations

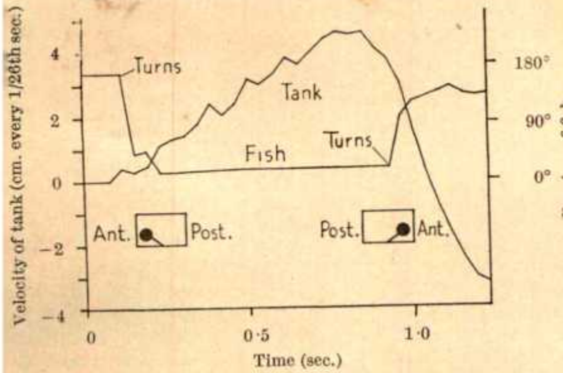

Fig. 1. Fish accelerated backwards. Acceleration, 170 cm./sec.^{2}; deceleration, 364 cm./sec.^{2}.

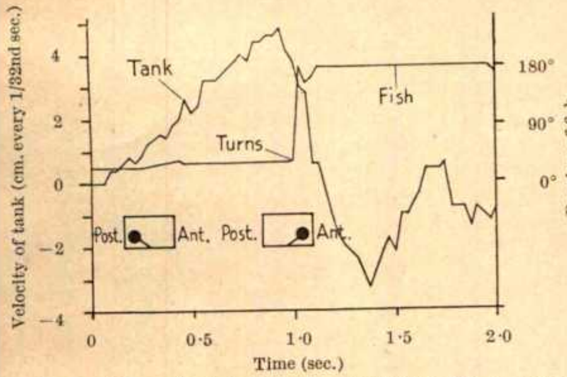

Fig. 2. Fish accelerated forwards. Acceleration 176 cm./sec.^{2}; deceleration, 710 cm./sec.^{2}.
The fish only appears to turn when the otolith organs are displaced anteriorly

clusively that the stimulus to which the fish responds is labyrinthine in origin. With these particular fish it was not possible to release the tank when they were at right angles to its line of movement, as they swam for the most part up and down the length of the tank. Furthermore, unless the ciné camera is mounted on the chassis itself, it is not possible to detect movement of the water relative to the fish, or to study the nature of any eddies or swirls that might be set up in the tank, all of which might stimulate the fish. In the early stages of this work, it was thought unwise to risk the camera in this way; but further experiments with other fish are now planned to look into these points.

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The Basement Membrane – Elastica System of the Dermo-Epidermal Junction

Reports (based on electron microscopy)[1] of the presence of a subepidermal basement membrane in human skin conflict with the orthodox histological view[2] that dermo-epidermal adhesion is effected by an interlocking of the subepidermal 'reticular fibres' with the foot processes of the basal cells, and that no basal membranous structure apart from this layer of reticulin exists.

A more satisfactory account of the stabilizing mechanism of the human dermo-epidermal junction can now be offered.

The basic dye alcian blue used in buffered aqueous solutions of *p*H 1·2–2·0 will stain certain tissue structures which are not generally basophilic even at higher *p*H levels. These structures comprise collagenous and reticular tissue, and various basement membranes (for example, subepidermal, vascular sub-endothelial, glomerular, renal tubular); and while previous treatment with testicular hyaluronidase prevents staining of the fibro-reticular tissue, basement membrane staining is unaffected. These results may indicate the presence of two chondroitin sulphate – protein complexes, one sensitive and the other resistant to hyaluronidase, like those isolated from rabbit skin[3]. The subepidermal basement membrane is also morphologically distinct from subepidermal reticulin; it appears as a delicate continuous tightly wrinkled band which is regular in thickness and discrete, whereas the reticulin forms a coarser interrupted layer of variable thickness which merges on its deep aspect with the fine dermal collagenous tissue.

Basement membranes are usually found in close association with reticulin; but in other respects (discreteness, optical homogeneity, apparent tenacity) basement membranes seem to have more in common with elastic tissue and even stain as elastica in certain sites (for example, around sweat glands).

It has been found that in tissue sections treated with the 'Mallory bleach', alcian blue will reveal certain additional tissue structures, some keratinous and others elastic. The elastic group comprises the sheaths of all those relatively coarse elastic fibres and laminæ demonstrable by recognized methods together with other very fine membranes and fibres, which in sections counterstained with orcein are often clearly continuous with the coarser fibres or their sheaths. In particular, the thin elastic fibres, which fan out as branches of the papillary layer of the dermal elastic plexus and run up towards the epidermis, are seen to consist of a brown orcein-

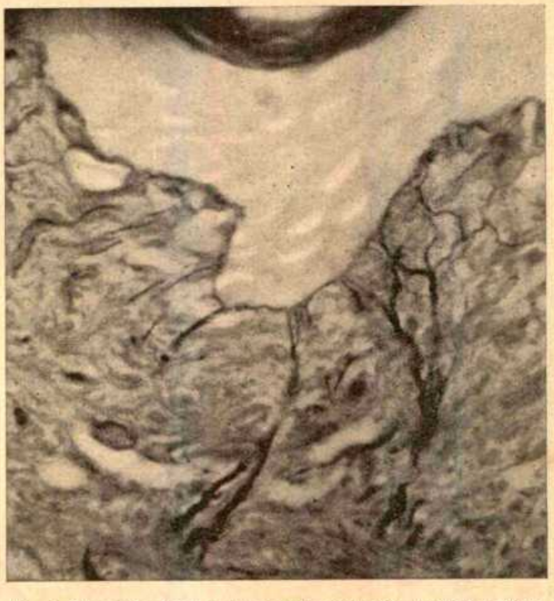

Fig. 1. The subepidermal basement membrane – elastica system. Hyaluronidase; permanganate bleach; alcian blue, *p*H 1·2 orcein. × 870

stained core (which tapers away into invisibility before the dermo-epidermal junction is reached) and of a blue sheath, which terminally remains visible as a delicate band and carries on to fuse with the blue subepidermal basement membrane.

Thus it appears that the epidermis is attached to the corium by continuity of the dermal elastic plexus with the subepidermal basement membrane, which itself must either be cemented to, or actually incorporate, the cell membrane of the inferior surface of each basal cell.

Finally, as basement membranes stain more strongly with alcian blue if the bleaching procedure is first performed, they may also contain that elastic tissue component which binds alcian blue after oxidation by permanganate. Basement membranes and elastica may form a morphological and chemical continuum analogous in some ways with the reticulin–collagen system.

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Demethylation of Dimethylnitrosamine in Rats and Mice

Dimethylnitrosamine is a powerful liver poison and carcinogen[1,2], the mode of action of which is being studied in these Laboratories. As part of this programme, we have investigated the metabolic products from rats and mice using (^{14}C) dimethylnitrosamine[3].

From both rats and mice the main radioactive product is expired carbon dioxide. Thus 50 mgm. of dimethylnitrosamine/kgm. were injected subcutaneously into a mouse, and 6 hr. after injection 65 per cent of the injected carbon-14 was recovered as expired carbon dioxide. The carbon-14 recovered as carbon dioxide from rats injected at the same dose-rate is shown in Table 1. About 40 per cent is recovered in the first 8 hr., after which only trivial amounts are expired. The remainder of the carbon-14 appears to be fairly evenly distributed in the tissues at the end of the experiment, except for some 7 per cent which appears in the urine.

Table 1. Percentage of Total Carbon-14 injected into Rats recovered as Expired Carbon Dioxide

Time (hr.)	0·5	1	2	4	8	12	24
Per cent recovered	1·1	4·1	11·3	29	41	42	45
	0·9	3·3	10·5	21	37	42	44·4

These results indicate that dimethylnitrosamine is demethylated, presumably via formaldehyde, which would explain the expiration of much of the carbon-14 and the very general distribution of the remainder. The metabolism is thus closely analogous to that of the several N-methyl substituted aminoazobenzenes studied by Miller *et al.*[4].

The rapidity with which dimethylnitrosamine is metabolized makes it necessary to consider the possibility that the biochemical lesion is produced by a metabolite, and not by dimethylnitrosamine itself. The first signs of histological damage[1] to the liver have been observed only at a time when the degradation of dimethylnitrosamine is practically complete, which is not inconsistent with such a hypothesis.

It is hoped to publish this work more fully elsewhere.

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Active Secretion of Sodium Ions from Isolated Sodium-rich Skeletal Muscle

The isolated sartorius of the frog, when immersed in Ringer fluid with normal potassium content, loses potassium and gains sodium rather rapidly at room temperature[1]. This also occurs at 0° C., but at a slower rate, the gain of sodium being greater when potassium-free Ringer is used[2]. When this potassium-free Ringer fluid has the same average inorganic composition as frog plasma[1] with a sodium content of 104 mM, the change in muscle sodium overnight is from its normal content of 24 m.equiv./kgm. to 47 m.equiv./kgm. (the average change in weight being only $-1·2$ per cent). If companion muscles are similarly treated and then immersed at room temperature for 2 hr. in similar fluid containing 10 m.equiv. potassium / litre, but the same concentration of sodium, there is no appreciable excretion of sodium. Steinbach's conclusions[3] to the contrary have been shown to depend very largely, if not altogether, on a faulty statistical procedure.

Similarly, if the potassium-free fluid contains 120 m.equiv. sodium/litre and the re-immersion fluid has the same sodium concentration but 10 m.equiv. potassium/litre, there is no net excretion after two hours[4].

Confirming the observations of Desmedt[5], on the other hand, we found that if the potassium-free Ringer fluid contained 120 m.equiv. sodium/litre and the companion muscles are re-immersed in fluid containing 104 m.equiv. sodium/litre with 10 m.equiv. potassium/litre, there is a marked excretion of sodium, far beyond what could be explained simply by passive diffusion from interspace fluid or injured fibres.

The magnitude of the changes are shown in the accompanying diagram (Fig. 1, *A*, *B* and *C*). The heights of the columns express the average sodium content of the fibre water. In calculating this concentration, an effective interspace volume of 0·13 litre per kilogram muscle is assumed[1]; also an additional 8 m.equiv. of sodium is considered as held in some external fibre region[4]. The total sodium external to the fibre water and represented as m.equiv./kgm. muscle is thus approximately 20 per cent of the external sodium concentration. (For the relative changes described here it makes no essential difference whether the above procedure is adopted or whether one regards the total sodium minus the interspace sodium as existing in the fibre water.)

The number of experiments and muscles used in Fig. 1 is as follows: *A* (120/120) 12 experiments,

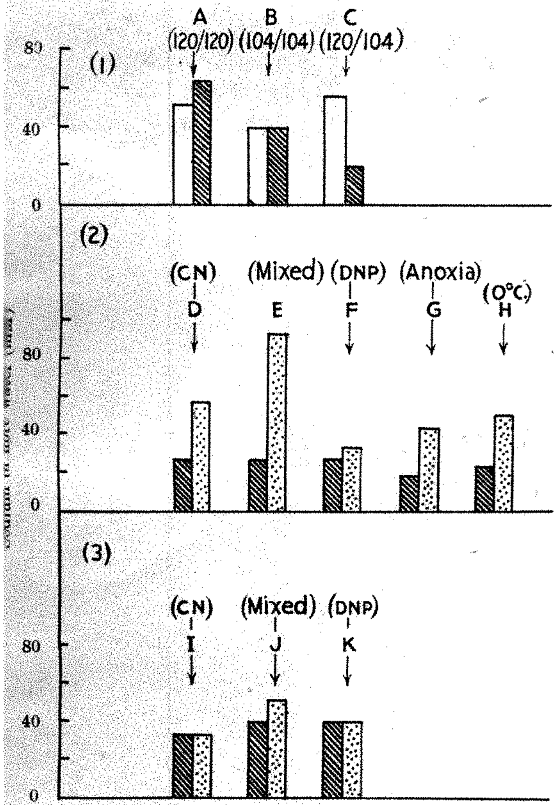

Fig. 1. (*A*) (120 : 120): Muscles immersed in potassium-free Ringer–Conway fluid (containing 120 m.equiv. sodium/litre) and reimmersed at room temperature for 2 hr. in similar fluid containing 120 m.equiv. sodium/litre and 10 m.equiv. potassium/litre. (*B*) (104 : 104): As in (*A*); the first and second fluids containing 104 m.equiv. sodium/litre and 10 m.equiv. potassium/litre. (*C*): (120 : 104): As in (*A*); the second fluid containing 104 m.equiv. sodium/litre and 10 m.equiv. potassium/litre

Fig. 2. (*D*): As in (*C*); one second immersion fluid containing 2 mM cyanide. (*E*): As in (*C*); mixed inhibitors (cyanide, 2.4-dinitrophenol and iodoacetate, each 5 mM) in one second fluid. (*F*): As in (*C*); 2.4-dinitrophenol (2 mM) in one second fluid. (*G*): As in (*C*); one second fluid free of oxygen. (*H*): As in (*C*); one second fluid at 0° C.

Fig. 3. (*I*): As in (*B*); cyanide (2 mM) in one second fluid. (*J*): As in (*B*); mixed inhibitors in one second fluid. (*K*): As in (*B*); 2.4-dinitrophenol (2 mM) in one second fluid

muscles; *B* (104/104) 51 experiments, 306 uscles; *C* (120/104) 55 experiments, 330 muscles. he symbol 120/120 signifies that the sodium connt of the potassium-free Ringer was 120 mM, as so that of the second immersion fluid, and similarly ith the other symbols.)

The considerable fall of muscle sodium in *C* is ery striking and such excretion we have found variably under these conditions. The active nature this excretion involves metabolic energy, as is own by the effect of inhibitors (Fig. 2). The contions were as in Fig. 1*C*, that is, immersion in e potassium-free Ringer fluid containing 120 .equiv. sodium/litre and re-immersion in 104 m.equiv. dium/litre with 10 m.equiv. potassium/litre. The tched columns give an average sodium content ter 2 hr. of the second immersion without inhibitor. will be seen from Fig. 2*D* that when 2 mM anide is present in the re-immersion fluid, there is nsiderable inhibition of the sodium excretion, the vel after 2 hr. being practically unchanged with spect to the muscle content after overnight imersion (13 experiments, 78 muscles). Fig. 2, *G* and show the effect of anoxia and of 0° C. (4 experiments in each, 48 muscles). It will be seen that there is considerable inhibition here also and very little, if any, active excretion. Fig. 2*F* shows the effect of 2.4-dinitrophenol inhibition (10 experiments, 60 muscles) and is of particular interest because, although the inhibitor is in 2 mM strength, its effect is very slight. Fig. 2*E* shows the effect of 5 mM cyanide, 5 mM 2.4-dinitrophenol and 5 mM iodoacetate present together (20 experiments, 120 muscles). In this case, not only is there no active excretion, but there is an increased uptake of sodium, possibly due to some degree of damage to the membranes.

The series in Fig. 3 are in striking contrast to these results. In these experiments, the re-immersion fluid contains the same sodium content as the potassium-free Ringer, namely, 104 m.equiv. sodium/litre. It will be seen that 2 mM cyanide has no effect (13 experiments, 78 muscles), neither has 2.4-dinitrophenol (10 experiments, 60 muscles). Also the mixed inhibitors have a comparatively small effect, the sodium content being somewhat increased (20 experiments, 120 muscles).

The results shown in Figs. 1*A*, 1*B*, 3*I*, 3*J* and 3*K* are quite in accordance with the results of Keynes and Maisel[6], and although these showed a considerable flux of sodium-24 across the membrane, the above results suggest that such fluxes are largely, if not entirely, explained by exchange diffusion as described by Ussing[7].

The sodium content of the muscles has been expressed on the weights after the first immersion. If one considers here that the active net extrusion of sodium from sodium-rich muscles depends on the presence of oxygen and is practically completely inhibited by cyanide (2 mM) but very little, if at all, by 2.4-dinitrophenol (2 mM), it is in full accord with what one would expect from the action of a redox pump[8].

In a recent communication in *Nature*[9], Shaw and Simon reported results of experiments in which sodium-rich muscles were immersed in Ringer fluid, diluted 1 : 1 with isotonic glucose solution, and sodium-levels were expressed in a somewhat similar manner to the way adopted here. They found considerable emergence of sodium from the sodium-rich muscles. This, however, was not appreciably inhibited by cyanide, and hence would seem to be different in kind from the results described here, in which even 2 mM cyanide completely inhibits excretion. The sodium emergence described by these workers may be largely of a passive kind, though it would appear to be much reduced by low temperature. The findings are considered in greater detail elsewhere[10].

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Concentration of Thiocyanate labelled with Sulphur-35 in the Thyroid of the Hamster

THIOCYANATES are known to inhibit the concentration of iodide by the thyroid. We have found that labelled thiocyanate is concentrated in the follicles of the hamster's thyroid. Adult hamsters were given ^{35}S-thiocyanate (150 μc. with 100 μgm. of carrier) by intramuscular injection. The thyroid was removed 1 hr. later and dried from the frozen state at − 40° C. Contact autoradiographs were then made from sections of the dried tissue[1]. Patches of blackening were seen on the autoradiographs, corresponding to the areas of colloid in the section (Fig. 1). The density of the photographic grains over the centres of the follicles varied from 2·1 to 4·9 times the density over the centres of blood-vessels, the density over the smaller areas of colloid tending to be greater than that over the larger areas.

Thyroids were removed from other hamsters 1 hr. after injection of ^{35}S-thiocyanate and the radioactivity compared with that in the plasma and whole blood (unpublished work). The ratio of the concentration of sulphur-35 in the thyroid to that in the plasma averaged 0·57, and in the thyroid/blood it averaged 0·56. Portions of thyroid taken from the same hamsters were homogenized with water, and the whole homogenate chromatographed on paper with the solvents recommended by Pollard and McOmie[2]. The radioactivity on the chromatogram was found to be confined to two well-defined peaks, one at R_F 0·10 (the R_F value of sulphate ion in the solvents used) and the other at R_F 0·75 (the R_F value of thiocyanate ion) (Fig. 2). The first peak of radioactivity accounted for 5–15 per cent and the second peak for about 85 per cent of the total on the chromatogram. Chromatograms made from plasma taken at similar intervals after injection of ^{35}S-thiocyanate showed 95 per cent of their radioactivity at R_F 0·75.

We conclude that thiocyanate ions are concentrated in the follicles of the thyroid as the unbound ion, some of them undergoing chemical change in the thyroid, probably by oxidation to unbound sulphat The low value of the ratio of the concentration sulphur-35 in whole thyroid to that in the plasn may be explained by the small proportion of tl total mass of thyroid tissue in which selective co centration occurs, and by the presence of muscle ar connective tissue removed with the thyroid.

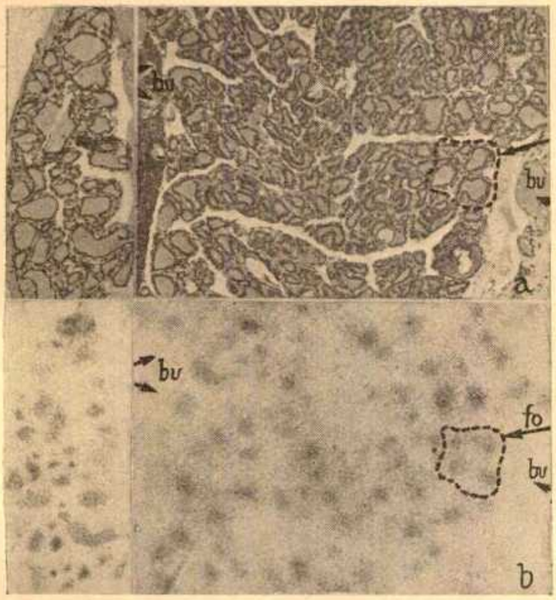

Fig. 1. Thyroid of hamster. (*a*) Sections stained with hæmotoxylin and eosin. (*b*) Autoradiographs from same sections. *fo*, Group of follicles; *bv*, blood-vessel. Corresponding areas shown on autoradiograph

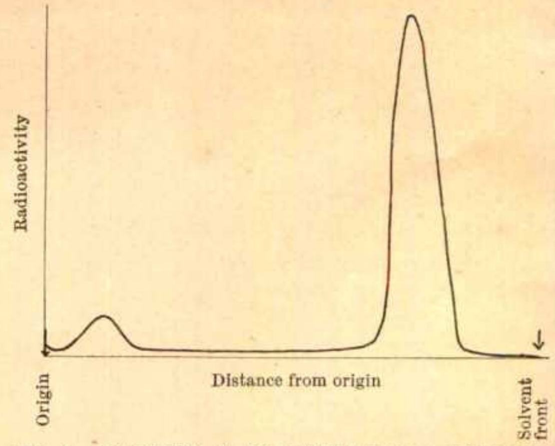

Fig. 2. Distribution of radioactivity along ascending paper chromatogram made from homogenate of thyroid 1 hr. after injection of ^{35}S-thiocyanate. Solvents: butanol, pyridine, water and ammonia

The pattern of blackening shown by ^{35}S-thi cyanate is similar to that shown by radioiodide wh thyroxine synthesis is blocked by propyl thiouraci This suggests that the inhibitory action of the thi cyanate ion on the concentration of iodide by tl thyroid is due to competition between the two io for the same transport mechanism.

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Octadecadienoic Acids of Lamb Caul Fat

IN the course of investigations on the fat of rum contents[1], it was observed that the iodine valu of C_{18} unsaturated fatty acid fractions were su stantially higher than could be accounted for by tl content of diene and triene acids determined l alkali isomerization[2]. However, the amounts material isolated were small, and in order to invest gate further the acids responsible for this anomal the methyl esters of the C_{18} unsaturated acids fro the caul fat of lambs two to three weeks old, earli described[3], were used.

Crystallization of 52·5 gm. of the C_{18} concentra three times at −60° C. from ten volumes of aceto yielded 12·0 gm. (iodine value 145·3) of solub constituents. These were chromatographed[4] silica gel to yield concentrates of diene acids.

ble 1. COMPOSITION OF C_{18} DIENE CONCENTRATES FROM LAMB CAUL FAT

raction	Weight (gm.)	Iodine value (Wijs 1 hr.)	Diene (%)* (a)	Diene (%)* (b)	Triene (%) (a)	Triene (%) (b)
1	0·65	110·7	—	—	—	—
2	0·66	150·7	—	—	—	—
3	0·50	163·1	33·8	89·5	Nil	Nil
4	0·54	165·7	29·4	92·4	Nil	Nil
5	2·30	182·0	29·5	89·0	12·7	11·0
6	0·53	237·6	—	—	—	—

* In all cases conjugated diene acids amounted to less than 0·6 per nt.
(a) From isomerizations.
(b) Calculated from iodine values, assuming fractions 3 and 4 to ntain mono-ene and diene, and fraction 5, diene and triene acids nly.

It is apparent that the content of diene acids stimated by isomerizations is about one-third that lculated from the iodine values. This suggests the resence of considerable proportions of non-conjugable iene acids.

To obtain further information 0·21 gm. of fraction 5 as ozonized in 15 c.c. of chloroform at −10° C., nd the ozonides taken to dryness *in vacuo* at room mperature. After standing for two days with erhydrol, the aqueous solution was extracted with ght petroleum (boiling point 40–60°). The water-luble acids were taken to dryness and chromato-raphed on silica gel according to the procedure of Marvel and Rands[5]. The acids were identified by means of their peak effluent volumes as compared with those of a standard mixture. Expressed as a ercentage of the original ester ozonized, they were : malonic 1·6, succinic 8·2, glutaric 2·9, adipic 3·1.

The identity of succinic acid was confirmed by means of its melting point, along with that of its iphenacyl ester.

Since free dicarboxylic acids could only come from xidative cleavage of the double bonds, the presence f such acids of longer chain-length than malonic n the products of ozonolysis of fraction 5 suggests hat there are present in lamb caul fat isomers of noleic acid having double bonds separated by two r more methylene groups. Van der Veen[6] has shown hat isomers of linoleic acid are produced on catalytic ydrogenation of methyl linolenate, while Rebello nd Daubert[7] demonstrated that three of these iso-ners were the 8,14-, 9,15- and 10,14-octadecadienoic cids. Since Reiser[8] has shown that polyunsaturated cids are hydrogenated by rumen micro-organisms, he presence of isomers of linoleic acid in lamb caul at could be explained by assuming their formation n the rumen and deposition in the depot fat.

The isomers of linoleic acid present in the caul fat mount to 1·2 per cent of the total fatty acids.

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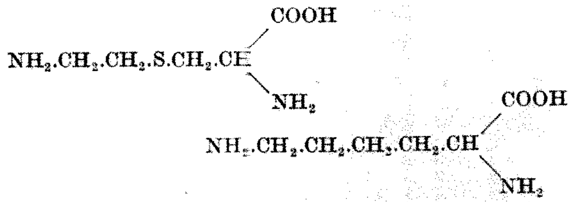
A New Synthetic Substrate for Trypsin and its Application to the Determination of the Amino-acid Sequence of Proteins

THE problem of the determination of the amino-acid sequence of a protein would be greatly simplified if methods were available for specifically hydrolysing peptide bonds involving a particular amino-acid. No satisfactory chemical method of doing this has been found, and the only controlled methods of hydrolysis available at present are digestion by proteolytic enzymes, in particular chymotrypsin and trypsin. It seemed possible that useful results might be obtained if a particular amino-acid side-chain could be modified in such a way as to resemble as closely as possible the side-chain involved in the specificity requirements of some enzyme. If the resemblance could be made sufficiently close, the enzyme might then hydrolyse the adjacent bond.

The hypothesis has been tested by studying the action of trypsin on the polymer of S-(β-aminoethyl-) cysteine. The side-chain of this amino-acid bears a strong resemblance to that of lysine, a —CH_2— group being replaced by a sulphur atom :



$NH_2.CH_2.CH_2.S.CH_2.CH(COOH)(NH_2)$

$NH_2.CH_2.CH_2.CH_2.CH_2.CH(COOH)(NH_2)$

S-(β-aminoethyl-) cysteine Lysine

A sulphur atom occupies much the same volume as a —CH_2-group, and the bond angle for sulphur is 100° compared with the 109·5° for a tetrahedral carbon atom. The preparation of the amino-acid polymer followed standard procedures and in outline was as follows. Cystine was reduced by sodium in liquid ammonia and coupled with N-carbobenzoxy β-bromo-ethylamine to give S-(β-carbobenzoxyaminoethyl-) cysteine. This was then converted to the dicarbo-benzoxy derivative and hence via the acid chloride to the N-carboxyanhydride of S-(β-carbobenzoxy-aminoethyl) cysteine, which was polymerized by heating at 110°. Removal of the protecting carbo-benzoxy group gave the hydrobromide of the polymer of S-(β-aminoethyl-) cysteine. This was soluble in water but could be precipitated from aqueous solution by the addition of ethanol. Fig. 1 shows chromato-graphic evidence that the polymer is an excellent substrate for trypsin.

It has also been shown that the thiol groups of reduced wool will react quantitatively with β-bromo-ethylamine in 0·5 *M* sodium carbonate at room temperature overnight. S-(β-aminoethyl-) cysteine resembles lysine so closely in its chromatographic behaviour that it is not possible to separate them on a two-dimensional chromatogram using butanol/acetic acid and phenol/ammonia. However, it was shown that the hydrolysate of wool treated in this way gave a spot which reacted with iodoplatinate and occurred in the position occupied by lysine, which suggests strongly that the cysteine residues of the reduced wool have been converted to S-aminoethyl cysteine residues by the treatment. Although direct evidence on a protein has not yet been obtained, it would seem likely that peptide bonds involving

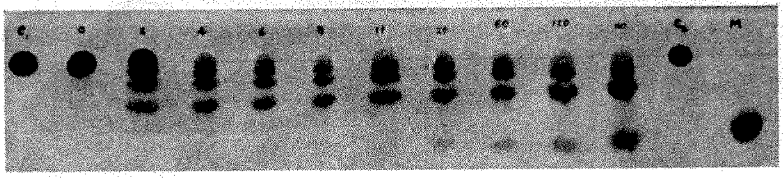


Fig. 1. Chromatogram showing hydrolysis of polymer of S-(β-aminoethyl-) cysteine by trypsin. Experimental conditions: 19·4 mgm. polymer hydrobromide/ml., 0·08 mgm. crystalline trypsin (Worthington)/ml., 0·1 M sodium bicarbonate (final pH 7·4), T = 26°. The numbers 0–120 refer to the time in minutes before spotting the sample on the paper, the reaction being stopped by the prior application of a spot of glacial acetic acid. The ∞ symbol refers to a solution from a similar experiment which had been left at laboratory temperature for twelve days. C_1 and C_2 refer to control solutions of the polymer in the absence of enzyme at times 0 and 120 min. respectively, while M is a sample of the monomer S-(β-aminoethyl-) cysteine. The chromatogram was run on Whatman No. 1 paper for five days using butanol/acetic acid/water/pyridine (30 : 6 : 24 : 20) as solvent (ref. 2)

cystine or cysteine residues in proteins will be specifically split by trypsin if they are converted to S-aminoethyl cysteine residues.

It is proposed to use this technique, first in an attempt to confirm earlier conclusions on the mode of reduction of insulin[1], and secondly in an endeavour to obtain information on the location of cystine residues in the wool proteins.

It might well be that the analogous O-β-aminoethyl derivative of serine would behave in a similar fashion if some simple method of converting the serine side-chains were available. It is not intended to investigate this possibility at present.

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The Major Anthocyanin Pigments of the Wild Strawberry (*Fragaria vesca*)

ALTHOUGH it has been definitely established that cultivated strawberries contain pelargonidin-3-monoglucoside as the major anthocyanin[1,2] and cyanidin-3-monoglucoside as a minor component[3], there is still some question about the identity of the pigments of *Fragaria vesca*. As a result of qualitative tests, Robinson[4] suggested in 1934 that the anthocyanin of *F. vesca* is pelargonidin-3-monogalactoside. In a more recent paper, Robinson and Smith[2] described a chromatographic procedure for distinguishing pelargonidin-3-monoglucoside and the galactoside, but left the identity of the anthocyanins of wild strawberries as an open question.

Strawberries from *F. vesca*, grown at Geneva, N.Y., were harvested in 1955 and stored at −18° for four months. These plants originated from one clone from East Malling, England. The thawed berries were pressed, and 300 ml. juice which had been saturated with sodium chloride was extracted with n-butanol; the extract was concentrated and the crude pigments precipitated with ether, yielding 0·6 gm. of red powder with an anthocyanin content of 7·5 per cent. The pigments were separated chromatographically by a procedure similar to that of Li and Wagenknecht[5]. The crude mixture, 120 mgm. in 0·75 ml. of the first aqueous phase plus 1·5 gm. silicic acid, was separated on a silicic acid column. The column was p pared from a slurry of 18·5 g silicic acid, 10·5 ml. of the fi aqueous phase and excess orga phase. The first developing s vent was 250 ml. of the orga phase from n-butanol, acetic ac chloroform and water (4 : 1 : 2·7 v/v), followed by 250 ml. the organic phase of the abo solvents in the ratio 4 : 1 : 5 v/v). 10-ml. fractions we collected and the optical densi determined at 525 mμ. As Fig. shows, resolution into four co ponents was accomplished. T two major pigments account for 93 per cent of t light absorption of the crude pigment extract 525 mμ. Recovery of the pigments from the colun was quantitative.

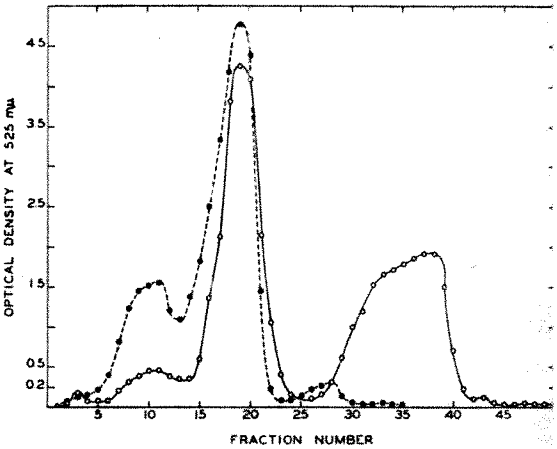

Fig. 1. Chromatographic separation of the anthocyanin pigments of wild and cultivated strawberries. ○——○, Pigments from *Fragaria vesca*, 120 mgm. crude pigments. ●——●, Pigments from cultivated strawberries, variety Culver, 40 mgm. crude pigments. In these solvent systems pelargonidin-3-monoglucoside, 1 mgm./10 ml., had an optical density of 4·38 and cyanidin-3-monoglucoside, 1 mgm./10 ml., had an optical density of 4·10 at 525 mμ

Fractions 14–26, band III, from two experimen were combined, the solvent evaporated and t residue converted to a crystalline picrate by trea ment with aqueous picric acid. Recrystallizatio from water and conversion to the chloride yielde 4·0 mgm. of chromatographically homogeneo material; R_F 0·40, on Whatman No. 1 paper an the solvent system n-butanol, acetic acid and wat (4 : 1 : 5)[6]. A mixture of this material and authent pelargonidin-3-monoglucoside yielded only one ban on the silicic acid column, and only one spot on pap chromatograms with the above solvent system. Th absorption spectra of band III and pelargonidin- monoglucoside in acidified ethanol also were identica Acid hydrolysis of the pigment from band III yielde a crystalline anthocyanidin which was shown to b indistinguishable from pelargonidin chloride by c chromatograming the aglycones (R_F 0·81 wit n-butanol saturated with 2 N hydrochloric acid), b comparison of their absorption spectra and by th usual colour tests. Chromatography with wate saturated phenol showed the sugar moiety to b indistinguishable from glucose, R_F 0·41, but readil separable from galactose, R_F 0·46. By analogou procedures the pigment from band IV (fractions 27 46) was shown to be indistinguishable from cyanidi nonoglucoside, R_F 0·32, and its drolysis products from cyanidin, $_F$ 0·68, and glucose.

On the basis of this evidence, it suggested that the major pig- ents of the fruit of *F. vesca* are largonidin-3-monoglucoside and anidin-3-monoglucoside. In the iits we examined, these pigments re present in a 1 : 1 ratio in wild rawberries, and 1 : 0·05 (pelar- nidin-3-monoglucoside to cyan- n-3-monoglucoside) in cultivated rawberries. Thus, the major dif- ence in the pigment composition wild and cultivated strawberries pears to be in the ratio of pelar- nidin to cyanidin glucosides.

Incidental to this study, evidence s obtained for the presence of other anthocyanin, band II, actions 7–12. This may be a cond pelargonidin derivative since has the same absorption spectrum pelargonidin-3-monoglucoside, but can be sep- ated from it on the silicic acid column. This material s absent in a pelargonidin-3-monoglucoside sample ich had been isolated from cultivated straw- rries and purified by recrystallization of its picrate[1]. e substance accounts for 6·5 and 21 per cent of e absorption at 525 mμ of the *n*-butanol extracts m wild and cultivated strawberries respectively. nd I, fraction 3, from the wild strawberries pears to be an anthocyanidin.

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Crystal Structure of Biotin

BIOTIN (vitamin H) is a substance of considerable ological interest. It has been found to have the ructural formula[1] shown in Fig. 1; but chemical vestigations have not elucidated with certainty e configuration about the three asymmetric carbon oms.

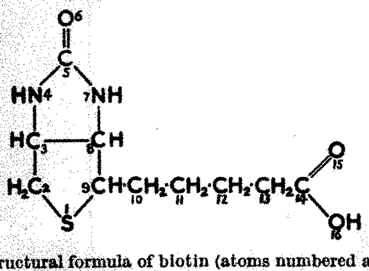

Fig. 1. Structural formula of biotin (atoms numbered arbitrarily)

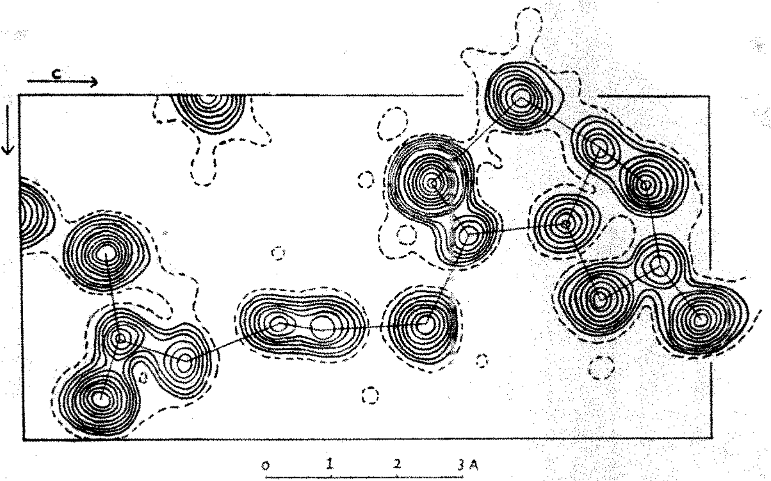

Fig. 2. Electron density projection on (100). Contours at intervals of one electron per A.^{2}, except for sulphur atom, where intervals are two electrons per A.^{2} after the seven-electron line. The two-electron line is broken

Crystals of biotin were found to be orthorhombic with unit-cell axes $a = 5{\cdot}19$ A., $b = 10{\cdot}33$ A., $c = 21{\cdot}00$ A., in good agreement with values previously reported by Fankuchen[2] and Crocombe (unpublished work). The density of the crystals, as found by flotation in a chloroform–benzene mixture, is 1·42 gm./cm.^{3}, necessitating the presence of four molecules of biotin in the unit cell. An examination of the X-ray spectra for systematic absences showed the space group to be $P2_12_12_1$.

Equi-inclination Weissenberg photographs were taken about the *a*- and *b*-axes up to the third and seventh reciprocal-lattice layers respectively. Some 70 per cent of the spectra falling within the sphere of reflexion for copper radiation were actually recorded, and a visual estimation made of their intensities.

As a first attempt at structure analysis, the Patterson projections along the *a*- and *b*-axes were calculated. However, in view of the large number of interatomic vectors arising from the 16 atoms (other than hydrogen) in the asymmetric unit, their interpretation proved very difficult, and it was not found possible to locate even the sulphur atom unequivocally. Seven sections of the three-dimensional Patterson function were then evaluated. These were at $u = 0, \frac{1}{4}, \frac{1}{2}$; $v = 0, \frac{1}{2}$; $w = 0, \frac{1}{2}$ (where u, v, w are expressed as fractions of the unit-cell axes a, b, c). The position of the sulphur atom was now easily found from an examination of the three Harker sections ($u = \frac{1}{2}$, $v = \frac{1}{2}$, $w = \frac{1}{2}$), and this was used to produce superposition maps from the Patterson projections by the method of Buerger[3]. Though even the *bc* Buerger map was not sufficiently well defined to enable the location of individual atomic positions, it gave a general outline of the shape of the molecule and proved a valuable guide during the subsequent analysis of the three-dimensional Patterson diagram. Because of the short *a*-axis and the fact that the Patterson diagram was not sharpened, all the sixty relatively heavy peaks corresponding to vectors between the sulphur and the other atoms in the molecule were in fact recorded on one of the sections $u = 0$, $\frac{1}{4}$ or $\frac{1}{2}$ (though several were very small and poorly resolved). A systematic correlation of these peaks (four for each atom) enabled a satisfactory trial structure to be obtained.

The *a*-axis projection was refined by a series of four Fourier syntheses in the course of which the reliability index, $R = (\Sigma \|F_0| - |F^c\| / \Sigma |F_0|$, decreased from 0·41 to 0·20. The final electron density projection is shown in Fig. 2. As a Fourier projection along the *b*-axis showed very poor resolution, the *x*-parameters alone were refined by the method of least squares. This was done in three stages, in the last of which all the observed *h0l* reflexions were used. The final value of *R* for this projection is 0·23.

The analysis confirms the accepted structural formula for biotin. The molecule has the *cis* configuration at the junction of the two five-membered rings, and though the configuration about bond C_8—C_9 is somewhat staggered, the aliphatic chain is *cis* with respect to the ureido ring system. These results are in accord with the suggestions of Grob and von Sprecher[4].

Within the limits of error, the six atoms of the ureido ring system are planar, as are the four carbon atoms of the adjacent ring; the two planes making an angle of approximately 120°. The sulphur atom lies 0·75 A. off the second plane, thus giving the ringed portion of the molecule a boat-shaped configuration. Whereas the four carbon atoms in the aliphatic chain follow approximately the normal planar zigzag configuration, the bond C_9—C_{10}, which links the chain to the ring system, does not conform to this pattern and consequently the molecule is considerably elongated. Hydrogen bonds O_6—O_{16}, O_{15}—N_4 and O_{15}—N_7 serve to bind all the molecules in the crystal together.

A further refinement of the structure using the full three-dimensional data is now in progress, and when this is completed a more detailed account of this work will be published elsewhere.

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Surface Tension as the Cause of Bénard Cells and Surface Deformation in a Liquid Film

IN 1900, Bénard[1] described his observations of a cellular deformation produced on the free surface of a liquid film the bottom surface of which (in contact with a floor) was uniformly heated and hotter than its top surface. He also observed a cellular flow associated with the deformation. These studies were made on films of thicknesses in the range 0·5–1·0 mm.

Rayleigh[2] and others analysed this phenomenon as an instability due to the density increasing from bottom to top. They obtained a critical film thickness below which there is stability.

This explanation in terms of density variation may be sufficient in the case of films thicker than about 1 mm. or when the liquid film has no free surface. Indeed, experimental investigations by Schmidt and Milverton[3] reveal a cellular motion in a liquid film bounded by horizontal plates, when the bottom plate is hotter than the top plate, that in agreement with the analyses. However, Béna cells, specifically defined here as the hexagonal ce in films (thinner than about 1 mm.) with a free su face, may not be due to convective instability.

We have carried out the following experimer with a number of liquids. Bénard cells were esta lished, for example, in a hydrocarbon liquid. needle point was wetted with a silicone insoluble the hydrocarbon. The needle point was then ma to touch the surface of the hydrocarbon film e hibiting Bénard cells. A skin or layer was there floated off and the effects observed as it spread ov the surface. Wherever and as soon as the layer pass over the Bénard cell, the surface deformation d appeared and the flow stopped. Clearly the variati of vertical density could not be affected so rapid by the covering by the layer.

Consider now that both the Bénard cell moti and deformation are produced by variations in t surface tension; which are in turn due to variatio in temperature. We may then apply the work Hershey[4], who analysed the flow and the deformati produced by a uniform surface stress arising fro a surface tension gradient (due to a temperatu gradient). Hershey also observed that the deform tion caused by a local cooling disappeared when insoluble monolayer covered it, explaining that t monolayer "takes up the tangential stress". Hershey analysis can be extended, for example, to accou for Bénard's observation that the colder parts the surface are the higher parts. On the other han Jeffreys[5] predicted, on the basis of free convectic that the hotter part should instead be the higher pa

I have therefore carried out the following expe ments. Bénard cells were first produced and th removed by covering with a monolayer. Then t thickness of the liquid film (covered by a monofil was increased until cellular surface deformation a circulation could again be seen. The thickness which this occurred was 2 mm., which is, in tl case, about the predicted critical depth for the ons of convective instability. The cellular deformati that occurred at 2 mm. did not have as regular pattern as the hexagonal Bénard cells previous obtained with a clean liquid surface. This irregul pattern occurred both when the surface was cle and when it was covered with the monofilm. Howeve decreasing the temperature at the base of a fil showing an irregular pattern caused the producti of the typical hexagonal Bénard pattern.

Bénard cells were observed, during these expe ments, for a thickness as small as 50 microns. that thickness, there was no indication that t limiting thickness, below which there would stability, had been reached. This thickness is least an order of magnitude smaller than the predict critical depth for convective instability.

Finally, I carried out an experiment in which liquid film (about 0·8 mm. thick) with a free surfa was cooled at its base and should therefore ha been convectively stable. Nevertheless, cellul patterns were observed, the more regular patter having the appearance of Bénard cells. It wou therefore appear that the instability causing Béna cells is quite different from the Rayleigh instabilit

Convection has also been considered, erroneousl in another case. Heintz[6] made an experiment study of the surface deformation caused by a te perature variation in liquid films (0·3–1·0 m thick). In a qualitative way he ascribed the effe convection. I have obtained similar experimental futation as in the case of the Bénard cells, again ing a floating layer. The importance of considering e role of surface tension in this phenomenon is ustrated by the failure of Heintz to obtain the fect he describes in water. However, whenever fficient care was used so as not to contaminate the ater surface, we obtained the effect.

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A New Uncertainty Relation

ONE of the consequences of the introduction of a ometry of four dimensions as a basis of physical ieory has been to reveal relations between certain uantities which had previously appeared to differ indamentally in character, the simplest being the elation between space and time. In geometries which itroduce new parameters or new dimensions, a milar unexpected unification may appear. This is articularly the case in the theory based upon the se of projective geometry associated with the names f Veblen and Hoffmann, and with the five-dimenonal theory introduced by Kaluza. It is necessary o express any results obtained in this way in a form hich satisfies the requirements of relativistic inariance; but the development of both these heories has proceeded in such a way as to make this ossible.

In this framework the principles of conservation of nergy and momentum are seen to be parts of a ider principle which embraces that of electric harge also. It was suggested also that an additional ondition should be added to the relations $\int p\,dq = nh$ f the old quantum theory, and this was interpreted s expressing the quantization of electric charge[1]. In he light of a recent discussion[2] concerning the fourimensional interpretation of such results, a new ncertainty relation is suggested. To the four familiar onditions it seems natural to add $\Delta m_0 \Delta\tau \sim \hbar/c^2$. he interpretation would be that in order to measure rest-mass m_0 to the accuracy Δm_0, an interval of roper time $\Delta\tau$ must elapse, the two quantities Δm_0 nd $\Delta\tau$ satisfying the above inequality.

This condition is also suggested by a work by K. H. zou[3] on the relativistic form of Heisenberg's quanum equation, in which the quantities m_0c and $c\tau$ ccur in such a way as to suggest a pair of conjugate uantities.

An application of it would be to cases of the ransformation of nuclear particles in which the time f decay, being the time available for observation, ould limit the observable change of rest mass.

At first sight the relation appears to be a special ase of the energy relation:

$$\Delta E\,\Delta t \sim \hbar$$

which for a particle of mass m in the absence of a field of force becomes,

$$\Delta m\,\Delta t \sim \hbar/c^2$$

This is usually applied to cases where the rest mass does not change. If it be assumed that it applies to the case of a particle which changes its rest mass while at rest, Δm is a change of rest mass and Δt a change of proper time.

The two conditions are the same in this case. Prof. P. Caldirola[4] has applied the energy relation in this way. Adopting the view that a μ-meson is an electron in a higher energy state, he points out that

$$(\mu_0 - m_0)\,\Delta t \sim \hbar/c^2$$

μ_0 and m_0 being the respective rest masses, and discusses the significance of the relation on the assumption that a minimum interval of time Δt exists. But the relation proposed here is not essentially an energy relation, and its application is not restricted to cases where the particle under consideration is at rest. When no restriction is placed upon the motion of the particle, the two conditions do not coincide. It is suggested that the rest mass condition is an independent one.

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Fixation of Carbon Dioxide into the Carboxyl Carbon of Glycine

IT has been observed that carbon dioxide is a precursor to the carboxyl carbon of glycine in incubations with a hen-oviduct mince. Carbon 2 of the glycine is completely unlabelled when determined as the formaldehyde dimedone complex obtained after ninhydrin degradation. Carboxyl-labelled acetate is also formed in this system from carbon dioxide[1]. Acetate 1,2-^{14}C, however, was found to be a poor precursor to glycine, although it was converted to glutamic acid much more efficiently than carbon dioxide.

These observations appear to diminish the likelihood that carbon dioxide is entering glycine through acetyl coenzyme A or acetate directly. There appear two possible explanations. Glycine may be formed directly from an activated acetyl compound arising from the carbon dioxide fixation previous to acetyl coenzyme A, or carbon dioxide may be fixed independently to two distinct acceptors, one of which yields acetate and the other glycine.

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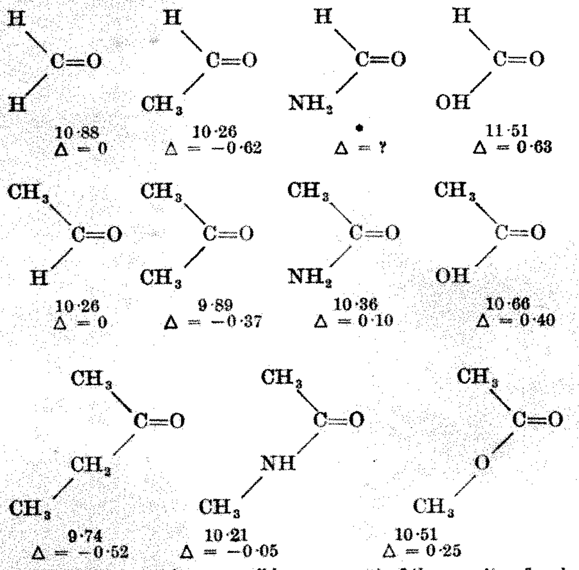
Ionization Potentials of Carbonyl Molecules

THE first ionization energies of carbonyl molecules are largely determined by the non-bonding electrons at the oxygen atom of the carbonyl group. If electric charge flows from the other part of the molecule into the oxygen, the effective electro-negativity of that atom will become decreased, and hence the ionization potential of the molecule will be reduced[1]. From this point of view, it is expected that the magnitude of the ionization potential will serve as a clue to the state of electron transmission in a carbonyl molecule.

In the present work, measurements were made of the first ionization potentials by use of a Hagstrum type mass-spectrometer[2]. The evaluation of the potentials was made according to the critical slope method[3], argon being employed as the calibration gas. The results are recorded in Table 1.

Table 1. FIRST IONIZATION POTENTIALS (eV.)



* No measurement was possible on account of the scarcity of molecular ion formed.

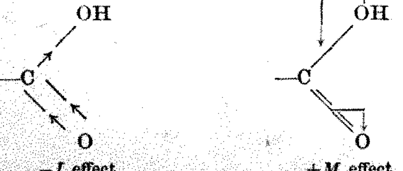
It will be seen that the replacement of a hydrogen atom in H·CHO and H·COCH$_3$ by CH$_3$ or CH$_2$·CH$_3$ lowers the potential values, while replacement by NH$_2$, OH or OCH$_3$ tends to raise them. This trend in the potentials may be accounted for if the inductive mechanism is taken into consideration. That is, the Ingold's sequence[4] of $-I$ effect is:

(a) $OH > NH_2 > H$; $OCH_3 > NHCH_3 > H$

and that of the $+I$ effect is

(b) $CH_2(CH_3) > CH_3 > H$

This is rather surprising, since the mesomeric effect of the group (a) which counteracts the $-I$ effect is supposed to be more important. Both effects are illustrated for the group —CO·OH.


$-I$ effect $+M$ effect

We thank Prof. C. A. Coulson for his interest this work.

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Effects of Pressure on the Superconductin Transition in Tin

RECENTLY, Muench[1] has investigated the displac ment of the critical temperatures T_c of tin and indiu produced by pressures of up to 100 atmospher (obtained by compressing helium gas), and by pressure of 1,900 atmospheres (obtained by the ic expansion bomb technique); and he has measure the value of $(\Delta H_c/\Delta p)_T$, where H_c denotes the critic magnetic field and p the pressure, at temperatur between 1° K. and T_c for each of these metals. The experiments are important in that they provide t most complete data yet obtained on the effects pressure on the superconducting transition.

In analysing his results, however, Muench assume that $(\partial H_c/\partial p)_T$ is independent of pressure. There no satisfactory experimental evidence in support this hypothesis: the earlier work of Kan, Sudovsto and Lasarew[2] at pressures of 1,350 and 1,700 atm spheres was not sufficiently accurate to allow on to deduce that $\partial^2 Hc/\partial p^2$ is negligibly small, whi Muench's own work only suffices to show that, at given temperature, H_c is a linear function of pressu within experimental error over the very restricte range between 0 and 100 atmospheres. Indeed, review of experimental results concerning secon order partial derivatives shows that the evidence i favour of $(\partial H_c/\partial p)_T$ being substantially independe of pressure is much less convincing than is that i favour of $(\partial T_c/\partial p)_H$ being substantially independe of pressure. Chester and Jones[3], for example, hav succeeded in extending almost tenfold the pressur range over which the superconducting transition i tin has been observed without thereby being ab to detect lack of linearity in the relationship betwe T_c and p; and, although their accuracy was not a high order at a pressure of 17,500 atmospheres, it significant that, within experimental error, the results conform to the same straight line as do the le extensive measurements of Kan, Sudovstov an Lasarew.

By making use of a consistency relation betwe the first- and second-order partial derivatives whic holds at any typical point on the H_c—T—p surfa separating the superconducting and the norm phases, it is possible to devise an iterative comput tional procedure whereby the Muench assumption pressure-independence of $(\partial H_c/\partial p)_T$ can be dispense with, and values for $\partial^2 H_c/\partial p^2$ can be deduced fro his data. Preliminary calculations made on this bas for the case of tin show that $\partial^2 H_c/\partial p^2 = -8 \times 10^{-}$ gauss dyne^{-2} cm.[4] at the zero-pressure critical ten perature of 3·73° K. The value of $\partial^2 H_c/\partial p^2$ increase as the temperature is reduced, becomes zero at abou

4° K., and remains positive between this latter mperature and 1° K. The work so far completed ggests that $\partial^2 H_c/\partial p^2$ may become as large as $\times 10^{-19}$ gauss dyne^{-2} cm.[4] at the lower end of the mperature-range covered by Muench's experiments. From the zero-pressure values computed for $H_c/\partial p)_T$ it is possible to deduce that, for any fixed mperature in the neighbourhood of T_c, it would be cessary to apply a pressure of at least 2,000 atmoheres to tin in order to produce an overall departure om linearity of 1 per cent in the relationship between $_c$ and p. It would, of course, not be easy to check perimentally such a small deviation from linearity, cause of the difficulty of measuring pressures of is order of magnitude with adequate precision.

A fuller account of the work will be presented in ie course.

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Interior Deformation Markings in Copper Fatigue Specimens

A METALLOGRAPHIC investigation of several fracred low-stress rotating cantilever specimens of lowygen copper was carried out, employing various chants, in an attempt to detect metallographically y evidence of deformation in the interior. Average mposition of the specimens was 0·0027 per cent ygen, 0·0007 per cent nitrogen, 0·8 c.c./100 gm. drogen, 99·95 per cent copper.

Wadsworth and Thompson[1] have electropolished pper fatigue specimens at various stages during e fatigue life, and have shown that, although most p bands are removed by polishing off 2μ, some slip nds persist, and that it is from these "persistent p bands" that fatigue cracks ultimately develop. heir observations have been restricted to the surface specimens.

In the present experiments, the specimens were pper plated, sectioned diametrically by a slitting heel flooded with coolant, polished mechanically d finally electrolytically polished in orthophosioric acid. The sections were then etched in each ten etchants in turn, an intermediate light polish ing given to remove completely the previous etch.

The etchants employed were those listed by muels[2] as capable of developing deformation markgs in copper and copper-base alloys. Briefly, they e:

1)	Potassium dichromate	5 gm.
	Sulphuric acid (conc.)	8 ml.
	Water	50 ml.
	Hydrochloric acid (conc.)	2 ml./50 ml.
2)	Ammonium hydroxide	1 vol.
	Hydrogen peroxide (3 per cent)	2 vol.
	Water	2 vol.
3)	Ferric chloride	5 gm.
	Hydrochloric acid (conc.)	10 ml.
	Water	100 ml.

4) 10 per cent phosphoric acid at 90° C.
5) 10 per cent ammonium persulphate at 50–60° C.
6) 10 per cent cupric chloride plus ammonia to alkalinity.
7) Electrodes of standard electropolishing bath short-circuited at end of polishing cycle.
8) Washed and dried specimen immersed in standard orthophosphoric acid polishing bath at 0·6–0·8 V.
9) 0·25 per cent sodium thiosulphate solution at 3·5 amp./dm.^{2}.
) 0·5 per cent sodium thiosulphate solution at 1 amp./dm.^{2}.

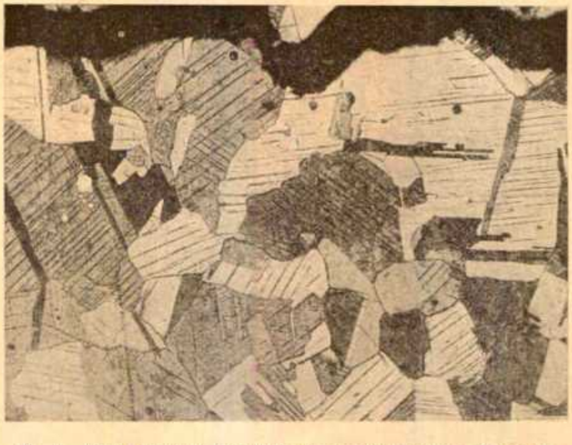

Fig. 1. Microstructure of rotating-cantilever specimen of copper, taken at the main fracture (black band) and on a section approximately 1 mm. under the original surface. Specimen fractured at 14,000 lb./sq. in. after 632,400 cycles at 21 c./min. Specimen axis vertical. Etched with acid ferric chloride. × 100

The results of using each of these etchants in turn showed that: (*a*) etchants (1), (4), (7), (9) and (10) produced a normal etch by developing grain boundaries, twin boundaries and oriented lustre in varying degrees; (*b*) etchants (2), (3), (5) (6) and (8) produced a similar etch, but in all cases the grains showed striations.

An area was selected on a specimen exhibiting these striations, and photographs were taken of this area after etching with each of the etchants in group (*b*) above. The striations observed were the same with each of these etchants, and simply varied in intensity. It was possible to arrange these etchants in order of decreasing effectiveness in developing striations, as follows: acid ferric chloride, cupric ammonium chloride, ammonium persulphate, electrolytic polishing cell etch, ammonium hydroxide – hydrogen peroxide.

An example of the striations is shown in Fig. 1. The area illustrated includes the main crack (black irregular band), and is approximately 1 mm. under the original curved surface of the specimen. This specimen had fractured at 14,000 lb./sq. in. after 632,400 c./min. Striations were observed in the area up to 5 mm. on either side of the main crack.

It will be noted that the striations bear no relation to the specimen axis, but are definitely crystallographic in nature, because: (i) they change direction when crossing an annealing twin; (ii) one or more parallel sets may be present in one crystal; (iii) they are essentially straight.

Samuels[2] has classified the deformation marks produced by compression in copper and copper-base alloys into four types, based on differences in visual appearance and on the orientation of the marks relative to the axis of compression. The striations shown in Fig. 1 do not correspond to any of these four types, and thus presumably indicate that deformation has occurred in the fatigue specimens in a different mode from that in compression.

The acid ferric chloride etch was used on specimens of the same copper, initially annealed and then deformed in tension to 1, 2, 4, 8, 10, 20, 30 and 40 per cent elongation, and also on a specimen cut from the compression side of a bent bar. Again in no case did the striations shown in Fig. 1 correspond to the deformation marks in the tension and compression specimens, a further indication that deformation has

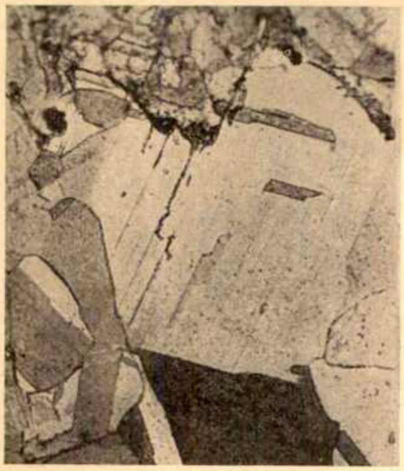

Fig. 2. Cross-section of the surface of a machined rotating-cantilever specimen of copper, showing short fatigue cracks running along striations. Specimen had fractured completely some 3 mm. from this point at 16,000 lb./sq. in. after 476,000 cycles at 170 c./min. Specimen axis horizontal. Etched with acid ferric chloride. × 370

occurred in the fatigue specimens in a different mode from that in tension and compression.

The striations are not produced by the sectioning technique, since they may also be readily developed on the polished surface of a similar fatigue specimen, free of striations before the fatigue test. Neither are the striations produced by gradual application of the stress during loading, since they do not develop until a later stage in the fatigue life.

Fig. 2 shows small cracks in a surface crystal of a low-stress rotating-cantilever specimen. The cracks run along the striations revealed by etching, indicating that these, or the mode of deformation which results in their development, may play an important part in the formation of fatigue cracks. Similar striations have also been observed in fractured low-stress push–pull specimens of copper. Thus, they appear to be characteristic of low-stress fatigue-deformation in copper. Experiments concerning the variations in intensity of the striations due to stress and to testing frequency are to be described shortly. Also, the nature of the markings is being investigated by annealing experiments and by electron microscope investigations.

This work forms part of the research programme on fatigue at the Aeronautical Research Laboratories, Department of Supply, Melbourne. Acknowledgment is made to the Chief Scientist, Department of Supply, for permission to publish this communication.

D. S. KEMSLEY

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Melbourne. Feb. 29.

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[2] Samuels, L. E., *J. Inst. Metals*, **83**, 359 (1955).

Mechanism of the Electrolytic Deposition of Titanium

ONE of the commercial methods of manufacturing pure titanium metal involves the high-temperature electrolysis of either K_2TiF_6, $TiCl_4$ or $TiCl_3$ in a molten alkali halide eutectic. Several such processes have been in operation for some time, and certain details of the preparative techniques have been published[1]. The mechanism of these electrolytic methods has, however, remained in doubt. Of the two possibilities, (1) primary deposition of a titanium ion, complex or otherwise, on to a suitable cathode or (2) secondary deposition where the titanium species are reduced by electrolytically produced alkali metal, the latter has seemed more probable because of the amorphous nature of the resultant titanium. It is true that fairly large dendritic crystals of titanium are produced during the electrolysis, but such dendrites are also found in the commercial preparation of titanium where $TiCl_4$ is reduced with liquid sodium. The current–voltage relations observed during electrolysis are also in keeping with a predominantly secondary process.

Recently, we have obtained direct evidence that the metal is finally produced by a secondary process but, depending on the starting materials, this can be preceded by one or more primary steps. Using the gas-flushed tungsten micro-electrode, recently developed by Inman[2], polarographic analyses have been made of solutions of K_2TiF_6, $TiCl_4$, $TiCl_3$ and $TiCl_2$ in the LiCl—KCl eutectic at temperatures between 380° and 550° C. Excellent reversible polarograms have been obtained for the primary reduction of $TiCl_3$ to $TiCl_2$, the half-wave potential with respect to platinum being $-2 \cdot 58$ V. at 400° C., that for the decomposition of the eutectic being $-2 \cdot 79$ V. The wave-height is strictly proportional to the concentration of $TiCl_3$ up to 0·01 weight per cent corresponding to ~ 200 μamp., the highest current measurable with the recorder. The log $i/i_d - i$ against E relation indicates a one-electron reduction step. That the reduction is to $TiCl_2$ and not to titanium metal is also evident when, after complete reduction, the reverse process is clearly indicated from the corresponding anodic polarogram.

$TiCl_4$ gives a cathodic wave at $E_{1/2} = -1 \cdot 4$ V. at 400° C., although its form is distorted because of the difficulty in maintaining any concentration of $TiCl_4$ in the melt.

Neither $TiCl_2$ nor K_2TiF_6 gives a detectable cathodic wave or limiting current. A finite current only flows when the applied voltage exceeds $-2 \cdot 79$ at 400° C. that is, the decomposition potential of the pure eutectic. It is therefore clear that K_2TiF_6 and $TiCl_2$ in this melt at least, can only be secondarily reduced to titanium by chemical reaction with alkali metal.

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[2] Hills and Inman (in preparation).

FORTHCOMING EVENTS

Tuesday, September 25

Institution of Civil Engineers (at Great George Street, Westinster, London, S.W.1), at 5.30 p.m.—Mr. F. R. Farmer: "The roblem of Liquid and Gaseous Effluent Disposal at Windscale".

Society of Instrument Technology (at Manson House, Portland lace, London, W.1), at 6 p.m.—Presentation of Bowen Prize by r. G A. Whipple. Dr. E. A. Spencer and Mr. A. T. J. Hayward: The Accurate Calibration of Flowmeters".

Wednesday, September 26

British Institution of Radio Engineers (at the London School f Hygiene and Tropical Medicine, Keppel Street, Gower Street ondon, W C.1), at 6.30 p.m.—Dr. H. W. Loeb: "Some Aspect f Transistor Progress".

Friday, September 28

Association of Applied Biologists (in the Mining Lecture heatre, Royal School of Mines, Prince Consort Road, London, S.W 7), t 10.30 a.m.—Symposium on "The Use of Antibiotics Against Plant, iseases".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or efore the dates mentioned:

Lecturer or Assistant, Grade B (with special qualifications in lant physiology and preferably teaching and research experience) Botany—The Clerk to the Governors, Chelsea Polytechnic, Manresa oad, London, S.W.3 (September 28).

Biochemist, Senior Grade (with a first- or second-class honours egree), for duties which include both routine hospital biochemistry nd work connected with the investigations into the uses of radioctive isotopes in medicine—The Secretary, Liverpool Radium nstitute Management Committee, 1 Myrtle Street, Liverpool 7 September 29).

Chemist (with a first- or good second-class honours degree or quivalent qualification and at least three years experience, and referably a knowledge of liquid fuels and lubricants) in the Central aboratory, Chiswick—The Recruitment and Training Officer (F/EV. 97), London Transport, 55 Broadway, London, S.W.1 (September 29)

Demonstrator (with a first- or second-class degree in chemistry) in the Department of Organic Chemistry—The Registrar, The niversity, Liverpool (September 29).

Entomologists (with at least a second-class honours degree in ntomology, and preferably a knowledge of botany and plant ecology echniques) in the Department of Tsetse and Trypanosomiasis ontrol and Reclamation, Federal Ministry of Agriculture, Federaion of Rhodesia and Nyasaland, for duties which will include field tudies and surveys in tsetse fly areas as a preliminary to land eclamation—The Public Service Attaché, Rhodesia House, 429 Strand, ondon, W.C.2 (September 29).

Physics Graduate in the Department of Radiotherapy, for vork which will include developments connected with rotation therapy, nulticurie cobalt units and the use of radioactive isotopes—The ssistant Administrator, Churchill Hospital, Oxford (September 29).

Scientific Officer (honours graduate) in the Plant Pathology ection to work mainly on seed-borne diseases—The Secretary, ational Vegetable Research Station, Wellesbourne, Warwick September 29).

Assistant Lecturer or Lecturer (with special qualifications n palæontology) in Geology—The Registrar, King's College, Strand, ondon, W.C.2 (October 1).

Lecturer (preferably with either (*a*) knowledge and experience f servo mechanisms or process control; or (*b*) research experience some branch of electronics) in Applied Electricity—The Secreary and Registrar, University College of North Wales, Bangor October 1).

Assistant (preferably with a special interest in vertebrates) in oology—The Secretary of University Court, The University, Glasgow October 5).

Lecturer in the Department of Metallurgy—The Registrar, he University, Liverpool (October 6).

Research Assistant (with a first- or second-class honours degree n chemistry) in the Chemistry Department—The Principal, Derby nd District College of Technology, Normanton Road, Derby (October)

Assistant Lecturer (Grade III) or Demonstrator in Pharmcology—The Registrar, The University, Bristol (October 8).

Staff Tutor in the Department of Adult Education—The egistrar, University College, Leicester (October 13).

Veterinary Bacteriologist (with a university degree in science r veterinary science, with honours, together with postgraduate research xperience in bacteriology, or equivalent qualifications) in the ivision of Animal Health and Production, Commonwealth cientific and Industrial Research Organization, Sydney, to participate n a research programme on the bacteriology of footrot and foot bscess, including studies on the pathogenesis and immunology of hese diseases; investigations on mycotic dermatitis and fleece rot f sheep will also be undertaken—Chief Scientific Liaison Officer, ustralian Scientific Liaison Office, Africa House, Kingsway, London, V.C.2, quoting Appointment No. 202/115 (October 13)

Lecturer in Inorganic Chemistry at the University College of hodesia and Nyasaland—The Secretary, Inter-University Council or Higher Education Overseas, 29 Woburn Square, London, W.C.1 October 15).

Lecturer (with a good honours degree, including heavy current subjects) in Electrical Engineering—The Secretary and Registrar, The University, Southampton (October 15).

Lecturer (Chemist) in the Department of Municipal Engineering—The Registrar, College of Science and Technology, Manchester 1 (October 20).

Director of the Computing Unit—The Secretary of Faculties, University Registry, Oxford (October 30).

Lecturer or Senior Lecturer in Fluid Dynamics at the University of Tasmania—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, October 31).

Professor (with high academic qualifications and considerable experience in research or development work in metallurgy or generally in the science of materials) of Materials and Metallurgy—The Principal, College of Aeronautics, Cranfield, Bletchley, Bucks (October 31).

Reader in Marine Biology in the Department of Biology, University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Hong Kong, October 31).

Senior Lecturer in Mineral Engineering at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, October 31).

Director of the Medical Physics Unit—The Secretary to the University, Old College, South Bridge, Edinburgh (November 1).

Agronomist (preferably with a good honours degree and practical experience) at Gambia Rice Farm (H.M. Oversea Civil Service), to undertake experiments in the cultivation of irrigated rice and of alternative crops suitable for dry-season cultivation under irrigation—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.63/12/08.

Assistant Conservator of Forests (with a university degree in forestry or a degree in natural science supplemented by at least one years training in forestry) in Tanganyika (H.M. Oversea Civil Service)—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.61/8/01.

Assistant (Grade B) in the Department of Physics—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W 3.

Assistant Lecturer in Agricultural Zoology—The Registrar, The University, Nottingham.

Bacteriologist, Scientific Officer or Senior Scientific Officer grade, to assist in work on the nutritional significance of micro-organisms of the digestive tract—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire.

Bleachers' Association Limited Fellow in the Department of Textile Industries, for research on cellulosic fibres—The Registrar, The University, Leeds 2.

Graduate in Biological Science, to assist in research on mass culture of marine algae—The Professor of Zoology, The University, Southampton.

Laboratory Technician (with experience and skill in general bacteriological methods, and preferably special experience in methods applicable to studies on viruses and tissue culture work)—The Secretary, The Research Institute (Animal Virus Diseases), Pirbright, Surrey.

Lecturer or Assistant Lecturer (Grade B) in the Department of Mathematics—The Secretary, Sir John Cass College, Jewry Street, London, E.C.3.

Lecturers (with an honours degree) in Electrical Engineering, Physics and Mathematics—The Principal, Paisley Technical College, 28–40 George Street, Paisley

Leverhulme Senior Research Fellow (preferably with experience of bio-assay or radioisotope techniques), to work on the effects of steroid hormones in ruminants, and in particular, to investigate the physiological bases for the improvement of growth-rate resulting from hormone treatment—The Registrar, The University, Nottingham.

Physics Technician (preferably with a knowledge of vacuum technique)—The Director, Radiobiological Research Unit, Medical Research Council, Atomic Energy Research Establishment, Harwell, Berks.

Records Officer (with a university degree in natural science or agriculture or a related biological science, and preferably experience in publishing, collecting or abstracting scientific work) in the Department of Agriculture, Federation of Nigeria, to assist in the collection and dissemination of information on agricultural research within the Federation of Nigeria, and to assist in the preparation of scientific publications and memoranda—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.63/14/041.

Research Officer (Cyto-Geneticist) (with a good honours degree and at least two years postgraduate experience in plant genetics, and preferably training and experience in cytology) with the East African Agriculture and Forestry Research Organization, Kenya, to undertake genetical studies of crop plants aimed at providing basic knowledge for the breeding of plants for disease resistance and other qualities—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.195/151/01.

Research Worker (physics graduate), for investigations on physical properties of rubber-like materials—The Secretary, Research Association of British Rubber Manufacturers, Shawbury, Shrewsbury.

Science Graduate (metallurgy, chemistry) for administrative and technical duties—The Assay Master, Assay Office, Newhall Street, Birmingham 3.

Senior Laboratory Technician—The Secretary, Research Station, Long Ashton, Bristol.

Senior Lecturer (with a good honours degree and industrial or research experience) in the Strength of Materials—The Secretary, The Royal Technical College, Glasgow.

Senior Scientific Officer (with a first- or second-class honours degree in electrical engineering or physics, and three years postgraduate experience, and preferably some experience in any of the following. (*a*) millimicrosecond pulse techniques, (*b*) weapon firing trials, or (*c*) the development of weapon test instruments) to lead a team responsible for the development trials of electrical and electronic equipment for use in weapons—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting Ref. A.1059/94.

STATISTICIAN (with at least a second-class honours degree and not less than two years postgraduate experience in the application of modern statistical procedures to biological experimentation) with the East African Agriculture and Forestry Research Organization, to take charge of the Statistical Section of the Organization, to study and to advise on the design of biological experiments, to advise on the procedures for the statistical analysis of results, and to collaborate in experiments to study sampling techniques, etc.—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting Ref. BCD.195/151/05.

TECHNICIAN IN THE DEPARTMENT OF GEOGRAPHY—The Secretary, Bedford College (University of London), Regent's Park, London, N.W.1.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

The Managers. (Speech delivered in London by Lord Heyworth, Chairman of Unilever Limited, and in Rotterdam, by Mr. S. J. van den Bergh, a Vice-Chairman of Unilever N.V., at the Annual General Meetings of the Companies, Thursday, May 24, 1956.) Pp. 18. (London: Unilever Limited, 1956.) [107

An Industry Within Industry: The Place and Purpose of Johnson Matthey. Pp. 44. (London: Johnson Matthey and Co., Ltd., 1956.) [107

The Libraries of Greater Manchester: a Guide to Resources and Special Collections. Edited by Harold Smith. Pp. 92. (Manchester: Library Association, Reference and Special Libraries Section (North-Western Group), 1956.) 15*s*. [107

Memorandum on the Closure of Schools and Exclusion from School on account of Infectious Illness. Pp. iii+20. (London: H.M. Stationery Office, 1956.) 1*s*. 3*d*. net. [107

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North Staffordshire Field Club. Transactions and Annual Report, 1954–55. (Vol. 89.) Pp. 123. (Stoke-on-Trent: North Staffordshire Field Club, 1956.) 10*s*. 6*d*. [107

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Rubber Technical Developments Limited. Annual Report for 1955. Pp. 16. (London: British Rubber Producers' Research Association and the Natural Rubber Development Board, 1956.) [107

Department of Scientific and Industrial Research. Report of the Mechanical Engineering Research Board with the Report of the Director of Mechanical Engineering Research for the year 1955. Pp. iii+72+4 plates. (London: H.M. Stationery Office, 1956.) 4*s*. net. [107

Statistics of Public (Rate Supported) Libraries in Great Britain and Northern Ireland, 1954–55. Pp. 33. (London: Library Association, 1956.) 5*s*. [107

Co-operative Electrical Research. (Being the Journal of the British Electrical and Allied Industries Research Association.) No. 1 (July, 1956). Pp. 40. (Leatherhead: British Electrical and Allied Industries Research Association, 1956.) 2*s*. 6*d*. [107

The G.E.C. Simon-Carves Atomic Energy Group. Pp. 15 (7 plates). (London: General Electric Company Limited, 1956.) [107

Committee of Privy Council for Medical Research. Report of the Medical Research Council for the year 1954–1955. Pp. v+286. (Cmd. 9787). (London: H.M. Stationery Office, 1956.) 10*s*. net. [107

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Colonial Development and Welfare Acts. Return of Schemes made under the Colonial Development and Welfare Acts by the Secretary of State for the Colonies, with the concurrence of the Treasury, in the period from 1st April 1955 to 31st March, 1956. Pp. 38. (London: H.M. Stationery Office, 1956.) 2*s*. 3*d*. net. [167

The Registrar General's Quarterly Return for England and Wales, 1st Qtr. 1956 (No. 429). Births, Deaths and Marriages; Infectious Diseases; Weather; Population Estimates, quarter ended 31st March, 1956. Pp. 32. (London: H.M. Stationery Office, 1956.) 1*s*. 6*d*. net. [177

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Other Countries

Republic of Egypt. Ministry of Commerce and Industry: Mineral Resources Department. Geological Survey of Egypt. Geology of Gebel Mudargag, West Area; Nugrus Sheet—Eastern Desert. By E. M. El-Shazly and M. Mamdouh Hamada. Pp. viii+32+18 plates. P.T. 60. Geology of Umm Lassaf District (Wadi Ithil Sheet). By Dr. M. S. Amin and Ismail H. Mohamed. Pp. viii+8+12 plates. P.T. 45. Geology and Mineral Deposits of Umm Rus Sheet. By Dr. M. S Amin. Pp. vii+51+34 plates. P.T. 90. Geological Museum. Pape No. 1: Meteorites and Related Bodies with a Guide to the Collectio of the Geological Museum, Cairo. By A. A. Attia, E. M. El-Shazl M. O. Moharram and A. A. Huzain. Pp. xi+52. P.T. 15. Paper No. 2 A Preliminary Report of El 'Atawi Copper Deposit, Eastern Desert. B E. M. El-Shazly and A. H. Sabet. Pp. vi+5+5 plates. P.T. 1 (Cairo: Ministry of Commerce and Industry, 1954 and 1955.) [10

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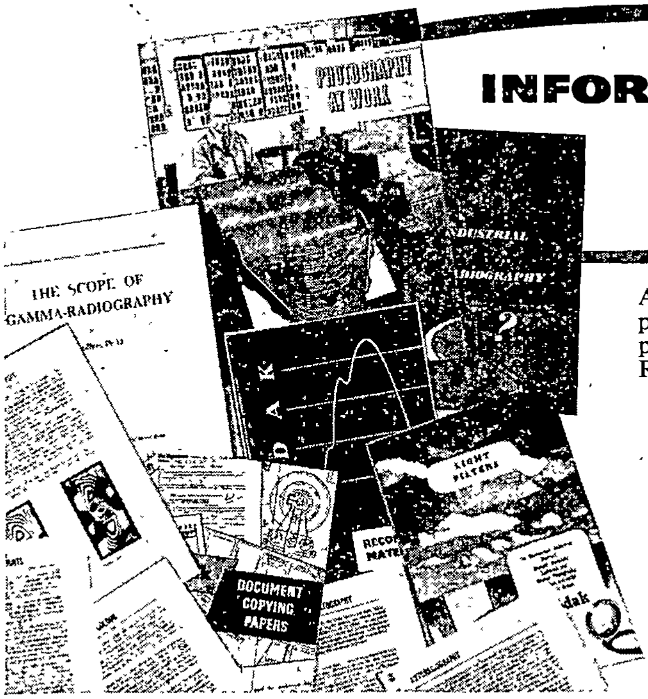

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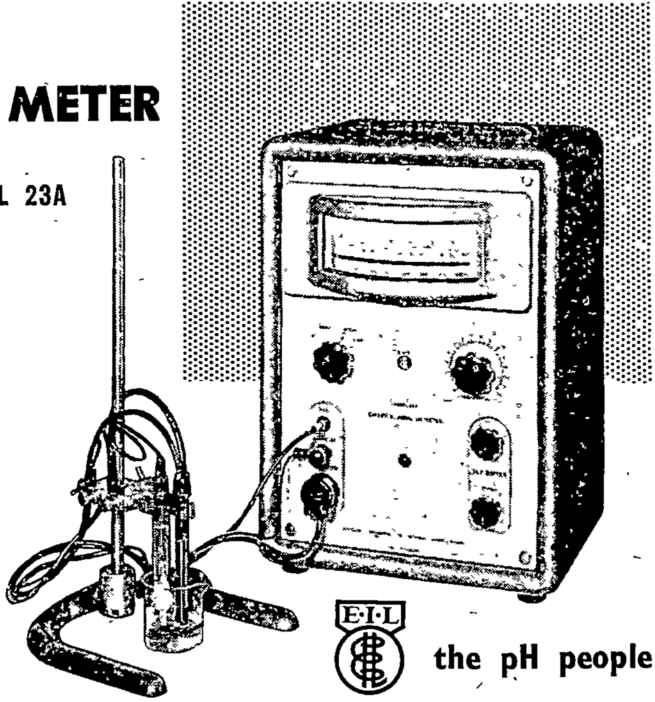

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FUTURE OF THE BRITISH ASSOCIATION

WHILE it is true that of recent years there has been a growing amount of criticism of the ritish Association, much of that criticism has come om within the Association itself. As such it reflects e effort of the Association to adjust itself and its nctions to serve more effectively the needs of the esent time. Moreover, as Mr. Ritchie Calder oserves in an article on the Association (see 664 of this issue), since the Association, more than y other scientific body, brings the whole range of ience within its scope and at the same time provides forum for discussion with the public, its proceedings ve in consequence inevitably mirrored the com-exities of modern science and the confusion of the y attitudes to science.

Mr. Calder's article, however, is concerned mainly set forth the new conception of the functions of e Association which has emerged from the work of e influential committee under the chairmanship of r Ben Lockspeiser appointed by the Council early is year to consider the functions of the British ssociation in the present-day world and to explain e way in which the Association works. The annual eeting of the Association is unique among scientific eetings in Great Britain both in range and in size, d the Lockspeiser Committee was concerned in the st place with re-defining the function of these eetings. There is likely to be little dissent from the ree broad objectives which the Council in conse-ience set forth in a statement issued at the Sheffield eeting. There is manifestly need for a platform in ich leading scientists can discuss their work in all theoretical complexities so that the public may derstand the integrity and discipline involved in e search for scientific knowledge for its own sake d, even if only incidentally, something of the nditions in which alone creative work is fruitful or en possible. No less apparent is the opportunity ich the very structure of the Association affords checking the excesses of specialization and the gmentation of science, which have separated ientists working in different fields and made them most unintelligible to each other, by bringing them gether in joint sessions so that they can share perience in related fields and recognize problems the frontiers of present knowledge. Lastly, and keeping with its consistent and unique tradition, e British Association must meet the needs of non-ecialists, whether they be scientists outside their n field or interested laymen.

It is not suggested that this is the order of relative portance of these three objectives, but all three e objectives which probably no other body is in so od a position to serve as the British Association, ovided it enjoys the full support of scientists them-ves and has at its disposal the necessary resources. e real problems arise in the field of technique, rticularly of organization and of communication. e latter, as Mr. Calder notes, may well involve ch fuller use of the instruments of mass-communication and the acceptance by scientists of some guidance by the Press and by broadcasting and television experts as to the most effective method of popular presentation of scientific material. The former, as the statement of the Council indicates, involves some measure of conscious planning of the Association's meetings.

The Council is clearly aware of some of the difficulties and of the value and importance of consultation with the Press, radio and television authorities. For the Association to discharge such functions to-day much more is involved than changes in the education of the scientist himself which will both widen his outlook and enable him to interpret his work more effectively to fellow scientists working in other fields and to the interested layman. The conflict of time-tables and interests, for example, which, as Mr. Calder points out, at present hinders full use being made of the opportunities of widening interests already to be found in the Association's annual meeting, will not be removed without the full understanding and co-operation of the several sections and their officers. The Programme Co-ordinating Committee which the Council has now to set up to supplement the work of the Section Committees is unlikely to succeed in ensuring a balanced programme for an annual meeting as a whole unless the purpose of such co-ordination is widely understood and appreciated in the sections.

There will be the more confidence that such planning by consent will be effective in that so much of the constructive criticism has come from within. It may be recalled that three years ago, at the Liverpool meeting, Dr. W. E. Swinton in his presidential address to the Assembly of Corresponding Societies subjected the functions of the Association and the Assembly and its constituent societies to a critical re-examination in the light of the environment and the climate of opinion in which they are set to-day (see *Nature*, 172, 782; 1953). At Sheffield, while Sir Raymond Priestley in his presidential address referred to the serious study now being made by the Association as to how best it could discharge its responsibilities in the circumstances of to-day, and asserted that its functions of integration and dissemination were more important than ever, Dr. F. J. North in his presidential address to the Assembly of Corresponding Societies reviewed critically the place of the local society in the community of to-day.

This particular address was indeed the subject of a subsequent discussion and should be noted for its bearing on what Mr. Calder suggests is an even more important aspect of the proposals for increasing the influence and effectiveness of the Association. The local societies are continuing bodies which to be effective must meet at regular and frequent intervals if they are to maintain close touch with the community. The British Association meets only once a year, and the Council is conscious that other forms of service are required to give continuity to its efforts. It suggests that there is a place for a suitably planned and presented non-specialist scientific journal, and since it is imperative that scientists and laymen should be seen to accept the need to foresee and debate the social and political consequences of science, it suggests also that prominent industrialists and political leaders and others should be invited to contribute to sessions not only at the annual meeting but also at special one-day meetings on specific subjects.

Such suggestions are not in fact new. The British Science Guild was formed more than a generation ago for much the same purpose, and since 1938 the Division of Social and International Relations of the Association, which at the discretion of the Council can meet anywhere, at any time, on any appropriate subject, has provided the means for such meetings of the Association during the year. Financial difficulties and the lack of adequate staff have severely restricted the meetings of the Division, however, since the War. A powerful new Committee has now been appointed, and it is proposed that during the year the Division should meet industrialists, farmers, administrators, trade unions, women's organizations and any other sections of the community whose interests are affected by science.

While in this way the Association may well establish contact with new sources of membership, this development should not be considered in isolation from the other proposals affecting the annual meeting. For one thing, the majority of members, in the future, as in the past, are likely to be scientists, and the solution of the problem of making the Association more effective depends at least in part in making the Association more attractive to scientists themselves and in particular in drawing to its meetings more of those age-groups and occupations which at present are largely absent. It is generally agreed that at the Sheffield meeting there was a larger proportion of those aged under thirty than in recent years. The bulk of the members attending the annual meetings are either under thirty or in the older age groups. The middle-age groups, which provide most of the active research workers and leaders of research teams, are usually absent, and the industrial scientist, if persuaded to present a paper or participate in a discussion, usually arrives just in time for his session and hurries away directly it is over. Often enough he has not even paused to consider whether or not the programme offers him a noteworthy opportunity to learn about or discuss advances or trends in some discipline other than that in which he is immediately concerned.

One of the first tasks of the new co-ordinating committee is, by tactful persuasion and consultation, to influence decisions on the main topics to be discussed at the annual meetings, at least to the extent of reducing the number of trivial and disconnected papers and increasing the number of more fruitful meetings at which specialists in different branches of science and laymen with varied interests can discuss questions requiring illumination from different directions. For this purpose the Association must be in close touch with scientific opinion in general. As has been observed, the British Association i a unique institution, and its traditions hold muc of value which should still help to determine it functions. Moreover, the character of professiona and scientific institutions generally is changing an in the past generation fairly rapidly. Against th proliferation of small societies must be set th growing size of the major bodies which increasingl robs them of the intimate and social character the once possessed.

Whether or not the mounting costs of publicatio will set limits to the proliferation of societies it i unlikely that the growth of the major institution will be halted. They are likely to be increasingl used by the Government and other bodies for consultation in professional and technical matters an to provide the most convenient and appropriat channels for co-operation with like institution abroad or for international action in professional o technical matters within their competence. Frequently they may come to be looked upon b their members rather as qualifying and publishin bodies than as societies requiring service from thei members.

Such tendencies may well make the new role forecast for the British Association even more importan and at the same time widen the opportunities for i to summon scientists to this twin duty of integratio and dissemination. While the Association itself is a the moment primarily concerned with improving th mechanics of the Association, it is unlikely that ther will be any halt in the efforts which in recent year have been made, within and without the Associatio to raise the general standard of scientific expositio and to devise improved methods of general educatio both for the scientist and for the non-scientist. Th Association may well with profit discuss such matte again in the future. For the moment it must concentrate on making its meetings as attractive a possible to the widest range of scientists and layme having regard to the limits which are inevitably se by any one place of meeting, and to ensure that th organization and timing of the meetings reall permit those attending them to take the fu advantage of them at least in relation to the thre specific objectives of the whole annual meeting.

If this is to be done it means that the Associatio must attract to its meetings not merely more of th younger scientists and lively minds of the youn generation but also a continuing reasonable proportion of leading scientists and technologists wh count it worth while to interpret their work an thought to such an audience and to discuss wit other specialists its social and political as well as it scientific or technological implications. A highe proportion of the middle-age groups of scientists an technologists is also desirable. Clearly this mean good publicity as well as a carefully planned an well-arranged programme of specific and majo topics. It involves also adequate finance. As S Raymond Priestley observed: "We have to mak our meetings so attractive that our membershi taxes the accommodation of the great cities in whic we meet. At the same time, we must convinc ndustry that we have a task worth doing and are equal to that task".

The Council's statement shows clearly that the British Association is fully alive to its changed responsibilities and new opportunities in the world of to-day. Given the support of scientists generally which the new proposals fully deserve, the Association may well make an even greater contribution to the ife of the nation than it has done in the past, provided only the handicap of inadequate financial resources is removed. If, however, the support of ndustrial or other benefactors is to be attracted on a large scale the programme of the Association must contain the large specific projects which manifestly compel the attendance and support of leading ndustrialists, scientists and administrators themselves and justify an industrial firm or other organzation sending its young people to attend the meetings. Its educational functions could well ustify support from Government sources; but the support from industry and commerce alone which an appropriate programme could attract would be much more worth while and in itself might remove the difficulty which since the War has handicapped so severely the Association and especially its Division of Social and International Relations.

PAVLOV AND HIS CONCEPTS

Selected Works

By I. P. Pavlov. (Edited under the supervision of Kh. S. Koshtoyants.) Pp. 654. (Moscow: Foreign Languages Publishing House; London: Central Books, Ltd., 1955.) 10*s.* 6*d.*

IT is fifteen years since any of Pavlov's major writings were issued in an English translation, so the publication of an English edition of a selection of his works is something of an event. The book acket claims this to be "the most representative selection of Pavlov's works yet published in English". In one sense only, namely that it includes publications on all the subjects on which Pavlov worked and from every period of his life, is this true. It is unfortunate, however, that the book gives no clue to the fact that rather more than two-thirds consists of a selection of lectures and addresses already published in English long ago. This section of the book therefore needs no comment. Among those which appear here for the first time in English are three papers on "The Accommodation Mechanism of the Blood Vessels" (1877), on "Digestion" (1899), on "The Trophic Action of the Nervous System" 1920) and a minor article dated 1936 on "Voluntary Movements". There is also a paper (1938) on "The Theory of Types", two on "The Problem of Sleep" of the same date and two on "The Experimental Pathology of the Higher Nervous System". These last two cover much the same ground as a paper read in the same year to the Second International Congress of Neurologists in London and published in 1941 in New York as Chapter 56 of Prof. Gantt's translation of Pavlov's writings on "Conditioned Reflexes and Psychiatry". New material also includes a collection of ten public peeches and addresses, mostly quite trivial, and a hree-page autobiography almost completely lacking in interest. The translation is reasonably adequate. The production is unattractive; but the price is very low. There is no index.

There are two other parts of the book which are both new and interesting: an introductory essay by Prof. Kh. S. Koshtoyants on "Pavlov and the Significance of his Works"; and the concluding section, consisting of about seventy pages of translations of stenographic records of selected statements made at the 'Wednesday' gatherings. These 'research seminars' were held from 1921 until 1935, and minutes were apparently kept for the last six years. Three volumes of these records were issued in the U.S.S.R. in 1949; but the fragments here given constitute the only translations so far published. It is thus to the first and last sections of the book that we must look for new material and for a clue as to the *raison d'être* of the publication as a whole.

The introduction contains some material of historical interest and is of some value in relating the development of Pavlov's work and of his views to the general attitude of mind of Russian (and by no means only Russian) biological science at that time. The real danger to the scientific study of behaviour presented by the subjective psychology of that time is made clear and Pavlov's violent reaction to it intelligible, and in this introduction some of his true greatness emerges. But unfortunately much of the introduction is taken up by bombastic statements about Pavlov's influence and achievement. Thus (p. 22) "Sechenov's basic postulate that the organism cannot exist without its supporting external environment is experimentally proved and in a way rounded off by Pavlov's theory of conditioned reflexes". Pavlov is given lavish praise for his naïve ideas on the second signalling system (merely a crude physiological scheme to account for the symbolism of human speech). We are told that "they point before his followers new avenues of research in the sphere of the physiology of the higher nervous activity, the way indicated to future generations of physiologists by their great teacher". Finally, on pp. 36–37, we read that because of Pavlov "it proved possible for the first time in the history of science to apply the precise method of investigation of natural science to the highly complex phenomena of the so-called psychical activity in man and animals", and this is why "it encountered the animosity of a number of scientists and idealist philosophers, lackeys of the imperialistic bougeoisie"—among whom are apparently numbered Sherrington, Lashley, Wolfgang Köhler and Woodworth! This kind of pathetic claptrap has been only too familiar in Russian writing in recent years, and there is, of course, the very real excuse for it that it was no doubt produced under a sense of extreme political threat. If, as we hope, the Russian sense of humour is now being freed from some at least of its chains, we may be sure that such writing will soon be treated with the same contempt and derision inside the U.S.S.R. that it has always received outside.

The final section (12), the "Records of the Wednesday Gatherings", is the most interesting part of the book. These fragments have apparently been chosen to show Pavlov's unswerving enmity to anything considered to be non-Marxist in science. This is a sad disservice to the memory of Pavlov, since it merely shows his worst side and makes him appear a petulant, intolerant and narrow-minded pedant. In fact, we know from his biographers that, although often appearing an irritable martinet, underneath he was a jovial, lovable enthusiast who, whatever his defects and whatever anyone else did, was enjoying himself hugely throughout his long life and was (to quote Rebecca West) "feeding his investigatory reflex like a king and filling it full of the good factual cheer it wanted".

The confusion of thought exhibited in some of the charges against men such as Sherrington, Köhler and Lashley is indeed a sad commentary on the limitations of a very great man and makes weary reading. But to students of the psychology of genius and still more of the philosophy of science they are extremely instructive. Wolfgang Köhler's "Mentality of Apes" and Sherrington's Rede Lecture "The Brain and its Mechanisms" come in for particularly severe criticism. Let us take the attack on Sherrington as perhaps the most fundamental and illuminating. The Sherrington booklet certainly has some obscure sentences, but Pavlov seems out for deliberate and blatant misrepresentation; and I believe that all this confusion is due to Pavlov's own gradually growing mental muddle over the meaning of the term 'reflex' and that it has an important lesson for present-day students of scientific method. The original idea of the reflex was simply an observed, consistent correlation between stimulus and response; using the last two words in a simple physiological sense. Obviously when receptor and effector are distinct and in different parts of the body, some form of conduction mechanism has to be postulated. Sherrington, like so many neurophysiologists before and since, was concerned with relating the characteristics of reflex response to a supposed elementary nervous conduction mechanism—the reflex arc—and it is upon the inclusion, within the reflex concept, of the idea of some such simple conduction mechanism that its usefulness as a physiological term really depends. Regarding the synapse as a physico-chemical system, Sherrington was, of course, trying to see how far the various characteristics of the reflex—summation, facilitation, latency, refractory phase, after-discharge, inhibition, post-inhibitory rebound—could help in accounting for the behaviour of the animal when a large number of such reflex arcs became integrated to form units of the higher nervous system.

To say that Pavlov was not a neuro-physiologist in the strict sense at all is in no way to belittle his great achievement. Strangely enough, he was, in his behavioural work, a psychologist, since he was concerned with investigating the laws governing relations between stimulus and response but not really interested in the possible mechanism intercalated between them as expressions of the known properties of neurones, the characteristics of conduction and of the synapse. Thus, as Konorski[1] (who has done more than anyone to relate the work of the two) has pointed out, his theory was essentially an anti-neurone theory. Nevertheless, all the time he undoubtedly had the idea at the back of his mind that, since a reflex arc is a physiological mechanism, the use of the term reflex itself made his work physiological and thereby gave it greater scientific reliability. So he was wont to attack not only the old introspective psychologists, some of whom no doubt deserved it, but all physiologists who saw that the known reflex-arc mechanism was inadequate as the sole basis of animal and human behaviour. He was quite unable to see that, as von Holst[2] says, there may be many mechanisms with other modes of function within the nervous system. "We merely recognize fragments of some of them and call them reflex; but this term denotes fragments of very different mechanisms." Yet Pavlov continually widened his own use of the term reflex (see his writings, of almost unbelievable naivety, on "the freedom reflex", the "reflex of life", and the "reflex of purpose") until gradually it came merely to mean 'response' and then finally meant practically nothing at all! He also spoke of "purposive acting science" of the dog having "the idea of food", and used other similar phrases in reference both to human and animal behaviour. He even spoke of an animal "aspiring to the attainment of a definite exciting object" ("Lectures", 1, Ch. 27, p. 276). Yet he repeatedly refused to allow that there was anything in behaviour except stimulation from the exterior. But, as Agar[3] has shown, he really planned his experiments, as we all do, simply by trying to set up situations which he hoped would yield fruitful results; and in devising such situations, he was constantly guided not by considerations of what may happen in the cortex but by the knowledge of human mental processes. "The tacit, and of course correct assumption underlying the plan of the classical Pavlov experiment is that in order that the dog may learn that the sound of the whistle means that food is coming, experience of the sequence silence–no food is as necessary as the sequence whistle–food. The reason for planning the experiment on this assumption can only be the recognition that we ourselves would have no ground to base an anticipation of food following the sound of a whistle unless we were able to compare the two experiences of silence followed by no food and sound by food."[3] So there is no reason for the oft-expressed statement that this method of biological investigation of behaviour possesses greater validity or is more physiological than any other method purporting to deal with memory, judgment, perception, etc. Both types of investigation must be carried out scientifically, and both must be judged by their results.

Marxists, of course, do not officially deny the effective existence of mind; but they do deny the dualism of mind and matter, and hence, calling themselves materialists, often come to speak as if mind is by definition something less important than matter. Pavlov was in effect, and of necessity, just as much a dualist as any of those he criticizes, probably more so than some of them. Over this he is ambiguous. At times ("Lectures", 2, Ch. 45) he appears to be a thorough-going mechanist, speaking as if he believes physiology can look forward eventually to absorbing psychology. Elsewhere ("Lectures", 2, Ch. 54) he denies being a mechanist and comes to admit, albeit rather confusedly, that he is a dualist. But Prof. Koshtoyants will not admit the fact. There is a highly significant mistranslation of Pavlov on this point in the book under review. In the 1941 standard edition of Vol. 2 of "Lectures on Conditioned Reflexes" ("Conditioned Reflexes and Psychiatry", Lawrence and Wishart, London) on p. 149 (also quoted in the introduction, p. 24) Pavlov says: "I wish here to emphasise the incoherence, the absurdity of a reconciliation between the subjective and the mechanical state. For me there is here a gross misunderstanding." This paper was published originally in French, and I have confirmed that this translation is correct. But Koshtoyants's edition, p. 546, makes Pavlov say: "they [his opponents] want to stress as strongly as they can the obvious inaptitude and absurdity of trying to link subjective feelings and mechanics. In my view this is an obvious misunderstanding”.

As a result of all this confusion, Pavlov burdened himself with a series of verbal subterfuges which are now seen to make nonsense. Worse still, he fastened these upon his followers in the form of a terminology which hindered a whole generation of them from going forward to tackle the really interesting problems which he had the insight to see were awaiting them. The modern development of elaborate cybernetic mechanisms as analogical tools for the study of the higher nervous centres is a very important one and likely to be of great service. Psychologists in recent decades have tended more and more to neglect the old concern with thoughts, feelings and sensations and to suspect introspection. There are good historical and other reasons for this. But consideration of brain models and of Pavlov's concepts brings one back again to the fundamental question whether, if one is concerned to understand behaviour, one is following the best course when one neglects altogether, to quote Tustin[4], the “one privileged access available to such immediate precedents and accompaniments of behaviour as thoughts and feelings, that are part of the complex of events of which behaviour is also a part”. The usual way of escape is to fall back on the precious word ‘complexity’ and to assume that, because of its complexity, the brain is conscious and that a machine elaborate enough to maintain an inner representation of the outer world may thereby be conscious. But, as Tustin says, this is no explanation. For to regard consciousness as an emergent does not merely fail to explain consciousness in terms of assumed elementary physical mechanisms; it assumes that it is inexplicable on that basis. This is the kind of fundamental theoretical difficulty which was the basis of Pavlov's confusion, as it is of many to-day. As Whitehead says, science must be continually criticizing its own foundations if it is not to be in danger of developing into a medley of *ad hoc* hypotheses.

W. H. Thorpe

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Holst, E. von, *Brit. J. Anim. Behav.*, **2**, 89 (1954).

Agar, W. E., “A Contribution to the Theory of Living Organism” (Oxford, 1943).

Tustin, A., *Brit. J. Psychol.*, **44**, 24 (1953).

AUTOMATIC CONTROL AND MACHINES

Automation

Friend or Foe? By R. H. Macmillan. Pp. viii+100+8 plates. (Cambridge: At the University Press, 1956.) 8*s*. 6*d*. net.

THIS small book of approximately twenty-four thousand words is based on the author's series of B.B.C. broadcasts, on automatic control and automatic production, in the Third Programme. In the introduction the meaning of the word automation is described as automatic production and the striving for a fully automatic factory. From the rest of the book it becomes obvious that the only new discovery in the past decade in this field is the word, automation itself. The three branches of engineering science which must combine to make automation possible—namely, automatic control or servomechanism theory, mechanization of production, and electronic digital computers—are dealt with in four of the six chapters of the book. The remaining two are devoted to economics and future prospects.

The theory of control systems, which is the author's own field of research work, is introduced by a historical sketch of various automatic mechanisms from seventeenth-century pressure cookers to mid-twentieth-century naval gunnery. The development of the understanding of these various individual mechanisms into a fundamental science is brought out by discussing some of the famous theoretical personalities—Maxwell, Routh and Nyquist—who have contributed greatly to the theory of servomechanisms. The aim of this section is to bring out in non-technical language the concept of feedback. The essence of the section on production can be summed up in the two phrases ‘line production’ and ‘transfer machines’. These are methods established in the 1920's. Automatic computers are dealt with in Chapter 5, again on a historical basis. Pascal (1642), Leibniz (1673) and Babbage (1829) are given as the early forerunners who laid down the basic principles of the modern high-speed electronic counterparts. Sufficient emphasis is not given to the major developments by ingenious inventions of large-capacity storage of data with, at the same time, rapid access to any required piece of stored information. Analogue computers are also mentioned and incorrectly termed ‘simulators’ (p. 63). The reader is also left with the erroneous view (p. 73) that, in general, the analogue computer is much faster than the digital machine.

The chapter on economics is weak; only the factors affecting the installation of equipment are considered. The overall economy, including the treatment of labour redundancy, is not dealt with. On reaching the last chapter, on “Present Impact and Future Prospects”, one is disappointed to find that it does not deal with the book's provocative title but is devoted exclusively to the expansion of the feedback concept of the control engineer into other sciences such as physiology, biology, zoology, theory of economics, etc.

This is a very interesting and well-written book which does not demand any scientific knowledge of the reader. It is a great pity the contents are not covered by the title.

John C. West

ELECTRONICS IN PHYSICS AND ENGINEERING

Advances in Electronics and Electron Physics

Edited by L. Marton. Vol. 7, 1955. Pp. x+527. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1955.) 11.50 dollars.

THE seventh volume in this now well-established and excellent series of specialist review articles contains much the same blend of physical and engineering electronics as its predecessors; but there is a somewhat stronger emphasis on related solid-state phenomena. The contents consist of seven independent reports of advances in widely different branches, ranging from semiconductors to radio astronomy. The reports vary in length from forty to a hundred pages, and each includes a very extensive bibliography of well over a hundred references. The “Advances”, like the many other similar annual reviews of individual branches of science, fulfil a very important function in these days when the volume of published research is so extensive. Each article is a model of clarity and conciseness, containing a wealth of up-to-date information, and is compiled by authors who have obviously a first-hand knowledge of their subjects.

Two articles—the physics of semiconductor materials, by E. Burstein and P. H. Egli (Crystal Branch, United States Naval Research Laboratory), and theory of electrical properties of germanium and silicon, by H. Brooks (Harvard University)—summarize our present knowledge of the nature and structure of semiconductors, including the recent substantial progress that has been made in the determination of the energy-level structure of the valence-type semiconductors. E. Rudberg in the early 1930's clearly demonstrated that when slow electrons impinge on solid surfaces there are characteristic values of energy losses that form a kind of line spectrum of the energy distribution, for which he coined the expression "characteristic energy losses". The last few years have seen rapid development in the observation and interpretation of these energy losses, and the article by L. Marton, L. B. Leder and H. Mendlowitz (United States National Bureau of Standards) describes the wealth of information acquired.

This is followed by an article on sputtering by ion bombardment, by G. K. Wehner (Wright Air Development Center), a phenomenon which is little understood owing to lack of reliable quantitative yield data. The report on electrical discharge in gases and modern electronics, by L. Goldstein (University of Illinois), is confined to a survey of work during the past ten years and deals with the fundamental processes occurring in the volume of low-pressure weakly ionized gases at ordinary temperatures, using the new experimental techniques involving high-frequency electromagnetic fields and microwave methods.

The two remaining articles deal with widely different branches of electronics—observational radio astronomy and analogue computers. The first summarizes the main results concerning the Sun, our galaxy and external galaxies, and the observational methods used for studying the universe at radio frequencies, together with the physical and astronomical significance of the radio observations. The second is concerned primarily with the advances during the past five years in analogue computation, though a short historical summary is given of computer developments since the Second World War. Various sections deal respectively with components; computer systems, the larger of which such as TRIDAC and TYPHOON were developed for the solution of problems in guided missiles; and a variety of uses to which analogue computers are now being put. S. WEINTROUB

SCIENTIFIC BACKGROUND OF TANNING

The Chemistry of Tanning Processes

By K. H. Gustavson. Pp. ix+403. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1956.) 9 dollars.

FROM time immemorial animal skins have been transformed by the tanning process into the fibrous and biologically stable product, leather. Recent research in the chemistry of tanning materials, proteins and the reaction between proteins, and substrates of small molecular weight, now permits the scientific investigation of tanning action and a critical appraisal in book form of this progress should therefore prove opportune. This book by K. H. Gustavson deals with the chemistry of chromium salts and chromium tannage, the effect of neutral salts and complex-forming agents in chromium tanning, miscellaneous factors in chromium tanning, the nature of the chromium–collagen complex, vegetable tannage, the reaction of lignosulphonic acids and syntans (synthetic tanning agents) with collagen, aldehyde tanning, quinone and oil tannages, combination (chromium and vegetable) tannages, and some tanning reactions of biological and medical importance.

In the first half of the book, the author approaches chromium chemistry and tannage through the agency of electrometric titration, ion-exchange chromatography, ionophoresis and reaction kinetics. The results are interpreted in terms of the ionic and co-ordinate valencies of chromium, and of the functional groups and polypeptide backbone of collagen. Much of the research was initiated by Gustavson, who commands the reader's attention.

The review of vegetable tannins is, however, inadequate and out of date. Recent work (cf. Schmidt O. T., and Mayer, W., *Angew. Chem.*, 68, 103; 1956) has restored order and interest to the untidy field of vegetable tannin chemistry. Of the ellagic acid free hydrolysable tannins, the constitutions of chebulinic acid and hamameli-tannin have now been elucidated, and a tetrasaccharide formula has been proposed for sumach-gallotannin. Among the ellagitannins, the structures of brevifolin, chebulagic acid, corilagin, and dehydrodigallic and valonic acids have also been elucidated. Recent application of conformational analysis to catechin and its epimerides deserves mention.

A lack of appreciation of the chemistry of vegetable tannins, particularly of gallotannin and of the constituents of myrobalans, is reflected in the subsequent treatment of their tanning action. Further conclusions drawn from adsorption experiments involving crude tannin extracts and hide-powder exceed in scope the nature of the experiment. Although the phrase "multipoint contact" is frequently employed, there is no reference to Fischer's (1894) provocative "Einfluss der Configuration auf die Wirkung der Enzyme" which initiated the spate of studies on enzyme substrate-inhibitor and agonist-antagonist relationships throughout the succeeding half-century. This approach to tanning action might have been advantageously developed within the context of vegetable tannage. It is surprising that no reference has been made to the application of reaction kinetics to vegetable tannage, despite its obvious importance, and its successful application to the analogous dyeing of wool. There is an excellent summary of synthetic tanning agents.

The book concludes with a stimulating account of biological reactions which possess a possible tanning implication. The biologists' discoveries require critical assessment, however, as their materials are often detected histochemically by staining reagents. Much of this work awaits intensive investigation by the natural products' chemist. In spite of its limitations, the book is the work of an enthusiast. Its chief merit is that it brings within small compass the salient references in the literature of leather chemistry. D. E. HATHWAY

Yearbook of the Universities of the Commonwealth

Thirty-third Issue. Pp. lix+1925. (London: Association of Universities of the British Commonwealth, 1956.) 63*s*.

THIS useful handbook has been steadily growing in size with each new edition, that for last year being just over two thousand pages. If the new material that has accumulated since then had been incorporated without any adjustment of the existing contents, the present work would probably have been a hundred or more pages longer, and the volume would have been in danger of becoming unwieldy—a fault the magnitude of which is in direct proportion to the frequency with which the book is consulted.

Fortunately, the editor has taken steps to rectify this and, by a slight reduction in the contents, has managed to make this year's edition about a hundred pages shorter than the previous one. The three appendixes in the 1955 edition on postgraduate awards, Anglo-American academic relations and international university organizations, respectively, have been omitted, although the first one is available as a separate pamphlet. In the entry for each university headed "The Year", there are no longer the paragraphs on principal changes in regulations, adult education work, and visits by teachers; furthermore, those on benefactions, new buildings, and new departments and posts have been pruned.

This lopping, not of dead wood, but of branches that were not over-fruitful, has made room for some new growths—notably a new appendix on British academic institutions abroad, and an analysis, in many of the separate university entries, of the distribution of students by faculties. The new appendix covers three institutions: the British Institute in Paris; the British School at Rome; and the British School of Archæology at Athens. Thus it will be seen that the "Universities Yearbook", as it used to be entitled and is still commonly referred to, is very much alive and is likely to flourish for many a year to come.

The Birds of the British Isles

By Dr. David Armitage Bannerman. Vol. 5: Falconidae, Accipitridae, Aegypiidae, Pandionidae. Pp. xiii+350+34 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1956.) 63*s*. net.

WITH this fifth volume, Dr. D. A. Bannerman's scholarly survey of knowledge of British birds nears the half-way mark. There is here interpolated a brief memoir and a portrait of George Edward Lodge, the author's artist partner who died after the work had begun to appear. This tribute could not have been more fittingly placed, because his artistry was at its very best when birds-of-prey were his subjects; and within the same covers we have many outstanding examples of his work—incidentally, in several instances more than one plate of a single species, illustrating geographical or developmental differences in plumage.

The whole volume is devoted to the four families of diurnal birds-of-prey—falcons, hawks (in the widest sense), vultures and osprey; and that there are only some two dozen species will give an idea of the extent and detail of the treatment. The author quotes freely from others; but some of their material has not been published before and he has often facts to add from his own observations. Nowhere else would one find together so much information about the migrations and habits of each species, based on study at home and abroad. In respect of this group there is a wealth of observation of spectacular passages in some parts of the world; and the variety of hunting habits is of much interest, including the aerial 'pass' of food from the male to his mate exemplified by Montagu's harrier and by the hobby. The account of British status is too often a sad story of dwindling numbers and of a lost or precarious foothold. The use of certain species in falconry, once "the sport of kings", receives due mention.

LANDSBOROUGH THOMSON

The Number System

By Dr. H. A. Thurston. Pp. viii+134. (London and Glasgow: Blackie and Son, Ltd., 1956.) 15*s*. net.

DR. H. A. THURSTON has two aims in view: he wishes to explain to the intelligent non-mathematician the way in which the number-field is extended from the integers through the rationals to the irrationals and the field of complex numbers; he also wishes to give the student of mathematics a complete logical account of these extensions. He has therefore divided his book into two parts: the first half is a semi-popular discussion of the way in which needs to extend the number system have arisen and have been met, a broad and interesting general survey from which details have been omitted; the second half, similar to Landau's "Grundlagen der Analysis", gives the austere logical development, from the integers founded on Peano's axioms to the rationals as ordered pairs of integers, the irrationals as Cauchy sequences of rationals, and the complex numbers as ordered pairs of real numbers. But the two parts are closely interwoven; serious readers of the first part will surely wish to see a portion at least of the detailed working-out of general principles, while the young student will grasp the occasional logical twists of the second part more readily if he makes constant reference back to the more discursive explanations of the first part. The author has taken great pains with both parts, and does not appear to have fallen between two stools.

T. A. A. BROADBENT

Grignard Reactions of Nonmetallic Substances

By Prof. M. S. Kharasch and Otto Reinmuth. Pp. xxii+1384. (New York: Prentice-Hall, Inc.; London: Constable and Co., Ltd., 1954.) 135*s*. net.

THE Grignard reaction is now a major method in organic chemistry. The range of its application is very extensive, and it has an enormous literature. A real service has been rendered in the preparation of this book.

It is by no means a bare catalogue of reactions and a bibliography, although it includes both. It contains readable statements of the underlying chemistry, brief historical surveys, and (what is valuable) new suggestions on possible reaction mechanisms. Particular attention is given to grouping reactions so as to facilitate reference, and the literature references are very complete. In the case of Russian and Japanese papers, references to *Chemical Abstracts* are also given. The 'normal' reactions are defined in each case, and deviations from them are explained.

The volume is an outstanding contribution to chemical literature which should be available in every organic chemical laboratory, where it is likely to be in daily use. Although the price is high, the book is worth it.

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

By RITCHIE CALDER, C.B.E.

EVERY year since the War, criticism of the British Association has been growing, and, forgetting resentments of much that was unfair in the strictures, the Council has decided, with the support of the General Committee, which is the membership body, to "put its house in order". Obviously, however, much more is involved than changing the structure and modifying the practices of a venerable institution, 125 years old. More than any other scientific body, the British Association brings almost the whole range of science within its scope and provides a forum for discussion with the public. To that extent, it has mirrored the complexities of modern science and the confusion of the lay attitudes to science.

When, therefore, the Council instructed an influential Committee, under Sir Ben Lockspeiser, "to consider the functions of the British Association in the present day world", it was in fact asking, in institutional terms, what Sir Raymond Priestley, this year's President, asked more rhetorically: "What can we do to help the world to make the choice which will ensure the survival and further progress of humanity ?"

Perhaps the public and the critics expect too much of the British Association as an instrument for resolving their fears and confusions about science. But that is a tribute to its traditions and to the part which it has played, since 1831, as the meeting-ground and market-place of science. The complaint is about the presentation of science; but, allowing for the perennial faults of obscure, inarticulate and slipshod lecturing at the meetings, the blame does not rest entirely with that institution. The newspapers, radio and television cannot escape their responsibilities. But the British Association can help to remedy, by example, the more obvious defects in the scientists' approach to the public.

That has been recognized by the Lockspeiser Committee in its restatement of functions. It is realized, for example, that the Association can no longer provide a platform for the immediate proclamation of original discoveries. That function has been replaced by the learned societies and the scientific journals; no one to-day would hold up an important announcement until the annual meeting of the British Association. It is also true that one of the purposes of the British Association in its origins—to convince an indifferent public and government that science was important and worth backing—is now superfluous. Other urgent tasks, however, present themselves. To quote the Lockspeiser Committee's report: "Science has brought into being a new world, in which the peace and prosperity of all peoples are increasingly dependent the one on the other—dependent because the units of organization (social, economic, political and national) are larger and their control more centralized; a world whose structure is in this sense more rigid and yet one in which both individuals and nations must respond more flexibly and more frequently to the changing situations forced on them by the discoveries and applications of science. The continuance of science is vital to modern society and this being so continued public goodwill is essential. To ensure this the methods and results of science and the nature o fundamental research must all be better understood by those concerned with Government, industry and business and the public at large. Such understanding is essential because, in any democratic State, an informed public is necessary if valid decisions are to be taken; because the public—as taxpayer and consumer—pays for science; because if, in the future, scientists and technologists are to be forthcoming in the numbers that the nation's wellbeing demands, the public should learn to value the contribution of science and come to appreciate the potential satisfaction and opportunity for service implicit in careers devoted to science; and above all because scientific discovery must be applied for the wellbeing of the nation".

The British Association can make its contribution through its annual meeting, which still fulfils its original purpose of taking science to the people (at least in the big cities which can accommodate its many scientific sections and membership), and it still attracts representatives from every branch of science as well as industrialists, Government servants, agriculturists, teachers and a large representation of the Press, radio and television. The first concern of the Committee, therefore, was the re-definition of the function of the annual meeting.

First: it should offer a platform on which leading scientists can discuss their work in all its theoretica complexities so that the public may understand the integrity and discipline involved in the search for scientific knowledge, for its own sake. Second: it must recognize the dangers of specialization and fragmentation of science which has separated the scientists in the various branches and has made them practically unintelligible to each other and must bring them together in joint sessions so that they can share experience in related fields and recognize problems on the frontiers of present knowledge Third: that it must provide for non-specialists whether they be scientists outside their own field or interested laymen. It should provide an annua stocktaking in intelligible language which will review the progress of science and help to make clear its possible social and political consequences. To thi end, prominent industrialists and political leaders should be invited to contribute to such sessions in order to put their problems in their wider setting.

The functions of the British Association are defined as "integration" and "dissemination". The integration involves bringing the specialists together to broaden their knowledge and their discussions beyond what is now possible in learned societies. The dissemination will involve a much closer relationship with the instruments of mass-communication—Press radio and television—and the guidance of scientists as to how they can best serve or make use of popular presentation. Such reforms are badly needed although they may not suggest the 'revolutionary' changes which some of the critics might have wanted. The Committee, however, has recognized that the influ nce, and indeed the functions, of the British Association depends on its traditions.

The British Association relies on a small and inadequate office staff and upon the unpaid efforts of the officials of its fourteen sections and local officers in the centres of its annual meeting. The sectional committees, responsible for the preparation of the programmes, have persisted in virtual autonomy. The presidents of the sections, selected and honoured for their distinction, are appointed for a year, while the recorders, appointed for five years, and the secretaries, provide the continuity. Sections and section officials are jealous of their rights and privileges and, under the constitution, are entitled to resist any interference or dictation from the Council or the general officers. They are entitled, without reference, to choose their subjects and their speakers. The result is more than three hundred papers, of very uneven quality and content, crowded into four and a half days. Although one of the most important purposes of the British Association is to allow members to widen their interests by moving from one section to another (all meet simultaneously), there is a conflict of time-tables and interests.

During the 1930's the principle of joint discussions, where several sections joined together, was encouraged, and they were conspicuously successful. They have continued since the War, at the discretion of the sectional committees.

Against this background, the difficulties of co-ordination are obvious. Although the proposal of 'conscious planning" was approved by the sections and the membership at Sheffield, there was outspoken distrust of any machinery to produce it. Guarantees had to be given that no pattern would be imposed from the top and that any co-ordinating would be done by persuasion and consultation. The Programme Co-ordinating Committee which has been appointed by the Council will therefore plan by consent. There will also be greater opportunities for advance discussions with Press, radio and television so that better material will be devised and better use made of it.

Perhaps more important than the refurbishing of the annual meeting are the proposals for making the British Association an active body throughout the year. The machinery for this has existed since 1938 in the form of the Division of Social and International Relations which, at the discretion of the Council, can meet anywhere, at any time, on any appropriate subject. Its original Committee (in 1938) included such men as Sir Frederick Gowland Hopkins, Sir Daniel Hall, Sir John Russell, Lord Stamp, Prof. P. M. S. Blackett, Prof. J. D. Bernal, Dr. Julian Huxley, Sir Alfred Egerton, Prof. A. V. Hill, Prof. L. Hogben, Prof. H. Levy, Lord Boyd Orr, Mr. H. G. Wells and Sir Solly Zuckerman. Its chairman was Sir Richard Gregory, and throughout the War, when he was president of the Association for six years, he kept the Association alive (although its meetings were suspended) by organizing conferences through the Division. Some of them, like that on "Science and the New World Order", were historic. International scientists were brought together in London, then subject to air-raids, to discuss momentous issues which are with us to-day, although the thinking about them is not as clearheaded as when the scientists and statesmen discussed them under the ægis of the Division.

Since the War, the activities of the Division have been restricted to occasional meetings or to sessions during the annual meeting. This comparative inactivity has been due to the financial difficulties of the Association and its lack of adequate staff.

A powerful new Committee of the Division has been appointed (and was the group which re-examined the functions of the British Association), and it is proposed that the Division should go out during the year to meet the industrialists, the farmers, the administrators, the trade unions, the women's organizations, and any other section of the community whose interests are affected by science. This break-down into common-ground discussions will give the British Association closer contact with reality and, it is hoped, with new sources of membership and finance. The British Association, like so many other institutions, has come to recognize that modern benefactors will finance specific projects and not, as in the past, endow a generalized ideal.

Given its 'New Deal' and the finances to implement it, the British Association can take on, yet again, a new lease of life.

UNITED STATES PROGRAMME FOR THE INTERNATIONAL GEOPHYSICAL YEAR

By Dr. JOSEPH KAPLAN

Chairman, U.S. National Committee for the International Geophysical Year, National Academy of Sciences

THE idea of international co-operation in the study of our changing physical environment is not new. The importance of geophysical data gathered intensively and simultaneously over large and relatively remote areas of the Earth was recognized in the last century in the conduct of the First Polar Year during 1882–83 and earlier this century by the Second International Polar Year, which took place during 1932–33. The proposed international effort for 1957 and 1958 surpasses in scope, intensity, and geographical coverage these earlier programmes, which were largely limited to the north polar regions and to but a few fields of geophysics.

The principal fields of study during the International Geophysical Year, 1957–58* will be aurora and airglow, cosmic rays, geomagnetism, glaciology, gravity, ionospheric physics, longitude and latitude, meteorology, oceanography, seismology, solar activity, and upper atmosphere rocket and satellite studies.

The proposal that 1957–58 be the time for this major international effort was based in part upon the fact that this period corresponds with a period of maximum solar activity. We shall be able to take advantage of this by a carefully planned series of 'alerts' and of 'special world intervals', occurring on such occasions as expected intervals of unusual magnetic, ionospheric, or auroral activity, days of solar eclipses and of abnormal solar activity, and unusual meteor showers. Special co-operative efforts on a world-wide scale will be made during these intervals to record the many phenomena which react to the complex activities of the Sun.

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* See Prof. Sidney Chapman's article, "The International Geophysical Year, 1957–58", *Nature*, Jan. 8, 1955, for a summary of the scope, aims, and methods of the project.

The current United States programme, planned and directed by the National Academy of Sciences, includes projects and programmes in all fields of the International Geophysical Year. This programme has considerable geographical as well as scientific coverage: the Antarctic, the Arctic, the Equatorial Pacific, and the continental limits of the United States represent the major regions of activity.

Long-range weather prediction and growth of knowledge of basic weather patterns will be greatly facilitated during the Year by the planned world-wide network of surface and balloon stations. The United States will conduct regular soundings to an anticipated height of 100,000 ft. at stations in Antarctica, the Arctic, South America, and the United States. We shall also maintain a Weather Central in Antarctica to collect and disseminate meteorological data to all interested groups both in and out of Antarctica, providing for the first time in history twice-daily weather maps of Antarctica.

As 1957–58 will be a period of maximum solar activity, scientists participating will develop detailed and comprehensive records in this field by means of systematic observations of the Sun with improved and faster co-ordination of the observing programme of solar observatories. Solar activity will be observed both in the visible spectrum and at radio frequencies. In particular, solar flares will be studied and correlated with changes in the intensities of cosmic-ray showers, ionospheric and auroral disturbances, and geomagnetic phenomena.

During the International Geophysical Year, a spectroscopic observation programme will give the distribution of radiations of the auroral spectrum both geographically and with respect to time during the auroral displays. The visual and photographic observations of the aurora have as objectives the creation of synoptic maps showing aurora distribution at small intervals and the collection of data for statistical studies of aurora with other geophysical phenomena and with solar phenomena. With modern techniques such as the all-sky camera, scientists will fill the gaps in knowledge about the aurora borealis in the Arctic, gather data heretofore unavailable about the aurora australis in the Antarctic, and trace the relationship between the two. The observing stations will be distributed along a longitudinal chain reaching from Arctic North America through Middle and Latin America to Antarctica. Measurements of the intensity of airglow radiations will also be made with photoelectric instruments of high sensitivity.

The source of cosmic rays and their possible effect on other particles and radiations in the outer atmosphere are far from adequately understood. During the International Geophysical Year, scientists expect to gain knowledge of the reasons for the large decreases of cosmic-ray intensity during some magnetic storms, fluctuations in cosmic-ray intensity near sunspot maximum, the world-wide variation of cosmic-ray intensity with the sunspot cycle, and the causes of sudden large increases of cosmic-ray intensity within an hour or less after the beginning of solar flares or chromospheric eruptions.

The ionosphere is studied chiefly by means of the radio waves which it reflects. Vertical incidence soundings will be taken at a number of sites in the United States and oblique incidence soundings both in the United States and in the Pacific area. There will be measurements of sporadic-*E*, backscatter by sweep and fixed-frequency techniques, and experiments in forward scatter. Radio noise and ionospheric absorption will also be measured, and there will be an extensive network of stations to study whistlers.

The United States geomagnetic programme consists of a series of experiments mainly designed to yield facts about the rapid fluctuations in the magnetic field, which are usually accompanied by disturbances in radio-wave propagation and often by auroral displays, and which also increase in number and intensity with an increase in the number of sunspots. To this end there will be a chain of geomagnetic stations stretching across the western United States in an east–west direction, another chain in Alaska in a north–south direction, and a third chain of four stations centred near the geomagnetic equator in South America.

Observations for the more precise determination of longitudes and latitudes will be made at twenty International Geophysical Year stations around the world. Astronomical longitudes and latitudes are obtained by observation of the positions of celestial bodies with respect to the direction of gravity. In the related programme on the position of the Moon, scientists using the Markowitz method will try to solve special problems in astronomy, geophysics, physics, and geodesy concerning universal and ephemeris time, the irregular rotation of the Earth, and the size and shape of the Earth.

The fragmentary nature of knowledge of gravity over vast areas in the oceans, the Antarctic, and the Arctic leaves considerable ambiguity about the shape of the Earth as a whole. The United States has therefore planned to carry out a number of gravitational studies. Gravimeter measurements are to be co-ordinated with the seismic exploration in the polar regions and can be carried out by the same personnel.

Seismological observations and measurements have long been conducted on an internationally co-operative basis. The United States programme includes additional measurements in remote areas, particularly in Antarctica and the equatorial Pacific islands. United States scientists will also attempt to measure linear strain directly with an instrument developed within the past few years by Dr. Hugo Benioff at the California Institute of Technology. There will also be projects to study the L_g phase wave and long-period seismic waves.

A study of motions of the deep currents in the sea, such as the vast exchange of polar water masses with those of warmer oceans, is related to problems of long-range weather forecasting. An island observatories project of the United States oceanography programme will be directed toward gaining an understanding of sea-level changes of both short and long periods and their relationship to other phenomena in the ocean and the atmosphere. 'Operation Deep Current', the other United States oceanographic project, will involve a study of the deep circulation of the water moving northward from Antarctica into and along the bottom of the Atlantic and Pacific and multiple-ship, detailed studies of the areas of convergence and divergence in the North Central Pacific and North Central Atlantic. These studies, as for all programmes in connexion with the International Geophysical Year, are co-ordinated with those of other nations.

The United States programme in glaciology will encompass detailed studies at points in the northern hemisphere and at stations in the Antarctic, as well as reconnaissance observations in the western United States, Alaska, and portions of the Arctic in co-operation with Denmark and Canada.

During the International Geophysical Year three approaches to obtaining direct upper-atmosphere data will be utilized: launching of large rockets from the ground, firing of smaller rockets from balloons and from aeroplanes, and launching of earth satellites. A total of more than two hundred rockets of different sorts will be launched by the United States for geophysical research purposes.

One of the limitations of the conventional rocket programme is that the rocket does not stay at great heights long enough to permit certain important types of measurements to be made. A single successful flight of a satellite will provide us with more observing time in the very high atmosphere than has been provided by all the ordinary rockets that have been fired.

Present plans call for the first earth satellite to be launched from the east coast of Florida at Cape Canaveral. There will be a three-stage rocket assembly to provide the means of placing the satellite in its orbit. When the satellite has reached a height of 300 miles, the last rocket will impel it into its orbit at a speed of about 18,000 miles per hour. The satellite will then revolve about the Earth in an approximate latitude range of about 40° on either side of the equator. Taking into account such factors as the Earth's rotation and the elliptical orbit of the satellite, its displacement will be about 25° for each revolution. This orbit will permit us to record observations over a broad expanse of the high atmosphere, while the latitudinal band-width coverage will permit scientists of a large number of nations to make observations and measurements.

The first satellite will be spherical in shape, about 20 in. in diameter, and will weigh approximately 21·5 lb. About half this weight will be required for the satellite itself, the remainder being available for instrumentation. At its closest point to the Earth it will be between some 200–300 miles distant, and at its farthest some 800–1,500 miles. Once placed in its orbit, the satellite becomes in effect a new celestial body. As such, the first problem becomes its acquisition—those preliminary observations which not only establish its existence in orbit but which also provide data for preliminary calculations of its orbit in order that ephemerides may be calculated and issued. These calculations will permit, first, the concentration of ground stations on the preliminary orbit and, second, the subsequent acquisition of more extensive data on the basis of which the various studies can be conducted.

The satellite programme thus affords an unusual opportunity for the acquisition of information about the upper atmosphere. As in other programmes of the International Geophysical Year, this opportunity is a broad one: the nations of the world will not only observe the satellite but will also participate in the scientific programme. The ground-station scientific programme, in particular, calls for extensive international participation in order to secure maximum advantage from the endeavour. Observations by radio or optical instruments will permit the conduct of important experiments relating to the density of the air of the outer atmosphere, the composition of the Earth's crust and various geodetic determinations. Moreover, it is hoped that other nations will be able to place satellites in orbit during the International Geophysical Year, increasing the amount of data thereby attainable and taking advantage of the interests, activities, and observing stations established during 1957–58 by the many participating nations.

PROGRESS OF CANCER RESEARCH

THE investigations described in the 500-page 33rd Annual Report of the British Empire Cancer Campaign covering 1955 can be divided into four categories, namely: (1) radiology, radiotherapy and radiobiology; (2) pathology and morbid histology and clinical themes; (3) carcinogenesis, statistical and demographic studies; (4) biochemical and biological lines such as those on nucleoproteins, cytogenetics, cytochemistry, steroid metabolism, tissue metabolism, viruses, cytotoxic agents, enzymes and hormones. It should scarcely be necessary to reiterate that in this short review only part of the large amount of research can be dealt with, and secondly that in such a wide field any reviewer is limited by his own experience.

The report affords an interesting cross-section of research at many centres into the vexed question of the relation between cigarette-smoking and cancer of the lung. The present position would seem to be summed up in a most interesting paradox: statistically, the case against cigarettes grows more and more convincing at the same time as, experimentally (at least so far as workers in Britain are concerned), it seems to grow thinner and thinner.

It would seem inescapable in the face of the formidable statistical evidence that cigarette smoke must contain something carcinogenic to the respiratory tract. Yet experimental proof of this is remarkably slow in appearing. At a number of centres the current experiment is to apply, to mouse skin, tar from cigarette smoke made in an apparatus which draws air through the lighted cigarette and condenses the smoke by passage through acetone cooled in a 'Drikold' bath. At none of six research centres have malignant tumours been evoked when the tobacco tar was applied to the mice. (These results are completely at variance with those of Wynder, Graham and Croninger in the United States, who obtained skin tumours in more than half the mice which were painted with tobacco tar.) Neither mice, rats nor hamsters have given positive results; nor have the different fractions from the tobacco tar obtained by separation with solvents shown activity.

It might be suggested that the disagreement with the American reports could depend upon some important difference in the technique of preparation of the tars or in the strain of mice employed for the tests. Since confirmation (or otherwise) of the report of Wynder *et al.* is urgently required, a thorough interchange of information and especially of materials, such as tobacco tars, tar fractions and mouse strains, should be instituted—and perhaps plans for such a liaison are already in process of being devised.

The lung of the rat has been used as the test material in experiments where either tobacco tar, or alternatively powerful carcinogens (benzpyrene, methyl-cholanthrene), were applied directly to the lung after thoracotomy had been performed. In forty-four rats only one carcinoma and seven sarcomas were obtained, indicating that the lung tissue of the rat is resistant to the carcinogenic potency not only of benzpyrene and methyl-cholanthrene but also of tobacco tar; the investigators were aiming at producing lung carcinoma of the type found in man, not at merely inducing sarcoma. None of the tumours was induced by the tobacco tar.

Tobacco tar injected directly into the lungs of thirty-six mice induced a low yield of lung tumour which was not very different from the incidence in the control untreated mice. In another experiment, soot containing nearly 100 parts per million of benzpyrene was used for direct injection into mouse lung. These experiments are not yet concluded; so far, the quantitative incidence of lung cancer could not be described as spectacular. Soot from railway engine funnels contains very little benzpyrene, whereas the soot from diesel engines which are operating slowly contains appreciable amounts of benzpyrene among other hydrocarbons.

The mortality-rates from respiratory cancer in Eire has been the subject of a very interesting investigation into the relation of tuberculosis to lung cancer in that country. Males in rural Eire have a low lung cancer-rate, less than a half of that in rural England. The data quoted afford plenty of material for speculation. For example, why was the Greater London lung cancer-rate (for 1953) 1,710 per million males at ages 45–64 and 4,125 at ages 65–74 years, while the corresponding rates for Dublin remained at 1,650 per million at ages 45–64 and 1,655 at ages 65–74? In 1953 the rate in rural England was 1,140 at ages 45–64 and only rose to 1,665 at ages 65–74 years.

The author states, "A study of the mortality rates per million for respiratory and non-respiratory tuberculosis and cancer from 1893 shows that apart from the disturbances due to the wars the sum of the mortality rates of the two diseases remains constant at 2,500 from the year 1910 onwards. It would appear that the mortality from respiratory tuberculosis has been replaced by that from non-respiratory cancer and that from non-respiratory tuberculosis by respiratory cancer".

Work on the relation of the atmospheric benzpyrene to smoking and lung cancer in Liverpool and nearby rural districts have shown that: "(1) rural death rate from lung cancer increases in proportion with the maximum number of cigarettes which have been smoked habitually per week, (2) Liverpool rates exceed the rural rates by about the same amount in each smoking category, (3) the urban/rural ratio between the death rates among non-smokers is about 9 to 1 and corresponds roughly with the ratio between the concentrations of 3 : 4-benzpyrene, some other polycyclic hydrocarbons and sulphur dioxide, found in the air of a Liverpool locality and the concentrations found in rural situations in Anglesey and Cheshire".

Stocks and Campbell's report just mentioned is a first-fruit of a major co-operative investigation into the environmental histories of patients dying of cancer of all sorts in North Wales and Liverpool. Data on 12,000 such patients and 19,000 controls are now available. Among other findings based on this series may be mentioned the following: (*a*) Cancer of the uterine cervix can be related better to early commencement of child-bearing than to numerous progeny. (*b*) Cancer of the stomach, in rural Wales where it has a high incidence, appears to occur most often in those who have lived for long periods over soil of high organic content. (*c*) Those with a high intake of beer (but not of milk or tea, the former appearing actually protective) have a raised incidence of most forms of cancer (but not, oddly enough, of gastric cancer).

This kind of survey, which depends for its success on the co-operation of many separate agencies, is one for which the British Empire Cancer Campaign seems particularly fitted. Another activity one would like to see it promoting more vigorously is the investigation of the geographical incidence of cancer, a subject on which even in its simplest aspects a remarkable amount of work remains to be done. There are accounts of only two activities of this type in this year's report. From Hong Kong come reports of investigations of two tumours of importance in that area. Hou describes the post-mortem appearances of infestation with *Clonorchis sinensis*, which he believes to be responsible for 15 per cent of liver cancers in the area. Teoh describes the nasopharyngeal tumours of Chinese, and comes to a firm conclusion that they are squamous carcinomata. In both of these, experimental investigations are under way; in the latter the possibility that incense smoke is the cause is being examined.

In Uganda a Cancer Registry has been set up, and has had the benefit of a visiting statistician. It is hoped to produce reliable statistics at least for one large district around Kampala. So far it has not gone beyond indicating that the true total incidence of cancer in the African is probably not very different from that seen in Europe. It has been possible to confirm roughly beliefs that cancer of the penis liver, skin (especially Kaposi sarcoma) and uterine cervix are especially common, cancer of the respiratory and alimentary systems and breast relatively rare, and cancer of the testis, tonsil and thyroid apparently absent. Fuller reports from this Registry will be awaited with interest. One piece of work given little space in this Report, which could be a key to the incidence of liver cancer in the tropics is the *Senecio* alkaloid studies of Schoental and Head.

The Great Ormond Street review of the tumours of childhood continues. This year's instalment is prefaced by some observations on the way in which improved treatment of other diseases is increasing the importance of tumours as a cause of death in early life. Though only 1 per cent of admissions to the hospital are for tumours, they are the cause of death of 17 per cent of cases coming to post-mortem a figure second only to congenital malformations. Of the tumours nearly a third are intracranial, which are dealt with in some detail this year. The 203 tumours seen in this situation include 174 (86 per cent) glial and 29 (14 per cent) non-glial—the latter consisting of eighteen meningiomata, six craniopharyngiomata, four choroid plexus tumours and one ependymoma. Bodian classifies the glial tumours into (differentiating) medulloblastoma (70 cases), nodular astrocytoma (59), diffuse astrocytoma (25) and subependymal glioma (20). (It may be noted that this makes medulloblastoma the fourth commonest tumour of childhood, or fifth if one includes leukæmia: neuroblastoma, Wilm's tumour and lymphoma stand above it.) Medulloblastoma and diffuse astrocytoma appear to be nearly always fatal. In the case of nodular astrocytoma, subtentorial meningioma and subependymal glioma, the prognosis is more encouraging and the results of treatment appear to be improving.

Further details of the study of the effect of treatment of neuroblastoma with vitamin B_{12} in massive dosage are given. Though only moderately encouraging, with 25 per cent of two-year cures, the genuineness of the effect would appear to be established.

In an experiment on the effect of environmental factors on cancer incidence, fowls were kept in a climatic chamber at constant temperature and humidity, while their siblings were exposed to the ordinary vagaries of climate; the diet was the same in both groups. The result of constant climatic condition was to increase greatly the incidence of cancer, for in the climatic chamber thirteen of nineteen fowls died and were found to have been suffering from adenocarcinoma of the ovary, oviduct, mesentary, alimentary tract, spleen, or liver. During the same period, only one death occurred in the control group (variable climate) and no cancer could be found at post-mortem. The fowls in the constant climate chamber were sexually inactive (that is, ceased egg-laying) for an average of 1·5 months in the three years of the experiment, while the control (variable climate) hens ceased egg-laying for eight months. These experiments suggest that a constant environmental temperature and humidity has a powerful effect on the reproductive cycle, and that in the fowl, cancer of the reproductive system and also of the alimentary tract, the liver and the spleen is facilitated by environmental factors via the endocrine organs.

Electron-microscope studies of the virus-induced Rous sarcoma in the fowl has made possible the first definite morphological identification of this virus. It has been shown to have a diameter of 70 mμ, but is not constantly detectable in all filterable Rous sarcomas. Obviously there are some interesting gaps in our knowledge of this tumour awaiting elucidation. From eight different Rous tumours, the 70-mμ particles were detected in four, and their occurrence varied from one particle-bearing cell in 2,000 cells to one in 50 cells. When the cells of the tumour were disintegrated mechanically so as to liberate the virus, it was found that there was a very close correlation between the sarcoma-producing activity of the tumour of origin and the percentage of cells which contained the 70-mμ particles.

The investigation of the carcinogenic action of cholesterol is continuing; recent reports from the United States have claimed that some oxidation derivatives of cholesterol have a much more powerful carcinogenic potency than the parent sterol. Fieser, Bischoff and collaborators state that solutions in sesame oil of lathosterol, 6-hydroxy-Δ^4-cholestene-3-one and particularly 6-β-hydroperoxy-Δ^4-cholestene-3-one all produce sarcoma in 30–60 per cent of injected mice.

An interesting example of species differences in sensitiveness to carcinogens has been demonstrated in the reaction of the tissues of the rat and of the guinea pig to 2-acetamidofluorene. The rat develops malignant tumours of the liver, kidney, ureter, bladder, pancreas, acoustic duct, mammary gland, uterus and skin; but feeding the compound to guinea pigs for as long as four years produced no tumours of any kind.

Interesting facts have been discovered in a study of the behaviour of normal and of malignant fibroblasts when these are grown in tissue culture. When the pseudopodia of normal fibroblasts touch each other, adhesions occur and movement ceases. On the contrary, when the pseudopodia of malignant fibroblasts touch, no permanent adhesion takes place; the cell surfaces slide over each other.

Berenblum's early work on co-carcinogens (now termed 'promotors') dealt chiefly with the polycyclic hydrocarbons, for example, benzpyrene or 1 : 2 : 5 : 6-dibenzanthracene, as 'initiators' which were applied in sub-threshold doses to mouse skin and then followed up by promotors, the most effective being croton oil, which behaves like a photographic developer in making visible the preliminary effect of the initiator.

This work has now been extended by other investigators to show that the entirely different compound urethane is a potent initiator for mouse skin and that croton oil is an initiator as well as a promotor. New initiators have been found; for example, one of the most effective is allyl methane sulphonate and also β-propiolactone; furthermore, applied in sub-ulcerative doses, the lactone is a complete carcinogen and produces papilloma and carcinoma. The detergent 'Tween 60' has been found to have promoting activity. The problem of relating chemical structure with carcinogenic potency thus becomes more complex as carcinogens (whether the compound is a complete carcinogen or is only a promotor or an initiator) of widely different structure become known.

Tobacco tar has been tested for co-carcinogenic activity and with positive results. Mouse skin pre-treated (initiation) with benzpyrene developed papillomas when afterwards painted with tobacco tar, showing that the tar had a promoting effect.

In the ever-widening range covered to-day in research into the causes and treatment of cancer, the boundaries of the different fields of work become less distinct, and the physicist works in increasingly closer co-operation with his medical and chemical colleagues. Although the particular sphere of any one worker tends to become narrower, yet he is quick to make the most of the very varied tools available to him. This is well illustrated at one centre by the use of electron microscopy and autoradiography in the study of ultra-thin slices of tissues which contain carbon-14 or sulphur-35. A 1,000-curie cobalt-60 unit for the joint use of chemists, physicists and radiotherapists forms common ground for radiobiological research in another laboratory, and leads to the mutual discussion of other problems which are common to workers attacking the same basic problems from such widely differing approaches.

A considerable number of centres are installing, or have installed, sources of radiation of increasing penetration. Reports from various regions give details of measurements of the depth–dose distributions with 4–15 MeV. linear accelerators, and with cobalt-60 sources. The effects of the inhomogeneity of body tissues on the dose received in the various tumour sites, and also the relative biological effect of the various qualities of radiations used in radiotherapeutic practice are being investigated.

Methods of calorimetric dosimetry are being perfected to enable an accurate measure of beams of high intensity but short duration, such as are met with when using the linear accelerator. Scintillation dosimetric techniques can now be applied with an energy response constant to ± 10 per cent over the range 20 keV. to 2 MeV.

At the other end of the activity scale, equipment has been constructed for the continuous monitoring of the natural radioactivity of the atmosphere, and regular measurements are being made of the radon content of the air in both hemispheres. Measurements have also been made of the natural radioactivity of different types of building materials from different parts of the world, and calculations carried out on the doses received at the gonads for both males and females. With the increasing development of radioactive materials, arising from a variety of uses from the luminescence of wrist-watches to the 'fall out' resulting from atomic explosions, the radiation dosage-level of the population as a whole becomes of increasing importance. This is confirmed in this report by the increasing use of radioactive isotopes, not as therapeutic agents, but as diagnostic and research tools, for labelling red blood cells with iron-59, for radiography with thulium-170 and xenon-133, and for diagnostic tests for thyrotoxicosis using iodine-131, to mention but a few of the numerous routine uses.

SCIENCE BY THE UPPER FORM

A SESSION of Section X (Assembly of Corresponding Societies) of the British Association meeting at Sheffield was devoted to a series of papers by sixth-form pupils under the title "Science by the Upper Form". Its object was two-fold : to introduce the young people to the meetings of the Association and to give adult listeners an insight into the work and interests of potential scientists.

The session was popular and attracted the largest audience that the Section enjoyed. The papers covered a wide range, from a consideration of the teaching of the history of science in schools to the mating customs of bullfinches, and from a school astronomical project to observations upon animal life in a stream. They were all indicative of much careful thought, and, where the subject demanded it, close and continuous observation combined with accuracy in recording. The young people were to be congratulated on their timing. None exceeded the limit imposed and some ended with a few minutes in hand.

The session was opened by Anthony E. Hanwell (King Edward VII School, Sheffield), who, under the title "The Value of the History of Science in a Sixth-form Science Course", gave an account of a course involving two periods a week for two years. The course began with the early attempts of man to exploit and adapt himself to his environment, all of which were characterized by the lack of a desire to seek theoretical explanations of the processes used. This was followed by attention to the study of Nature by the early Greek philosophers; to the Roman attitude to such matters; to the general decline in learning in the Dark Ages, and the impact upon European thought and life of the rise of Arabic nationalism and the recovery of the ancient Greek writings.

The course dealt fully with the lives of Copernicus, Tycho Brahe and Kepler, and the far-reaching effects of the work of Newton. Other sections were concerned with the histories of magnetism, electricity and light, to which a considerable amount of time was given; but it was surprising to learn that the history of biology was dealt with only in outline, and that of geology apparently not at all.

The speaker said that he was impressed by the way in which the study of the experiments of the pioneers emphasized the necessity for accurate observation. This in ordinary class-room work seemed directed mainly toward "obtaining a more accurate answer to a particular experiment, when if the answer were known it is usually possible to surreptitiously modify the observations". He appreciated the necessity for dealing with failures as well as with successes, and concluded that "a history of science course can do much to rectify the errors of undue specialization" by providing the scientist with a broader knowledge of his subject, its aims, its limitations, and its possibilities for good.

In a paper entitled "British Finches", Kenneth R. Hughes, of Chesterfield, gave the results of observations on three of the common species that he had kept under observation. The behaviour of some kept under aviary conditions was found to be identical with that of the wild birds. From accounts of mating displays, nest-making and brood-rearing it appeared that the courting of bullfinches began in mid-April and lasted for about a fortnight. Nest-building began soon after mating and when incubation commenced the cock was rarely seen near the nest, though he shared in the feeding of the young while the hen was sitting on her second clutch. When the birds of the second brood were able to feed themselves the whole family gathered and remained together until spring, changing their summer woodland habitat for gardens and allotments during autumn and winter. In March the flocks separated into pairs and the yearly cycle began again.

Hawfinches next received attention. The courtship was seen to be a vigorous affair in which the female seems almost to be driven to build a nest. The young are reared on insects, and it is only later that they become the enemies of fruit growers and gardeners.

The work is continuing, for Kenneth Hughes has seven other species under observation. He regards finches as suitable for his purpose on account of the ease with which they may be kept under conditions almost natural to them.

Miss Anne Bunting contributed a paper on "Some Little-known and Unpublished Aspects of the Life-History and Habits of *Periplaneta americana* (L.)". Having reared the large American cockroach for a number of years, she had come to the conclusion that the periods of incubation and of growth from incubation to final moult were shorter than is stated in text-books. She found that the incubation period lengthens as the temperature decreases, that below 50° F. no incubation takes place, and that oothecæ submitted to this low temperature do not incubate if later exposed to more favourable temperatures. This was suggested as a partial explanation of the failure of the species to become widely established in Great Britain. Miss Bunting is a pupil of Thorne Grammar School, near Doncaster.

Keith L. Watson (Charterhouse) described "The Charterhouse Astronomical Project", the chief object of which was to revive within the school an astronomical society, first conceived when an observatory was added to the science laboratories in 1907. A retired master, Mr. R. C. Sclater, set up an observatory in his garden and made it a practice to invite parties of boys to make use of his telescope at week-ends. Unfortunately, he soon died and the project collapsed, to be revived again about four years later, in 1936. The organizers decreed that only sixth-form boys could become members—a rule that has now been wisely abandoned on the grounds that in order to maintain continuity with a changing school-population it is necessary to encourage the younger boys to take part. The work had to be suspended when war broke out and the observatory was used as a fire-watching post.

The present project was commenced in 1953 through the influence of a physics master, Mr. Hayward, and has been encouraged and assisted by a local medical practitioner, Dr. Lyne-Pirkis. To use Keith Watson's own words, "on a clear evening we are at liberty to telephone him and he picks us up in his car and takes us to his observatory where we always spend a very pleasant and instructive evening".

The work planned for the society is determined by the equipment available. The mirror of its original 6¼-in. reflecting telescope has been damaged, and since they cannot afford to pay for it to be repaired professionally the members intend to grind a new mirror for themselves. They now have also a 3-in. Cooke refractor, which, being simpler to use, is more popular.

Some of the boys are mapping portions of the Moon's surface, paying special attention to regions on the edge of the disk that, being difficult to observe and in many cases not very interesting, tend to be neglected by most astronomers. The main task of the solar section has been to plot the course and cycles of sunspots.

The society has about fifty members, but as with most local societies only a few are really active, the others being what Keith Watson aptly described as satellites, attending lectures but doing little practical work. It is interesting to record that a paper embodying observations on "Bee-eaters in Britain" was read by another Charterhouse boy, James J. Swift, at another session of the Section.

The last paper was on "The Ecology of Porter Brook", by John K. Chesters (High Storrs Grammar School, Sheffield). It was a description of work done on the headstream of the River Porter, which runs off the moors on the west side of Sheffield.

Animals were collected in a Surber net, the horizontal frame of which marked out one square foot of the bottom surface. The net faced upstream and collected all the animals loosened from the rocks and the bottom debris. The contents of the net were washed into jars and afterwards sorted, counted and identified.

A chart was prepared expressing the results of the count in terms of the distance in feet from the source of the brook and the months in which the samples were taken. This revealed interesting variations in the number and relative importance of several stonefly nymphs and chironomid larvæ in various parts of the brook and at various times of the year, and showed that annelid worms were found in large numbers near the source of the stream but not elsewhere.

As one of several examples of the results obtained, it was pointed out that the numbers of chironomid larvæ increased greatly (in April and May) at the junction of the Porter Brook with another small stream, the Mayfield. Since the larvæ live in the bottom organic debris and are liable to be swept away by fast bottom currents it was thought that their greater abundance in the combined stream was due to there being a relatively slower bottom current in the somewhat deeper water. Tests showed that on similar bottoms the bottom velocity above the junction was twice as great as below it.

The general conclusions arrived at were that the main factors affecting life in the stream during winter and early spring were the velocity and volume of the water, but that during the remainder of the year there were complications due to other factors such as the amount of vegetation overgrowing the stream and controlling not only the supply of higher plant material but also the intensity of illumination.

F. J. NORTH

OBITUARIES

Dr. G. J. H. Swoboda

GUSTAVE SWOBODA, who died at Geneva on September 4, aged sixty-three, was widely known to meteorologists as the administrative head of the pre-war International Meteorological Organization and its successor, the World Meteorological Organization. Swoboda was a Czech (he later acquired Swiss nationality), a native of Prague, where he graduated in 1920 with the degree of Ph.D. In the same year he joined the State Meteorological Institute and ultimately became chief of the forecasting service. During this period he lectured on meteorology at the technical college in Prague and wrote a technical treatise on aeronautical meteorology. He was one of the first meteorologists outside Norway to give whole-hearted support to the ideas of the Bjerknes school, and among other works he collaborated with T. Bergeron in a memorable essay on waves and vortices on a quasi-stationary surface.

The turning point in Swoboda's career came when he was appointed a member of the International Meteorological Organization's Commissions for Synoptic Weather Information and for Aeronautical Meteorology. The International Meteorological Organization was a non-governmental body, supervized by a conference of directors of various national services. Swoboda had, apart from his meteorological knowledge, one great asset for such international work. He was a very accomplished linguist, who spoke Czech and German as mother tongues, English and French with complete ease and had considerable knowledge of Dutch and several other European languages. It was therefore no surprise that in 1938 he was selected to succeed Dr. Cannegieter as chief of the secretariat of the Organization, and it was he who supervized the transfer of its headquarters from De Bilt to Lausanne.

Swoboda managed to hold the Organization together during the years of the Second World War and gained his reward in 1951 when the World Meteorological Organization, a Specialized Agency of the United Nations and the successor to the International Organization, appointed him as its first secretary-general. This post he held until September 1953 when he reached the normal age of retirement; but he continued to serve in an acting capacity until August 1955. At the time of his death he was professor of meteorology at Istanbul.

Swoboda's work as a scientist was recognized in 1953 when the Royal Netherlands Academy of Sciences awarded him the Buys Ballot Medal; but his unique contribution to meteorology undoubtedly was in the field of international co-operation. He was, in many ways, the ideal international Civil servant, and his success in this role arose as much from his kindliness and tact as from his linguistic gifts and administrative ability. He had not only a wide knowledge of his subject but also a great charm of manner and a genuine concern for the happiness and welfare of all around him. He leaves a widow and one son.

O. G. SUTTON

Dr. C. B. Rees

COLIN BEVAN REES died on September 2, a victim of cancer, at the early age of forty-one; and by his death marine biology has lost an enthusiastic and original plankton worker who was developing important new lines of research. Born at Pontardawe in Glamorgan on October 25, 1914, he was educated at Pontardawe Grammar School and University College, Cardiff. After graduating with first-class honours and making an ecological study of the fauna of the Severn Estuary, he was appointed in 1937 to the research staff of the Department of Zoology and Oceanography at University College, Hull, which was then expanding its plankton recorder survey. Jointly with Mr. K. M. Rae, he produced a report on the distribution of the Copepoda which was noteworthy for its account of the month-by-month advance of Atlantic indicator species into the North Sea from the north.

After war service as a captain in R.E.M.E., he returned to the plankton recorder team and moved with them to the new Oceanographic Laboratory of the Scottish Marine Biological Association at Edinburgh. He now conclusively demonstrated the reality of the previously disputed two forms of *Calanus*: *finmarchicus* and *helgolandicus*, and studied their distribution and development in different areas of the North Sea. Next he turned his attention to the planktonic larvæ of bottom-living invertebrates. He first set out to devise a method of identification for the multitude of lamellibranch larvæ; by using shape, form of hinge, and texture he distinguished seventy-seven types and produced an account, illustrated with diagrams and photographic plates, which has proved invaluable for other workers. A series of reports followed on the distribution of the larvæ of lamellibranchs, decapod crustaceans, echinoderms and other benthic animals. His University awarded him the D.Sc. in 1951. During his illness he made the final corrections to a further study of the two forms of *Calanus*, this time comparing their population production in the Atlantic and the North Sea over different seasons. He leaves a mass of data on the other copepod species which it is hoped may be prepared for publication later.

Colin Rees will be remembered by his colleagues and many friends for his devotion to research and for his cheerful good company. He was artistic and, as a hobby, painted in water-colour with distinction, exhibiting in leading Scottish galleries. Our sympathy goes to his widow and two children.

A. C. HARDY

NEWS and VIEWS

Brazilian Society for the Progress of Science

THE annual meeting of the Brazilian Society for the Progress of Science was held this year during July 2–7 in the old gold-mining centre of Ouro Preto. The president of the Society, whose term of office runs for two years, is Dr. Anisio Teixeira, the distinguished Brazilian educationist, and the inaugural lecture was given by Prof. Carlos Chagas, the president for the meeting, on "Prospects and Problems of Scientific Research in Brazil". The subjects discussed at the meeting, which was attended by about two hundred Brazilian scientists, were divided into nineteen sections. The largest number of papers were presented in the four sections devoted to physiology (including biophysics, biochemistry and pharmacology); physics (and astronomy); microbiology (including epidemiology and preventive medicine); and chemistry. Papers on biological and medical subjects accounted for 65 per cent of the total of 211 papers presented. Foreign guests included Prof. A. M. Monnier, neuro-physiologist, Prof. J. L'Héritier, geneticist, both of the Collège de France, Prof. J. A. D. Cooper, biophysicist, of the University of Chicago, and Mr. F. M. Beatty, science officer of the British Council in Brazil, who lectured on the training of scientists and technologists in British universities. The next annual meeting of the Society will be held in Rio de Janeiro during July 1957; the 1958 meeting, celebrating the first decade of the Society's existence, will be more international and will probably be held in São Paulo.

Electronic Equipment working at Red Heat

A DEMONSTRATION has recently been given at the Research Laboratory of the General Electric Company, Schenectady, N.Y., of electronic components and devices working at temperatures of red heat and, in some cases, under the action of intense nuclear radiation in an atomic reactor. Conventional electronic equipment usually breaks down at 200° F. or above (about 100° C.), although with the advent of guided missiles and supersonic aircraft a number of components have been developed capable of operation at 500°–600° F. (about 300° C.). If high-speed flight is to make considerable advances in the future, bulky power-consuming equipment for cooling will have to be eliminated, and components must be capable of working at very much higher temperatures. By suitable choice of such metals as titanium and special ceramics, General Electric has developed—so far only at the laboratory-level—electronic components that function at temperatures up to 1,500° F. (about 800° C.) and also at a high temperature in the neutron flux of the graphite reactor of the Oak Ridge National Laboratory. Among the equipment shown at the demonstration were a radiogram and valve amplifier operating in an oven at 1,500° F., and an electric motor in the flame of a blow-lamp. In some respects, the new 'heaterless' valves are an improvement on the more conventional pattern in that the power supply normally required for heating the filament is eliminated, and it is thought that this new type of valve, if operating under constant high-temperature conditions, may have a superior performance.

The French Atomic Energy Programme

ISSUE No. 16 of *Laboratoires*, the quarterly review in French and English of French scientific and technical developments, is devoted to the French atomic energy programme, and in particular, to the peaceful applications of atomic energy and to France's participation in the International Conference on the Peaceful Uses of Atomic Energy held in Geneva last year. J. Guéron, director of the French Atomic Energy Commission, contributes a brief foreword in which he stresses the rapid expansion of the French atomic energy programme since the adoption in 1952 of a five-year plan for atomic equipment. Prof. Y. Rocard reports briefly on the Geneva conference and the associated industrial exhibition, and Prof. P. Auger follows with a most interesting article on the training of research workers in the field of atomic energy, in which he maintains that care should be taken to avoid the introduction of specialization directed towards the new fields of science and technology at too early a stage. It will be necessary to modify the university curriculum so that student engineers and scientists are made familiar with the new domains of physics, chemistry and biology which are now assuming major importance; but the practical aspects of particular applications should not be given excessive importance. They should form part of a training programme to be given later at specialized centres probably attached to the larger establishments where the technique is being employed. Future research workers and engineers should be encouraged to extend their basic knowledge to fields outside their own professional spheres; for example, the chemist to radioactivity, and the mathematician to nuclear physics. In addition, Prof. Auger emphasizes the importance to the atomic scientist and engineer of ancillary services, the provision of an adequate number of trained technical assistants, a good information service and library, and the time and facilities to attend scientific meetings and conferences and for visits to other research establishments. Other articles in the issue are on automatic instruments for recording radioactivity, by Prof. P. Bonet-Maury, and on analogue computor simulation of the kinetic performance of nuclear reactors, by J. Girerd. Finally, there is a detailed illustrated technical review of the various exhibits of French instruments and equipment displayed by the forty-six French firms which took part in the international exhibition at Geneva last August.

Studies of the Upper Atmosphere

ONE of the classic works of meteorology is W. H. Dines's discovery (M.O. Geophys. Mem. No. 13; 1919), using his balloon-sonde observations, of the positive correlation between temperature in the troposphere, pressure in the upper troposphere, and the height of the tropopause and the negative correlation between these quantities and temperature in the stratosphere. Thus low pressure in the upper troposphere goes with a cold troposphere and a low tropopause. This discovery was the death-blow to the convective theory of temperate-zone depressions, which required depressions to be relatively warm. Using recent radiosonde observations, J. K. Bannon and A. Gilchrist (*Quart. J. Roy. Met. Soc.*, 82, 58; 1956) have repeated and much extended Dines's work. Bannon and Gilchrist used radiosonde observations at Arctic Bay (North Canada, lat. 73° N.), Lerwick, Larkhill, Malta, Aden and some equatorial Pacific stations for heights up to the level where pressure is 60 mb. (about 63,000 ft.). They confirmed Dines's results for the Lerwick and Larkhill observations and found the same result for Malta in winter and Arctic Bay in summer and autumn. At Aden and the equatorial stations and at Malta in summer no correlation could be found, and at Arctic Bay in winter and spring the correlation was less marked than at the British stations. Malta in winter and Arctic Bay in summer and autumn have a similar meteorological regime of travelling depressions and anticyclones and changing types of air-mass to that of the British Isles throughout the year. In summer, however, Malta is mostly in the area of the subtropical anticyclone, and Arctic Bay in winter and spring is in the area of a fairly constant low-pressure area with little change of air-mass. The conclusion is that the Dines correlations are characteristic of travelling depressions and anticyclones with frequent changes of air-mass. Dines evaluated correlations between tropospheric temperatures and pressure up to 9 km. (30,000 ft.). Bannon and Gilchrist found the correlation decreased rapidly at greater heights, so that the influence of travelling depressions and anticyclones was only half at 60 mb. what it was at 150 mb. (about 45,000 ft.).

Photometry of Telescopes and Binoculars

THE booklet "Photometry of Telescopes and Binoculars", which is No. 14 in the series of "Notes on Applied Science" produced by the National Physical Laboratory, Teddington (pp. 18+2 plates. London: H.M.S.O., 1955; 2*s*. net), explains the objects and methods of some of the test work performed for industry by the Laboratory. The quality of a telescope is judged by its definition, that is, its power of producing a sharply defined image of a distant, often inaccessible, object; but this quality is extremely difficult to express quantitatively and is not dealt with in the booklet. However, closely connected with definition is the question of contrast. If there is little difference in contrast between an object and its surroundings and the contrast-rendering properties of the telescope are poor, the image may be undetected. Veiling glare is a measure of the light scattered or reflected in the instrument which, falling on the image, reduces its contrast. Light transmission, the percentage of light transmitted in the central portion of the field of view by the optical parts of the telescope, is obviously also of importance in assessing the general performance of the instrument, in addition to field brightness, which gives a measure of the falling-off in illumination towards the edges of the field of view. The booklet describes in some detail the apparatus developed and used at the Laboratory for making measurements of the axial light transmission, the veiling glare index and the field brightness of telescopes and binoculars. The apparatus for the last-named measurement is still in prototype form.

Guide to the British Museum (Natural History)

It is interesting to compare the general format of the publications of the British Museum (Natural History) issued at the present time with those of, say, twenty years ago. Then an austere approach to the subject in strictly traditional covers repelled all but the most ardent of students; but to-day the "Short Guide to the Exhibition Galleries of the Natural History Museum", now in its fourth edition (pp. 28; 1956; 1*s.* 6*d.*), is in an attractive coloured and original cover and invites even the least interested in museums to glance at the contents. Following a brief historical introduction, the "Guide" describes in outline contents of the Central Hall and its five bays. Attention is then directed to a set of cases introducing the five Departments of the Museum—Zoology, Entomology, Geology, Mineralogy and Botany. The reader is quickly led through the Departments, and the special features of each are described in a few—in some cases dramatic—words. The "Guide" includes a table giving the geological time-scale and some general information concerning the Museum and its main activities. This indeed is a booklet which can be used equally as a guide during a visit to the Museum and afterwards as a reminder of the objects seen.

The Gila Monster of North America

The Helodermatidae are marked off from other lizards by the possession of grooved teeth in the lower jaw and of poison glands. The most widely known species is the gila monster, about which a number of myths and tales have gathered. Charles M. Bogert and Rafael Martin del Campo have made an exhaustive investigation into the natural history and ecology of the family and produced an interesting memoir (*Bull. American Mus. Nat. Hist.*, 109, 238+20 plates; 1956; 4 dollars). It does not deal with the anatomy except for a brief reference to the lower jaw, the arrangement of the bones of which provide a specific differentiation. The authors recognize two distinct species, *Heloderma horridum* and *H. suspectum*, which are distinguishable by definite external characters and have different distributions. *H. horridum* with three subspecies, each occupying its own area, is found on the Pacific drainage of Mexico, and it is suggested that it should be called the beaded lizard from the characteristic appearance of the skin: it is known in Mexico as the escorpión. It was first mentioned by Hernández in 1615. The other and better-known form is the gila monster, *H. suspectum* with two subspecies, found from just inside Mexico northwards into central Arizona. It has been shown experimentally that heloderms secrete a poison that is quite lethal to a wide range of animals including the common laboratory types. The authors have traced thirty-four recorded cases of gila monsters having bitten human beings, and in eight of these death was stated to have followed; but the actual records are not satisfactory, and in some there were contributory factors. The possibility cannot be ruled out, but the poison mechanism is not efficient, and it is probable that only in exceptional conditions could sufficient poison be injected to prove fatal. In the chapter dealing with myths there is an amusing tilt at the ardent systematist in the setting up of a genus *Sampoderma* for a creature described by a Mr. Holmes and a Dr. Watson from a locality near Baker Street.

Overseas Students at British University Institutions

Appendix III of the 1956 "Yearbook of the Universities of the Commonwealth" gives the number of overseas students enrolled for full-time study or research in British universities and university colleges at the beginning of the academic year 1954–55 as 9,050, of whom 1,261 were women, compared with 8,619 in 1953–54 and 6,264 in 1938–39. Of these, 5,575 came from other parts of the British Commonwealth, including 346 from Australia, 372 from Canada, 238 from the Gold Coast, 1,229 from India, 173 from New Zealand, 700 from Nigeria, 319 from Pakistan, 193 from Malaya (with 60 more from Singapore) and 491 from South Africa. Arts claimed 3,741 students, technology 1,799, medicine 1,597, pure science 1,316, dentistry 311, agriculture and forestry 214, and veterinary science 72. Excluding external students, London had 3,454 overseas students, Cambridge 820, Oxford 855, Edinburgh 683; but of the rest only Durham (356), Leeds (348), Manchester (393) and Glasgow (313) had more than three hundred. Outside the Commonwealth, the United States provided 820 students, and Egypt 306.

Guide to the Manchester Libraries

The North-Western Group of the Reference and Special Libraries Section of the Library Association has published, under the title "The Libraries of Greater Manchester" (pp. 92; 1956; 15*s.*), a guide to the resources and special collections of the region which both shows the wealth of recorded information available in the area and also the appropriateness of Manchester on this count alone as a regional centre if the Government ever attempts to develop a national library system, at least for science and technology. As Mr. L. L. Ardern, chairman of the North-Western Group, explains in an introduction, the guide is based on the 141 returns received to a questionnaire which was sent to all likely societies. Mr. Harold Smith's editing has provided a work which is both clear and concise and should enable the student or expert seeking information to decide readily which of the many libraries of the area is most likely to be able to help him; at the same time, it should minimize the chance of a library being troubled with a request which it is unable to meet by reason of its holdings and scope or on constitutional grounds. The guide is well produced and should materially assist in library co-operation and the more effective use of regional resources.

The Night Sky in October

New moon occurs on Oct. 4d. 04h. 24m., U.T., and full moon on Oct. 19d. 17h. 24m. The following conjunctions with the Moon take place: Oct. 1d. 02h., Venus 5° N.; Oct. 2d. 18h., Jupiter 6° N.;

Oct. 7d. 20h., Saturn 2° N.; Oct. 16d. 15h., Mars 9° S.; Oct. 30d. 11h., Jupiter 6° N.; Oct. 30d. 21h., Venus 6° N. In addition to these conjunctions with the Moon, Venus is in conjunction with Regulus on Oct. 5d. 14h., Venus being 0·4° S., Venus with Jupiter on Oct. 25d. 14h., Venus being 0·2° N., and Mercury with Spica on Oct. 26d. 09h., Mercury being 4° N. Mercury can be seen before sunrise during the middle of the month, rising at 4h. 45m. on October 15. Venus rises at 2h. 0m., 2h. 30m. and 3h. 15m. on October 1, 15 and 31, respectively, and is very bright, its stellar magnitude being about −3·7; its distance from the Earth is increasing throughout the month, from 87 to 106 million miles, and the visible fraction of the apparent disk also increases, from 0·65 to 0·75. Mars rises at 17h. 20m., 16h. 15m. and 15h. 05m. on October 1, 15 and 31, respectively, and sets at 3h. 30m., 2h. 35m. and 1h. 50m. on the following mornings; its stellar magnitude decreases during the month from −2·2 to −1·3. Mars was at minimum distance from the Earth during September and is now getting farther away, being at 53 million miles by October 31; it is near ψ Aquarii throughout the month. Jupiter rises at 4h. 05m., 3h. 30m. and 2h. 45m. at the beginning, middle and end of the month, respectively; at the beginning of the month it is near σ Leonis and moves into Virgo, being near β Virginis at the end of the month. Saturn sets at 19h. 30m. on October 1, and is too close to the Sun for satisfactory observation. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: Oct. 14d. 20h. 28·3m., c^1 Cap. (*D*); Oct. 22d. 23h. 05·4m., 129 H^1 Tau (*R*); Oct. 27d. 03h. 27·6m., A^1 Cnc. (*R*); *R* and *D* refer to reappearance and disappearance, respectively. The Orionid meteors are active during October 15–25, but conditions are unfavourable; the radiant is near R.A. 6h. 24m., Dec. 15° N. Taurid meteors may be seen during the last few days of the month; conditions are favourable and the radiant is near R.A. 3h. 36m., Dec. 14° N.

Announcements

The Messel Medal for 1956 of the Society of Chemical Industry has been awarded to Sir Alexander Fleck, chairman of Imperial Chemical Industries, Ltd. The Medal will be presented to Sir Alexander at a special meeting of the Society on October 12 at 6.30 p.m., held in the Royal Institution, Albemarle Street, London, W.1, when he will deliver an address on "The Chemical Industry: Some Achievements; Some Problems".

Mr. L. A. Wiseman, who is at present working at the Atomic Weapons Research Establishment at Aldermaston, has been appointed deputy director of the British Rayon Research Association.

The following appointments have been made in the Department of Chemistry of the University of British Columbia, Vancouver: Dr. J. Halpern, associate professor; Dr. H. G. Heal, assistant professor; and Dr. G. Porter, instructor.

Six transfer scholarships provided by Imperial Chemical Industries, Ltd., have recently been awarded to sixth-form boys for study at the University of Liverpool. The scholarships are specially designed for those who have specialized in arts subjects at school but who wish to pursue scientific studies at a university, and they cover a one-year course of intensive preliminary training in the basic sciences as a preparation to study for a degree in science (see *Nature*, March 31, p. 606). In general, the scholarships are tenable at the Imperial College of Science and Technology, London, King's College, Newcastle upon Tyne, and the Universities of Cambridge, Liverpool and Oxford.

The Chemical Society invites applications for the Corday–Morgan Medal and Prize for 1955, for work in experimental chemistry, published in that year, by a British person who at the time of publication was less than thirty-six years old. The award consists of a silver medal and prize of 200 guineas. Details of the application, to be made by December 31, and further information can be obtained from the General Secretary of the Society at Burlington House, London, W.1.

A Harrison Memorial Prize, not exceeding 100 guineas, is being offered this year for chemical research over the past five years by a natural-born British subject not more than thirty years old. The selection will be by a committee consisting of the Presidents of the Chemical Society, the Royal Institute of Chemistry, the Society of Chemical Industry and the Pharmaceutical Society. Details of application, which must be made by December 1, and further information can be obtained from the President of the Chemical Society, Burlington House, Piccadilly, London, W.1.

The Royal Commission for the Exhibition of 1851 is increasing the value of its awards for scientific research, and as from October 1 the senior studentships for workers recommended by universities in Great Britain will be £800 a year and the overseas scholarships for students from universities of the British Commonwealth (and Eire) will be £550 a year; in each case, annual grants of up to £100 a year for approved fees and expenses will be available.

A congress on "Rockets and Guided Missiles for Continental Connexions and Telecommunications", together with an exhibition of rockets and guided missiles and their associated equipment, will be held in Paris during December 3–8 under the auspices of the Association pour l'Encouragement à la Recherche Aéronautique. The congress will be international in scope and will be broadly divided into two groups on scientific and technical studies and on economic studies, respectively. Further information can be obtained from A.E.R.A., 1 rue de Courty, Paris 7^e.

An international conference on "Operational Research", organized by the Operational Research Society (Great Britain), the Operations Research Society of America and the Institute of Management Sciences (United States), will be held in the University of Oxford during September 2–6, 1957. There will be four sessions on the common themes in operational research; methodology; and applications (two sessions). Those wishing to read papers should send summaries in duplicate, and not more than two hundred words in length, not later than November 30 to either Dr. Thornton Page, Operations Research Office, 7100 Connecticut Avenue, Chevy Chase, Maryland, or to Mr. B. H. P. Rivett, Operational Research Society, 2 Grosvenor Place, London, S.W.1.

Erratum.—In the article on "The 1956 Cambridge Summer School in Physical Chemistry", published in *Nature* of September 15, on p. 578, eleven lines from the bottom of column 1, for "carbon monoxide" read "chlorine monoxide".

MICROSCOPY WITH X-RAYS

SYMPOSIUM IN CAMBRIDGE

IN the sixty years since the discovery of X-rays, very wide use has been made of them in industrial and medical radiography. These macroscopic studies of internal structure have proved of value both in research and for purposes of non-destructive testing. Only comparatively recently, however, has attention turned to the value of X-rays for microscopic investigation, and real progress towards a resolving power of optical order has had to wait until the post-war decade. Refinement of the normal radiographic technique, by using photographic emulsions of high resolution, has been accompanied by the development of a point projection method and by the use of reflecting mirrors to form an instrument more nearly akin to an optical microscope. The very short wave-length of X-rays, compared with visible light, holds out the ultimate prospect of a greatly improved resolution; but a more immediate advantage lies in the ability to examine specimens that are opaque at the usual optical wave-lengths. With X-rays it is also possible to get good micrographs from much thicker sections of transparent materials than can be tolerated in the optical microscope, on account of its very small depth of focus at high magnification.

These prospective advantages, as well as interest in the physical principles involved, have stimulated an increasing interest in the use of X-rays for micro-structural investigation. To bring together those actively working in the subject, a symposium on X-ray microscopy and microradiography was held in the Cavendish Laboratory, Cambridge, during August 16–21. It was sponsored by the International Union of Pure and Applied Physics, and received financial support from the United Nations - Educational Scientific and Cultural Organization and from a number of industrial concerns in Britain. The response to its announcement was much greater than anticipated. In addition to those from the three main centres of activity, in Stanford University, California, the Caroline Institute, Stockholm, and the Cavendish Laboratory, participants came from nine other countries and papers, to be read in absence, from two others (Uruguay and the U.S.S.R.). In all, there were 125 members of the symposium and sixty-six papers were read.

The symposium was opened by Prof. N. F. Mott, as president of the International Union of Pure and Applied Physics and head of the Cavendish Laboratory. A general survey of the use of X-rays for microscopy by Dr. V. E. Cosslett (Cambridge) was followed by introductory accounts of the three chief methods: of the grazing-incidence reflexion technique by Prof. P. Kirkpatrick (Stanford), of contact microradiography by Prof. A. Engström (Stockholm) and of the projection method, using a point-focus tube, by Dr. W. C. Nixon (Cambridge). The following two days of the meeting were devoted to the problems of each technique in turn, including the special needs of micro-diffraction and of quantitative analysis by absorption, emission and fluorescence spectrometry.

Conditions of grazing incidence are new in optical theory. Considerable progress has been made at Stanford in the design of the form of aspheric surface best calculated to provide a practically useful compromise between width of field and resolving power. A four-mirror system computed by Dr. H. H. Pattee (Stanford) should give a resolution of 500 A. over a field of at least 20μ with X-rays of wave-length 4 A. However, to obtain this performance, the mirror contours must be true to within 50 A., and, to reduce scattering to a sufficiently small value, the surface must be molecularly smooth. The immediate problems therefore lie in the working and testing of mirrors and, once they have been made, in their precise alinement. New techniques were described for these purposes, as it is not enough simply to refine existing optical methods. An experimental microscope, reported by Dr. J. F. McGee (Stanford), incorporates two uncoated silica mirrors and two adjustable aperture stops. Using aluminium radiation (8 A.) a resolving power between 0·5 and 1μ has been obtained. In these systems the mirrors of an imaging pair are axially separated. M. Montel (Laboratoire de Chimie-Physique, Paris) has devised an elegant method of sectioning spherical mirrors and uniting two half-mirrors at the appropriate mutual angle, so as to eliminate astigmatism and anamorphism.

By contrast with reflexion microscopy, which is faced with severe technical problems, the contact method of microradiography is limited in performance only by the effective grain size of the photographic emulsion. The development of emulsions of resolving power 2,000 lines/mm. now permits microradiographs to be obtained with a resolution approaching that of the best optical microscope. Prof. Engström described his work with softer X-rays (200–2,000 V.) than those usually employed. X-ray pictures of chromosomes and other cell components were shown which had a resolution of 0·3–0·5μ. An X-ray tube specially developed for these wave-lengths was described by Prof. P. J. Fitzgerald (College of Medicine, State University of New York), and an adapted commercial tube by Dr. A. Recourt (Philips, Eindhoven). Dr. B. L. Henke (Pomona College, California) has developed a tube having a gas-discharge type of electron source and a reflecting mirror for X-rays of 10–100 A. wave-length, in order to obtain better intensity in a region where efficiency of X-ray production decreases rapidly.

The point projection type of X-ray microscope, using magnetic lenses to obtain an electron spot as small as 0·1μ, was discussed by Dr. W. C. Nixon (Cambridge), Dr. J. B. Le Poole and S. P. Ong (Technical University, Delft) and Prof. B. M. Siegel (Cornell University). A resolving power approaching that of ultra-violet microscopy has been obtained by Nixon, with an exposure time of about 1 min. Smaller electron spots, certainly down to 100 A., can be obtained, but only with rapidly decreasing X-ray output, since the final electron lens has to be stopped down because of high spherical aberration. The need to increase the intensity of the electron beam, in compensation, was discussed by several authors. Dr. B. M. Rovinsky (Institute of Machine Sciences, Moscow) described a tube with ring cathode and needle-point anode, and the converse system using a point cathode and field emission was discussed by Dr. Pattee and by Dr. L. Marton (National Bureau of Standards, Washington, D.C.). The former has obtained high emission, but only at very high vacuum; the latter has worked at the vacuum more usually prevailing in a demountable apparatus, obtaining so far only small beam currents. In view of the difficulty of obtaining stable field emission in such circumstances, it appears at present that the best prospect for increased intensity in the point-focus tube lies in correction of the spherical aberration of the magnetic lens. The projection method has the advantage of direct enlargement on normal emulsions, but at cost of small field of view; the contact method gives a large field, but has greater difficulties of specimen preparation (since the specimen has to be very thin and placed almost directly on the emulsion) and of photographic processing. Even if a grainless film of reasonable speed can be developed, the optical viewing system will impose a limit on resolution—unless the emulsion can be stripped and viewed in the electron microscope. A possible technique of this nature was described by Dr. W. A. Ladd (Ladd Research Industries, New York), in which the 'emulsion' is a plastic film in which X-rays produce solubility changes depending on amount of exposure.

Even though X-ray methods may equal and perhaps exceed the optical resolving power, their main value in biology is likely to lie in the ability to distinguish different elements in the specimen, by means of differential absorption, emission and fluorescence. A large number of contributions was devoted to these methods of quantitative analysis. The Stockholm school has investigated in detail the accuracy attainable in absorption spectrophotometry, utilizing the characteristic absorption edges of the different elements. Dr. B. Lindström reported on analysis of sulphur and phosphorus in biological material, using a new high-vacuum apparatus and soft X-rays, and Dr. G. Wallgren described his studies in the mineralization of developing bone in human embryos. By direct microphotometry, analyses can be carried out on areas of tissue down to $3\mu^2$; a scanning and computing instrument for this purpose was described by Dr. O. Hallen (University of Gothenburg).

The projection method can also be adapted to microanalysis, and is especially useful for areas smaller than a few square microns, since photometry or photon-counting is carried out directly on an enlarged image. Mr. P. Duncumb (Cambridge) dealt with the design and operation of a flying-spot system for the analysis of thin layers by X-ray emission: the characteristic lines are detected and their strength measured by a proportional counter. An accuracy approaching 1 per cent can be obtained with a spot 1μ in diameter, and neighbouring elements in the periodic table can be separated if a crystal spectrometer is used. Mr. J. V. P. Long (Cambridge) described the adaptation of a projection X-ray microscope for the analysis of selected regions of a specimen, under a stationary spot, by fluorescence, absorption or emission methods at will. In emission, the specimen can simultaneously be viewed in transmitted light by an optical microscope. The limits of microchemical analysis by these methods were discussed by Prof. A. V. Baez (Redlands University, California). A detection limit of 1 per cent in a volume of $1\mu^3$ is equivalent to a mass sensitivity of 10^{-14} gm. of substance of unit density. At the moment, it is possible to determine elements of medium atomic number, down to aluminium or perhaps magnesium. Prof. Engström and Dr. Henke discussed the practicability of analysing separately the carbon, oxygen and nitrogen content of biological tissues with very soft X-rays, and it appears that this may be done with an accuracy of 5–10 per cent. Such a technique will be of revolutionary value in cytochemistry, just as the qualitative results obtained with microradiography are creating a new subject of microanatomy.

The sessions on applications of X-rays to microscopy, at the moment primarily using the contact method, covered a very wide range of subjects at the symposium. In biology, reports were presented of work on plant cancers and the growth of inorganic crystals in leaves, on the progress of osmium fixation in tissues, on the microstructure of wood and on insect flight musculature. In the medical field, investigations were reported of cancer of the breast and of the cervix, the human eye, the vascular patterns of human muscle and skin, growth of stone in the kidney and the embryonic stages of dentition. New techniques are now making it possible, particularly with the projection method, to observe changes in living tissue under experimental treatment. The metallurgical session was shorter, but contained accounts of the use of microradiography in studying segregation effects in ferrous metals and in light alloys, especially of aluminium, and the growth of oxide films. Preliminary studies of the distribution of heavy elements in rock sections were also reported.

Some discussion took place, formally and informally, on the need for further meetings on the subject of X-ray microscopy, for a specialized abstracting service and for clearing up matters of terminology. A small committee was set up to look into possible forms of organization, with particular regard to existing bodies and the need for connexion with the International Council of Scientific Unions. Its report will be prepared in time for discussion at the next symposium, which it is hoped to hold in Stockholm in 1959. V. E. Cosslett

THE EIGHTEENTH INTERNATIONAL GEOGRAPHICAL CONGRESS

THE eighteenth International Geographical Congress was held in Rio de Janeiro during August 9–18. The 1,006 delegates actually present included nearly four hundred from overseas, representing more than forty countries. The first congress was in 1871, yet this was the first to be held in the southern hemisphere, the first in the Tropics and the first in Latin America. It was opened in a blaze of pageantry by the President of Brazil in person at the Municipal Opera House. The delegates were welcomed by the President of the Organizing Committee of the Brazilian National Committee for Geography, and the British President of the International Geographical Union (Prof. L. Dudley Stamp, elected at Washington in 1952) gave a précis of his presidential address on the "Measurement of Land Resources". In order to secure some more precise measure of the capability of different types of land in differing climates and under differing types of management to support human life, he suggested the introduction of a 'Standard Nutrition Unit' of 1,000,000 calories annual production or 900,000 calories of net annual consumption. It was shown that a varied diet based largely on meat may require 3½ acres or more to produce one such unit, whereas with an extreme concentration on high-calorie foods (for example, rice and sweet potatoes) and intensive multiple cropping, as many as 6½ units per acre are produced in Japan, or more than twenty times as much.

At the first session of the General Assembly, four countries were elected to full membership—the U.S.S.R. (which had sent a strong delegation), Iceland, Hungary and Ethiopia. This was the first participation of the Russians since before the Second World War. With the object of helping the development of geographical research in countries with an insufficient number to set up the National Committee required of adhering nations, the General Assembly added to the Statutes provision for a class of Associate Members and elected as such the Sudan, French West Africa, Nigeria, Uganda, Kenya and Iraq.

More than three hundred papers, printed in abstract in advance, were presented to the dozen working sections into which the Congress was organized. Much attention was also given to the presentation and discussion of commission reports. At each Congress, the General Assembly, with the guidance of the Executive Committee, appoints commissions, consisting of not more than six full members, to carry out investigations into specific problems. Each commission must present a report at the next Congress, but may be reappointed for a further term. Reports presented were those on Medical Geography (which also had an active and flourishing section dealing both with the geographical distribution of disease and relevant factors), Evolution of Slopes, Erosion Surfaces around the Atlantic, Coastal Sedimentation, Periglacial Phenomena, Karst Phenomena, Arid Zones, the Library Classification of Geographical Books and Maps, An Inventory of World Land Use (a record of work known to be in progress in different countries) and The Teaching of Geography in Schools (a factual survey). Published reports, printed or mimeographed, on all these subjects were presented; an interim note was received from the Commission for the Bibliography of Ancient Maps. A Special Committee on Conversion Tables presented a report recommending what tables should be prepared and published. Some of the reports have been published as special parts of scientific journals; of most a small number is retained for distribution by the secretariat. An immense amount of valuable work is in progress and, despite extremely limited funds, the General Assembly agreed at its final session to the reappointment of all these commissions. In addition, the Executive Committee has set up two official commissions: one on the Mapping of Population, and the other on the Humid Tropics, to collaborate with other organizations working in these fields. Two new commissions were also approved: on National Atlases and on Applied Geomorphology.

The arrangements for the conference were excellent. The Brazilian Government made generous financial provisions which enabled a number of distinguished foreign delegates to be offered free air passages. The Navy allowed the meetings to be held, and some two hundred delegates to live, in the well-equipped Escola Naval, delightfully situated in Rio harbour on an island, now almost linked with the heart of the city by the reclaimed land on which the City airport is situated. Many nations joined in providing a magnificent map exhibition housed in the new Ministry of Education building, which also provided an auditorium equipped with simultaneous translation facilities for plenary sessions. In another building was a large selection of Brazilian maps.

The field trips arranged before and after the Congress enabled a large number of delegates to appreciate some of the problems of a vast and difficult country larger than the United States. Travelling by motor-bus over the winding mountainous dirt roads made the reason why 40 per cent of travel is by air obvious: there were times during each day when delegates saw more than one plane a minute handled by the Rio City airport. The extreme contrast between such great skyscraper cities as Belo Horizonte—their very names scarcely known to foreigners—and the vast uninhabited scrub-lands and forests impressed itself on all, while the two three-million cities of Rio and São Paulo left the impression of a growth too rapid for local administration to catch up. Everywhere the delegates met the lavish hospitality and boundless enthusiasm of the Brazilians; but standing above all was the organizing genius of Prof. Hilgard O'Reilly Sternberg and his faithful band of volunteer helpers.

At the final session of the General Assembly the presidency of the Union was handed over to Dr. Hans W:son Ahlmann, of Sweden, distinguished glaciologist, diplomat and don, and the joint invitation of the five Nordic countries of Norway, Sweden, Denmark, Finland and Iceland for the Congress of 1960 was accepted. For the past seven years the secretariat of the Union has been in the able charge of Dr. G. H. T. Kimble as secretary-treasurer: it is now to be transferred to the University of Zurich under Prof. Hans Boesch. The new Executive comprises the President, Secretary-Treasurer and Prof. Sternberg as first Vice-President, together with six Vice-Presidents—Profs. Hassan Awad (Egypt), Chauncy Harris (United States), Max Sorre (France), L. Dudley Stamp (United Kingdom), Fumio Tadâ (Japan), and Carl Troll (Germany).

L. DUDLEY STAMP

SCIENCE AND STRATEGY

THE modern Totalitarian Government considers itself above all moral criticism, and pursues its aims by murder by the million, routine employment of torture, the use of deliberate lies, the perversion of justice and, above all, by treating formal agreements as stopgaps to be broken whenever any least advantage is to be gained. Into this world, where good faith has almost vanished from international relationships, there has arrived the control of nuclear energy, which at the same time holds out great hopes for the improvement of man's estate and permits the construction of weapons which stand in a more extreme ratio to those of the Second World War than the latter do to the weapons of the Stone Age.

The authors of the papers in a discussion published in the *Bulletin of Atomic Scientists* for May, while repeating again and again the urgency of a genuine peace, consider the functions of the Armed Services in a world where no such agreement has been reached. It is generally agreed that the H-bomb is a great deterrent; but the first contributor, Sir John Slessor, tries to see just exactly what it will deter. He concludes that global war in the 1914 or 1939 style is finished, since the object of governments is to win a war, and the new weapons imply such appalling destruction that no war can be won. But he points out that any ban on nuclear weapons alone would "obviously suit the Communists to engage in a war in which their enormous superiority in manpower and conventional armaments could hardly fail to be decisive". For the Western Powers to refuse ever to use the bomb first would ensure their defeat; any uncertainty about its use might lead to another "drift into war". He then puts forward some very interesting arguments that the function of conventional armaments in this situation is as a "trip-wire" to ensure that any future aggression cannot gain its ends without having to face full-scale nuclear war and that, since no future global war can possibly last long, economies must be looked for in those applications required only for long-term hostilities.

The second author, Dr. R. L. Meier, sets out a series of propositions which he considers valid where "there are no important constraints upon how the major powers may act in the short run". The most important and most controversial are No. III, in which he argues for a sharp distinction between conventional weapons and nuclear weapons (Sir John Slessor separates "tactical" nuclear weapons from the H-bomb), and No. VI, that when superweapons have reached a certain level "it appears to be no longer possible to negotiate disarmament at the nuclear level" because "any nation which does not act in good faith would be able to dictate terms to any part of the world, or annihilate it" since "the margin of error in detection and accounting is still enough to dominate". Back to good faith once more.

The third author, Mr. Hanson W. Baldwin, starts with an illuminating and balanced discussion of the new methods for delivering nuclear explosives, and points out that, while the power of the attack has so enormously increased the power of defence, interception has considerably decreased. He recommends that "we must be capable of fighting all-out nuclear war, a limited nuclear war, a major non-nuclear war, small scale brush-wars". This counsel of despair may perhaps be practicable for the United States with its immense resources; it could scarcely be so for Great Britain.

The fourth author, Mr. C. W. Sherwin, emphasizes a further point. That old-fashioned principle of war was to seek out and neutralize the armed forces of the enemy. But in a modern future war these armed forces will be small, light, mobile machines, which can be fairly easily protected against blast, while cities are large, immobile and from their construction very sensitive to blast. In other words, success is probably much easier by attacking civilian populations. This was once forbidden by a Geneva Convention; but such conventions again imply good faith. Mr. Sherwin proceeds by outlining a set of rules for nuclear strategy in a deterrent war; even supposing these rules to be correct it is most unlikely that they could be followed in the mass hysteria of an atomic war. He concludes by hoping that, while the Mark I solution of peace-through-deterrence is perhaps not the ultimate means of preventing major war, it may give time for a final solution. Dr. Warren Amster concludes the discussion in a short article which emphasizes the points made by the previous authors.

This discussion is of the utmost interest, and can scarcely be summarized in so short a review. The discussion is being continued. E. C. BAUGHAN

RESEARCH COUNCIL OF ALBERTA

REPORT FOR 1955

THE thirty-sixth annual report of the Research Council of Alberta*, covering 1955, refers to increased emphasis on basic geological research and survey in view of its importance to much of the Province's resources. Besides the oil-sand area project, clay research, glacial geological studies and micropalaeontological research carried over from 1954, further work undertaken included a ground-water survey of the Province, stratigraphical studies of the southern foothills, and a laboratory study on the chemical variation between marine and non-marine sediments. The Council's soil surveyors were again engaged principally in the Peace River district of Alberta; but the report refers also to other projects of the Alberta Soil Survey conducted mainly by Federal Survey staff, such as the field-work on the Edmonton map-sheet and irrigation research on solonetzic soils at Youngstown, in co-operation with the University of Alberta Department of Soil Science, the Canada Experimental Farms Service and the Provincial Department of Agriculture.

Encouraging progress has been made in the re-orientated coal research programme. Investigations of the physical behaviour of coal in an ultrasonic field demonstrated that the 'true' density of coal appears to remain substantially unaffected, but that the surface area of the coal tends to increase with the frequency of vibration and time of exposure; preliminary carbonization tests have indicated that the presence of traces of nitric oxide in the retort can induce significant modifications in the nature of the tar. A combination of infra-red studies and elementary analysis has indicated the relation between humic acid and coals of various ranks, and studies of the oxidation of phenols to humic acid have shown that oxidative polymerization of aromatic substances can yield naphthenic structures known to occur in coal and petroleum. Polarographic studies indicate that humic acids from hydroquinone and low-rank coal have less condensed structures than humic acids from material of higher rank. The presence of a cracking catalyst such as alumina-silicate in carbonization about 600° C. appeared to affect the primary decomposition of the coal as well as the secondary decomposition of the primary tar.

The work of the Applied Research Laboratory was confined to attempts to surface-seal Albertan sub-bituminous coals against loss of water so as to prevent or reduce disintegration during storage. Some success was achieved with emulsions of wax or bitumen, and substantial progress was also made in a study of the grindability of coal.

Petroleum research has included studies of the kinetics of thermal degradation or maturation for the removal of vanadium or nickel from McMurray oil; the work indicates that geological time has been too short to account for the observed maturation of crude oils in Alberta at the temperatures usually regarded as reasonable during geological time, and suggests that considerable importance must be attached to catalysis in the formation of crude oil. A survey has been undertaken of the carcinogenicity of crude oils of Western Canada; detailed investigations of the sulphur content of heavy oils using chromatography on the distillate fraction showed that extraction methods for removing sulphur from the oil-sands oil are unsatisfactory, and studies are being made of desulphurization by catalytic decomposition or oxidation.

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* Research Council of Alberta. Thirty-sixth Annual Report, 1955. (Report No. 73.) Pp. 52. (Edmonton: Research Council of Alberta, 1956.)

Work on natural gas and its utilization was limited to three projects: the partial oxidation of *n*-butane; the production of carbon black; and the high-temperature pyrolysis of butane. Results in the first project indicate that the reaction is essentially that of the 'cold flame', characterized by a pronounced induction period, sharp reaction peak and self-quenching termination. Use of the permeable tube technique has permitted continuous production of carbon black from natural gas for up to four hours; but extensive semi-works tests are required before any economic evaluation of the process can be made. Preliminary results indicate higher partial pressures in the pyrolysis of butane favour formation of ethylene and lower pressures that of acetylene. Winter field trials of the injection of lignosol and lignosol–chromate mixtures to prevent frost-heaving in soils showed that the highly mechanized procedure was less efficient than anticipated and that the designed proportions of lignosol and chromate were not set up in the field as successfully as in the laboratory; a study of the electrosmosis of soils showed that addition of lignosol enabled the solution to move through coarse sands in which the process was ineffective in its absence.

The paucity of the cyclic animal populations continued throughout central and northern Alberta; but a careful census showed increases in selected locations, especially in the south-east of the Province. Measurements of solar ultra-violet radiation were continued. Work on the hatchability of turkey eggs demonstrated that the use of upstanding males in the breeding pens increased fertility compared with eggs from pens in which front-heavy males were used.

Some attention has been given by an *ad hoc* committee to the prevention of hail damage.

RELATIVITY AND SPACE TRAVEL

AFTER the publication in *Nature* of April 28 of communications on this subject by Prof. H. Dingle and Prof. W. H. McCrea, a number of letters were received by the Editors, some of them supporting Prof. Dingle's views and some Prof. McCrea's. Many were mathematical in character, whereas others developed the argument in general terms. It would have been impossible for reasons of space alone to print these letters in full; it seemed to the Editors, therefore, that the best course was to collect the correspondence and to submit a copy of each letter to Prof. Dingle and to Prof. McCrea, who were then invited to prepare their concluding statements in the light of the letters received. This has been done, and the two statements are published below.

THE outstanding fact confirmed by this correspondence (in which I include letters received privately) is profoundly disquieting. In various ways we now actually deal with velocities at which the abnormal relativity phenomena become important, and in matters the gravity of which can scarcely be exaggerated and in which we must act on calculation alone, we are at the mercy of physicists, many of whom can believe that what can be thought away can have effects which cannot.

For obvious reasons, I reply only to correspondents who agree in (and only in) thinking me wrong. They comprise two classes: (*a*) those who hold that the accelerations are irrelevant and I have misread 'special' relativity; (*b*) those who regard the accelerations as important. (McCrea so regards them, but bewilderingly uses them only as a talisman to fecundate the otherwise sterile 'Lorentz contraction' during the *uniform* motion.)

It is difficult to understand the existence of class (*a*), since without the accelerations M and R are indistinguishable. A number 'refute' me by the phenomenon of mesons, the half-life and velocity of which imply that they have suffered a 'time dilatation'. I am astonished that this is thought relevant. The argument seems to be this: "Dingle says that the relativity anomalies are only imaginary: this one is observed: hence Dingle is wrong". What I say is not that these anomalies are "only imaginary", but that they occur only when at least one of the times involved refers to an absent clock and so must be determined by a conventional definition. This is so in the meson case, where effectively the starting time (conventional) is compared with the arrival time (observed); the 'time dilatation' must therefore be expected. In the space traveller problem, however, the clocks are directly compared; convention is eliminated and the anomalies disappear.

In reply to requests, I reluctantly indicate McCrea's error. He writes: "At the event [E_1] of M's completing the part of his outward journey performed with speed V, observer R plots M as at a distance X. . . . Owing to the Lorentz contraction, M at the same event plots R as at distance αX. . . . It does not matter which observer regards himself as at rest". But M observes *another* event, E_2, at which R's uniform travel ends, and McCrea later confirms that it is at E_2 that R's distance is αX. Hence he connects R's estimate for one pair of events (E_0 and E_1, where E_0 is the event of R and M beginning their separation with velocity V) with M's for another (E_0 and E_2) by the "Lorentz contraction", which is clearly wrong. But I repeat that the error of the conclusion should be obvious without this.

A complete solution of the space traveller problem on the basis of special relativity, showing how the anomalies cancel out, will be published by the Physical Society.

Now for the accelerations. General relativity asserts that *all* motion is relative (that is, all coordinate systems are equivalent). It has convincingly formulated this principle only for gravitational motions; but, if it is true, no acceleration affects a clock. Some think this inconsistent with the displacement of spectrum lines in a gravitational field, but that is caused by the *field*, not acceleration. If the stellar atoms are stationary it is still required.

We do not know what effect other causes of acceleration may have. Hence, since our traveller will certainly not be ejected by gravitation, we cannot state the effect, if any, of the means employed. But, by hypothesis, the process is too brief for appreciable slowing down.

The only escape is by supposing, as some do, that the initial acceleration causes a change of rate which persists when the motion becomes uniform. This is arbitrary, and to justify McCrea's formula the change would astonishingly have to be exactly equal to the

Lorentz value for the final uniform motion for all methods and degrees of acceleration. Also, it would stultify modern astronomy, because every supposed Doppler effect might be actually the legacy of earlier unknown accelerations.

The only attempted defence of this is by an enormous generalization. The paths of the Earth and traveller are considered as world-lines in some specifiable space-time, and it is pointed out that such a space-time permits alternative world-lines with very different proper times. No doubt; but those who reason thus omit to specify the space-time and to show that the paths in our problem differ by the assigned amount, and I am certain that they cannot. The invocation of space-time is quite unnecessary, but if done it must be done thoroughly.

To sum up: if accelerations are ignored, symmetry shows that the clocks cannot differ on re-union. If, however, accelerations determine the issue, then either the 2½ years (if gained at all) is gained during them or they affect the later rate of the uniformly moving clock. The former is impossible; the accelerations may be far too brief. Hence the rate of a uniformly moving clock, for no known reason, depends on previous accelerations, and all astronomical deductions from supposed Doppler effects are vitiated.

A final word on the moral of the whole thing. I have been told by some who omit to give reasons for their views, that although I may not understand the matter, mathematicians do so very well and agree that I am wrong. I am not, and have no wish to be, a mathematician in the restricted sense; by nature and taste I choose the world of experience, and I trust reason rather than personal authority however graciously exercised. Nevertheless, "when the wind is southerly" I know a group from a tensor, and in science it is better to be the master of a little mathematics than the slave of much. But what is needed here is not mathematics but a faculty for refusing to be bemused by mathematicians. Unfortunately, this seems to be a rare faculty. Still more unfortunately, it is held in such low esteem in Great Britain that we have the unenvied distinction of being the only major country in the world which has not thought it worth while to join the International Union for the History and Philosophy of Science. It is no accident that we rank high as builders of massive mathematical edifices on rotten foundations. I hope that this small but dangerous one has at least received a shaking.

HERBERT DINGLE

PROF. DINGLE's statements about the work of others are irresponsible. He says I connect "*R*'s estimate for one pair of events with *M*'s for another by the 'Lorentz contraction', which is clearly wrong". The procedure is clearly right, since it is precisely the way in which the Lorentz contraction arises. But the pairs of events named by Dingle are not simultaneous in the reckonings of the respective observers and so are not pairs that can be directly connected by the Lorentz contraction; reference to my work will make it at once obvious that I did not apply the procedure directly to these pairs. On the other hand, if Dingle means merely that I used the contraction in the course of connecting these events, that is all right. Either way, he has detected no error.

Dingle's treatment[1] of Einstein's "most regrettable error" follows the same pattern. (I had not seen this passage of Dingle's before writing my previous reply.) Again he categorically asserts the reverse of the truth. He says Einstein is wrong because he deals with the motion of a clock that is "continuously accelerated and with such motions the special theory of relativity is powerless to deal"[1]. But the truth is that (special) relativistic kinematics, mechanics and electrodynamics deal throughout with motions that are in general continuously accelerated.

As to the result itself that is under discussion, Dingle appears still to assert that there is symmetry between the space-traveller and the stay-at-home. But, were the reversal of the space-traveller's motion sufficiently violent, the space-traveller, not Prof. Dingle, would be killed. Dingle would not be symmetrical with a traveller who turns into a corpse. Since there is obviously not symmetry and, according to relativity theory, there is not universal time, there is no *a priori* reason for the journey to have the same duration by the clocks of the two observers. In general, the journey does not take the same time by the two clocks. This is the immediate consequence of relativity theory that Einstein derived correctly fifty years ago.

The main points mentioned by correspondents concern (*a*) inertial frames, (*b*) accelerations and the behaviour of clocks, (*c*) the resolution of the 'clock paradox'. Other matters raised seem to be outside the scope of the discussion.

(*a*) In classical theory, an inertial frame is one in which Newton's laws of motion hold good; the existence of such a frame is postulated and it is proved that any frame in uniform relative motion, and no other, is an inertial frame. The situation in special relativity is strictly analogous. Some correspondents give the exact quotation from Einstein[2] that Dingle failed to discover. There is not symmetry between *R*, *M* because *R* remains at rest relative to an inertial frame and *M* does not. Dingle implies that *M* cannot identify the event of his ceasing to be in a particular inertial frame. The simplest way of settling the whole argument would be to give Dingle the opportunity to see if *he* would identify a swift change from one inertial frame to another—allowing him thus to "choose the world of experience".

We know how to use inertial frames. We know also, as correspondents remark, that whether or not a particular frame is inertial is determined by its relationship to the universe in the large. But we probably do not adequately understand the physics of this relationship[3]. Dingle could have directed attention to a real problem here.

(*b*) In the example previously considered, the durations of the accelerations could be made arbitrarily short compared with the other times involved. But this served only to simplify the calculation. In the general case there is no mystery about accelerations. If an observer is accelerated in any given possible way, we can integrate the interval along his world-line and so get the proper-time as shown by his ideal standard clock.

Some correspondents think the simple example may be deficient since, they say, *M* could not separate from *R* without producing a reaction upon *R*. This is false because the case would be realized by *M* using rocket-propulsion having no effect on *R*.

Questions are raised about 'biological' time. During acceleration relative to an inertial frame, biological processes need not be synchronized with a standard clock accompanying the system. This is obvious because, as already said, a violent enough acceleration may have fatal consequences. Beyond showing the absurdity of Dingle's views on what events can and cannot be identified, this is not relevant to the discussion. It is on the same footing as the fact that a living organism is not a rigid body. In any case, we could choose accelerations such that, for any given organism, the difference between 'biological' time and clock-time is made proportionately arbitrarily small. That is, the sort of case mentioned by Sir George Thomson could be realized, as regards ageing of observers, as closely as we please.

(*c*) All the foregoing has been known since Einstein's paper of 1905. The communication[4] of mine that has drawn Dingle's attack was a demonstration that these well-known conclusions do not produce a paradox. At least one correspondent reproduces my calculations in full and one detail has to be mentioned. If M treats himself as at rest, I had pointed out that his plot of R's journey shows R moving out to distance αX at speed V, rushing out to distance X and back to distance αX in negligible time, and finally completing his return at speed V; total time $2\alpha T$, where $\alpha = (1 - V^2/c^2)^{1/2}$. Throughout all but the negligible portion of this time, M is in one or other of two inertial frames and plots R as having a uniform speed V; so, by the time dilatation, the parts of R's career so plotted have duration $2\alpha^2 T$ by R's clock. However, between these parts there is also the part that M plots as taking negligible time but that by R's clock makes up the total duration to $2T$. By overlooking this last-mentioned part, other correspondents encountered a difficulty.

I express the results in terms of what the observers would *plot* after making all their observations and allowing for times of light-travel, each regarding himself as at rest. Alternatively, I could have expressed them in terms of what each observer would *see* at each instant in his career. Some correspondents have trouble through confusing these two methods. However, the only thing that matters is that the observers get different descriptions of each other's behaviour, and consequently there is no paradox in their assigning different durations to the journey. The curious details of M's plot of R's behaviour when M treats himself as at rest are not really important, because M will discover that it is much simpler not to treat himself as at rest.

In my previous reply I gave arguments concerning geodesics that are valid in special and in general relativity. In my present reply, I refer only to special relativity. This is correct because, when gravitational effects are irrelevant, the theories are identical.

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THE STOICHIOMETRIC RELATIONSHIP BETWEEN AMINO-ACID AND NUCLEOTIDE RESIDUES IN A RIBONUCLEOPROTEIN

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The statement that there exists some evidence of a relationship between pentose nucleic acid and the synthesis of proteins does not demand the acceptance of one or the other of the numerous 'template' mechanisms that have been put forward[1]. In their usual form, these proposals envisage the condensation of amino-acids along a polynucleotide chain or the simultaneous and interdependent polymerization of nucleotides and amino-acids to form an intermediary nucleoprotein complex from which, for the protein itself to emerge, the nucleic acid would have to be removed, either by dissociation or by degradation. Should an enzyme have been formed in this manner, it would presumably not function before being released from its association with the nucleic acid. The literature contains few systematic studies of the properties of nucleoproteins; but occasional reports of an enhanced enzymic activity of cell preparations or cellular fractions after treatment with ribonuclease[2-4] tend to support this concept. If pentose nucleoproteins are to be regarded as an intermediate stage in protein synthesis, their study assumes added interest.

We wish to present observations made in the initial phase of a study of pentose nucleoproteins from rat liver. Our immediate objectives were: (*a*) the development of a relatively rapid and simple procedure for the purification of pentose nucleoproteins; and (*b*) the examination of the stoichiometric relationship between the nucleotides and the amino-acids present in the conjugated protein. As regards the latter aim, we have pointed out recently[5] that a 'template' arrangement could be expected to impose rather definite restrictions on the relative quantities of the two types of monomer.

The microsome fraction of rat liver[6] served as the source of pentose nucleoprotein. These cytoplasmic structures contain, or are associated with, small granules which appear to be pentose nucleoproteins. (For literature, compare several recent articles[7-10].) For the release of these granules from the microsomes, structures rich in lipids, sodium deoxycholate has often been employed[8,10]—an agent that had been shown previously to produce the cleavage of other lipid-nucleoprotein complexes[11]. This effect is no doubt related to the surface activity and, even more, to the strong complexing ability of this bile acid. The treatment with sodium deoxycholate causes the microsomes to disintegrate, but leaves the small dense granules apparently intact and largely recoverable by high-speed centrifugation. The pellet so obtained

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contains a large part of the pentose nucleic acid, but little or none of the lipid, of the microsomes and a proportion of protein that decreases in measure with the rise in the concentration of deoxycholate.

We have found that a limiting value for the molar ratio of nucleotide to amino-acid is reached at a concentration of approximately 0·5 per cent of a neutral solution of sodium deoxycholate. Moreover, this ratio remains unchanged when the nucleoprotein preparations are subjected afterwards to successive precipitation with ammonium sulphate and with barium and calcium ions.

The suspension of microsomes in 0·9 *M* sucrose solution (isolated from the livers of male Sherman rats weighing about 250 gm. and unfed overnight) was brought to the desired deoxycholate concentration by the addition of a freshly prepared 5 per cent solution of sodium deoxycholate (*p*H 7·3–7·5). The sedimentable material, which in no case comprised more than about one-half of the microsomal pentose nucleic acid, was collected by centrifugation at 105,000 × *g* for two hours. An attempt was made to fractionate such sediments, prepared in 1·6 per cent deoxycholate, by subjecting them to consecutive precipitation with ammonium sulphate, calcium acetate and barium acetate. The latter two reagents may be considered less likely to precipitate protein that did not form an integral part of the nucleoprotein. Data on the composition of the nucleoprotein insoluble at different concentrations of sodium deoxycholate are summarized in Table 1, details of two reprecipitation experiments in Table 2.

For analysis, protein and pentose nucleic acid were separated in the following manner. The material was precipitated or washed with cold 7 per cent trichloroacetic acid, extracted with alcohol-ether, and kept overnight at 30° and *p*H 13–13·5, in order to hydrolyse the nucleic acid to mononucleotides. During this treatment one protein fraction precipitates (Fraction I). For purposes of analysis, this material was not examined separately. The mixture was centrifuged briefly and chilled, and the supernatant fluid acidified to *p*H 5–6 and left in the cold for 15–20 hr., when a second crop of protein (Fraction II) precipitated which was collected by centrifugation. The final supernatant solution was considered as the nucleic acid fraction and the combined precipitates (I and II) were taken as the protein fraction. The effectiveness of this separation procedure was roughly checked by comparing the ultra-violet light absorption of the nucleotide solution at 280 and 260 mμ. The relative values regularly found were those expected of a hydrolysate of pure ribonucleic acid from the cytoplasm of rat liver[12] and gave no sign of contamination by aromatic amino-acids. Direct amino-acid analyses also showed that less than 1 per cent of the total amino-acids was carried into the nucleic acid fraction.

Table 1. COMPOSITION OF RAT LIVER RIBONUCLEOPROTEIN PREPARED AT DIFFERENT SODIUM DEOXYCHOLATE CONCENTRATIONS

Experiment No.*	Final concentration of sodium deoxycholate, per cent	Molar ratio of nucleotide to amino-acid
1	0·4	0·32
2	0·5	0·44
3	0·8	0·53
4	1·2	0·52
5	1·6	0·52
6	1·6	0·44
7	2·0	0·47

* In Exps. 1, 3 to 5, and 7 a Riedel–de Haen preparation of sodium deoxycholate was used; in Exps. 2 and 6 a preparation furnished by A. Maschmeijer, Jr. Inc. When 0·2 per cent sodium deoxycholate was employed, about 90 per cent of the microsomal nucleic acid was recovered in the pellet; with the higher deoxycholate concentrations used here the recovery varied between 40 and 50 per cent.

Table 2. COMPOSITION OF RIBONUCLEOPROTEIN AFTER TREATMENT with DIFFERENT REAGENTS

Experiment No.	Precipitating agent*	Recovery of ultra-violet absorption, as per cent of preceding precipitate	Molar ratio of nucleotide to amino-acid
1	3·2 *M* ammonium sulphate[1]	89	0·50
	0·08 *M* calcium acetate[2]	96	0·49
	3·2 *M* ammonium sulphate[1]	83	0·52
2	3·2 *M* ammonium sulphate[1]	80	0·44
	0·08 *M* calcium acetate[2]	82	0·50
	3·2 *M* ammonium sulphate[1]	90	0·61
	0·08 *M* barium acetate[3]	38	0·56

* The precipitating agent (dissolved in 0·7 to 0·9 *M* sucrose solution to yield the final concentrations listed in the text) was added to the suspension of the preparation in 0·9 *M* sucrose solution and the precipitate collected by centrifugation at 3,000–4,000 × *g*. It was dispersed in the appropriate medium (see following footnotes); the mixture was cleared by low-speed centrifugation; a portion was withdrawn for analysis, and the process was repeated with the next precipitating agent, in the order indicated for each experiment.

[1] 60 per cent saturated at 0°. The precipitate was redispersed in 0·9 *M* sucrose; the solution was subjected to dialysis if barium acetate was to be used next.

[2] The precipitate was redispersed in 0·8 *M* sucrose containing 0·01 *M* sodium oxalate.

[3] The precipitate was redispersed in 0·8 *M* sucrose containing 0·01 *M* sodium sulphate.

The molar nucleotide content of the solution was estimated from the difference of the extinction values at 260 and at 280 mμ at *p*H 7·0. A figure of 1·0 was taken as equivalent to 0·110 micromole of nucleotide per ml.; a value based on observed data and agreeing with the calculated absorption of a mixture of nucleotides in the proportions characteristic of rat liver cytoplasm[12]. The values so obtained were very close to those derived from phosphorus determinations and quantitative paper chromatography[13].

The protein fraction was hydrolysed in 6 *N* hydrochloric acid at 110° for 24 hr. and the residue, resulting from the evaporation of the hydrolysis mixture *in vacuo*, was dissolved in water. The molar amino-acid content was determined colorimetrically by means of ninhydrin[14], with known quantities of alanine or glycine as an internal standard. The values agreed closely with those obtained with external standards and, independently, with the ninhydrin/carbon dioxide technique[15,16].

Some of the properties of the nucleoprotein may be of interest. The two protein fractions mentioned before, namely, Fraction I, insoluble at *p*H 13, and Fraction II, soluble at this *p*H, were present in almost equal proportions. In three preparations, the following figures, as per cent of moles of total amino-acid present in the nucleoprotein, were found for Fraction I: 54, 56, 56. When the ribonucleoprotein was treated with papain[17], it was found that about one-half of the protein moiety was digested. With several specimens, the proportion of protein liberated as amino-acids after a treatment of 4–5 hr. varied from 42 to 57 per cent of the total; no further digestion took place even after 24 hr. The ease of detachment of the nucleic acid from the protein by heat[18] was also studied. When a 0·2 per cent suspension of the nucleoprotein in 0·13 *M* sodium chloride solution was kept near 100° for two minutes almost the entire protein (92 per cent) was precipitated, whereas 60 per cent of the nucleic acid remained in the supernatant fluid.

It will be seen in Table 1 that the molar ratio of nucleotide to amino-acid in the nucleoprotein preparations apparently rises to a limiting value of about 0·5 and remains constant over a fairly wide range of sodium deoxycholate concentration. What is also noteworthy is that this ratio continues essentially unchanged throughout a series of additional mild precipitation procedures (Table 2). It will be understood that we are here concerned only with the number, not the nature, of the nucleotide and amino-acid residues; but it should be mentioned that in a few specimens that were more fully analysed no deviation from the nucleotide proportions previously reported[12] was found.

We conclude that the nucleoprotein preparations under study contained about two amino-acid residues for one nucleotide residue. That this relationship was not changed by successive treatment with different precipitating or solubilizing agents may indicate that virtually all the protein was linked to nucleic acid, though not necessarily all in the same manner. The specific structural significance of this finding must, however, remain obscure until the modes of linkage between protein and nucleic acid and the meaning of the two protein fractions that are distinguishable in the nucleoprotein are better understood. The stoichiometric relationship discussed here is not contradicted by previous analytical findings in the literature[7,8,10,19]; it is of a not unreasonable order of magnitude for a 'template' complex; but it fails to lead to a model as capable of explaining the regularities in the composition of pentose nucleic acids, namely, the equality of the number of 6-amino-nucleotides (adenylic and cytidylic acids) and 6-keto-nucleotides (guanylic and uridylic acids)[5,20], as is the hypothetical arrangement (a polypeptide chain linked to two polynucleotide chains) suggested by us recently[5].

We are very grateful to Mr. H. M. Schulman for technical assistance, to Dr. E. L. Smith for a specimen of the crystalline mercury complex of papain, and to Drs. G. E. Palade and P. Siekevitz for acquainting us with some of their findings before publication. This work, which is being continued, was supported by research grants from the U.S. Public Health Service, the National Science Foundation, and the Rockefeller Foundation.

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MECHANISM OF ENTRY OF 5-BROMOURACIL AND ORTHOPHOSPHATE INTO DEOXYRIBONUCLEIC ACID OF *E. COLI*

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STUDIES seeking information on *in vivo* roles of nucleotides in nucleic acid biosynthesis[1] have hitherto proved inconclusive, interpretation of the experimental findings being complicated by difficulty in appraisal of contributions of the following phenomena: (1) the rate of penetration of nucleotides *per se* through cell walls may be low compared to the rates of side reactions[2]; (2) the rate of renewal of the phosphorus of intracellular mononucleotides is generally very high compared to the rate of renewal of the phosphorus of nucleic acids[2-4].

Phosphomonoesterase and phosphotransferase enzymes of high activity are doubtless implicated. The phenomena apparently merit special consideration in the design of experiments on this aspect of nucleic acid metabolism. To eliminate the problem posed by the permeability property, we have used mixtures of traceable, diffusible compounds that are potential precursors of the nucleotides, in place of the isotopically labelled nucleotides employed before[1,2]. To avoid complications resulting from superimposable isotope dilutions of labelled precursor atoms by (*a*) pools of endogenous intermediates, and (*b*) rapidly reversible side reactions, it occurred to us that dilution (*a*) can be eliminated in experiments with biological systems that readily accept a physiologically abnormal base, such as 5-bromouracil, in lieu of a base normally present in their nucleic acid.

Zamenhof and Griboff have described a mutant of *E. coli* that normally requires 5-methyluracil (thymine) for synthesis of deoxyribonucleic acid, but is capable of utilizing 5-bromouracil in reversible replacement of

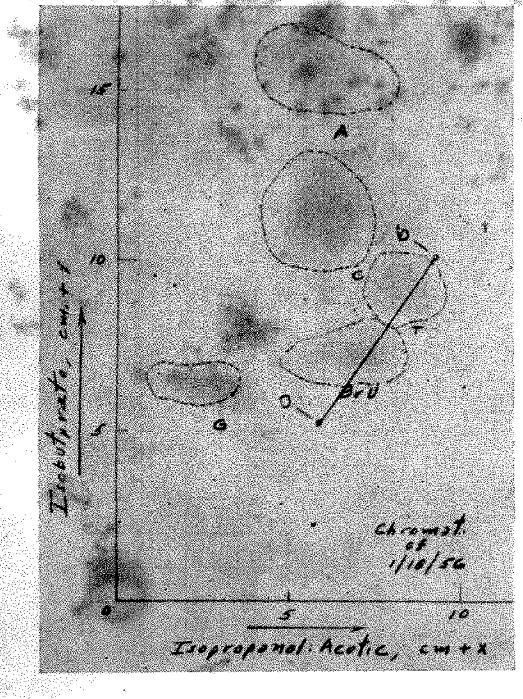


Fig. 1. Radioautograph of a chromatogram containing deoxyribotides of deoxyribonucleic acid from *E. coli* grown from a culture of 5·32–6·46 × 10^{12} cells in a medium with 0·1 mgm./ml. 5-bromouracil and 3 mc. of orthophosphate-^{32}P. *G*, *BrU*, *T*, *C* and *A* identify deposits of deoxyribotides of guanine, 5-bromouracil, thymine, cytosine and adenine, respectively. Measurements shown in Fig. 2 were along line crossing *BrU* and *T*. Photograph taken with radioautograph over labelled centimetre scale

the thymine[5,6]. The main advantage sought by the use of this organism in the present study follows from the possibility of conducting an experiment wherein one of the bases is all newly acquired by the deoxyribonucleic acid. The abnormal base, with the deoxyribose and phosphate to which it becomes attached, can be separated as a unit from enzyme hydrolysates. We reasoned that growth of an originally normal culture from, say, 100 per cent to 120 per cent, in the presence of simultaneously added 5-bromouracil and phosphate-^{32}P, would yield deoxyribonucleic acid with a 5′-isomer of 5-bromouracil 2′-deoxyribotide having specific phosphorus-32 activity markedly dependent upon the source of the phosphorus in this unit of its molecule. On performing the experiment, it was found that the 5′-isomer of 5-bromouridylic acid isolated from the *E. coli* ribonucleic acid had a specific activity comparable to that which would be expected if all its phosphorus is acquired from the medium during the experimental interval.

Bromouracil and orthophosphate-^{32}P were added near the end of the logarithmic stage of growth of strain I *E. coli*[5] in a normal thymine-containing medium[6]. In the typical experiment considered here, the cells were then cultured for 17 hr., during which time the cell count increased 21 per cent. They were lysed with 'Duponol'[6]; crude deoxyribonucleic acid was isolated by conventional means, and treated with 0·3 *N* lithium hydroxide[7] to hydrolyse residual ribonucleic acid and phosphoprotein. After a preliminary development by chromatography with an *iso*butyrate solvent (*p*H 3·6) which moves small-molecule contaminants away from the immobile deoxyribonucleic acid[8], it was eluted, and hydrolysed in 60–80 per cent yield to 5′-mononucleotides employing deoxyribonuclease and arsenate-inhibited intestinal phosphatase[9]. To isolate 5-bromouracil deoxyribotide, Dunn and Smith's[10] electrophoretic separation at *p*H 9·0, and Smith and Allen's[8] two-dimensional paper chromatographic separation were used; the latter system separates all the 5′-monodeoxyribotides (Fig. 1). These compounds were identified by their absorption spectra measured on the paper[11]. Specific phosphorus-32 activity of the nucleotides was determined from measurements of radioactivity and light-absorption of identical fractions[12], the quantity of compound in a measured area of neutral Whatman 3 *MM* paper being computed from a light-diffusion equation that corrects for decrease in the optical depth of a papergram with increase in the concentration of absorber[11,13]. A detailed report on the derivation and use of the practical form of the equation[13] is in preparation. Radiochemical purity was evaluated by constancy of the specific activity at successive areas along lanes of transit[12]. In the illustrative case shown in Figs. 1 and 2, however, the measurements were made along a diagonal line traversing two important deposits. The ordinate values of points in the top graph of Fig. 2 are proportional to specific activity, which may be computed as follows:

$$\text{Specific activity} = R/C = RL\varepsilon/\Delta E \qquad (1)$$

where R is phosphorus-32 radioactivity (counts per min. per sq. cm.), C is concentration (millimoles per sq. cm.), L is optical depth (a dimensionless relative-length variable)[11,13], ε is the conventional molar

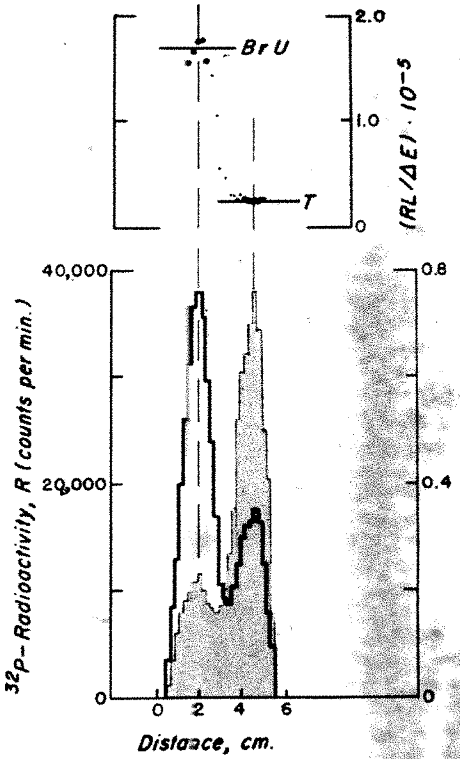


Fig. 2. Open bars: ^{32}P-radioactivity, R. Shaded bars: absorbance of deposited material (ΔE) corrected[13] to a constant optical depth equalling the rectilinear thickness of the papergram, $\Delta E/L$. Circles: ^{32}P-radioactivity divided by corrected absorbance, $RL/\Delta E$. Results from measurement of ^{32}P-radioactivity and absorbance of light of 254 mμ at successive 0·15 sq. cm. areas along line (Fig. 1) through centres of deposits of 5-bromouracil deoxyribotide and thymine deoxyribotide

Table 1. SPECIFIC ACTIVITY OF DEOXYRIBONUCLEOTIDES OF *E. coli* DEOXYRIBONUCLEIC ACID AFTER 21 PER CENT AND 10^3-FOLD INCREASES IN NUMBER OF CELLS

Compound	Specific activity*			
	21 per cent increase		10^3-fold increase†	
	Experimental (*A*)	Relative to 5-BrU (*B*)	Experimental (*C*)	Relative to 5-BrU (*D*)
5-Bromouridylic acid	357 ± 17	100	229 ± 16	100
Thymidylic acid	60 ± 1·2	17	233 ± 12	102
Deoxyribocytidylic acid	104 ± 14	29	214	93
Deoxyriboguanylic acid	130 ± 6·3	37	186	81
Deoxyriboadenylic acid	131 ± 5·1	37	249	109

* Experimental values in columns (*A*) and (*C*) are expressed in counts per minute per millimicromole of nucleotide. Values in (*B*) and (*D*) are relative to 5-bromouridylic acid as 100.

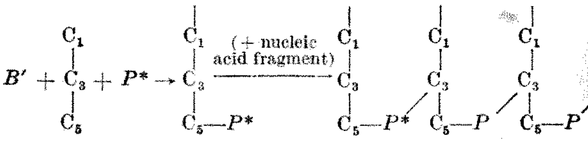
† Theoretically the nucleotides here should be uniformly labelled with phosphorus-32, since virtually all cells were newly formed. Except for the compounds of major interest, 5-bromouridylic acid and thymidylic acid, the values in column (*C*) are results of single measurements. From both theory and results of more critical studies, all values in column (*D*) should be very close to 100.

extinction coefficient (sq. cm. per millemole), and ΔE is absorbance (or optical density) of the measured area with the paper adjacent to the deposit as blank. ε_{264} used for deoxyribotides of 5-bromouracil, thymine, cytosine, guanine and adenine were 4,600, 5,800, 6,000, 13,100 and 13,100, respectively. The specific activity so obtained was multiplied by a factor of 0·447 to correct to a standard phosphorus-32 dosage for the values listed in column *A* of Table 1.

Table 1 shows the results, with those from a control experiment (columns *C* and *D*) where there was a 10^3-fold increase in the number of *E. coli* cells following addition of the bromouracil and orthophosphate-^{32}P at inoculation. After the 21 per cent increase in number of *E. coli*, the specific phosphorus-32 activity of 5-bromouracil deoxyribotide released from the deoxyribonucleic acid as the 5′-isomer is seen to exceed greatly that of any of the other 5′-deoxyribotides. Its isotope concentration at this time was about 50 per cent higher than that of orthophosphate (240 counts/min./millimicromole) isolated from a water extract of the lysed cells. The time curve for specific activity of the 5-bromouracil deoxyribotide of deoxyribonucleic acid is a descending curve, as we would expect if its phosphorus is all newly acquired from labile phosphate of the medium and it enters a deoxyribonucleic acid which has initially no bromouridylic acid. Since the concentration of phosphorus-32 in phosphorus of the labile pool decreases because of continuous dilution with non-radioactive phosphorus that was originally in organic combination with constituents of the cells and the medium used, so also the specific activity of a labile free 5-bromouridylic acid entering the deoxyribonucleic acid must decrease.

The deoxyribonucleic acid of *E. coli* contains the four natural bases in equimolar quantities[14], and the process of replacing thymine by bromouracil is found not to alter this state, providing that the abnormal substituting base is considered as part of the 'thymine'[5,6]. If all the bases enter deoxyribonucleic acid by way of 2′-deoxyribonucleoside-5′-phosphate units, and renewal of phosphorus in these mononucleotides before entry is so rapid that they all quickly have equal specific phosphorus-32 activities, we might expect to find that in the deoxyribonucleic acid the specific phosphorus-32 activity of 'thymidylic acid' (that is, the sum of activities of deoxyribotides of 5-bromouracil and 5-methyluracil in an aliquot of hydrolysate divided by the corresponding number of millimicromoles) should equal the specific phosphorus-32 activity of each of the other nucleotide constituents (column *A*, Table 1). The value found from further data of the typical experiment cited is close, namely, 140 ± 5·3 counts/min./millimicromole. Furthermore, the same practical equality is found to obtain when the increase of *E. coli* cells is 4·4, 35, 121 or 99,900 per cent.

The findings on the 5-bromouracil deoxyribotide of deoxyribonucleic acid demonstrate that there is acquisition of phosphate from the 'labile pool' when 5-bromouracil enters the deoxyribonucleic acid. A reasonable explanation is that the abnormal base (B') and the radioactive phosphate (P^*) become affixed to a pentose at its 1′- and 5′-positions, respectively, forming a 5′-nucleotide, which condenses with the 3′-hydroxyl group of another 5′-nucleotide situated at the end of a fragment of a deoxyribonucleic acid chain, thus :



(2)

where *B* signifies a naturally occurring base, C signifies carbons at reactive positions of the pentose, and *P* is a normal internucleotide phosphate link.

Equation 2 may well depict essentials of the condensation reactions that take place in assembly of the natural nucleotide units of the nucleic acids. Considering effects mentioned in the opening paragraph, data from earlier studies no longer seem to exclude nucleotides (including potentially important nucleoside-5′-pyrophosphates[15]) as the condensing precursor compounds in nucleic acid biosynthesis. Our data on the natural deoxyribonucleoside-5′-phosphate units isolated from the *E. coli* deoxyribonucleic acid were easily reconciled with the hypothesis that they originally entered it as the same units.

The technical assistance of Miss R. De Giovanni and Mr. K. Rich is gratefully acknowledged. The investigation was supported by grants from the Division of Biology and Medicine of the U.S. Atomic Energy Commission, the U.S. Public Health Service, and the American Cancer Society.

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LETTERS TO THE EDITORS

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Rotation Period of the Planet Venus as determined by Radio Observations

In previous communications, observations of the planet Venus at a wave-length of 11 metres at the Ohio State University have been reported[1]. Based on these and subsequent observations, it has been possible to deduce a probable value for the rotation period of the planet.

As was mentioned, the Venus signals show marked fluctuations in intensity, and during March 1956 the periods of peak Venus activity appeared to group at an interval tentatively estimated as about eleven days. In subsequent observations this tendency has been re-observed, but with the interval appearing to be more like thirteen days. In Fig. 1 the periods of more intense activity during most of June and July 1956 are plotted as a function of the time (E.S.T.) and day of the month. The manner in which the peak activity periods drift from day to day suggests: (1) that the signals originate at a single localized region or several such regions grouped more to one side of the planet, and (2) that the rotation period of Venus is slightly less than one day, this 13-day interval being the beat-frequency rate between the rotation periods of Venus and the Earth; that is, the two planets return to the same relative angular phase every thirteen days. It is assumed that the source regions are relatively fixed with respect to the surface of the planet.

The slanting lines in Fig. 1 indicate the time a fixed source on the planet would cross the central meridian on a given day for the 13-day repetition interval. This interval provides a satisfactory fit with the observations of Fig. 1 and also with data as far back as March 1956. Actually an interval of 12·75 days fits the observations almost equally well. Neglecting second-order effects, the rotation period is given by $24\ [1 - \{1/(N + 1)\}]$ hours, where N is the number of days in the repetition interval. For an interval of thirteen days, the rotation period is 22 hr. 17 min., while for an interval of 12·75 days the rotation period is 22 hr. 15 min.

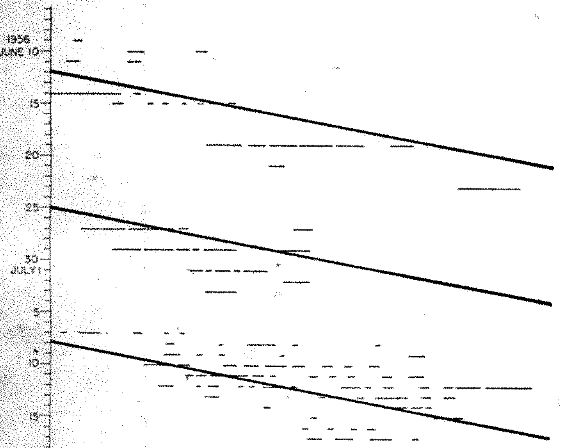

Fig. 1. Periods of peak intensity of 11-m. radio signals from Venus during June and July 1956

For a number of days beginning with July 9, 1956, records were obtained in which the activity peaks appeared to have a particularly distinct pattern which was repeated the following day but 1·6–1·85 hr. earlier, this interval corresponding to the difference between the periods of the Earth and Venus. Daily drifts of 1·6–1·85 hr. correspond to periods of 22 hr. 24 min.–22 hr. 09 min., respectively. These observations make it appear unlikely that the 13-day interval is itself equal to the rotation period, since in this case (13-day rotation period) it is rather improbable that the activity peaks would be repeated each day with a characteristic pattern which advances, on the average, by a fixed time increment each day.

If no correlation is made between a particular peak of activity on one day with a similar one on succeeding days, the data of Fig. 1 show a drift-rate not only of somewhat less than 2 hr. per day but also a drift-rate of about 8 min. per day. A similar rate was reported for the March 1956 data[1]. This rate may be explained as follows. The peaks of Venus activity tend to occur on the average at intervals of about 96 min. (and also half this value), so that a succession of such peaks shows an apparent displacement of 8 min. if displaced each day by 96 + 8 min. This would be the case if the rotation period was 22 hr. 16 min., since the total interval (96 + 8 = 1 hr. 44 min.) is equal to the time Venus gains on each rotation as based on this period.

It may be concluded from the radio observations that a probable value for the rotation period is 22 hr. 17 min., with an uncertainty of about ± 10 min. In calculating these periods the apparent motion of the planet has been neglected. However, the correction due to this is small and uncertain as to sign, since the observations do not indicate the direction of rotation. Since Venus is perpetually covered with clouds, no direct optical observations of the rotation period of the planet have been possible and estimates by indirect means have varied widely[2].

Although the mechanism producing the fluctuations in the signals from Venus is not known, a simple, plausible explanation might be the following. It is likely that Venus has an ionosphere at least as dense as that of the Earth. Radio waves originating on or near the surface of the planet and reaching the Earth would most readily penetrate this ionosphere in the general vicinity of the planet's central point. In this vicinity the ionosphere would appear more transparent to signals travelling earthward, so that, in effect, the ionosphere has a hole. Assuming that the hole remains relatively fixed in position with respect to the central point of the planet's disk, the sources would be observed only as they pass, by virtue of the rotation of the planet, beneath the hole, each source producing a peak of activity as it passes by. A similar ionospheric mechanism is presumed to be responsible for the limited duration of the signals from Jupiter[3]. The fact that the hole has been on the dark side of the planet in recent months (Venus was at inferior conjunction on June 22) would tend to make the hole even more transparent. If the sources are thunderstorms or similar disturbances, which move with respect to the surface of the planet, some variation in the apparent period of rotation may be expected when comparing activity peaks on successive days.

The data in Fig. 1 are based mostly on Venus signals of the atmospherics-like variety (class I), since the class II signals are not observed so frequently. With reference to the latter signals, a recent additional observation is that the pulse-like class II signals occur over a frequency-band of at least 2–4 megacycles per sec. with a given pulse being received earlier at higher frequencies, the dispersion in time being about 2 sec. per megacycle per sec. of frequency difference.

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The Second Purple Light

BY photoelectric observation of the twilight sky, Bigg[1] has found evidence of scattering of the Sun's rays from an elevated atmospheric layer. Assuming primary scattering, he calculates its height to average some 81 km. and finds an association between the intensity of the effect and the incidence of meteor showers. He also observed scattering by a lower dust layer (10–25 km.), which is the cause of the purple light frequently observed above the western horizon after sunset and before sunrise. But after some great volcanic eruptions a striking feature of the brilliant sunsets has been the long-continued after-glows, with a second purple light appearing some time after the first had set and only fading away some $1\frac{1}{2}$–2 hr. after sunset.

It is interesting to recall, in the light of Bigg's work, the discussion which took place in *Nature* after the great Krakatoa eruption in August 1883 as to the origin of this second purple light—a discussion continued and amplified in the Report of the Krakatoa Committee of the Royal Society published in 1888. In the first place, R. von Helmholtz[2] suggested that primary scattering of light from dust at heights around 70 km. was the cause of the second purple light; but this view did not gain general acceptance and it was instead held that both purple lights were caused by the lower dust layer. This explanation is still current—Neuberger[3], for example, says "the purple light is sometimes sufficiently intense to cause a secondary purple light for an observer situated farther on the night side of the earth". The primary scattering hypothesis was rejected mainly owing to the "*a priori* improbability that the reflecting stratum, whether derived from cosmical or from terrestrial sources, should occur in two definite layers" (Archibald[4]). Now that we know more of the complexities of the atmosphere and, in particular, of the strong temperature inversion with its base at about 80 km., this argument fails, and Helmholtz's explanation seems much the more probable. The relative intensity of the purple lights seems more in keeping with a two-layer theory; a secondary effect of the first purple light would not be expected to have as great intensity as reported in 1883 and 1884.

If we assume primary scattering from a high-level dust layer, then six observations of the second purple light by Riccò[4] at Palermo give a mean height of 85 km. and others by Brauner[5] at Prague about 80 km. These values compare well with Bigg's mean of 81 km.; so it seems very probable that Krakatoa dust was held in suspension at these heights over a period of some months.

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Physical Constants in Extra-Galactic Nebulæ

RECENT wave-length measurements by R. Minkowski and O. C. Wilson[1] of spectral lines of H, N II, O I, O II, Ne III and Ne V for the colliding galaxies identified with the radio source Cygnus *A* permit comparison of galaxy values of physical constants with local values. In particular, radio measures by A. E. Lilley and E. F. McClain[2], in combination with the optical measures, permit estimates on the ratio of galactic to local values of the fine structure constant, α, and the proton gyromagnetic ratio, g. The observed system is estimated to be 3×10^8 light years from us on the Humason, Mayall, Sandage scale[3].

In the discussion of these measures, we shall be concerned with a gross red shift, assumed of the form $\Delta\lambda/\lambda$ = constant, upon which may be superimposed changes in fine and hyperfine structure. It is not necessary to decide whether the gross red shift arises from a change of constants or from a velocity shift. It is further assumed that the interaction Hamiltonian for atomic spectra is of the form:

$$H = H_0 + \alpha^2 H_f + g \frac{m}{M} \alpha^2 H_{hf} \qquad (1)$$

Among these terms, H_0 arises from electrostatic interactions, H_f from relativistic effects usually represented by spin-orbit interactions, and H_{hf} in this specific case is the spin-spin interaction as in the hydrogen hyperfine structure. If we use the ionization energy of hydrogen as the energy unit, we obtain from equation (1) the quantity $hcR = \frac{1}{2}\alpha^2 mc^2$.

In writing equation (1) it is assumed that both fine structure and hyperfine structure are small perturbations, and especially for the former that Russell-Saunders coupling predominates (see Condon and Shortley[4] and Bethe[5]). Note particularly that the ratio of the fine and hyperfine interaction energies to the electrostatic interaction energies depends upon no other physical constants except those indicated in equation (1).

From measures of all available lines, Minkowski and Wilson conclude that for the optical Cygnus *A* the quantity $c\Delta\lambda/\lambda = 16{,}805 \pm 6$ km./sec. The fine structure produces the doublet splitting of the terms ${}^3P_n - {}^1D$. Of the three doublets measured, the measures of O I appear to suffer from blends and only those of N II and Ne III will be discussed. The doublet separations are taken proportional to $(1 + \Delta\lambda/\lambda)\,\alpha^2$. With $\Delta\lambda/\lambda$ as above, we obtain from the data:

$$\frac{(\alpha^2)\ \text{Cyg. } A}{(\alpha^2)\ \text{local}} = 1{\cdot}0036 \pm 0{\cdot}0032$$

E. Salpeter (private communication) points out that if the red shift is understood as arising from a change in α^2, then :

$$\frac{(\alpha^2)\ \text{Cyg. } A}{(\alpha^2)\ \text{local}} = \left(1 + \frac{\Delta\lambda}{\lambda}\right) = 1{\cdot}057$$

The observed wave-length of the hyperfine structure hydrogen line at 21 cm. is assumed to be given by the following equation :

$$\lambda_{\text{Cyg. } A} = \lambda_{\text{local}}\ (1 + \Delta\lambda/\lambda)\ \frac{\left(g\frac{m}{M}\alpha^2\right)_{\text{Cyg. } A}}{\left(g\frac{m}{M}\alpha^2\right)_{\text{local}}}$$

Since Lilley and McClain report $c\Delta\lambda/\lambda = 16{,}700 \pm 50$ km./sec. we find

$$\frac{\left(g\frac{m}{M}\alpha^2\right)_{\text{Cyg. } A}}{\left(g\frac{m}{M}\alpha^2\right)_{\text{local}}} = 1{\cdot}0003 \pm 0{\cdot}0007$$

This corresponds to

$$\frac{\left(g\frac{m}{M}\right)_{\text{Cyg. } A}}{\left(g\frac{m}{M}\right)_{\text{local}}} = 0{\cdot}9967 \pm 0{\cdot}0032$$

It must be mentioned, however, that the difference of 100 km./sec. could also be understood as resulting from an expanding hydrogen envelope of which only the front surface projects on the source.

Note that α is the coupling factor for quantum electrodynamics. The proton gyromagnetic ratio is observed to be 2·8 times the ratio predicted by quantum electrodynamics and is apparently determined by interactions with the meson field. My conclusion is that, within the precision of current measurements, the above physical constants of Nature are indistinguishable in two galaxies 3×10^8 light years apart.

Similar conclusions were mentioned by E. M. Purcell at a symposium in April 1956.

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Suggested Experiment on the Relativistic Contraction of Time

It has been questioned whether a discrepancy in time would be observed when comparing clocks at the completion of a space journey. It seems to me that one need not await the advent of space travel at extreme speeds for experimental evidence, since a closely analogous experiment could be performed on the Earth. A suitable clock exists in the form of unstable particles of known half-life. Particles possessing charge in combination with a convenient mass and half-life could be injected into a synchrotron and circulated for a measured time-interval before emerging. Some would disintegrate within the synchrotron and fail to emerge. By comparing the number entering in unit time with the number emerging, any increase in the life of the particles, as measured by the stationary observer, could be determined.

In case it should be objected that motion in a circular path, implying continuous acceleration, does not correspond to a flight path which would be adopted in space travel, an alternative technique is possible. The particles could be accelerated in an electric field, allowed to coast for a relatively long distance in a field-free region, reflected by a second electric field or a magnetic field, and finally brought to rest at the starting point after retraversing the field-free region and the first electric field. To obtain maximum velocities the electric fields could take the form of linear accelerators.

Incidentally, if an increase in life of the particles were in fact observed, there might be interesting applications for this technique of 'freezing' short-lived particles.

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A Determination of the Line-width of the λ6300 Line of Oxygen in the Twilight Sky

The red doublet (λ6,300–λ6,363) due to oxygen in the upper atmosphere of the Earth is greatly enhanced in twilight, as was shown by Elvey and Farnsworth[1] and others. The present study has been undertaken to determine the temperature of the emitting layer from the contour of the λ6,300 component.

A Fabry–Perot interferometer with multi-layer dielectric reflecting surfaces, described in an earlier study of the λ5,577 line in the night sky[2], was placed in front of a camera with an effective focal ratio of 3·9. The interferometer plates were coated with five layers—two of cryolite and three of zinc sulphide—giving a reflectance of 0·87 in the spectral region under study. A quartz spacer of 11·7 mm. was used.

In front of the system a multi-layer dielectric interference filter (Baird Associates) with a band-width of 60 A. was inserted to reduce the scattered light from the twilight sky and to isolate the λ6,300 line from the weaker λ6,363 component. The entire instrument was contained in an airtight enclosure to provide constant density of the air between the interferometer plates, and this, in turn, was placed in an insulating case to permit careful temperature control.

Observations were made at the Geophysical Institute at College, Alaska (lat. 64° 52′ N.), at a time when twilight conditions favourable for the study existed at midnight. This permitted long exposures during which the depression of the Sun below the horizon remained nearly constant. Exposures of from one to two hours were necessary to obtain satisfactory results. The optical axis of the instrument was directed to the north and at a zenith distance of 70°.

The instrumental effect on the contour of the fringes was determined from a comparison of the observed line-width with the width of the λ6,438 line

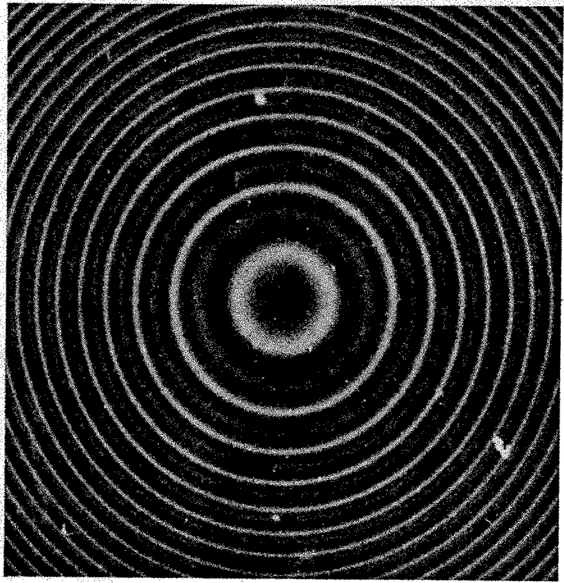

Fig. 1

of cadmium. Periodically the exposure to the twilight was interrupted and the cadmium lamp (Philips type 93107*E*) exposed to the interferometer so that a second set of fringes was formed on the photographic plate. By trial a spacer was found that would give suitable spacing to the two sets of fringes.

Fig. 1 shows the result of a complete exposure (plate *B*): the more intense set of interference fringes are due to λ6,438 of cadmium and the less intense are due to λ6,300 of oxygen.

In the reduction of the line contours, microphotometer tracings made along several diameters of the pattern were converted to intensities and averaged; the several fringes on this average pattern were then converted to a linear scale and combined into a mean fringe for each source.

Using the intrinsic contour of the λ6,438 line, as determined by separate experiment, and assuming the λ6,300 line to be Gaussian in shape, the method of Voigt parameters[3] was employed to find, by a series of approximations, a curve that would best represent the observed curve and would establish the width of the λ6300 line. The instrumental contribution was found to be asymmetrical, with the right side having a resonance shape and the left side a shape intermediate between resonance and Gaussian.

Fig. 2 shows one complete phase of the fringe system: the dotted line is the observed average contour of the fringe system, while the solid line is the best representation of this curve; the dashed lines are the known intrinsic contour of the λ6,438 line and the derived contour of the λ6,300 line. The difference between the solid and the dashed lines represents the instrumental effect.

The zero intensity as shown is probably quite reliable. The overall shape of the fringes and the asymmetry of the instrumental effect combine to restrict the selection of the zero point. It was found that a small change in the zero point would result in a serious deviation in the shape of the curve. This zero intensity is consistent with the minimum intensity of about 2 per cent between the fringes which is to be expected from the reflectance of 0·87 if due consideration is given to the blending of the two sets of fringes.

In listing the results, consideration must be given to the height of the emitting layer, which is that region illuminated by the Sun. However, the height of the horizon for the radiation responsible for the enhancement may very likely be quite great, due to the opacity of the atmosphere; 100 km. has been selected arbitrarily as the height of the opaque layer.

Table 1

	h_0	h_{100}	$\Delta\lambda$	T
Plate *A*	64	155	0·0315 ± 0·0024	790 ± 120
Plate *B*	78	155	0·0299 ± 0·0026	710 ± 130
Plate *C*	74	151	0·0266	560

In Table 1, h_0 is the height of the Earth's shadow in the line of the observation in kilometres; h_{100} is the height of the shadow of a layer 100 km. above the Earth's crust in the line of the observation; Δλ is the width at half-intensity of the λ6,300 line in A.; and *T* is the temperature in degrees K. corresponding to Δλ. The results from plates *A* and *B* are consistent with the probable errors listed. Plate *C*, which shows considerably lower values for Δλ and *T*, has been included only to indicate the order of magnitude of the result; due to fogging of this plate by the twilight, much difficulty was encountered in calibration of the exposure and it cannot be given much weight. A value of 750° K. may reasonably be adopted for the temperature of the emitting layer for the conditions of the first two observations.

This temperature contrasts with the result of the study of λ5,577 of oxygen in the night sky[4], which showed a temperature of about 200° K. Such a difference in temperature would suggest that the emissions in the two cases arise in substantially different levels of the atmosphere: the λ5,577 line in the night sky coming from a level near 100 km., in accordance with evidence from night sky studies[4] and from rocket ascent studies[5], as well as with theoretical argument[6]; the enhanced λ6,300 line in the twilight sky, under the conditions of this study, coming from a level of at least 150 km. and perhaps above 200 km., in accordance with the results from rocket ascent studies[5].

A further discussion of this study will be published elsewhere in the future.

I wish to thank Dr. C. T. Elvey, director of the Geophysical Institute of the University of Alaska, for suggesting the work and for his aid; Prof. J. G. Phillips, Prof. F. A. Jenkins and Dr. J. M. Stone

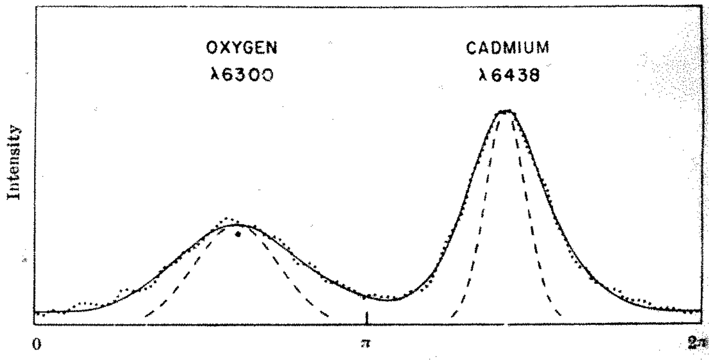

Fig. 2

of the University of California for their assistance and guidance; and the U.S. Weather Bureau for its co-operation.

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The Maximum of a Distribution- or Spectrum-Function

RECENTLY, Bracewell[1] published a paper, in which he explained why the position of the maximum of Planck's energy spectrum depends on whether the frequency or the wave-length is plotted on the horizontal axis. I wish to direct attention to the fact that this is true for all distribution- or spectrum-functions. Though it is indeed obvious that the maximum must move, when the horizontal axis is non-linearly transformed, yet errors have been made in this respect. Zernike[2] pointed out that, for example, an error of this kind was made when Stern and Gerlach[3] described their famous experiments, in which rays of silver atoms were deflected by a magnetic field. They assumed (Fig. 1) that the atoms with the most probable velocity v_p would have the most probable deflexion y_p (thickest part of the precipitation layer). This is only true if the deflexion y and the velocity v of an atom are related by $y = av + b$. However, they are related by $yv^2 =$ constant. The true value of y_p is one-half of the value derived from the last equation with $v = v_p$. This result is due to Semenoff[4], who was apparently the first to recognize the danger, described here. Though geophysicists are particularly vulnerable in this respect, as they have been investigating spectra of all sorts of time-series, yet almost all of them have succeeded in escaping the pitfall.

One exception is Schumann[5], who obtained the spectrum of the daily air pressure on the North Atlantic by a Fourier analysis. He found $T = 5{\cdot}7$ days as the most frequent period in air-pressure. However, when he changed from period to frequency, he found $n = 0{\cdot}033$ (equivalent to $T = 30$ days) for the maximum of the frequency distribution, a result apparently so strange to him that he looked for an explanation in the wrong direction.

A group of oceanographers from New York University[6] have studied the energy spectrum of ocean waves. In this case, too, the position of the maximum changes when one considers the distribution of periods instead of the distribution of frequencies.

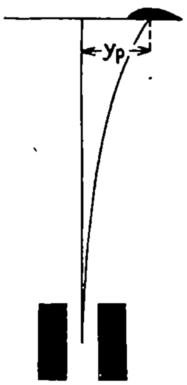

Fig. 1

Spectra of turbulence, especially turbulence of the lower atmosphere, have been analysed by an American group under Panofsky[7] and by an Australian one under Priestley and Swinbank[8]. Both groups have succeeded in avoiding difficulties, though possibly not for reasons inspired by the risk described in Bracewell's paper and here, as is shown by quotations of Panofsky and McCormick (ref. 7, p. 551): "Since meteorological turbulence covers a wide range of frequencies, a logarithmic frequency scale was judged appropriate"; and of Webb (ref. 8, No. 5, p. 7): "It is appropriate to display the results by plotting $n\,F(n)$ which is the fraction of energy per unit fractional increment of frequency. If a logarithmic scale is used for n, the area under a portion of the curve still represents the energy fraction $\int F(n)dn$."

The use of log n or log λ as abscissa ensures that for most cases the spectrum peak frequency and the spectrum peak wave-length are related by $n_{\text{max.}} \times \lambda_{\text{max.}} = c$. This was proved by Bracewell[1] for the case of $c =$ constant. It is also true when $c = c_0\lambda^k$ (this occurs, for example, with waves in deep water, where $k = \frac{1}{2}$); but it is certainly not valid for cases of, for example, $c = c_0 \exp(-\beta\lambda)$.

I wish to express my thanks to my colleague, Dr. H. J. de Boer, for valuable discussions.

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March 21.

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Phase-distribution in and near the Bright Nucleus of an Aberration-free Diffraction Image

IT was shown in the course of a recent investigation[1] that the three-dimensional phase distribution very close to the geometrical focus of an aberration-free diffraction image in light of wave-length λ is substantially the same as that in a parallel beam of wave-length $(1 - \frac{1}{4}\sin^2\alpha)\lambda$, travelling in the direction defined by the principal ray, where $\sin\alpha$ denotes the numerical aperture of the converging pencil.

Let φ and $\bar{\varphi}$ denote the respective phases, both normalized to $\pi/2$ at the geometrical focus O, of the complex displacements in the converging pencil and in the parallel comparison beam.

When the numerical aperture $\sin\alpha$ is varied, the form of the equiphase surfaces $\varphi =$ const. undergoes a transformation which is more complicated than a simple linear scale-distortion. However, the difference $\varphi - \bar{\varphi}$ between the phases of the actual and the comparison waves at a point P near focus can be expressed, to a useful approximation, as a function of the two optical parameters u, v alone, where $u/4\pi$ measures the 'number of fringes of defocusing' of P relative to O, and v/π the 'number of fringes of lateral displacement' of P relative to O, as they would be seen in an interferometer. In fact, from the approximate equation,

$$d(P)/d(O) = 2\exp\{-iu\operatorname{cosec}^2\alpha\}\int_0^1 \exp\{\tfrac{1}{2}iut^2\}\, J_0(vt)\, t\, dt \qquad (1)$$

for the ratio of the complex displacement $d(P)$ at a point P near O to the complex displacement at O itself, we obtain:

$$\varphi - \tilde{\varphi} = \omega + \tfrac{1}{4}u - \frac{\pi}{2}, \qquad (2)$$

where

$$\cos\omega = \frac{U_2}{\sqrt{U_1^2 + U_2^2}}, \quad \sin\omega = \frac{U_1}{\sqrt{U_1^2 + U_2^2}} \qquad (3)$$

and the Lommel functions U_1, U_2 are given by the equations

$$U_n = U_n(u,v) = \sum_{m=0}^{\infty}(-1)^m\left(\frac{u}{v}\right)^{n+2m} J_{n+2m}(v) \qquad (4)$$

$$(n = 1, 2).$$

In the course of the investigation already mentioned, the distribution of $\varphi - \tilde{\varphi}$ was computed over the region $u^2 + v^2 \sin^2\alpha \leq 4$, which is a spheroid about 3·5 times as wide and one-sixth as long as the elongated bright nucleus of the three-dimensional diffraction image (see ref. 1, Fig. 4). An extension of the computations, carried out with the assistance of Miss C. P. Wilks, has now made possible the construction of Fig. 1, which exhibits the distribution of $\varphi - \tilde{\varphi}$ over a region about 2·5 times as long, and six times as broad, as the bright nucleus of the diffraction image. Only one (u,v)-quadrant is shown, since the remaining three are readily deducible from it with the help of symmetry relations derived from equation (1).

In this figure, which forms a natural complement to Zernike and Nijboer's well-known diagram[2] of the intensity distribution, Z_1 and Z_2 are the first two axial nodes (points of zero intensity) in the diffraction image, while R_1, R_2, . . . generate the successive Airy dark rings when the figure is rotated about the optic axis Ou. The numbers on the contour lines indicate the values, measured in radians, of the phase-discrepancy $\varphi - \tilde{\varphi}$ between the complex displacements in the diffraction image and in the comparison parallel beam defined above.

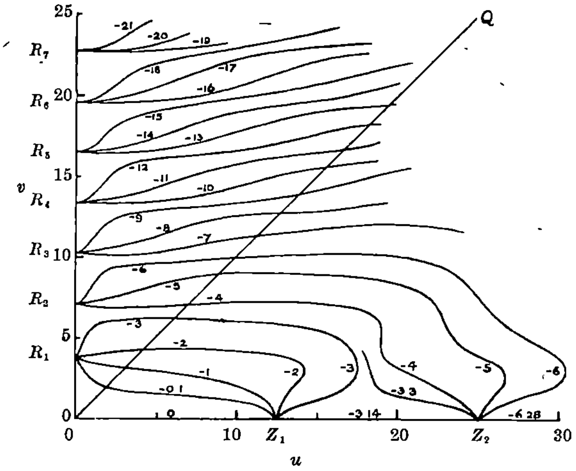

Fig. 1. Values of $\varphi - \tilde{\varphi}$

The diagonal line OQ corresponds to the edge of the geometrical shadow.

One of us (E. W.) wishes to acknowledge the award of an I.C.I. Research Fellowship covering the period in which this work was carried out.

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A Very Rapid Two-Stage Solid–Solid Reaction and the Mosaic Structure of Potassium Permanganate

Studies of self-sustained reaction by the temperature profile method[1] have recently been extended to compressed mixtures of molybdenum and potassium permanganate and have shown that reaction occurs in two stages.

The observed temperature-time record (obtained by placing a thermojunction in the path of the reaction wave) consists of two sigmoid parts, joined by a flat step which corresponds to completion of the first stage of reaction. When the reactants are initially at room temperature (20° C.), the step temperature is 120° C. and the final temperature 850° C. Thus the heat evolved in the first stage is roughly one-eighth of the total.

This observation may be explained in terms of the mosaic structure of the reactants. If molybdenum ions are the mobile species, as seems probable since they are much smaller than permanganate ions, they may react by diffusing into the permanganate along the grain boundaries. The first stage of reaction probably corresponds to complete coverage of the internal surfaces with a layer of product. No further reaction takes place until the temperature has risen above 120° C.; then, at a temperature at which molybdenum can penetrate the lattice, reaction with the bulk of the permanganate begins. The bulk reaction is expected to be complete because molybdenum is in large excess, and it is probable that the heats evolved in the first and second stages are directly proportional to the numbers of permanganate ions on the surface and in the bulk respectively. On this basis, with the assumption that the surface layer is monomolecular, the average dimension of the mosaic blocks in potassium permanganate may be calculated. It is found to be approximately 10^{-5} cm., which is of the same order as that found in other crystals by X-ray methods[2].

It is apparent that if the mosaic blocks in crystals have dimensions of this order, we may expect roughly 10 per cent of the substance to be in a more reactive state than the rest; and it is noteworthy that partial reaction of this degree is fairly common. Other solid–solid reactions with this behaviour are those between iron and potassium dichromate and between iron and barium peroxide[3]. These are particularly interesting because the reaction time was several hours, or 10^4 times longer than the reaction time (1 sec.) in the self-sustained reaction of molybdenum and potassium permanganate. Similar partial reaction has been noticed during the thermal decomositions of solids, for example, of lithium aluminium ydride[4] and of mercury fulminate[5].

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Mass-Spectrometric Detection of the Ion $(SrOK)^+$

In a study of the ionization produced by traces f alkali and alkaline earth elements in hydrogen/air lame gases, Wheeler[1] has found evidence for ions of he type $(BOA)^+$, where A represents an atom of lkali metal and B one of alkaline earth. Theoretical alculations, by the method of Rittner[2], suggest that uch ions should be of high stability in the gas hase, the heat of dissociation into BO and A^+ being f the order of 100 k.cal./mole. A mixed ion of this ype was suggested by the highly specific behaviour iven by various A/B pairs. The basic measurements ere, however, of electron concentrations, the xistence of this particular positive ion being in-erred from them, and it seemed desirable to have ndependent and more direct evidence for their resence.

An attempt to obtain and identify such ions has een made by mass-spectrometric analysis of the nic content of the vapour from a strongly heated ixture of a potassium and a strontium salt in a acuum oven. The diagram of the oven is shown in ig. 1. The oven cell (A), of molybdenum, was contructed in two pieces, rammed together after loading ith the charge (B). It was maintained at a potential f + 1,500 V. (stabilized) relative to the remainder f the oven, this serving to accelerate the ions into he mass spectrometer, and also allowing the front nd to be heated to the required temperature by lectron bombardment from the filament (C). A econd filament (D) allowed of further heating (of he rear end) by radiation. The temperature of the ront (exit) end of the oven was determined pyro-etrically, and that of the rear by a thermocouple E), which also carried the emission current, via the ven, from (C). The inner radiation shields (F,G) ere of nickel, and the outer, water-cooled, shield (H) as of copper.

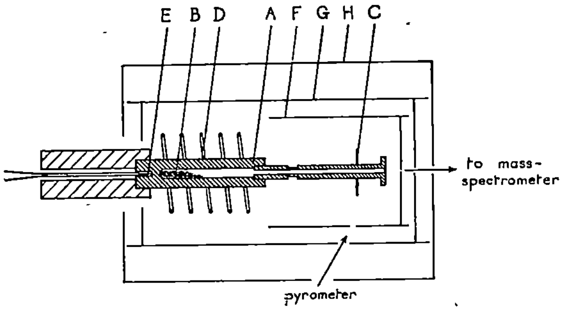

Fig. 1

Any positive ions in the vapour from the charge ere repelled from the oven, through the slit system, nto a mass spectrometer, which was a 90° Nier type. n electron multiplier detection system was used so hat actual counts of ions could be made. A mixture f strontium and potassium carbonates was heated, a ttle cæsium being added to give a reference peak t mass 133. With this mixture, the rear of the oven eing at about 1,000° K., and the tip at about ,900° K., which were found to be optimum working onditions, an ion current was noted at mass 143. his was not evident with either of the carbonates heated alone under the same conditions. It corresponds with a positive ion $(^{88}Sr^{16}O^{39}K)^+$, which combines all the most abundant isotopes, and should give at least eight times as large a peak as any other combination. The observed peak corresponded with a current of about twelve ions per sec., with a noise-level of about two per sec., so that no other $(SrOK)^+$ peak would be expected.

It is considered that this provides reasonable evidence for the existence of this type of ion, first postulated in the flame studies referred to. The ions probably owe their stability to the very large electrostatic attraction between the alkali metal ion A^+ and the large dipole of the alkaline earth oxide BO. It is interesting to note that Inghram, Chupka and Porter[3], also using a mass-spectrometric method, have been able to demonstrate the formation of the ion $(Ba_2O)^+$ from the vapour of barium oxide heated in an alumina crucible.

One of us (P. F. K.) is grateful to the Department of Scientific and Industrial Research for a grant covering the period of this investigation.

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Isolation of the Stable Boron Trifluoride – Hydrogen Fluoride Complexes of the Methylbenzenes ; the Onium Salt (or σ-Complex) Structure of the Friedel-Crafts Complexes

The alkylation of aromatic hydrocarbons catalysed by aluminium chloride and similar Friedel-Crafts catalysts is ordinarily accompanied by the formation of deeply coloured oily liquids of high density. The structure of these 'Friedel-Crafts complexes' has been investigated by a number of workers[1]. H. C. Brown and H. W. Pearsal[2] have proved the formation of a molecular complex from toluene and aluminium chloride – hydrogen chloride at low temperature. In further work, H. C. Brown and J. D. Brady[3] have established the structure of the hydrogen chloride – aluminium chloride complexes of the methylbenzenes as σ-complexes in contrast to the proposed hydrogen chloride complexes which have a π-complex structure (after the representation of Dewar[4]). The formation of the onium or σ-complexes was proved by Brown by the hydrogen chloride technique by measuring the solubility of hydrogen chloride in the presence of aluminium chloride in the isomeric methylbenzenes.

Similarly, the complexes of hydrogen bromide – aluminium bromide with aromatic hydrocarbons have been intensively investigated. Norris reported the isolation of several crystalline products from mesitylene (Mes) and 1,3,5-triethylbenzene (TEB) with aluminium bromide – hydrogen bromide: 3Mes.Al_2Br_6.HBr ; 2TEB.Al_2Br_6HBr [5] ; Mes.Al_2Br_6.HBr ; TEB.Al_2Br_6.HBr [6]. Brown and Wallace[7] suggest, as a result of their investigations of hydrogen bromide – aluminium bromide complexes of aromatic hydrocarbons, the σ-complex structure of the resulting Friedel-Crafts complexes ('red oils').

The concept that aromatic hydrocarbons possess basic properties sufficiently strong to form salts with hydrogen halide – aluminium halide and similar reagents suggests that such reagents could be utilized to extract, preferentially, more strongly basic aromatic hydrocarbons from those less basic. McCaulay, Shoemaker and Lien[8] have recently demonstrated that hydrogen fluoride – boron trifluoride can be readily utilized to extract the more basic *m*-xylene from its mixture with the less basic *o*- and *p*-xylene isomers. These authors have established the ratio Ar : BF_3 = 1 : 1 in the complexes formed from aromatic hydrocarbons, boron trifluoride and hydrogen fluoride, the latter being present in excess as the solvent. The formation of the complexes was proved by the determination of the solubility of boron trifluoride in the hydrogen fluoride – methylbenzene system.

We have now been successful in isolating the stable boron trifluoride – hydrogen fluoride complexes of the methylbenzenes in the previously investigated cases of toluene, *m*-xylene, mesitylene and *iso*durene.

In the absence of hydrogen fluoride and at low temperature (– 25° to – 85°), boron trifluoride neither interacts with nor dissolves appreciably in toluene, xylene, mesitylene and *iso*durene. Hydrogen fluoride itself is also not soluble to more than 1 per cent in the methylbenzenes[9]. In the presence of an equimolecular quantity of water-free hydrogen fluoride, the boron trifluoride dissolves in methylbenzenes to give a clear solution with a bright colour (greenish-yellow, yellow or brownish-red), which solidifies by cooling. The one mole of methylbenzene, one mole of hydrogen fluoride and one mole of boron trifluoride is needed to form the stable complex. The reaction is reversible: when heated, the complexes melt with subsequent evolution of boron trifluoride and hydrogen fluoride and the aromatic compounds are regenerated. We were able to determine the melting points of the stable methylbenzene hydrogen fluoride – boron trifluoride complexes in the cases of toluene, *m*-xylene, mesitylene and *iso*durene. Also the specific conductivity of the stable complexes were determined.

PROPERTIES OF $ArH^+BF_4^-$ COMPLEXES PREPARED

R	Melting point (° C.)	$\varkappa$ Ω^{-1} cm.$^{-1}$
$(CH_3)C_6H_5$	–65	0 8 × 10^{-2}
m$(CH_3)_2C_6H_4$	–55	2·0 × 10^{-2}
s$(CH_3)_3C_6H_3$	–15	1 6 × 10^{-2}
as$(CH_3)_4C_6H_2$	–10	0 6 × 10^{-2}

The reaction is believed to involve the formation of a carbonium ion salt of the hypothetical acid, HBF_4 : $(CH_3)C_6H_5 + HF + BF_3 = (CH_3C_6H_6)^+BF_4^-$. The complexes which are formed in the course o Friedel-Crafts reactions are believed to be carbonium ion salts of this kind.

Using deuterium fluoride (prepared by the reaction of C_6H_5COF with deuterium oxide[10]) in the place of hydrogen fluoride in the complex formation, deuterated tetrafluoroborate complexes of the $(CH_3C_6H_5D)^+BF_4^-$ type are formed. By the slow decomposition of the complexes we obtain *o*- and *p*-D-toluene, which confirms unambiguously the electrophilic character of the D^+ substitution via the stable onium ion salt of the hypothetical DBF_4 acid and the structure of the complexes.

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Notation for Serum-Protein Groups and the Genes controlling their Inheritance

SEVERAL workers[1–3] have described the presence in serum of a protein with the striking characteristic of binding hæmoglobin. During electrophoresis on filter paper, this hæmoglobin-binding protein migrates in the α_2-globulin position. It is the haptoglobin o Jayle *et al.*[1]. The serum-protein groups described by Smithies[4,5] are characterized by several protein demonstrated by electrophoresis in starch gels which also have this property of binding hæmoglobin. They appear to be the only serum proteins with hæmoglobin-binding powers. Furthermore, they also migrate in the α_2-globulin position when the electrophoresis is carried out on filter paper[5,6]. Consequently, the identity of haptoglobin and the proteins characterizing the serum groups can be regarded as established, even though previous work had no shown the multiple nature of haptoglobin. Th serum-protein groups are therefore basically determined by differences in the haptoglobins of differen individuals.

A genetic pattern for the inheritance of the serum protein groups has been outlined by us in a previou communication[7]. More extensive family studies in which all possible matings have been observed confirm this mode of inheritance—namely, that th serum groups are determined by two autosoma genes with incomplete dominance. Complicatin factors which we intend to discuss in a comin publication may make it necessary in the future t extend this genetic mechanism; but its essentia correctness is, we believe, established.

Since differences in the haptoglobins of individuals determine their inherited serum groups, we suggest that the system comprising these groups be known as the 'haptoglobin system'. If other inherited serum groups are discovered in the future, the systems can also be named according to the nature of the proteins concerned. We should like to stress that the demonstration of serum-protein groups makes it necessary to distinguish two classes of blood groups: the red blood-cell class (with the corresponding serum antibodies when these are present), and the serum-protein class which does not involve the red cells[7]. To assist in distinguishing the two classes, we propose that serum-protein groups be described by the name of the system followed by numerals to designate the specific group, thus contrasting with the use of letters in the red-cell groups.

In describing the genetic pattern for the haptoglobin system, we suggest that the locus symbol be *Hp* and the genes Hp^1 and Hp^2. The notation for the system would then be as follows:

HAPTOGLOBIN SYSTEM OF THE SERUM PROTEIN GROUPS

Old nomenclature	New nomenclature	Genotypes
Group I	Haptoglobin 1–1	Hp^1/Hp^1
Group II*A*	Haptoglobin 2–1	Hp^2/Hp^1
Group II*B*	Haptoglobin 2–2	Hp^2/Hp^2

A summary of some of the factors which were considered in selecting this notation may be given:

(i) The use of numerals prevents confusion between red-cell groups and serum protein groups.

(ii) The new names for the serum-protein groups have the advantage of indicating the specific proteins which distinguish the three serum groups, and yet they are close to those originally used in describing them. Thus haptoglobin 1–1 (one–one) is similar to group I; haptoglobin 2–1 (two–one) to group II*A*; and haptoglobin 2–2 (two–two) to group II*B*.

(iii) The names given to the three phenotypes correspond closely to the respective genotypes.

(iv) The close similarity of the haptoglobins 2–1 and 2–2 (which differ considerably from haptoglobin 1–1) is reflected in the names.

(v) The relative rates of migration in starch gels of the haptoglobins of the three groups are implied by the numbers, since haptoglobin 1–1 migrates considerably more rapidly than haptoglobins 2–1, and these in turn migrate slightly more rapidly than haptoglobins 2–2.

(vi) If further work indicates that either of the alleles representing the haptoglobin system is multiple, the notation can readily be extended to show this by using subscript letters to the numerals (for example, 2_a, 2_b, etc.) to describe the subgroups in the way that subscript numerals are used with letters in the red-cell groups (for example, A_1, A_2, etc.).

In describing blood groups, there are occasions when the use of an abbreviated form is essential, so it seems advisable to suggest standard abbreviations for the haptoglobin system at this juncture. The three types can readily be abbreviated to *Hp* 1–1, *Hp* 2–1 and *Hp* 2–2.

We are grateful to Dr. Helge Laurell, of the University of Upsala, for directing our attention to the work on haptoglobin, and for the suggestion in a private communication to one of us that this protein might be identical with one of the hæmoglobin-binding substances of serum demonstrated by starch-gel electrophoresis. We wish to thank Drs. Bruce Chown, William Donohue, Harold Gunson, Philip Levine and Ruth Sanger for their helpful comments on the notation here proposed.

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Hæmoglobin *E* in Malaya

Of the variants of normal adult hæmoglobin (*A*), four are now known to be present in large numbers of people. Sickle-cell hæmoglobin (*S*) is found in tropical Africa, in some Mediterranean and Middle Eastern countries and in the New World in populations derived from these parts. It is also present in a few aboriginal communities in southern India. Hæmoglobin *C* is frequent in West Africa, where it is at its highest incidence in the northern Gold Coast. Hæmoglobin *D* has been found in India in 3 per cent of north-west Indians and in 1 per cent of Gujeratis.

Hæmoglobin *E* is present in Siamese[1], Burmese[2] and in Indonesians[3]. In Ceylon it was found in some aboriginal Veddas but not in the Singhalese themselves. Single instances have been seen in India, Turkey, Persia and in the Philippines, but none has so far been found in the Chinese[1,3].

It was of interest to see whether the Malaysians were similar to their Burmese and Siamese neighbours in the north, where hæmoglobin *E* was found in 15·3 [2] and 13·6 [1] per cent respectively, or whether they resembled the Indonesians in the south, where the incidence is 2·9 per cent[3].

We have examined the blood of 346 Malaysians, all non-related, and have found twenty-four to show hæmoglobins *A* and *E*, one hæmoglobins *F* and *E* (hæmoglobin *E*: thalassæmia), and one hæmoglobin *E* only (hæmoglobin *E* disease). With an incidence of 7·3 per cent, the Malaysians are somewhere midway between the Siamese and Burmese in the north and the Indonesians in the south.

Table 1 suggests that there is a gradient even within Malaya. The peninsula is divided into an eastern and western part by a central range of mountains. Most of the immigrants from Indonesia, especially Sumatra, have settled in the south (Johore) and west of the range of mountains, which acted as a barrier to settlers from across the Straits of Malacca. It seems that there is an inverse relationship between the extent of Indonesian admixture in the past and the incidence of hæmoglobin *E*. In the southern parts of the Western States of Malaya, only one person with this hæmoglobin was found among fifty-four examined from Negri Sembilan, Malacca and Johore.

In one person—from Kelantan—part of the hæmoglobin was neither *A*, *F* nor *E*. The electrophoretic mobility and the progressive denaturation

Table 1. HÆMOGLOBIN *E* IN MALAYSIANS IN MALAYA

State	No. examined	No. with hæmoglobin *E*	Per cent
Eastern States :			
Kelantan	78	8	13·1
Trengganu	16	2	
Pahang	13	4	
Western States :			
North—			
Kedah	33	1	6 0
Penang and Province Wellesley	26	2	
Perak	25	2	
Central—			
Selangor	101	6	5 2
Negri Sembilan	26	–	
Malacca	7	1	
South—			
Johore	21	–	0
Total	346	26	7·5

of the purified hæmoglobin by freezing and thawing were properties described for hæmoglobin *H*, first seen in a Chinese family in the United States[4].

We hope to continue this survey, and to extend it to other communities of Malaya—of three aborigines so far examined one, a Senoi, showed hæmoglobins *A* and *E*. It seems already that the distribution of hæmoglobin *E* in Malaya follows an ethnological pattern, as was noted for that of sickling in Uganda[5] and of hæmoglobin *C* in the Gold Coast[6] and in Nigeria[7].

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Oxidation *in vitro* of Radioactive Œstradiol by Preparations of Human Tissue

THE oxidation of œstradiol to œstrone and œstriol in the pathway of degradation of the œstrogens has been inferred from *in vivo* studies in which œstrone and œstriol were found in the urine of the male human[1] and œstrone in the urine of other mammals[2] after the administration of large amounts of œstradiol. More recently, Ryan and Engel[3] found an *in vitro* interconversion of œstradiol and œstrone by tissue-slice preparations of several organs of the rat and man. Using counter-current distribution to achieve separation of the steroids, an accumulation of either œstradiol or œstrone was found when the other œstrogen was present in the substrate. These workers were not able to demonstrate formation or utilization of œstriol. We have observed the *de nov* formation of œstrone and œstriol from labelle œstradiol by human-tissue slice and homogenat preparations from a variety of organs.

Tissues obtained from surgical specimens wer placed in cold phosphate–nicotinamide buffer[4] immediately after excision. The sera used were freshl obtained pooled sera from the individually centrifuge blood specimens of several female donors. Tissu slices were suspended in 5 volumes of buffer ; homogenates were a 20 per cent suspension in buffer ; an sera were diluted in 20 volumes of buffer. 7 ml. of tissue preparation and 1 mgm. adenosine monophosphate, 1 mgm. diphosphopyridine nucleotide an 0·10 mgm. œstradiol-16-^{14}C (2 μc./mgm.) were place in each flask and incubated at 37° C. under oxyge for 2½ hr. After incubation, 0·15 gm. metaphosphori acid, 0·5 gm. 'Celite' and 3 gm. sodium chloride wer added to each flask. 10·0 mgm. of carrier, eithe œstrone or œstriol, was then added.

The œstrogens were isolated from an ether extrac by the paper chromatographic procedure of Mitchel and Davies[5]. The area which contained the sampl and which corresponded to authentic œstradiol œstrone or œstriol was cut out and extracted wit alcohol. This alcoholic extract was evaporated t dryness in planchets, weighed and assayed fo specific radioactivity.

Table 1. OXIDATION OF ŒSTRADIOL-^{14}C BY VARIOUS TISSUES

System		Œstrogen recovered (range (counts/min.)/mgm.)	
		Œstrone	Œstriol
Ovary	Slice	4,970–6,139	187–203
	Homogenate	5,130–7,100	87–130
Testis	Slice	3,470	0–4
	Homogenate	4,150	0–4
Liver, male, homogenate		6,350–7,800	20–88
Kidney, male, homogenate		335	—
Muscle, male, homogenate		245	0–18
Serum		30–60	20–84
Blank		20–38	30–37

Liver, ovary and testis preparations, in this order are highly active in converting œstradiol to œstrone kidney and muscle preparations are less active. Th conversion to œstriol occurs in ovarian preparations and to a lesser degree in preparations of liver. Ther is no or negligible conversion in pooled female-bloo serum. The homogenates were as active or perhap slightly more active than comparable tissue-slic preparations.

The incorporation of acetate-^{14}C into œstradiol b tissue preparations of dog ovary prior to its incorporation into œstrone[6] is consistent with the concep that œstradiol is the œstrogen primarily synthesize in the ovary, and that œstrone and œstriol are the formed by oxidation.

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Pseudo-cholinesterase in Rat Erythrocytes

Although there are many references in the literature to the existence of different types of cholinesterase in mammalian sera[1], it is generally believed that human red cells contain only one type[2]. Furthermore, we can find no evidence in the literature for the existence of a pseudo-cholinesterase in any mammalian erythrocytes, although many workers have stated that benzoylcholine is hydrolysed by red cells. Since, however, the rate of hydrolysis is slow, this breakdown of a substrate formerly presumed to be specific for pseudo-cholinesterase has been attributed to true cholinesterase. Indeed, Adams[3] has shown that purified true cholinesterase does hydrolyse benzoylcholine, at a rate which would account for such observations. In spite of this, some results obtained by Fraser with benzoylcholine[4] imply the existence of more than one type of cholinesterase in red cells.

Experiments which we have recently carried out on erythrocytes twice washed with 0·9 per cent sodium chloride demonstrate quite clearly the existence of a true and pseudo-cholinesterase in rat red cells. The latter differ markedly from human erythrocytes in that they hydrolyse butyrylcholine as rapidly as acetylcholine (Table 1).

Table 1. Relative Rates of Hydrolysis of Choline Esters by Rat and Human Red Cells

	Acetylcholine	Acetyl-β-methylcholine	Butyrylcholine	Propionylcholine
Rat	100	85	101	79
Human	100	78	10	63

This hydrolysis of butyrylcholine can be suppressed by tetra*iso*propylpyrophosphoramide at a concentration (2×10^{-4} *M*) which does not inhibit the hydrolysis of acetyl-β-methylcholine to any marked extent. Tetra*iso*propylpyrophosphoramide is an inhibitor which has been shown[5] to be specific for pseudo-cholinesterase. 1 : 5 - bis - (4′trimethylammonium-phenyl)pentan-3-one diiodide (62*C*47 Wellcome), a specific inhibitor of true cholinesterase[6], at 7×10^{-5} *M* inhibits the hydrolysis of acetyl-β-methylcholine but not of butyrylcholine.

Table 2. Inhibition of Hydrolysis of Choline Esters by Rat Red Cells in the Presence of Inhibitors of True and Pseudo-cholinesterase

Inhibitor	Per cent inhibition (calculated from the ratio of hydrolysis-rate in the presence, and absence, of inhibitor for the given substrate)			
	Acetyl-choline	Acetyl-β-methylcholine	Butyryl-choline	Propionyl-choline
Tetra*iso*propylpyro-phosphoramide	20	15	100	30
62*C*47	92	97	0	45

We have insufficient evidence to enable us to draw any definite conclusions concerning the nature and source of the pseudo-enzyme. For example, we cannot say whether it is similar to, or derived from, the serum enzyme. It is certainly firmly attached to the cells, since it cannot be easily washed off. All the experiments quoted were done on pooled erythrocytes of male rats; hence the presence of this enzyme in female red cells has yet to be established. The precise type of pseudo-cholinesterase, too, is a matter for speculation. The almost complete lack of activity towards benzoylcholine makes it most unlikely that it is a benzoylcholinesterase[7], and the low propionylcholine to acetylcholine ratio of 0·8 would appear to rule out the possibility of a propiono-cholinesterase such as that found in rat heart[8], and which has a corresponding value of approximately 2·3. On the basis of its substrate ratio, it is possible that it may be a butyro-cholinesterase.

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Receptor Occupancy and Tissue Response

One of the cornerstones of all quantitative applications of classical receptor theory has been the postulate that the response of a given organ or tissue is proportional to the number of receptors occupied by the activating agent, and that the maximal response occurs when all receptors are occupied. Although never proved experimentally, and perhaps *a priori* somewhat unlikely in view of the complex nature of tissue responses, this relationship is necessary if agonist dose – response curves are to be explained in terms of mass-action equilibria, and it provides the basis for differentiating reversible competitive from non-competitive or irreversible inhibition. Basic formulations applying mass-action considerations to the differentiation of types of inhibition are those of Gaddum[1], applied largely to tissue and organ responses, and of Linweaver and Burke[2], which have been applied both to relatively simple enzyme systems and to complex responses of tissues and of intact animals.

In general, use of the Linweaver–Burke equations to evaluate data obtained from studies on enzyme systems has proved satisfactory. However, some fundamental error in the application of these equations to data obtained from experiments on intact animals or isolated tissues is suggested by reports which classify the β-haloalkylamines (dibenamine congeners) as reversible competitive blocking agents on this basis[3]. Except at high concentrations of the inhibitor, data for the blockade of responses to adrenaline or histamine by these agents are typical of reversible competitive inhibition when plotted by either of the methods mentioned above. This observation conflicts with several lines of evidence which indicate that the blockade, although it is ‘competitive’ in the sense that the agonist and the antagonist react with the same receptors, is predominantly irreversible because of a stable bonding of the inhibitor to some tissue constituent in the area of the receptor[4].

Two types of experiments have been combined in the present study to provide a possible explanation for the above discrepancy. Isolated strips of guinea pig ileum were exposed to *GD*-121 (*SY*-14, *J*10; N-1-naphthylmethyl-N-ethyl-β-chloroethylamine) for 5 min., and the degree of blockade of the isotonic

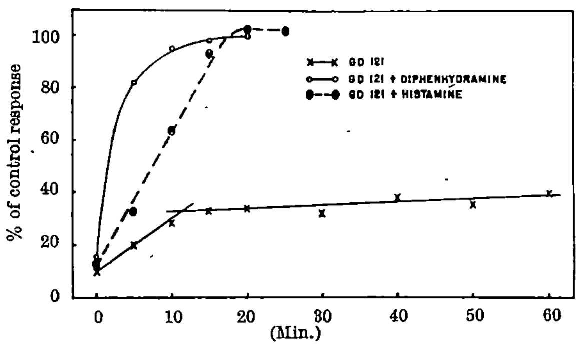

Fig. 1

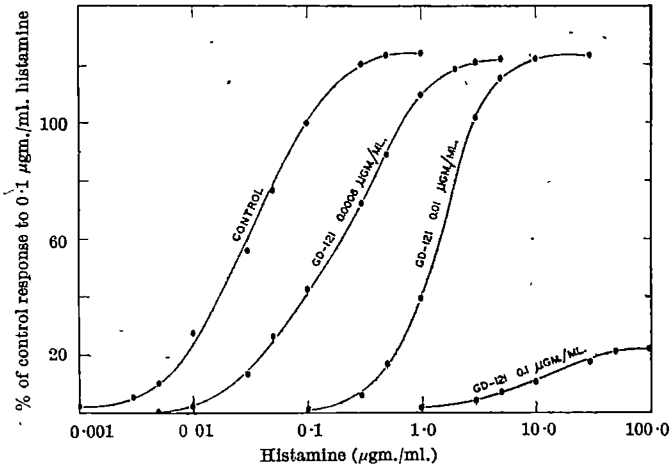

Fig. 2

response to a standard dose of histamine (0·1 μgm./ml.) was then determined in the presence of the inhibitor and after successive washes at 5- and 10-min. intervals. As shown in Fig. 1, a minor portion of the blockade was readily reversible; but the blockade remaining after 10 min. was essentially irreversible to washing. Some experiments were continued for as long as 8 hr. without a significant change in the slope of this line. As shown in the figure, histamine or diphenhydramine (benadryl) introduced prior to the *GD*-121 prevented the development of irreversible blockade, indicating that all three agents react with the same receptors. On the basis of these experiments, it may be concluded that in tissue treated with *GD*-121, a portion of the specific histamine receptors are inactivated essentially irreversibly, providing a relatively long period during which responses of a tissue with a reduced number of free receptors can be studied.

Histamine dose – response curves were then determined on untreated ileum and on segments exposed to varying concentrations of *GD*-121 and washed to remove blocking agent not irreversibly bound. The response of each preparation to a standard dose of 0·1 μgm./ml. of histamine prior to blockade was arbitrarily designated as 100 to facilitate compilation of results. In both figures, each point represents the average of six to ten separate determinations. It was found (Fig. 2) that the histamine dose – response curve could be shifted at least 2 log units along the agonist dose axis by low concentrations of *GD*-121 without changing either its slope or asymptote significantly[5]. Higher concentrations of *GD*-121 decreased both. These curves, except that on the extreme right, are characteristic of reversible competitive antagonism when plotted according to the equations of either Gaddum or Linweaver and Burke—an interpretation obviously incompatible with the results of the preceding experiments.

These observations can best be explained by assuming that receptor occupancy is not the limiting factor in the tissue activation, and that occupancy of only about 1 per cent of the histamine receptors is adequate to produce a maximal response. As the total number of free receptors is progressively decreased by irreversible combination with blocking agent, larger concentrations of agonist are required to provide the receptor occupancy necessary for any given response. Ultimately, the total number of free receptors is reduced below that required for a maximal response even when they are saturated by a very high concentration of agonist. This formulation explains why classical dose – response plots erroneously indicate reversible competitive antagonism at low, and irreversible or non-competitive antagonism at high, concentrations of a β-haloalkylamine. It does not necessarily imply that responses are not proportional to the number of receptors occupied over most of the response range. However, the evidence that receptor occupancy is not necessarily the limiting factor in determining the magnitude of a tissue response suggests that all theoretical deductions from mass-action analyses of dose – response curves should be accepted with caution.

This investigation was supported by grants-in-aid from the Canadian National Research Council and the Smith, Kline and French Laboratories.

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Ammonia Production in the Collecting Ducts of Mammalian Kidneys

COMPARED with other parts of the nephron, the cells of the collecting ducts are morphologically conspicuous by the absence of any particular differentiation. This has led to the assumption that their function is exclusively mechanical, that is, to convey the urine from the distal part of the nephron to the renal pelvis. Physiologists have not been able to assign any active cellular function to this part of the nephron though Glimstedt[1] and Wirz[2] presented convincing evidence for its importance in water reabsorption and we have suggested[3] that back-diffusion of ammonia might occur in this segment. Both these functions are presumably of physico-chemical nature and independent of cellular activity.

In good agreement with this morphological and physiological undifferentiation are the results of biochemical investigations. Dickens and Weil-Malherbe[4]

Table 1

	Dog				Rabbit			
	No.	Cortex	Medulla		No.	Cortex	Medulla	
			Outer	Inner			Outer	Inner
Dry weight in % of wet weight	6	24	22	18	4	25	21	17
Glutaminase I*	6	1·86	0·35	0·52	4	0·08	0·04	0·13
Glutamine-α-keto acid transamination–deamidation system*	6	0·17	0·06	0	4	0·01	0·02	0
Glutamine synthesis†	6	0·04	0·01	0	4	0·09	0·01	0
Weight in % of kidney	3			15	4			11
Total glutaminase I/animal in μM ammonia/minute	3			66	4			0·21
Maximal ammonia excretion in μM ammonia/minute‡	6	50–75			7	0·08–0·35		

* In μM ammonia liberated by 100 mgm. wet weight per minute
† In μM ammonia taken up by 100 mgm. wet weight per minute
‡ In acute metabolic acidosis following infusion of 0·1 N hydrochloric acid

showed that renal medulla is one of the few adult mammalian tissues having a high aerobic glycolysis. Weil and Jennings[5], using the Linderstrøm-Lang technique, provided evidence that the collecting ducts are almost devoid of cathepsin, dipeptidase, amino polypeptidase, esterase and amylase. Histochemical studies have indicated the lack of active SH-groups, glycerophosphate dehydrogenase, adenosine triphosphatase, glucose-6-phosphatase, alkaline and acid phosphatase, lipase, esterase and succinic dehydrogenase in the lower part of the collecting ducts[6]. These studies, especially the observation of high glycolysis, indicate a low level of biochemical differentiation.

During investigations of the ammonia excretion in different mammalian species[3], it was observed that under different experimental conditions ammonia excretion correlated particularly well with glutaminase I activity of the kidney. To localize this enzyme, kidneys of different species were dissected into cortex, outer medulla and inner medulla and each part analysed using histological and biochemical methods. In this report the results of the analyses of two species, dog and rabbit, as representatives of animals with very high and very low ammonia excretion are presented (Table 1).

Determination of the dry weight of the different parts of the kidney showed marked differences, the cortex giving the highest, the papilla the lowest values. Such an analysis makes it very simple to check the quality of the dissection. The activities of glutaminase I [7], the transamination–deamidation system[7] and glutamine synthesis[7] were measured in homogenates of different parts of the kidney under optimal conditions[8].

Glutamine synthesis from glutamic acid, ammonia and adenosine triphosphate in the presence of magnesium and at a pH of 7·5 was found to be largely a function of the cortex. The renal transamination–deamidation system which liberates ammonia from glutamine in the presence of α-keto acids is optimal at pH 8·8. This enzyme system was localized primarily in the cortex of the dog and in the outer medulla and cortex of the rabbit. It may well be that these two systems participate in the process of amino-acid reabsorption.

Glutaminase I, a phosphate-activated enzyme with an optimal pH of 7·5, was observed in all parts of the kidney, though most of the activity was present either in the cortex or the papilla. The concentration of the enzyme in the inner medulla was conspicuous, since histological examination revealed only collecting and papillary ducts in these samples. It is therefore highly probable that enzymatic ammonia production occurs in this part of the nephron.

The total amount of papillary glutaminase I activity of the examined species was calculated by multiplying the weight of the inner medulla or papilla by the enzyme activity in a number of animals. As shown in Table 1 the total enzyme activity of this particular renal segment, containing exclusively collecting and papillary ducts, is sufficient to account for the maximal ammonia excretion observed in these species under acid stimulation. Various other correlations were tried, such as the total glutaminase I activity and the difference between glutaminase I activity and glutamine synthesis, but there was poor correlation with *in vivo* ammonia excretion.

It is well known that enzyme concentration is rarely a limiting factor for *in vivo* activity of biocatalytic systems; but, on the other hand, substrate or co-factor availability, intracellular pH and activators or inhibitors determine the rates of *in vitro* biochemical reactions[9]. Our observations seem to indicate that in ammonia excretion under maximal stimulation enzyme concentration may become limiting. This particular system offers the opportunity for the study of biocatalytic rate limitation by enzyme concentration.

These comparative enzymological and physiological studies suggest that enzymatic ammonia production for excretion in the mammalian kidney is a function of the collecting duct system. This was suggested by the micropuncture studies of Walker[10] in the frog, where the highest ammonia concentrations were found in the collecting ducts and ureters. Corroborative evidence is also supplied by clinical studies. Albright *et al.*[11] observed a patient with severe calcification of the renal pyramids who had deficient ammonia and acid secretion. The same metabolic defect was reported by Baines *et al.*[12] in a patient with extensive calcification of the pelvis and the pyramids but histologically intact tubular cells. Since hydrogen ion secretion is probably a function of the distal tubule[13], a separate anatomical localization of these two important mechanisms of acid secretion is highly probable and may explain th dissociation of these two tubular functions observed under certain pathological conditions. Oliveira[14] found a normal ammonia excretion but defective hydrogen-ion production in two patients with tubular necrosis. The same defect is frequently observed in the de Toni–Fanconi syndrome[15]. The opposite defect, normal acid excretion but impaired ammonia secretion, has been reported to occur in another renal disease of children with organic aciduria, hydrophthalmos, mental retardation and symptomatic rickets[16].

This work was supported by a grant *RG*-3795 from the National Institutes of Health, United States Public Health Service.

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Catalase Production by Lactobacilli

Lactobacilli are considered to be catalase-negative[1], or occasionally to produce very small amounts of catalase[2]. The lactobacilli isolated from dairy products have always been found to be catalase-negative[3,4]. During recent work on the microflora of Cheddar cheese, we have encountered strains of lactobacilli which possess both strong and weak catalase activity. Three strains of *Lactobacillus plantarum*, originally isolated by Sherwood[3] from New Zealand Cheddar cheese, were found to be catalase-positive. Two of the strains gave strong catalase reactions whereas the other strain was much weaker (see Table 1). Serological[5] and physiological[6] tests have shown that these latter organisms are typical strains of *L. plantarum*.

Production of catalase was detected by streaking the cultures on to the following agar media: (1) tomato juice, dextrose of Briggs[7]; (2) lactose, yeast, phosphate of Hunter[8]; and (3) yeast, tryptone, glucose of Felton, Evans and Niven[9]. The plates were incubated anaerobically at 30° for two or three days, and then either flooded with 5 ml. of a 3 per cent hydrogen peroxide solution (10 vol.) or the growth was washed off with 0·5 ml. of sterile distilled water and 0·5 ml. peroxide added, and then observed for the appearance of oxygen evolution. The effect of composition of the medium upon the production of catalase by the three strains of *L. plantarum* is shown in Table 1.

Table 1. CATALASE PRODUCTION BY LACTOBACILLI ON DIFFERENT MEDIA

Strain No.	Medium 1 (2 per cent glucose)	Medium 2 (2 per cent lactose)	Medium 2 (0·5 per cent glucose)	Medium 3 (0 05 per cent glucose)
1 1	++	++	+++	+++
3 1	–	–	+	+
4·3	+	++	+++	+++
Control plates (uninoculated)	–	–	–	–
Staph. aureus *A* 227				++++

Catalase production was much increased when the strains were grown on a medium with a low glucose content, as Felton, Evans and Niven[9] found also with the *Pediococci*.

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Staining Properties of the Golgi Zone of the Shell Gland of the Dogfish

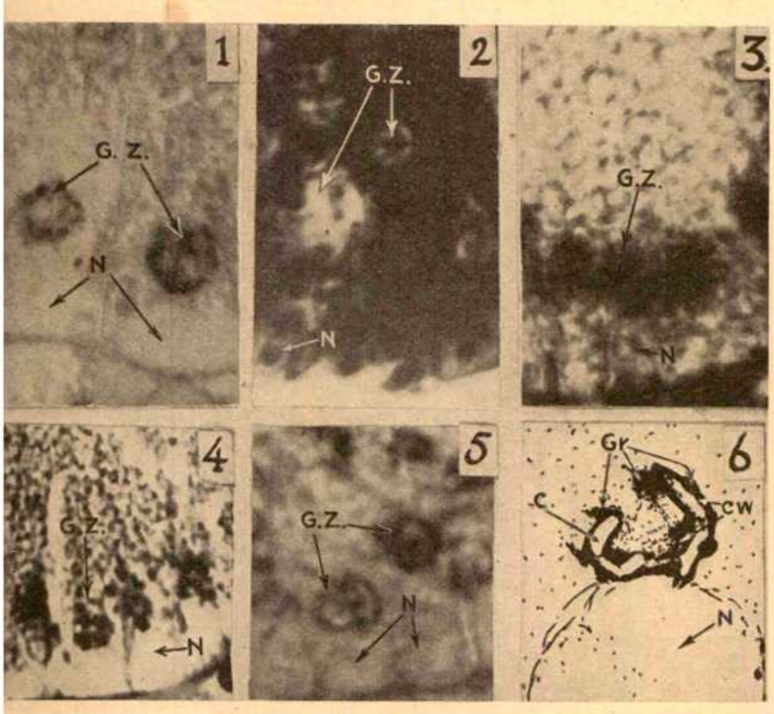
During research on the histochemistry of the shell gland of the dogfish, *Scyliorhinus caniculus*, some interesting reactions of the Golgi zone of the secretory cells have been observed.

In such material prepared according to Aoyama's silver technique, an oval or horse-shoe-shaped structure, either solid or with an argentophil exterior and an argentophobe interior, was visible in the Golgi zone (Fig. 1). In sections fixed in Regaud's fluid and afterwards postchromed, the secretory granules stained intensely with Heidenhain's hæmatoxylin, and an unstained circular or horse-shoe-shaped area was present in the Golgi zone above the nucleus (Fig. 2). Sections prepared in a similar manner and stained with sudan black showed a well-marked but diffuse zone without structural detail (Fig. 3).

In sections of the gland fixed in Bouin's fluid and stained with aniline blue (dilute, in 90 per cent alcohol) two diverse results were obtained. In some of the secretory cells a number of solid blue granules in size and appearance similar to the secretory granules contained within these cells, were localized in the Golgi region (Fig. 4). In other instances, however, such localized granules were absent, and in their place a diffuse zone similar to that shown by sudan black was clearly visible.

Finally, it was observed that gland tissue fixed in 70 per cent alcohol and afterwards stained with aniline blue in 90 per cent alcohol, after treatment with catechol[2], also demonstrated the presence of a

Golgi zone throughout the gland. This zone consisted of a circular or horse-shoe-shaped unstained canal (*c*, Fig. 6), with blue-stained walls (*c.w.*, Fig. 6), in contact with which were a number of dark blue granules (*g.r.*, Fig. 6).



(1), (2) and (5), × 1,200. (3) and (4), × 400. (6) Diagrammatic drawing of Golgi zone in Fig. 5.
G.Z., Golgi zone; *N*, nucleus; *c*, Golgi canal; *c.w.*, Golgi canal walls; *g.r.*, granules in contact with the Golgi canal walls

Of the above observations the most interesting is the constant staining, as opposed to metallic impregnation, of the Golgi zone with aniline blue, after treatment, either of whole tissues or sections, with catechol. That the resulting appearance of the Golgi region after such staining is identical with that revealed by the silver technique is surely not without significance, and lends support to the classical view of the morphology of this cell organoid. The constituent parts of the Golgi zone of these secretory cells, that is, the blue-stained walls bounding the unstained vacuoles, would appear to correspond respectively to the areas of double membranes and of vacuoles which have been shown by electron microscope studies to make up the Golgi region of other cells[1]. At present the action of the catechol in this technique is not understood; but it seems reasonable to assume that it acts on the protein part of the Golgi region, either as a mordant or by unmasking it so that it becomes 'stainable'.

Further research, with the object of standardizing this technique in its application to both invertebrate and vertebrate cells, is continuing, and it is hoped that the results will be published elsewhere.

I wish to thank Prof. R. A. R. Gresson for help and advice during this work.

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A Toxic Lipid from the Surface of *Corynebacterium ovis*

WE have been studying the pathogenic properties of *Corynebacterium ovis*, a diphtheroid bacillus which causes the well-known and widespread disease of sheep known as caseous lymphadenitis. Natural infection takes the form of an initial suppurative inflammation of skin wounds. This is followed in about 20 per cent of cases by chronic metastatic abscesses in the regional lymph nodes. In most cases the infection in sheep does not progress any further; but occasionally *C. ovis* escapes from lymph node lesions to give rise to further abscess formation in lungs, spleen, liver and other visceral organs. The guinea pig is readily infected experimentally, but in contrast to the sheep is far less resistant to progressive extension of these pyogenic lesions and dies in eight to twelve weeks with abscesses in various internal organs.

When grown in liquid media, *C. ovis* produces an exotoxin possessing hæmolytic and lethal properties for the sheep, guinea pig and rabbit, the *LD*50 for guinea pigs of 250 gm. by subcutaneous injection being of the order of 0·1–0·005 ml. The exotoxin, or its formol-toxoid, is a good antigen, eliciting the production of a specific antitoxin which readily neutralizes toxin *in vivo* and *in vitro*.

In contrast with *C. diphtheriae*, in natural infection by *C. ovis* there is no evidence of acute intoxication, and antitoxin appears to play little or no part in protecting against infection. The great majority of experimental animals, both guinea pigs and sheep, in which high levels of antitoxin have been induced either actively or passively, are still readily infected with very small doses of live organisms (for example, 15 bacilli in guinea pigs by subcutaneous inoculation).

Phagocytosis of *C. ovis* by leucocytes of both sheep and guinea pigs occurs rapidly *in vivo* and *in vitro*. Leucocytes which have engulfed small numbers of *C. ovis* and are then maintained under tissue culture conditions undergo rapid degeneration and die.

In seeking the mechanism of this injurious action of engulfed organisms on leucocytes, we have found that a light extraction of live *C. ovis* with petrol ether removes a lipid without impairing the viability of the organism on ordinary culture media. This lipid extract is a wax-like substance with interesting toxic properties. It is insoluble in water; but when dissolved in either liquid paraffin or sterile guinea pig fat and injected intradermally in guinea pigs or rabbits, it produces a marked reaction characterized by swelling, congestion and, at the higher dose-rates, a central zone of hæmorrhagic necrosis which afterwards sloughs out. This reaction is not influenced by prior inoculation of the guinea pig with large doses of antitoxin, which specifically neutralizes exotoxin. We have also found that this lipid, dissolved in either liquid paraffin or sterile guinea pig fat, or absorbed on small particles of activated charcoal, when phagocyted by leucocytes, is followed by characteristic degenerative changes and death of the latter. On the other hand, doses of up to 500 mgm. of lipid in liquid paraffin inoculated intraperitoneally in guinea pigs produced no evidence of general systemic toxic effects.

There are obvious similarities between this toxic lipid of *C. ovis* and the surface lipoid component ('cord factor') of the virulent tubercle bacillus recently reported by Bloch and others[1], which, in addition to having toxic properties, appears to be closely concerned with the mechanism of the immunological response to the tubercle bacillus[2]. In contrast with the reported toxicity of 'cord factor', which produces death with pulmonary hæmorrhages in mice two to three weeks after intraperitoneal injection, *C. ovis* lipid has a local toxic action which appears within twenty-four hours after intradermal injection, leucocytes are especially vulnerable and no delayed systemic toxic effects have been observed in guinea pigs.

A detailed account of this work, including chemical and immunological studies at present in progress, will be published elsewhere.

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Occurrence of New *Salmonella* Types from South Africa

UPON bacteriological examination of day-old chicks imported by air from the Union of South Africa and found dead on arrival at Elizabethville, the following types of *Salmonella* were detected by culturing the bone marrow of fourteen of them on the usual media: 2 strains of *S. saint paul* (4,5,12 : *e,h* : 1,2); 1 strain of *S. vejle* (3,10 : *e,h* : 1,2); 1 strain of *Salmonella* unidentified, probably *S. newport* (6,8 : *e,h* : 1,2) rough.

Salmonella saint paul and *S. vejle* seem never to have been isolated in South Africa[1-3]. A few strains of *S. newport* have been isolated by Henning[2], one from a human being and another from a duck.

In the Belgian Congo, *S. saint paul* has only been isolated from human stools (7 strains)[4]. *S. vejle* has been isolated only once from a native child's stools[4]. *S. newport* is well known and has been isolated several times from human material and from horse and goat[5-7].

In East Africa, between 1948 and 1953, Mackey[8] isolated in Dar es Salaam 3 strains of *S. saint paul*, all from human origin; none of *S. vejle* and 11 strains of *S. newport* (9 from humans and 2 from lizards).

We might thus consider that *S. saint paul* and *S. vejle* are new for South Africa.

This is also their first isolation from animals in the Belgian Congo, and the fact that they were found in imported chickens is one more hint on the complex epizootology of salmonellosis in animals.

We acknowledge with gratitude the co-operation of Dr. Joan Taylor, director of the Salmonella Reference Laboratory, Colindale Avenue, London, to whom all these strains were sent for identification.

J. DEOM

Veterinary Laboratory,
Elisabethville,
Belgian Congo.
March 23.

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Influence of Nutritional State on the Heat Tolerance of Cattle

ON completion of an experiment in which two differently fed groups of cattle were used for studying the effect of low nutrition on seasonal changes in the hair coat, opportunity was also taken to make observations on the heat tolerance of the animals. The results of these latter observations are reported here.

On April 20, 1955, eight poll shorthorn heifers aged 6–8 months and weighing an average of 351 lb. were randomly divided into two groups of four animals each. One group, kept on clean straw bedding, was fed liberally, calf meal (18 per cent crude protein) being supplied at the rate of 2 lb. per animal per day together with as much lucerne hay as the animals would consume. On this ration, individuals of the group increased to an average of 672 lb. weight by February 28, 1956. The feed of the other group was restricted as necessary to maintain constant weight of the individuals over the same period. They were bedded on sawdust and received meal at the rate of 4 oz. per animal per day, one-quarter the amount of lucerne hay supplied to the well-fed group and less straw than sufficient to satisfy appetite. Both groups received vitamin supplement in the form of a commercial preparation of fish liver oil.

On February 28, 1956, immediately following their usual morning feed, the eight heifers were subjected to a heat tolerance test in a psychometric room. The duration of the test was three hours unless an animal's rectal temperature reached 107° F., in which case the individual was withdrawn. The room temperature during exposure was 105° F. dry bulb and 92° F. wet bulb. Rectal temperatures were taken at the end of each hour, and each animal's heat tolerance coefficient was calculated from its rectal temperature at the end of the test, using Rhoad's[1] formula:

$$\text{Heat tol. coeff.} = 100 - 10\,(\text{rect. temp.} - 101)$$

The mean heat tolerance coefficient of the fat, well-fed group was 43; that of the thin, poorly fed group 55. The difference of 12 between the group means is highly significant ($P = 0{\cdot}01$) and reflects the greater heat tolerance of the thin animals. This was also evidenced by their relative freedom from drooling, their calmer breathing and less anxious state at the end of the test.

Following this test, the poorly fed group was placed on the liberal ration, whereas no feed at all was allowed the well-nourished group. These feeding conditions obtained for the post-test period of February 28, for all of February 29 and for the morning of

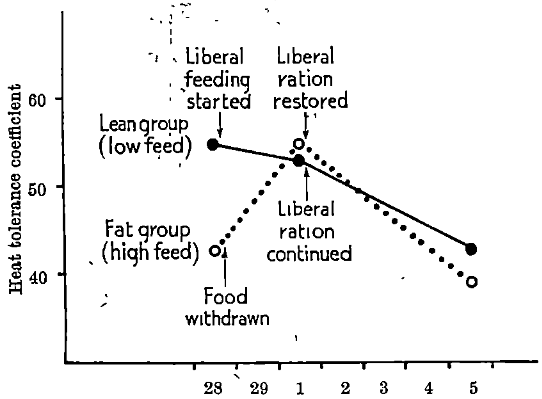

Fig. 1. Influence of the current rate of feeding on the heat tolerance of two groups of cattle reared on different planes of nutrition

arch 1, when the heat-tolerance test was repeated. his time the heat tolerance of both groups was good nd the difference between the mean of the fat group 55) and the mean of the thin group (53) was not tatistically significant. The notable result was the 2-point improvement in heat tolerance of the fat nimals.

After this test, both groups were placed on the iberal ration until a third heat-tolerance test was onducted four days later, on March 5. This time oth groups showed poor heat tolerance. The mean eat-tolerance coefficients were 39 and 43 for the fat nd thin groups, respectively, the difference not being tatistically significant.

The results, presented graphically in Fig. 1, show hat high condition is not in itself a disadvantage to attle in withstanding heat. A high current rate of eeding, however, in either fat or poor cattle may, nder hot conditions, add seriously to the heat load f the animals. This is similar to the conclusion eached for hens, sheep and pigs by Robinson and ee[2], who also reported that the proportion of protein ontained in the diet was without effect on the heat olerance of these three species.

The present experiment also showed that, following hange to the liberal ration, the heat tolerance of the nder-nourished animals was still high two days after he change, but was low by the sixth day. The lag s probably a reflexion of the time required for the igestive tract of cattle to condition itself to assimilating and utilizing more and better feed, following long period of restriction.

These results emphasize, *inter alia*, the importance f standard feeding routine when seasonal or other eriodic heat tolerance tests are to be made.

The environmental studies of which this experiment orms a part are being conducted at the Physiology epartment, University of Queensland, and, as an fficer of the Division of Animal Health and Production, Commonwealth Scientific and Industrial esearch Organization, I am grateful to Prof. W. V. Macfarlane for his co-operation and help.

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Commonwealth Scientific and
ndustrial Research Organization,
and
Physiology Department,
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Brisbane. May 8.

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Identification of *Pseudomonas pyocyanea* by the Oxidase Reaction

Although the identification of *Pseudomonas pyocyanea* is generally very simple, the diagnosis of 'atypical' strains may take several days, and, as Schaub and Foley[1] stress, "its identification may present a problem". Yow and Townsend[2], in their study on the sensitivity of *Ps. pyocyanea* to various antibiotics, limit the scope of their examinations: "Because of the difficulty in positively identifying the non-pigment-producing strains of Pseudomonas, only those producing either pyocyanin, fluorescin, or both, were included in this study". However, apyocyanogenic strains are common. These strains are either primarily deficient in producing pigment or may have lost their ability to do so. Haynes[3] therefore points out: "Strains not producing pyocyanin, from whatever source, cannot be dismissed from consideration as Ps. pyocyanea."

Already Gordon and McLeod[4] have observed that *Ps. pyocyanea*, besides other bacteria, gives a positive oxidase reaction although much less markedly than the Neisserias.

I have increased the sensitivity of the oxidase reaction by the following technique. A piece of Whatman's No. 1 filter paper, about 6 cm. square, is laid in a Petri dish. Two to three drops of 1 per cent tetramethyl*para*phenylenediamine dihydrochloride solution is dropped on the centre of the paper. The suspect colony is removed with a platinum rod and is smeared thoroughly on to the reagent-impregnated filter paper in a line 3–6 mm. long. If the reaction is positive, the transferred colony turns dark purple in 5–10 sec. The reagent should be prepared every two weeks and kept in a dark, glass-stoppered dropping bottle in the refrigerator.

All 436 *Ps. pyocyanea* strains examined gave a positive oxidase reaction with the technique described, while the other common Gram-negative rods are oxidase negative. The oxidase reaction can be used as a simple, rapid screening test in the diagnosis of *Ps. pyocyanea*.

Detailed investigations on the confirmatory test for *Ps. pyocyanea* will be published elsewhere.

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May 1.

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Structure of the Ascidian *Octacnemus* Moseley

The tunicate family Octacnemidae contains two genera, *Octacnemus* Moseley and *Polyoctacnemus* Ihle, and four species, all from great oceanic depths. The species have been described by Moseley[1], Herdman[2], Metcalf[3], Ritter[4], and Madsen[5]; but their structure is peculiar and has never been satisfactorily related to that of other tunicates.

Octacnemus, the better-known genus, has in particular the following characters not found in other tunicates: (1) a crown of eight large triangular lobes on the upper side, (2) an upper and a lower cavity between the test and the body proper, (3) a 'horizontal membrane' separating these two cavities and extending out into the eight lobes. The organs of the body are less peculiar; but the pharynx is much modified, having only a few imperforate branchial stigmata or none at all. The nature of the crown of lobes has never been satisfactorily explained, and the upper and lower cavities between the test and the body have generally been taken to represent the expanded cavity of the oral siphon and the modified atrial cavity respectively (Ihle[6], Madsen[5], Brien[7]). Ritter[4], however, maintained that at least the upper cavity is an artefact.

I have recently been able to examine a single specimen of *Octacnemus bythius* Moseley, taken in 1952 by the Danish Deep Sea Expedition from 2,700 metres in the Kermadec Deep. The specimen showed the well-known features of the species; but dissection revealed the presence of a true atrial cavity agreeing in position with that of unmodified ascidians—that is, dorsal to the pharynx—although in *Octacnemus* it is too small to envelop the sides of the pharynx. The partition between the atrial cavity and the pharynx is perforated by a few small openings, but it is uncertain if these represent modified branchial stigmata. There is a short tubular atrial siphon, the outer end of which has been torn away from the test. The atrial siphon is evidently the structure described and illustrated by Moseley as the rectum; the true rectum opens within the base of the atrial siphon as in other ascidians.

The crown of eight lobes and the corresponding prolongations of the 'horizontal membrane' represent, with little doubt, the greatly developed lobes of the oral siphon. The position of the lobes around the opening to the pharynx, their number, the relation of their circular and longitudinal muscles, and the presence of test on both faces of the lobes all point to this conclusion. The 'horizontal membrane' is simply the expanded and opened-out base of the oral siphon.

The Octacnemidae are therefore true, although much modified, ascidians, since the crown and 'horizontal membrane' are the enlarged oral siphon, a true atrial cavity and atrial siphon exist, and the upper and lower cavities between test and body may be artefacts produced at death. The number of oral lobes and the arrangement of the gonads indicate that the family belongs to the sub-class Enterogona, probably having been evolved from an ancestral form rather like *Ciona*.

A fuller account of this work is being published elsewhere.

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May 23.

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Hand-rearing of Rabbits

Rabbits that were completely free of coccidia infection were desired for experimental purposes. It appeared to be impossible to obtain such rabbits by normal breeding methods, as infection, usually very mild, occurred during contact with the doe in the nest. It was therefore decided to try to hand-rear rabbits which had been removed from the doe at birth.

The expression of milk from the doe was found to be impractical, so cow's milk was used. The protein content of rabbit milk is approximately 10 per cent, whereas that of the cow is 4 per cent, and therefore in order to increase the protein, calcium caseinate was added at the level of 15 gm. to 10 oz. of cow's milk. After several attempts it was found that this mixture could be used until the animals were seven days old, when it was necessary to increase the amount of calcium caseinate to 17 gm. for 10 oz. cow's milk and at fourteen days old the level of calcium caseinate was further increased to 20 gm. This level was maintained until the young rabbits were able to eat fresh green food when about four weeks old, at which time they were weaned. Fig. 1 shows the weight curves for the hand-reared animals and their litter mates still with the doe.

The calcium caseinate did not dissolve freely in the cow's milk unless the whole was beaten with an egg whisk. This mixture would keep for several days in a refrigerator. The milk mixture was warmed by placing it in the feeding bottles and immersing them in a cup containing warm water.

As delivery of the milk was not satisfactory with a pipette, feeding bottles with rubber teats as used for dolls were obtained. After making a hole in the end of the teat, the only difficulty encountered was the over-anxiousness of the young rabbit to obtain its milk; and a little practice was necessary in order to insert the teat satisfactorily between the tongue and upper jaw of the animal. The rapidity with which the milk was consumed did not appear to affect the animal adversely. Sufficient was judged to have been given when the rabbit would take no more, despite a rest of a few minutes.

The feeds were given approximately every three hours, the last feed being at midnight and the first

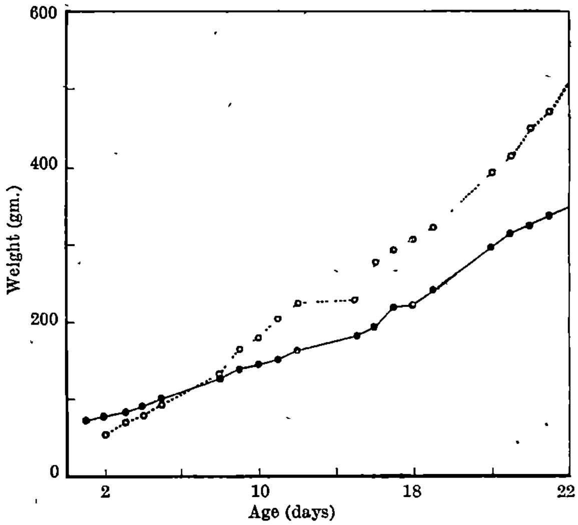

Fig. 1. ●—●—, Hand-reared; ○ -- ○--, naturally reared

at 5–6 a.m. The animals were transported in a box ined with hay and cotton-wool and care was taken o ensure that they were at all times kept warm.

One danger that was met was the accidental nhalation of some of the milk, which caused a fatal pneumonia. Another hazard was an enteritis which was successfully treated with intramuscular injections of chloramphenicol.

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I. MACDONALD

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May 23.

Insecticide Resistance in *Anopheles gambiae* Giles

THE appearance of *Anopheles gambiae* resistant to dieldrin only eighteen months after this insecticide was first used in a malaria control pilot project in Northern Nigeria has recently been reported[1]. It was calculated to be some eight times as resistant as a susceptible strain of the same species maintained at the Ross Institute of Tropical Hygiene, London[2].

Through the courtesy of Dr. L. J. Bruce-Chwatt, malariologist, Government of Nigeria, eggs of the esistant *A. gambiae* were dispatched to the Ross nstitute, and this strain has now been successfully olonized. This successful dispatch of viable eggs from such an out-of-the-way part of Africa was in tself a major achievement. Colonization proved a elatively simple matter, in fact much more simple than the colonization of a susceptible strain of the ame species from Lagos. This latter colony was tarted in 1951 and has been maintained in London ver since[3].

The two strains of the same species have now been ompared for their susceptibilities to a range of nsecticides using the technique described by Busvine n an annex to the Fifth Report of the World Health Organization Expert Committee on Malaria[4]. This echnique involves the exposure of mosquitoes to lter paper impregnated with various concentrations f insecticides in Risella oil for 1 hr. and recording mortalities 24 hr. later. Table 1 records the median lethal concentrations of various insecticides after this -hr. exposure. The resistant strain was so highly esistant to dieldrin and aldrin that even 4 per cent olutions of these insecticides (a percentage nearing aturation in the case of dieldrin) failed to give any kill after exposure for 1 hr. This strain was, however, usceptible to DDT, pyrethrins and malathion. The slight difference in median lethal concentration of the two latter insecticides for the two strains is thought merely to be a reflexion of the difference in size and vigour generally of the resistant strain. The Northern Nigeria strain was some twenty-six times as resistant to gamma-BHC as the Lagos strain.

able 1. Median lethal concentrations (percentages in Risella oil or live oil) of various insecticides when susceptible and resistant strains f *Anopheles gambiae* are exposed for one hour. (Numbers of female mosquitoes tested at concentrations giving more than 0 and less than 100 per cent mortalities are given in brackets)

Insecticide	Lagos strain (susceptible)	Ambursa strain (resistant)
Pyrethrins	0·4 (138)	0·8 (302)
DDT	0·6 (201)	0·6 (97)
Malathion*	0 8 (60)	1·4 (50)
Gamma-BHC	0·007 (177)	0·18 (62)
Dieldrin	0·08 (831)	no kill at 4 per cent
Aldrin	0 2 (142)	no kill at 4 per cent

* In solution in olive oil.

Table 2. Percentage mortalities among susceptible and resistant *Anopheles gambiae* exposed for 5 hr. to various concentrations of insecticides. (Numbers of female mosquitoes tested are given in brackets)

Percentage concentration of insecticide in Risella oil	Dieldrin	Aldrin	Isodrin	Endrin	Alpha-chlordane	Beta-chlordane
	Susceptible strain					
0 001	4 (50)	6 (38)				
0 01	81 (52)	15 (35)	32 (63)	14 (43)		
0 05			64 (47)	64 (44)		
Check	5 (20)	0 (18)	8 (39)	8 (39)		
	Resistant strain					
2 0			11 (19)	5 (21)		
4 0	10 (70)	2 (57)	65 (82)	76 (80)	0 (21)	
5 0						0 (22)
8·0			79 (42)			
10·0					0 (20)	
Check	0 (46)	0 (18)	3 (76)	3 (76)	0 (24)	0 (24)

To ascertain the degree of resistance to other insecticides, the exposure time had to be increased, and this necessitated decreases in concentrations for the susceptible strain. Table 2 summarizes mortalities 24 hr. after 5-hr. exposures to dieldrin, aldrin, isodrin, endrin, alpha-chlordane and beta-chlordane and shows the resistant strain to be some 140 times as resistant to isodrin and some 90 times to endrin as the Lagos strain. These results also show the resistant strain to be at least 400 times as resistant to dieldrin; but kills with the other three insecticides were still too small to indicate the degrees of resistance.

Exposures of 18 hr. were then resorted to, but this brought in the complication of check mortalities; these were eventually reduced to almost zero by exposing the mosquitoes in open-ended tubes, the ends being covered with mosquito netting. Table 3 compares the mortalities after 18-hr. exposures of the susceptible and resistant strains to dieldrin, aldrin, alpha-chlordane and beta-chlordane. The resistant strain is some 800 times as resistant to dieldrin and some 400 times to aldrin. Kills were again too low with alpha- and beta-chlordane to assess the degrees of resistance, which must be more than 1,000 in the case of alpha- and more than 500 in the case of beta-chlordane.

These results show a remarkably high degree of resistance to dieldrin and related compounds in the Northern Nigeria strain, a degree much higher than that recorded on the spot[1]. It is suggested that in the

Table 3. Percentage mortalities among susceptible and resistant *Anopheles gambiae* exposed for 18 hr. to various concentrations of insecticides. (Numbers of female mosquitoes tested are given in brackets)

Percentage concentration of insecticide in Risella oil	Dieldrin	Aldrin	Alpha-chlordane	Beta-chlordane
	Susceptible strain			
0·001	24 (104)	14 (59)	37 (59)	24 (82)
0 005	65 (61)			
0·01	98 (63)	24 (25)	40 (62)	55 (84)
Check	3 (93)	1 (72)	7 (68)	7 (88)
	Resistant strain			
4·0	70 (140)	24 (131)	0 (21)	
5·0				8 (131)
10·0			19 (119)	
Check	7 (97)	7 (98)	7 (122)	7 (122)

susceptibility tests made in Nigeria itself a mixed population of susceptible and resistant mosquitoes was used. This is borne out by the fact that significant kills were produced by an exposure of only 1 hr. to dosages of dieldrin considerably less than 4 per cent, even as low as 0·5 per cent. The eggs sent on three separate occasions to London may also have been mixed susceptible and resistant strains; but only a small percentage survived the journey. It is suggested that these were the highly resistant individuals; in other words, the journey by air has resulted in a selection of only the most vigorous mosquitoes, which are at the same time the ones highly resistant to insecticides.

Cross-resistance to the related chlorinated hydrocarbons, aldrin, alpha- and beta-chlordane, isodrin, endrin and gamma-BHC, has previously been commented on by Busvine[5] and Metcalf[6]. Busvine places these insecticides in the following order from the degrees of resistance shown by houseflies: alpha-chlordane (highest), beta-chlordane, aldrin, dieldrin, gamma-BHC, isodrin and endrin (lowest). With the resistant *A. gambiae* the order would appear to be: alpha-chlordane (highest), beta-chlordane, dieldrin, aldrin, isodrin, endrin and gamma-BHC (lowest).

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Keppel Street,
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A High Frequency of Heterozygous Diploids and Somatic Recombination produced by Ultra-violet Light in Imperfect Fungi

PONTECORVO and his co-workers[1] have demonstrated that, by the use of appropriate selection techniques, heterozygous diploids can be secured from heterocaryons of *Aspergillus nidulans*. Further, these diploids produced, on cultivation, recombinants by both somatic crossing-over[2] and somatic reduction. Later, similar results were obtained with the asexual strains, *Aspergillus niger*[3] and *Penicillium chrysogenum*[4]. I have succeeded in producing heterozygous diploids in the asexual fungi *A. sojae* and *A. oryzae* by the use of similar methods. These diploids also showed somatic segregation and yielded recombinations of the original genotypes. First-order segregations showed further segregation upon cultivation. Only a few segregants have been analysed and all proved to be still diploid in having double the haploid amount of deoxyribonucleic acid per nucleus. Their occurrence can be explained by the same type of somatic crossing-over as that discussed by Pontecorvo[5] and originally discovered by Stern[6].

The frequency of spontaneously arising somatic diploid nuclei in *A. sojae* is about 10^{-7}, or the same as that in *A. niger* and *A. nidulans*. In all three fungi, camphor increased this frequency to about 10^{-6}. It was further found that the frequency of heterozygous diploids in *A. sojae* could be raised to more than 10^{-2} by ultra-violet light.

When conidia of a heterocaryon between yellow-leucineless and albino-histidineless mutants of *A. sojae* were exposed to ultra-violet light until only about 1 per cent survived and were then plated on complete medium, 2–9 per cent of the survivors formed green colonies which were also prototrophic and diploid. Similar results were obtained with other heterocaryons and with one between yellow-methionineless and albino-leucineless mutants of *A. oryzae*. This great increase in diploidization was not simply due to the selective survival of diploid nuclei which were spontaneously present, as the relation between a survival of 10^{-2} and the increase from 10^{-7} to 10^{-2} in the frequency of diploids clearly shows; there was an absolute increase in the numbers of diploids.

Ultra-violet light was also active in stimulating somatic segregation in these diploids. When conidia from a green diploid colony were irradiated with different doses, there was a progressive decrease, from 9 to 75 per cent, in the green colonies formed upon plating. Correspondingly, there was an increase in the frequency of albino, yellow and sectored segregants. This phenomenon may be similar to that observed by James[7] with heterozygous diploid yeast.

The use of ultra-violet light to produce an extraordinarily high frequency of heterozygous diploids in asexual fungi should make feasible an analysis of their mode of origin and their subsequent behaviour and should also greatly facilitate the production of new and improved strains for industrial use.

The results of this investigation will be published in detail and in English in the *Journal of General and Applied Microbiology*.

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Division of Microbial Genetics,
Institute of Applied Microbiology,
University of Tokyo.

April 28.

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"Polyploidy in Bluebells"

J. YANNEY WILSON has recently given an account of polyploidy in bluebells (*Endymion non-scriptus* and *E. hispanicus*)[1]. There are some errors in this paper which it is desirable to correct. The "extraordinarily large forms" to which reference is made have not been determined by me as hybrids. Apparently the author has misunderstood the excellent coloured figures in the *Botanical Magazine*, N.S., 176 (1952). The central figure is of *Endymion hispanicus* the left-hand one is of *E. non-scriptus*, and the right-hand one is of the putative hybrid. Further, the impression is given that Mr. Yanney Wilson examined my material cytologically; but he has not done so and I have not had the opportunity of studying his plants taxonomically.

W. B. TURRILL

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Kew.

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FORTHCOMING EVENTS

(*Meeting marked with an asterisk * is open to the public*)

Monday, October 1

Society of Engineers (in the Apartments of the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. K. J. Frost: "The Calder Hall Nuclear Power Station".

Tuesday, October 2

Institution of Civil Engineers (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. A. J. Harris: "Prestressed Concrete Runways: History, Practice and Theory".

Tuesday, October 2—Thursday, October 4

Department of Scientific and Industrial Research, Chemical Research Laboratory (at Teddington, Middlesex)—Open Days

Tuesday, October 2—Wednesday, October 10

Fuel Efficiency Exhibition (at Olympia, London, W.14).*

Wednesday, October 3

Technical Meetings to discuss "The Efficient Use of Fuel in Industry". (Further meetings on October 4, 9, and 10.)

Wednesday, October 3

Institute of Petroleum (at 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. J. B. Capdeville: "The Le Havre–Paris Pipeline".

Society for Analytical Chemistry (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Meeting on "Chromatography". Mr. W. H. C. Shaw, Mr. J. P. Jefferies and Mr. T. E. Holt. "The Determination of Vitamin D and Related Compounds. Part I: Introduction and Preparation of Compounds in the Irradiation Series. Part II: Analysis of Irradiation Products"; Dr. A. S. Curry: "Some Examples of the Use of Paper Chromatography in Toxicological Analysis".

Thursday, October 4

Bone and Tooth Society (at the Institute of Orthopædics, 234 Great Portland Street, London, W.1), at 5 p.m.—Symposium on "Tissue Culture and the Induction of Bone and Connective Tissues". Prof. J. J. Pritchard: "Bone and Cartilage Induction in the Rabbit, Rat and Guinea Pig"; Lady May Mellanby and Mr. P. J. Holloway: "Tissue Culture as a Tool in Dental Research"; Dr. J. D. Biggers: "Studies in the Cultivation of Embryonic Bones in Chemically Defined Media"; Mrs. Shirley Hughes: "Experimental Embryology of Teeth".

Institution of Civil Engineers (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Prof. W. R. Jones: "Mineral Resources". (First of a series of six lectures on "The Conservation of Natural Resources.")

Institution of Electrical Engineers (at Savoy Place, London, W.C.2), at 5.30 p.m.—Sir Gordon Radley: Inaugural Address as President.

Friday, October 5

Society of Chemical Industry, London Section (at 14 Belgrave Square, London, S.W.1), at 6.30 p.m.—Sir Charles Dodds, F.R.S: "Application of Chemical Analysis to Medical Diagnosis and Treatment". (Chairman's Address.)

Society of Chemical Industry, Fine Chemicals Group (joint meeting with the Microbiology Group, at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 7 p.m.—Prof. A. Neuberger, F.R.S.: "Some Uses of Isotopes in Biochemistry".

Saturday, October 6

Association of Clinical Biochemists (joint meeting with the Association of Clinical Pathologists, at the Royal College of Surgeons, Lincoln's Inn Fields, London, W.C.2), at 9.30 a.m.—Scientific Papers and a Symposium on "Biochemical Lesions: Keto-Acid Metabolism and the Citric Acid Cycle".

Nutrition Society, and Laboratory Animals Bureau (at Guy's Hospital Medical School, St. Thomas Street, London, S.E.1), at 10.40 a.m.—Joint Symposium on "The Nutrition of Laboratory Animals".

British Interplanetary Society (in the York Hall, Caxton Hall, Caxton Street, London, S.W.1), at 6 p.m.—Prof. H. S. W. Massey, F.R.S: "The Study of the High Atmosphere in the International Geophysical Year".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant, Grade B (with an honours degree in chemistry, and preferably experience in industry, teaching or research), to teach organic and inorganic chemistry—The Principal, Wigan and District Mining and Technical College, Wigan (October 5).

Senior Lecturer in Radiology at University College, Ibadan, Nigeria—The Secretary, Senate Committee on Colleges Overseas in Special Relation, University of London, Senate House, London, W.C.1 (October 5).

Assistant Lecturer (medically qualified) in the Department of Physiology—The Registrar, The University, Liverpool (October 6).

Chair of Agriculture in the University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (October 9).

Lecturer or Assistant Lecturer in Physics—The Registrar, The University, Hull (October 13)

Assistant Lecturer in Mathematics—The Registrar, University College of North Staffordshire, Keele, Staffs (October 15)

Lecturer in Mechanical Engineering Design—The Secretary of University Court, The University, Glasgow (October 17).

Assistant Lecturer (with special interests in the field of historical geography) in Geography—The Registrar, University College, Singleton Park, Swansea (October 20).

Lecturer in (*a*) Physical Geography and (*b*) Economic Geography at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (October 20).

Lecturer in Pure Mathematics—The Secretary, Queen's University, Belfast (October 20).

Lecturer (with a degree or diploma or equivalent qualifications, and preferably previous lecturing experience) in Zoology at the New South Wales University of Technology, Sydney, Australia—The Agent-General for New South Wales, 56 Strand, London, W.C.2; and The Bursar, New South Wales University of Technology, Box 1, Post Office, Kensington, N.S.W., Australia, marking envelope "University Appointment" (October 26).

Lecturer/Senior Lecturer in Applied Mathematics at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, October 2[illegible]).

Chair of Education in the University of Adelaide, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, October 31).

Lecturer in Physical Metallurgy at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, October 31).

Lecturer or Assistant Lecturer in Geology at the University of Malaya—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (October 31).

Senior Lecturer (with a degree in engineering and practical experience in applied hydraulic work) in Civil Engineering (Hydraulics) at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, October 31).

Senior Lecturer (with a degree in veterinary medicine or an honours degree in science or agricultural science) in Animal Husbandry at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (October 31).

University Demonstrator in Biochemistry—Prof. H. A. Krebs, Department of Biochemistry, South Parks Road, Oxford (October 31).

Biologist (with a recognized university degree, with honours, or equivalent qualification, for which an adequate study of biology or zoology was necessary)—The Secretary, The Salmon Research Trust of Ireland Incorporated, St. James's Gate, Dublin (November 1).

Nuclear Technologist (with an honours degree in physics or engineering, and experience in nuclear engineering, reactor technology, and instrumentation) at the Central Electricity Authorities' Research Laboratories at Leatherhead, to deal with problems likely to arise in the operation of reactors in nuclear power stations—The Director of Establishments, Central Electricity Authority, Winsley Street, London, W.1, quoting Ref. E./884 (November 12).

Chair of Physics in the University of Khartoum—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (November 30).

Biochemist (with a first- or second-class honours degree in biochemistry or equivalent qualification, and postgraduate research experience) to study the chemical properties of cervical mucus in relation to the action of sex hormones—The Secretary, National Institute for Research in Dairying, Shinfield, Reading.

Biochemist (with a good honours degree in biochemistry) at the Government Tea Research Station, Mlanje, to conduct research on the fermentation of tea—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD 63/4/018.

Botanist (with at least a second-class honours degree in botany) to undertake taxonomic botanical work at Kew and the British Museum (Natural History) and possibly periods of field work in Africa, in connexion with the preparation of a Flora of Rhodesia—The Director of Recruitment, Colonial Office, London, S.W.1, quoting RES.134/1/02.

Chief Research Chemist (with a Ph.D. degree in biochemistry and some successful experience in an organized research programme) in the Saskatchewan Department of Public Health, to supervise the biochemical aspects of psychiatric research in Saskatchewan—The Public Service Commission, Legislative Building, Regina, Saskatchewan, quoting Ref. No. 4356.

Chief Technician or Senior Technician to take charge of Hydrogen Liquefaction Plant—The Steward, Physics Department. The University, Edgbaston, Birmingham 15.

Cyclotron Engineer or Physicist (graduate in light electrical engineering)—The Senior Cyclotron Engineer, Medical Research Council, Hammersmith Hospital, Ducane Road, London, W.12.

Head (graduate of a British university and good experience in teaching and in industry) of the Department of Electrical Engineering and Physics—Clerk to the Governing Body, Borough Polytechnic, Borough Road, London, S.E.1.

Head of the Microbiology Department—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire.

Lecturer (science graduate, preferably in microbiology, and with experience in dairy technology)—The Principal, National College of Food Technology, Cranwood Street, City Road, London, E.C.1.

LECTURERS (with an engineering or science degree, preferably lecturing experience, and a specialist knowledge of either electrical engineering or electronics, or servo-mechanisms) AT THE R.E.M.E. TRAINING CENTRE, Arborfield—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.387/6A.

PALÆONTOLOGIST (with a first- or good second-class honours degree in geology and at least six years postgraduate work in palæontology, and a fair knowledge of micropalæontology) with the Government of Cyprus Geological Survey, to identify fossils and microfauna in order to determine the age of sedimentary formations, and to assist in the mapping of fossiliferous formations—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.105/17/03.

RADIATION CHEMIST (with a Ph.D. or equivalent qualifications, and several years experience in the radiation chemistry of aqueous systems and solution reaction kinetics) in the Defence Research Chemical Laboratories, Ottawa, Canada—Defence Research Member, Canadian Joint Staff, Moncorvo House, 66 Ennismore Gardens, London, S.W.7.

RESEARCH ASSISTANT (graduate in biochemistry or chemistry) IN THE DEPARTMENT OF CLINICAL PATHOLOGY—The Administrator and Secretary, University College Hospital, Gower Street, London, W.C.1.

SENIOR RESEARCH ASSISTANT (with a good honours degree in metallurgy or physics, practical experience and/or research training) IN THE FACULTY OF APPLIED SCIENCE, to work in the field of creep and fatigue of ferrous materials—The Registrar, The University, Nottingham.

TECHNICAL OFFICER (with good practical experience, and preferably a degree or diploma in agriculture) FOR CEREAL MULTIPLICATION—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Food Manufacturing Industries Research Association. Ninth Annual Report and Accounts, 1955. Pp. 36. (Leatherhead: British Food Manufacturing Industries Research Association, 1956.) [177

National Institute of Agricultural Botany. Thirty-Sixth Report and Accounts, 1955. Pp. 54. (Cambridge: National Institute of Agricultural Botany, 1956.) [177

Department of Scientific and Industrial Research. Report of the Fuel Research Board with the Report of the Director of Fuel Research for the year 1955. Pp. vi+70+8 plates. (London: H.M. Stationery Office, 1956.) 4*s*. net. [177

Institute of Personnel Management. Occasional Papers. No. 10: Employment of Coloured Workers in the Birmingham Area. By Leslie Stephens. (Report of an enquiry initiated by the Birmingham Christian Social Council and undertaken by the Race Relations Group of Fircroft College, Birmingham.) Pp 30. (London: Institute of Personnel Management, 1956.) 3*s*. 6*d*. [177

Publications of the Thoresby Society. Kirkstall Abbey Excavations—Sixth Report, 1955. Pp. 26+2 plates. (Leeds: The Thoresby Society, 1956.) 1*s*. [177

Industrial Diamond Information Bureau. Bibliography of Hardness and Hardness Testing from 1937 to 1955. Pp. iv+118. (London: Industrial Diamond Information Bureau, 1956.) 5*s*. 6*d*. [177

Press Authority Bill (H.L.) Pp. ii+3. (London: H.M. Stationery Office, 1956.) 6*d*. net. [177

Iodine Information. No. 46: Influenza and the Common Cold: Iodine Prophylaxis and Treatment. Pp 16. No. 47: Iodized Minerals. Pp. 24. No. 48: Nutrition of Farm Animals. Pp. 14. (London: Chilean Iodine Educational Bureau, 1956.) [197

The Morgan Crucible Company Limited. Battersea Works 1856–1956. Pp. 67 (3 plates). (London: The Morgan Crucible Company Limited, 1956) [197

Thirty-sixth Annual Report of the Board of the Institute of Physics, 1955. Pp. 18. (London: Institute of Physics, 1956.) [197

Ministry of Agriculture, Fisheries and Food. Bulletin No. 37: Silage. Seventh edition. Pp. iv+58+4 plates. (London: H.M. Stationery Office, 1956.) 3*s*. net. [197

London and Home Counties Regional Advisory Council for Higher Technological Education. Bulletin of Special Courses in Higher Technology, including Management Studies and Commerce, 1956–7. Part 1: Autumn Term 1956. Pp. 82. (London: London and Home Counties Regional Advisory Council for Higher Technological Education, 1956.) 1*s*. 6*d*. [197

Ministry of Housing and Local Government: Department of Health for Scotland. Alkali, etc. Works Regulation Act, 1906, and Alkali etc. Works Orders 1928–1950. Alkali etc. Works Regulation (Scotland) Acts, 1906 and 1951. Ninety-Second Annual Report on Alkali etc. Works by the Chief Inspectors, 1955. Pp. 51. (London: H.M. Stationery Office, 1956.) 2*s*. net. [257

University Grants Committee. Returns from Universities and University Colleges in receipt of Treasury Grant, Academic Year 1954–1955. Pp. 50. (Cmd. 9800.) (London: H.M. Stationery Office, 1956.) 2*s*. 9*d*. net. [257

University of Bristol. Annual Report of the Agricultural and Horticultural Research Station (The National Fruit and Cider Institute), Long Ashton, Bristol, 1955. Pp. 224+12 plates. (Bristol: The University, 1956.) 15*s*. [257

Ministry of Fuel and Power. Dust Prevention and Suppression. Instructional Pamphlet No. 2: Dust Suppression with the Meco-Moore Cutter Loader and the Gloster Getter. By the East Midlands Divisional Committee on Dust Prevention and Suppression. Pp. ii+9. (London: H.M. Stationery Office, 1956.) 1*s*. 3*d*. net. [257

Other Countries

New Zealand Forest Service: Forest Research Institute. Researc Notes. No. 5 (March 1956): Yield of Unthinned Douglas Fir, Corsica Pine, and Ponderosa Pine in New Zealand. By G. Duff. Pp. 40 (Wellington: Government Printer, 1956.) [197

United States Department of Commerce: National Bureau o Standards. Circular No. 571: Electron Physics Tables. By L. Marton C. Marton and W. G. Hall. Pp. i+83. (Washington, D.C.: Government Printing Office, 1956.) 50 cents. [197

U.S. Department of the Interior: Geological Survey. Water-Supply Paper 1287: Surface Water Supply of the United States Part 13: Snake River Basin. Prepared under the direction of J. V. B Wells. Pp. viii+255. 1 dollar. Bulletin 975-E: Geology and Or Deposits of the Atacocha District, Departamento de Pasco, Peru By Robert F. Johnson, Richard W. Lewis, Jr., and Guillermo Abele C Pp. iv+337–388+plates 23–30. 2 dollars. Bulletin 1021-E: Geolog of Comb Ridge and Vicinity North of San Juan River, San Jua County, Utah. By Julian D. Sears. Pp. iv+167–208+plates 17–20 75 cents. Bulletin 1026: Geology of the Bighorn Canyon-Hardi Area, Montana and Wyoming. By Paul W. Richards. Pp. v+94+7 plates. n.p. Bulletin 1027-I: Perlite Resources of the United States. By Marion C. Jaster. Pp. iii+379–404+plate 44. n.p. Professional Paper 273: Geology and Mineral Deposits of the Boleo Copper District, Baja California, Mexico. By Ivan F. Wilson. Pp. vi+134+11 plates. n.p. Professional Paper 282-A: Ephemeral Streams—Hydraulic Factors and Their Relation to the Drainage Net. By Luna B. Leopold and John P. Miller. Pp. iv+37. 45 cents. (Washington, D.C.: Government Printing Office, 1955 and 1956.) [197

Proceedings of the United States National Museum. Vol. 105, No. 3360: The Spongilla-Flies, with Special Reference to Those of the Western Hemisphere (Sisyridae, Neuroptera). By Sophy I. Parfin and Ashley B. Gurbey. Pp. 421–529+3 plates. Vol. 106, No. 3363: A Revision of the Flies of the Genus *Rivellia* (Otitidae, Diptera) of America North of Mexico. By Ryoji Namba. Pp. 21–84. (Washington, D.C.: Smithsonian Institution, United States National Museum, 1956) [277

Metropolitan Life Insurance Company. Statistical Bulletin. Vol 37 (June 1956): Cancer in Midlife. Pp. 12. (New York: Metropolitan Life Insurance Company, 1956.) [277

United States Department of the Interior: Geological Survey. Bulletin 1027-P: Geology of the Murray Area, Shoshone County, Idaho. By John W. Hosterman. Pp. iii+725–748. 1 dollar. Bulletin 1036-F: A Spectrographic Method for Determining the Hafnium-Zirconium Ratio in Zircon. By C. L. Waring and W. H. Worthing. Pp. iii+81–90. 15 cents. (Washington, D.C.: Government Printing Office, 1956.) [277

Bulletin of the Bingham Oceanographic Collection. Vol. 16, Article 1: The Annual Cycle of Phytoplankton in the Labrador Sea, 1950–51. By Robert William Holmes. Pp. 74. (New Haven, Conn.: Peabody Museum of Natural History, Yale University, 1956.) 1.50 dollars. [277

Carnegie Institution of Washington. Publication 552A: The Mutants of Drosophila Melanogaster Classified according to Body Parts Affected. By Norma B. Braver. Pp. v+36. (Washington, D.C.: Carnegie Institution of Washington, 1956.) 0·25 dollars. [277

Australian and New Zealand Association for the Advancement of Science. Report of the Thirtieth Meeting, Canberra, January, 1954. Edited by C S Daley. Pp. x+370. (Sydney: Australian and New Zealand Association for the Advancement of Science, 1955.) [277

Symposium on Structure of Enzymes and Proteins given at the Research Conference for Biology and Medicine of the Atomic Energy Commission, Gatlinburg, Tennessee, April 4–6, 1955. Sponsored by the Biology Division, Oak Ridge National Laboratory. (Reprinted from the *Journal of Cellular and Comparative Physiology*, Vol. 47, Supplement 1, May, 1956.) Pp. vii+294. (Philadelphia: Wistar Institute of Anatomy and Biology, 1956.) [277

Théodore Schwann et les Débuts de la Médecine Scientifique. Par Prof. M. Marcel Florkin. (Les Conférences du Palais de la Découverte, Série D, No. 43.) Pp. 22. (Paris: Université de Paris, 1956.) [277

Mitteilungen des Deutschen Wetterdienstes. No. 15 (Band 3): Berechnung monatlicher Mittelwerte der Gebietsverdunstung nach einer Merhode von Kalweit. Von Siegfried Uhlig. Pp. 30. (Bad Kissingen: Deutschen Wetterdienstes, 1956.) [277

Bulletin of the American Museum of Natural History. Vol. 110, Article 5: On the Original Varieties of Taxonomy and Their Regressions Upon Size in Fishes. By Albert E. Parr. Pp. 369–398. 50 cents. Vol. 110, Article 6: Triassic Metoposaurid Amphibians. By Edwin Harris Colbert and John Imbrie. Pp. 399–452+plates 25–28. 1 dollar. Vol. 111, No. 1: A Monograph of the Ithomiidae (Lepidoptera). By Richard M. Fox. Pp. 1–76+plates 1–9. 1.50 dollars. (New York: American Museum of Natural History, 1956.) [277

Report of the Thirty-first Meeting of the Australian and New Zealand Association for the Advancement of Science, Melbourne, August, 1955—Part 3. (*The Australian Journal of Science*, Vol. 18, No. 5A, May, 1956) Pp. 125–204. (Sydney: Fairway Publications, Pty., Ltd., 1956. Published on behalf of the A.N.Z.A.A.S.) [277

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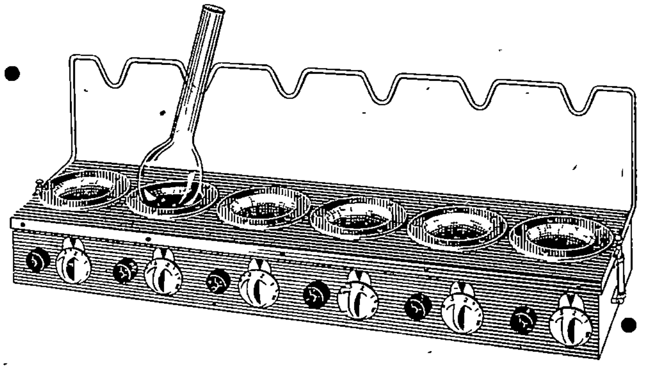

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Further particulars and application forms should be obtained from the Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1. Applications close on October 15, 1956

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ROBT. T HUTCHESON,
Secretary of University Court.

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Technician (female) required to assist in biological research at the Pollards Wood Research Station of the Institute of Cancer Research: Royal Cancer Hospital, at Chalfont St. Giles, Buckinghamshire. Previous experience in cytological or histological techniques is desirable. The post is superannuable and the salary is on a scale in accordance with age and qualifications —Applications, marked "OGF," should be sent to the Secretary, Chester Beatty Research Institute, Fulham Road, London, S.W 3, within a week of the appearance of this advertisement

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Applications, with names of two referees, to the Secretary, N.I.R D., Shinfield, Reading. Quote reference 56/3

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Applications are invited for a post as Assistant Physicist (basic grade) in the Physics Department of the Sheffield National Centre for Radiotherapy. Candidates should have a good honours degree in physics Experience in hospital physics is not essential but experience in electronic and nuclear physics techniques will be an advantage. The successful candidate will assist in the development and research work of the Centre. Salary according to Whitley Council Scales For first- and second-class honours £525 by £25 to £625 (others £475 by £25 to £575) for probationary period Subsequent salary in basic grade £650 by £30 to £740 by £35 to £845 Starting salary will depend on postgraduate experience.

Applications, with names of at least two referees, should be sent to the Secretary, "Broom Cross," Tree Root Walk, Sheffield, 10, and should reach him within twenty-one days of the appearance of this advertisement. Further particulars of the post may be obtained on application to the Secretary

UNIVERSITY OF THE WITWATERSRAND

JOHANNESBURG, SOUTH AFRICA

Applications are invited for appointment to a post of Lecturer in Physical Metallurgy on the staff of the University's Department of Metallurgy. The salary attached to the post will be on the scale £850 by £50 to £1,150 per annum, plus a cost-of-living allowance at the rate of £234 per annum in the case of a married man. Membership of the Provident Fund is compulsory and involves a contribution at the rate of 7 per cent of the salary paid. Membership of the Staff Medical Aid Fund is obligatory in the case of an officer who is found eligible for membership.

Applicants are advised to obtain further information regarding this vacancy from the Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1. Applications close in South Africa and London on October 31, 1956

NOTTINGHAM NO. 1 HOSPITAL MANAGEMENT COMMITTEE

Applications are invited for a post as Assistant Physicist (Basic Grade) in the Physics Department of the Hogarth Radiotherapeutic Centre at the General Hospital, Nottingham Candidates should have a good honours degree in physics. Experience in hospital physics is not essential, but experience in electronics would be an advantage Work in the Centre includes radioactive isotopes, deep, superficial and rotation therapy and radium and radon treatment. Salary according to Whitley Council scales. For first- and second-class honours £525 by £25 to £625 (others £475 by £25 to £575) for probationary period Subsequent salary in basic grade £650 by £30 to £740 by £35 to £845. Starting salary will depend on postgraduate experience

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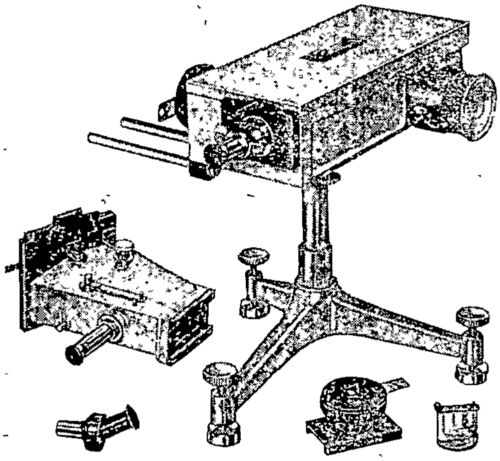

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ATOMIC ENERGY AND THE BALANCE OF SCIENTIFIC EFFORT IN BRITAIN

IN its first annual report, the United Kingdom Atomic Energy Authority set in the forefront its difficulties in recruiting sufficient scientists and technologists to permit the due execution of its civil and military programmes. It recognized that this situation was only one aspect of the national shortage of technological skill. Less is said in its second report (see p. 717 of this issue) about the staff position, though the recruitment difficulties have not entirely disappeared. The problem presents itself rather as one of the distribution of resources of trained man-power or of the balance of research effort in Britain, and this aspect is the more important with the great increase of interest in the development of nuclear energy as a source of power and in the independent activity of industrial firms in the field of nuclear energy which has marked the past year or so.

In view of the importance of the staff position, it is disappointing to find such slight indication in the report of the magnitude of the Authority's demand for skilled man-power. The figures given show that non-industrial staff increased by some 30 per cent during the year and the industrial staff by 13·6 per cent; but we are not told what proportion of the 10,795 non-industrial staff or 13,178 industrial employees represents technicians or what scientists or technologists. Nor, again, does the report give an idea of the magnitude of the research effort for which the Authority is responsible, even of that which is entered as fundamental research to be charged to the Exchequer; though it is true that the chapters of the report dealing with technical developments and research and devolopment as well as reactor technology make it clear how wide and varied are the Authority's demands for scientists and technologists, and the many fields of knowledge which its research programme involves.

Nor is what little is disclosed about the staff position entirely reassuring. Some 88 per cent of the non-industrial staff taken over had accepted offers of employment when the lists were closed in February 1956, and three-quarters of the Civil servants who had decided against joining the Authority's staff had been released by March 31, 1956; 91 per cent of the industrial staff seconded from the Department of Atomic Energy or taken over from other government departments accepted offers of employment with the Authority. Nevertheless, the expansion during the year was only achieved by an intensive recruitment drive, and although this was reasonably successful in the middle and lower ranges of staff, difficulty continued to be experienced, particularly in the engineering field, in filling the more senior posts.

It may be surmised that, with the considerable advance in the removal of security restrictions from information on nuclear energy emphasized in the report, security considerations will be a factor of diminishing importance in recruitment, though such considerations are likely to be relevant in the appointment of senior staff. There has been, indeed, in general an encouraging desire to enter the nuclear energy field, and a fair supply of candidates for senior posts. Only a small proportion, however, were of the high standard required in this pioneering sphere; and, with the increased activity of private industry in nuclear power development, the Authority has lost a small number of experienced staff to firms entering this field. However, unless the Authority continues to act to some extent as a training ground for industry in this field, its demands for scientific and technical man-power might be viewed with more misgiving. When the Lord President of the Council addressed the Parliamentary and Scientific Committee on nuclear energy on June 13, Dr. G. E. Foxwell and Sir Andrew Bryan expressed anxiety as to the effect of the magnitude of the research effort of Britain in the field of nuclear energy on research in other directions; but Lord Salisbury in his reply did not wholly succeed in removing concern as to the balance of research effort.

What is disturbing in the present report is the magnitude of the effort going into the Authority's recruitment campaign. More than 52,000 applications for non-industrial employment were received during the year, and more than 12,000 candidates were interviewed. Even assuming that these figures relate to the total increase (almost 2,500) in such staff, they represent a considerable tax on man-power in themselves, which it should be worth some trouble to reduce or eliminate.

The report shows that the Authority is fully aware of the wider implications of its activities. It is considering what expansion should be made in its training facilities, particularly for scientific and technical staff, in the light of the White Paper on Technical Education. The Authority is, of course, already through its Isotope School, its Reactor School, and its programme of training for staff from the four industrial teams noted in its first annual report, an important source of technical training in this special field. While this can never represent in magnitude more than a minor but important feature of the Authority's activities, the report shows clearly the value of this contribution to the spread of knowledge and technique in this field. Up to and including the first course in 1956, 199 full-time and 100 part-time students have passed through the Reactor School, while, internally, bursaries are awarded to members of the staff for full-time university education; experiments were made with 'sandwich courses' in which training in a technical college alternates with periods of practical experience in the Authority's establishments, and nine graduates were recruited in 1955 to the scheme for postgraduate apprenticeship.

These figures may seem small; but they represent an important consideration to be taken into account against the Authority's demand for trained man-power, if that were known. The Authority's staff has also made important contributions to technological education in universities, polytechnics and technical colleges by assisting with lecture courses in the nuclear sciences; and specialized lectures have been given to learned societies. Apart from the question whether the Authority is yet doing all that is reasonably possible in these directions—and doing it in the most effective way—it should be noted that the remoteness of most of the Authority's establishments has not prevented such work. Moreover, as the magnitude of the sales of radioactive isotopes both by the Radiochemical Centre and the Isotope Division of the Atomic Energy Research Establishment alone shows, the Authority is itself an industrial undertaking on a considerable scale. Its Industrial Group operates factories, and its participation in technical education thus demonstrates the practicability of the co-operation of industry in technical education in the way in which the Minister of Education has suggested.

There is, however, another related factor to be considered in this connexion to which also the present report directs attention. The Reactor School at Harwell is not simply a technical educational institution. It is an important vehicle for the dissemination of information. The development of nuclear energy in the United Kingdom has led to a situation in which the great bulk of the scientific and technical knowledge has been concentrated in the Atomic Energy Authority and, as the report emphasizes, it is imperative that this knowledge be disseminated if industry is to play its full part in exploiting the commercial applications of nuclear energy.

The Reactor School is one such means. Others described in the report include the issue of a monthly list of unclassified documents, copies of which are supplied to seven 'depository' libraries, in which the documents are freely available to the public, and access agreements with individual firms. The Authority is prepared to enter into such agreements on conditions which ensure that the Authority secures some financial return for commercially valuable information or for the use of patents owned by the Authority, and that firms are not enabled to use the Authority's assistance to build up exclusive rights for themselves. The subject-matter to which access is given must be carefully defined, on the basis of a demonstrated 'need to know', and the firm must observe the security precautions specified by the Authority. Access may be by means of receiving classified reports, or by visits to the Authority's establishments, or—more rarely—by the attachment of staff or secondment from firms to the Authority's establishments for defined periods. Although the Authority can only provide limited facilities in this way, more than a hundred scientists and engineers from British firms were attached to the Authority's establishments at the end of the year under appropriate agreements.

These agreements have proved to be advantageous both to the firms and to the Authority, because attached staff have worked as members of the appropriate research teams and have often made substantial contributions to the work of the Authority. The importance of this method of disseminating information is further illustrated by the new industrial projects to which reference is made in the report. The firm of Associated Electrical Industries, Ltd., for example, is to construct the first privately owned reactor in the United Kingdom, for which the Authority will provide enriched fuel elements on loan terms, and it is understood that in addition to using the reactor for its own long-term research in physics and engineering, and for training its own staff, the Company intends to make it available to universities for graduate and postgraduate training in nuclear science and technology. Two new major groups have entered the nuclear field during the year: Vickers Nuclear Engineering, Ltd., formed by Vickers, Ltd., Rolls Royce, Ltd., and Foster Wheeler, Ltd., are considering the application of nuclear energy in marine propulsion, and the Hawker–Siddeley Nuclear Power Co., Ltd., is initially studying the application of liquid-metal-fuelled reactor systems.

In these circumstances, the dissemination of information should be as efficient as possible and should not be impeded by secrecy considerations unless they can be fully justified. The Geneva Conference last year demonstrated that a high price can be paid for secrecy with no advantage in security. This aspect requires continual re-examination, for although the attitude of the Authority as indicated by this report is reassuring, in practice it could easily happen that information remained classified long after there was any sound reason for it being kept secret. The very scale of the operations of the Authority disclosed by this report makes it essential in the national interest that there should be the widest possible discussion of the complex questions involved. Even now the information is not being supplied which will permit realistic and responsible discussion of such issues as the balance of our research effort, the distribution of man-power and the relation of Britain's effort in the development of nuclear energy to her export trade and to the Colonial development and other assistance she is providing to the more backward countries under the Colombo Plan and in other ways.

The Atomic Energy Authority clearly has enlightened views on such matters; but it was scarcely to be expected that its report would throw much light on the relations of Britain to the proposals for closer European co-operation in the nuclear energy field, whether through the Organization for European Economic Co-operation or Euratom. Its judgment, however, as to the development of export trade in nuclear reactors could well be wrong, and while orders from overseas are likely to follow rather than precede the achievement of nuclear power on a competitive basis in Britain, the demand may well represent a significant part of the total value of the engineering industry's exports earlier than the Authority expects. The Authority could easily under-estimate the capacity of the engineering industry for development in a new field, given the nformation and facilities which the industry itself, nd not some outside body, judges to be essential.

It is at this point that the attitude of the Government becomes important. It is known that Britain s reluctant to co-operate fully in the European tomic Agency which the Council of the Organization or European Economic Co-operation decided on uly 18 in Paris to establish. Questioned in the Iouse of Commons on July 31, the Chancellor of he Exchequer said that it is too early to define the xtent of United Kingdom participation in the gency, but that the United Kingdom will play a ull part in the steering committee which is to draft statute for the Agency. From what Sir Edward oyle, Financial Secretary to the Treasury, said in aris, it appears that, while Britain is prepared to lace its technical knowledge and experience at the isposal of the Agency, the Government is nervous f the supra-national authority which the new agency ill probably possess eventually, and reluctant to ommit itself to full participation.

Obviously, co-operation in the field of nuclear nergy has implications for European co-operation enerally, and participation might involve great ifficulties due to commitments in the Commonealth. A negative attitude, however, has its own rawbacks; and although the British Government esitates with reason to participate in the Euratom roject, in which the proposals for a supra-national uclear energy pool may well involve a degree of ontrol over civil and military uses of nuclear energy eyond what Britain could accept, it is nevertheless ssential to give full support to the more limited roject for a nuclear energy agency, the main purpose f which is to facilitate joint undertakings among ember countries. At the least, if the Government not prepared to participate fully, it should give lear and convincing reasons for its reluctance.

The Atomic Energy Authority's second annual eport does nothing to remove the impression that ver the whole field of nuclear energy the Governent is lacking in imagination. This is true no less regard to European co-operation than in regard secrecy. Just as it may well be disastrous to ritain to be left out when European co-operation in he nuclear energy field gets well under way, so lack f imagination in regard to policies of secrecy and egulations could well frustrate the promising developents in industry to which the report refers. The uthority itself is well aware of the importance of nterprise and imagination in activities dependent rgely on experimental science; but that very factor hould emphasize that the Authority is not necesarily the best judge of the worth of an experiment lsewhere, or of the needs of a firm for some particular iece of information.

This is not to suggest that the present organization f the Authority itself is not reasonably sound and dapted to its purpose. So far as can be judged, it ossesses the freedom of operation and the flexibility hich are so important in a field where initiative and xperiment are vital, as well as readiness to modify lans as the tempo of development increases or new ossibilities emerge. It is at the top, or rather outside the Authority, that doubts exist. As Mr. R. Davey Best points out in a survey of the organization of the Authority in *Public Administration*, very large responsibilities are placed on the Lord President of the Council in relation to the Authority; but the Lord President still has only a very small office to enable him to discharge these and other functions. It is here that the Government appears to be lacking in imagination and foresight. As Lord Salisbury himself said in the House of Lords on December 14, 1953, the Lord President is concerned with main questions of policy, and in particular, the balance of use of nuclear material between the needs of defence, power, biology and so on, so as to ensure that the broad needs of government policy and the broad needs of the country are satisfied. He is also generally responsible for the Government's contact with the world of science and technology and is in a position to be impartial between the different users of nuclear material. Lord Salisbury's address to the Parliamentary and Scientific Committee showed how admirably qualified he is for this vital post, that he appreciates fully the need for flexibility and that decision, for example, between the various types of reactor to be selected for nuclear power stations depends on the considerable research experience now being acquired by the Authority, or, again, the importance of public confidence in the experts working in such fields. This very suitability, however, tends to obscure the importance of two points: first, the necessity for the Lord President to be supported by an adequate staff to enable him to discharge adequately and flexibly his heavy responsibilities for promoting a reasonable balance in the research effort of Britain and the supply and distribution of its trained man-power; and secondly, the need for a direct spokesman of his office in the House of Commons. The very reasons that to-day in practice require the Chancellor of the Exchequer to be a member of the House of Commons demand no less insistently that there should be in the House of Commons a member of the Cabinet who can speak directly and from first-hand knowledge on Government decisions and policy in regard to scientific and technical effort, and who can satisfy Parliament that the great opportunities which nuclear energy has brought about are being fully explored and used with vision, enterprise and decision.

THEORY OF FLOWING WATER AND SILT

An Introduction to Fluvial Hydraulics

By Serge Leliavsky. Pp. xii+257. (London: Constable and Co., Ltd., 1955.) 30*s*. net.

THIS short book by a distinguished expert in river hydraulics is an excellent summary of the various theories, methods and facts bearing upon the flow of water in erodible channels, which are themselves the natural creations of this flow. The current which erodes such a channel is in turn controlled by the ever-changing shape of the channel it has eroded; hence, we are faced here with a problem of successive approximation which converges either to the stable or equilibrium channel of canals and some rivers, or to the fluctuating pattern characteristic of meandering rivers and shifting estuarine channels. Much work has been done, and some progress made, with the equilibrium shape of stable channels transporting both water and silt; but the problem of meandering channels under natural conditions has received less attention, and the causes and factors which control the size and sinuosity of the meanders are still a matter of conjecture.

As might be anticipated, in a field in which active investigation is at the moment being pursued and in which new ideas are constantly being put forward and older theories revised, the historical treatment has much to recommend it. This is the treatment followed in the book, and the author has performed a valuable service in directing attention to much that is suggestive and thought-provoking in the works of earlier engineers. In particular, river engineers will be grateful for the exposition of the rationale and art of river training practised by earlier engineers, which are not widely known and which can still be scarcely improved upon. Also, those concerned with hydraulic models of meandering rivers would do well to ponder the criteria for similitude given by earlier workers—it is clear that attention to earlier laboratory results would have rendered unnecessary a good deal of later experimentation on similar lines.

The basic property of fluvial hydraulics calling for study is the capacity of flowing water to transport from place to place solid particles of greater density than the water itself. In reviewing the numerous attempts at this problem, two distinct lines of inquiry can be traced. While French, German and American research aimed at finding the forces and other mechanical factors acting on the particles individually and so coming eventually to an explanation of the behaviour of the system, the second school, including mainly Anglo-Indian and some Austrian engineers, attempted a study of the macroscopic properties of the system under the simplest conditions—that is, in 'silt-stable' canals and rivers, which neither silted nor scoured over a long period of years. By measuring the dimensions and discharges of such channels, they derived empirical formulæ, correlating the capacity of the stream to transport silt and sand with its main hydraulic characteristics. These formulæ were then used for the design of new canals and proved reasonably satisfactory. While it may appear that the second school cannot achieve great depth of insight into the basic mechanism of transport, it is nevertheless a fact that thus far it is this school which has provided the engineer with reliable design criteria. In fact, although several interesting and possibly significant attempts at practical solutions have been produced by the first school, none of them has yet achieved as wide and universal recognition as those of the second school.

The usual treatment of particle transport by a stream recognizes three different modes of movement: rolling and sliding along the bed; saltation or motion in short hops; and suspension. Unfortunately, the movement of particles along the bed of a stream is complicated by the presence of small-scale ripples as well as the large-scale dunes and shoals. These occur over a wide range of flow conditions in Nature, their size depending on the size of the bed material as well as the hydraulic factors. So far, very little progress has been made with a detailed explanation of the reason for the existence of such ripples. The tendenc in the theories and analyses which have been frame to express bed movement has been either to leav rippling out of account or to force it into the background by incorporating disposable factors the valu of which must be determined by experiment. This lack of an adequate theory of rippling also has adverse repercussions on the investigations of saltation an suspension. For the material travelling in this wa has been taken from the bed by eddies generated b the ripples which may take particles directly int suspension in the manner of a whirlwind or, b sweeping them from the crests of the ripples, start them into saltation. It is perhaps significant that the existing theory of turbulent suspension become obscure and unsatisfactory near the bed, wher ripples become a dominant feature. There is n doubt that, whatever progress may be achieved i the future in this branch of physical science, our knowledge will remain incomplete and empirical s long as this particular phenomenon remains unexplained in terms of mechanical theory.

G. H. Lean

FROTH FLOTATION OF MINERALS

Principles of Flotation

By Dr. K. L. Sutherland and Dr. I. W. Wark. Pp
xv+489. (Melbourne: Australasian Institute o
Mining and Metallurgy (Inc.), 1955.) n.p.

THIS is a revised and enlarged edition of Dr. I. W. Wark's "Principles of Flotation" published i 1938. It is to be welcomed, for there have bee considerable advances in the knowledge of th principles of froth flotation of minerals during th past twenty years; and during that period the process of froth flotation has been used much mor extensively than before in mineral processing. Sutherland and Wark and their co-workers hav made noteworthy contributions to our knowledge o flotation; it is inevitable that they should dra freely on their own results and on those of the colleagues. Their results, many of which are given in detail, are carefully discussed and compared wit those of other workers; and, although it is not th intention of the book to deal with the technology of flotation, the bearing of the results on the practic of flotation is made clear.

The flotation process is influenced by many variab factors; indeed, a froth flotation cell in operation presents a very complex system because of the inte actions between certain of the variables, some o which cannot readily be controlled by the operato In their book, Sutherland and Wark deal with som of the important factors, but they are chiefly concerned with the action of the four groups of flotation reagents—collectors, frothers, activators and depressants—and the underlying principles of their roles in flotation. The most important chapters are concerned with the variables of flotation, physica principles, adsorption, experimental methods, flotation of sulphide minerals by collectors of the xanthat type, depressants, activation, joint effect of depressan and activator, flotation of superficially oxidize sulphide minerals, paraffin chain salts as collector (about one-quarter of the book); kinetics of th flotation process, colloids and slimes in flotatio electrical properties of surfaces in relation to flotatio and frothing. The text is supported by a bibli raphy of nearly six hundred references ; this is not, nd is not intended to be, exhaustive, but each eference mentioned is touched on in the text. It ndicates the careful consideration given by the uthors to available results.

It should be emphasized that this book is concerned vith principles and not with practice. There are no escriptions of flotation machines or flotation plants, lthough certain types of machine are referred to n the chapter on kinetics. The treatment of many pecific minerals by froth flotation is mentioned, but t is surprising that the froth flotation of coal, which s becoming more and more important in the preparaion of coal, is not mentioned (except incidentally in onnexion with the adhesion of bubble to mineral).

The book is well written and well produced. There re few errors or misprints, but the error in definition f Reynolds's number given at the foot of p. 363 hould not have escaped detection when the proofs vere checked. The indexes are very good. This is n outstanding book, not suitable for the beginner ut of considerable value to the advanced student, he research worker and the inquiring operator of the otation process and, not least, to the teacher.

S. G. WARD

THE POLAR AURORA

he Polar Aurora

y Prof. Carl Størmer. (International Monographs n Radio.) Pp. xvii+403+34 plates. (Oxford: larendon Press; London: Oxford University ress, 1955.) 55*s*. net.

IT would be presumptuous to attempt to 'review' the present volume by Prof. Carl Størmer on the olar aurora—a field of study which he has truly ade his own. At an advanced age he has collected ogether in book form the greater part of his esearches on the observations and interpretation of he aurora. Everyone interested in this fascinating henomenon will be greatly indebted to him, not nly because, as he reminds us in the preface, his ong series of papers on the subject is difficult to btain in complete form, but also because of the nvaluable and extensive theoretical investigations hich the book contains.

On several occasions Prof. Størmer has related how is interests were diverted from the field of pure athematics by the striking experiments carried out y his compatriot Birkeland on the deflexion of athode rays in the field of a uniformly magnetized phere. His great mathematical skill served him well n discussing the idealized, but nevertheless difficult roblem of the motion of a charged particle in the eld of a magnetic dipole with which he sought to lustrate the results of Birkeland's experiments. he great variety of orbits possible, beautifully illusrated by many plates in the book, is testimony to he infinite patience of the man who pursued the aborious calculations involved. These theoretical nvestigations, which form the second part of the ook, were primarily intended as a contribution to he corpuscular theory of the aurora in the form roposed by Birkeland. The trajectories derived by tørmer indeed showed many analogies with the orms of the aurora, and though the neglect of the utual interaction between the corpuscles in the tream makes the bearing on auroral theory uncerain, it is most gratifying that the theory has found a secure place in the interpretation of the global incidence of cosmic rays.

The first part of the book is concerned with the observation, forms, height measurement and spectroscopy of the aurora and also with its close connexion with geomagnetism. Our present knowledge about the position of the aurora in space is indeed almost entirely due to the photographic measurements of Størmer and Vegard ; the methods used as well as the results they obtained are extensively described, as are also the geographical distribution and the methods of observing and photographing the aurora. Here will also be found an account of Størmer's important discovery of sunlit auroræ and of their intensity and colour. Other chapters are devoted to the auroral spectrum, auroral radio wave emission and radio echoes from the aurora. The author also considers such questions as the possibility of the existence of electrical currents outside the Earth's atmosphere, reviews the spectroscopic evidence for a solar corpuscular stream between the Sun and the Earth and considers the absorption of corpuscular radiation in the atmosphere and the emission of electric corpuscles from the Sun.

Though the accent in the theoretical parts lies on the Birkeland–Størmer theory of the aurora, brief accounts of other theories are given ; and perhaps because in this field one is too apt to indulge in speculations, Prof. Størmer has kept almost entirely to verifiable facts. Thus, though it is generally believed that magnetic storms and auroræ are due to solar corpuscular streams, the evidence so far has been indirect and not entirely unassailable. The detection of hydrogen lines in the spectrum of the aurora by Vegard, Gartlain and Meinel clearly points to the entry of protons in the atmosphere. Nevertheless, as Størmer seems to imply, definite evidence that these originate from the Sun is perhaps still not definite.

The book is very well produced and the typography excellent.

V. C. A. FERRARO

NUCLEAR POWER ENGINEERING

Thermal Power from Nuclear Reactors

By Dr. A. Stanley and Oliver E. Rodgers. Pp. xiii+229. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1956.) 7.25 dollars; 58*s*. net.

A MECHANICAL engineer, noting the title of this book and reading the introductory remarks on the jacket, might expect to find a work designed to give him an idea of the special difficulties associated with the design of a nuclear power plant. If so, he would be disappointed. He would, perhaps, be surprised to find nearly one-third of it devoted to an elementary treatment of familiar topics such as thermal stress in isotropic elastic solids, laminar and turbulent pipe flow and convective heat transfer. Very little space is devoted to the fundamentals of topics such as thermal stress in non-isotropic and plastic materials, thermal shock, and transient heat transfer, which have increased in importance since the advent of nuclear power, and which are less familiar to the non-nuclear engineer. No literature references to specialist papers are given.

In restricting themselves to fundamentals, the authors have avoided dealing with any particular reactor system. This is a pity, since only by so doing can the real engineering difficulties, the necessity for special materials and the economic incentives for high heat release-rates, be brought out. Although the choice of engineering topics is in question, those chosen are dealt with in a very elegant and satisfying manner. The text is concise and enjoyable, and the layout of the equations admirable.

The chapter on the reactor equations is particularly interesting, since slowing down and diffusion theories are dealt with in an unusual manner. The treatment has the great merit of uniformity and coherence, and teachers of this subject would do well to study it. The approach is direct and does not involve the use of such concepts as laboratory and centre-of-mass reference frames, buckling or reactor Laplacian. Dimensional analysis is applied to yield some interesting parameters, and a section is included on numerical methods. No treatment is given of fine-structure effects in natural or low-enrichment reactors. The value of this chapter to the engineer would be greatly improved if a comparison with experiment were provided.

There are two chapters on kinetics and shielding respectively. In the latter only basic principles are dealt with, and no design information is given.

In general, what has been done has been well done; but the whole book does not, in my opinion, justify the description given on the jacket. If the authors could be persuaded to write a book on reactor theory, expanding the treatment given in the present book, and dealing at greater length with numerical methods, a very useful work would result.

W. MURGATROYD

HUSSERL'S 'FIRST PHILOSOPHY'

Edmund Husserl

Erste Philosophie (1923/24). Erster Teil: Kritische Ideengeschichte. Herausgegeben von Rudolf Boehm. (Husserliana, Band 7.) Pp. xxxiv+468. (The Hague: Martinus Nijhoff; London: B. T. Batsford, Ltd., 1956.) 26.25 guilders; 52*s.* 6*d.*

THIS, the latest addition to the series of 'Husserliana' to be issued from Louvain, is of exceptional importance in that it bridges the gap between 1913, when Husserl's "Ideen" appeared, and 1928, which year witnessed the advent of his "Formalen und transcendentalen Logik". In 1923–24, however, the master had delivered his great course on a 'First Philosophy' at the University of Freiberg-im-Breisgau, and it is the historical content of these lectures which is now before us. His treatment of the classic problem of phenomenological reduction is reserved for the next volume, to be published in due course.

The structure of the present work is tripartite. First comes an examination of the whole field from Plato to Descartes. This is followed by a close scrutiny of the initiation by Locke of an attempt in egology, and of the questions which such studies have generated. Then Husserl traces in minute detail the development of sceptical prototypes of phenomenology by Berkeley and Hume, followed by the rise of dogmatic rationalism. These highly specialized sections are rounded off by a large number of appendixes, together with some subsidiary remarks concerned, for the most part, with textual criticism.

Taking these main divisions in order, Husserl is at great pains to stress (what of course is well known and appreciated historically) the accidental character o the term 'metaphysics', in its Aristotelian setting and to fasten upon 'first philosophy'—which incidentally was very nearly equivalent to theology—as the potent phrase for the gradual build-up toward a conscious phenomenological system in the West The claim to do this is made not only to avoid th vagueness inherent in any structure of metaphysics but also and more positively to establish a disciplin of first philosophy as basic for all science. Thi pattern of thought excludes the possibility of switching over at any period in history from concept which are fundamentally devoid of scientific conten to those of scientific value. In a word, the world o thought must begin how it means to go on. That i has not always consistently done so is probably major factor in the recurrent crises (judgments) i European civilization, each one carrying the risk o a retrogression into barbarism. Yet phenomenolog —as first philosophy—is closer to theology than som of Husserl's followers might always be ready t grant. He speaks of a 'philosophia perennis' in term not altogether different from those of St. Thoma Aquinas.

In considering the period leading on to Locke' stress upon "actions of our own minds", the distinctio between the empirical ego and the pure ego i important. The former concept is that of a numbe of conscious acts of which the individual can becom aware by immediate introspection. There is a connexion here with Hume's 'bundle' theory, accordin to which the self consists of an aggregate of dynami states, continually changing in a way suggestive of revival of the philosophy of Heraclitus. In contradistinction, the pure ego is non-empirical, and i more in the nature of an inference from any dat obtained by introspection.

The basic claim of phenomenology lies close a hand, which is that observation is not so muc 'straightforward' as reflective. The former is descriptive of objects *per se*, the latter of objects intentionally. The difference is significant because, as Samue Alexander once declared, the whole force of æsthetic appreciation may reside in contemplation, that is, i the power to reflect upon things (even our ow handiwork), rather than merely to use them.

Husserl pays gracious and generous tribute, in th section dealing with phenomenological prototypes, t the genius of Berkeley regarding the influence whic his pattern of thought has had upon the moder empirical theory of knowledge. His was, in fact, th first systematic attempt to make the world as w know it—as viewed subjectively—theoretically comprehensible. The misinterpretation, however, of th problems of constitution arises primarily from a lac of insight into the immediate field of consciousness as might be expected when the fundamental assumptions are naturalistic in character. Nevertheless phenomenology as we perceive it in the twentiet century has developed from a variety of sources metaphysical as well as empirical; and this is as i should be, so long as the former always connote 'first philosophy', rather than its fortuitous positioning by Andronicus of Rhodes.

For the scientist, phenomenology is valuable i that it aims relentlessly at rigour, not merely as discipline, but constructively by placing 'the matter themselves' at the centre of his mental image; an in so far as they are self-given, he may assuredl accept them as true knowledge.

F. I. G. RAWLINS

Thorpe's Dictionary of Applied Chemistry

Fourth edition, revised and enlarged. Vol. 12: General Index. Pp. iv+187. (London: Longmans, Green and Co., Ltd., 1956.) 42*s.* net.

With the appearance of a general index, which forms the twelfth volume, the fourth edition of "Thorpe's Dictionary" is now complete. This harvest of chemical knowledge is safely in, and this s an opportunity to congratulate those who have helped in the gathering. Boswell reports himself as saying to the author of another dictionary: "You did not know what you was (*sic*) undertaking". To which the author replied: "Sir, I knew very well what I was undertaking—and very well how to do t—and have done it very well". No better summing-up can be found for "Thorpe's Dictionary".

It is fitting to recall those who have undertaken the editorial work during the past twenty years and so placed us in their debt. Sir Jocelyn Thorpe was one of the two first editors of the fourth edition and saw the first six volumes published. Next came an editorial board consisting of Sir Ian Heilbron, Prof. H. J. Emeléus, Prof. H. W. Melville and Sir Alexander Todd. The assistant editors were Drs. L. N. Owen and A. J. E. Welch. The central figure throughout was Dr. Martha Whiteley, who died this year at the age of eighty-eight (see *Nature*, June 30, p. 1202), and who was editor for the whole period, in addition to her work for earlier editions and supplements. It s peculiarly appropriate that Dr. Whiteley was able to pass the whole edition through for publication, ncluding this index. *Finis coronat opus.*

R. P. Linstead

ntroduction to Reference Books

By A. D. Roberts. Third edition, revised. Pp. vii+237. (London: Library Association, 1956.) 16*s.* (12*s.* to L.A. Members).

The first edition of this book was based on lectures given during the 1945–46 and 1946–47 sessions of the School of Librarianship at University College, London, and it remains designed essentially for those taking up a career as librarian. For the scientist it may well give a surprising revelation of the wealth of material which awaits him in any inquiry outside his special field; but although Mr. A. D. Roberts has a short chapter on the literature of special subjects, a chemist, physicist or engineer will be surprised at the absence of any mention of works to which he is wont to turn at the first introduction to the literature of his subject.

Mr. Roberts has his answers. He has sought to avoid compiling an enormous list of titles, and in his successive chapters—on encyclopædias, dictionaries, directories and other business publications, bibliographies, serials, indexing and abstracting services, current national bibliographies and bibliographies of books in print, bibliographies of older British books, directories of societies and institutions, government publications, bibliographical works of reference, and atlases and maps—he describes clearly the kinds of reference books available.

Surprise at any particular omission should accordngly be balanced against the clear picture of the material at his disposal which is set before the student; and it is probable that the student who conscientiously follows the guidance and hints which he is given will come across the particular works omitted if they are relevant to any particular inquiry on which he is engaged.

R. Brightman

Vector Analysis

By Homer E. Newell, Jr. (International Series in Pure and Applied Mathematics.) Pp. xi+216. (London: McGraw-Hill Publishing Company, Ltd., 1955.) 41*s.* 6*d.*

In the first eight chapters of this book, vector calculus is developed from the elements to the operator ∇; the integral theorems of Gauss and Stokes, and the standard elementary work on vector fields. The treatment is geometrical in flavour, but analytical difficulties are not ignored; when they are not completely disposed of, the reader is warned of their existence, and indications of how they may be overcome are given. In the last three chapters, Mr. H. E. Newell has selected as his chief application, apart from some work on kinematics, an account of electromagnetic theory.

In the preface, Mr. Newell deplores the familiar fact that students "who have been exposed to a course in vector analysis" so seldom learn to think vectorially. The remedy, for the student of applied mathematics, is surely to be found in a thorough integration of theory and applications; each new step should be introduced as the answer to a demonstrable need, and should be buttressed immediately by varied and significant applications. In the present book, as in so many others, the new concepts often come in rather abruptly, and too much of the buttressing is left to the exercises for the reader.

Mr. Newell has many merits as an expositor, and it is therefore to be regretted that he has not given the fully integrated account which the young student of physics and engineering would find so valuable.

Lithium Aluminum Hydride in Organic Chemistry

By Prof. Vukić M. Mićović and Dr. Mihailo Lj. Mihailović. (Serbian Academy of Sciences' Monographs. Vol. 237. Section for Natural Sciences and Mathematics, No. 9.) Pp. xi+193. (Beograd: Serbian Academy of Sciences, 1955.) 3 dollars.

This is an interesting account of the more important uses of lithium aluminium hydride, or, as the authors have it, lithium aluminum hydride. There are twenty-five chapters. Chapter 1 is concerned with the hydride as a reducing agent in organic chemistry, and Chapter 2 with its formation and properties. The next chapter deals with reactions of the hydride with inorganic and organometallic compounds, and Chapter 4 with its reactions with compounds containing active hydrogen. Then there is a chapter devoted to general experimental procedures, with notes on fire hazards and the like.

Chapters 7–24 cover the reactions of lithium aluminium hydride with compounds containing the commoner functional groups. The last chapter in the book reviews the various suggestions offered for the mechanism of reduction by the hydride.

Considering the tremendous literature of the subject, the authors have done very well indeed to produce, as they have, a small, readable volume which gives the general chemistry, shows up the important features, and gives no fewer than 1,732 references to the literature. The book is written by two men who have themselves experimented with lithium aluminium hydride and therefore are capable of appreciating its amazing versatility as a reagent. The chemistry is well described, with clear reaction formulæ.

E. E. Turner

PERMAFROST RESEARCH IN NORTHERN CANADA

By ROBERT F. LEGGET

Director of the Division of Building Research, National Research Council, Canada

A NEW Northern Research Station for Permafrost Research was recently dedicated at Norman Wells, Northwest Territories, by Dr. E. W. R. Steacie, president of the National Research Council of Canada. The opening of this far northern laboratory coincided with a visit of members of the National Research Council to the northwest of Canada. This visit and the establishment of the station at Norman Wells are significant indications of the steady awakening of Canada's northland.

The tour of the members of the National Research Council followed the regular summer meeting of the Council, which was held in Saskatoon instead of Ottawa as is the usual practice. Two years ago the Council had its first special summer meeting in Newfoundland, visiting this newest of the ten provinces of Canada in order to demonstrate the interest of the Council in the scientific and technical problems of this island province. The visit to northwestern Canada was arranged in view of the success of the visit to Newfoundland, and in order that the members of the Council might gain personal acquaintance with the great Mackenzie River valley, seeing also something of current developments on the arctic coast.

The party numbered about thirty. Most of the members made the tour by a specially chartered aeroplane; others were able to make most of the journey using regular commercial airline services. The party proceeded from Saskatoon to Beaverlodge on the northern shore of Lake Athabasca, where they inspected one of the major uranium mines of Canada. They then proceeded to Yellowknife, the mining centre of the Northwest Territories, and there inspected an operating gold mine. The next part of the journey was to Norman Wells, which the party used as a centre for special flights to the arctic coast. One of these was to Tuktoyaktuk, where the members were able to visit an Eskimo village and one of the DEW-line radar early-warning stations now under construction. No greater contrast between new developments in northern Canada and its traditional life could be imagined. The other special flight was to the existing town of Aklavik, located in the middle of the great delta of the Mackenzie River, at the meeting point of Indians from the south and Eskimos from the north. This principal settlement of the arctic coast is shortly to be moved to a new site on the east rim of the delta. The party was able to visit the new site and to see the start of construction for the new Aklavik.

After inspecting the facilities of Imperial Oil, Ltd., at Norman Wells, and the new National Research Council research establishment, the party flew up the Mackenzie valley to Fort Simpson, where a special Experimental Farm of the federal Department of Agriculture now has more than 50 acres under active and successful cultivation. Flight was then made over the mountains to Whitehorse, capital of the Yukon Territory, where local engineering developments were inspected prior to the return of the party to Edmonton. During this journey of more than 8,000 miles, the Council held two special dinner meetings, at Yellowknife and Whitehorse, where they met leading local residents and had an opportunity of bringing research to the attention of those concerned with the development of these northern communities.

It was during the visit to Norman Wells that Dr. Steacie, in the presence of most of the members of the National Research Council and of a large proportion of the local population, officially opened the two new prefabricated buildings of the Northern Research Station of the Council's Division of Building Research. The buildings are of simple wooden construction, designed and constructed for service in the rigorous climate of Norman Wells. They are so arranged that they can be moved in the future if it should be found eventually that the new Aklavik will be a more suitable location for the station. The residence measures 24 ft. by 48 ft. and can accommodate five or six research workers. The other building, 24 ft. by 72 ft., is a fully equipped soil mechanics laboratory with an associated workshop and garage for the special drilling and sampling equipment needed for permafrost investigation.

Norman Wells was selected as a site for this research establishment after careful survey of all possible sites in the northwest of Canada, most of which lie along the banks of the Mackenzie River. It is the present terminus for the wheel-equipped aircraft used on the regular commercial route of Canadian Pacific Air Lines; it is thus conveniently located for transportation. It is the site of a small oil field and oi refinery of Imperial Oil, Ltd., so that this Company's shop and service facilities are available. These have been most generously placed at the disposal of the National Research Council staff at the station at Norman Wells. The building programme of Imperia Oil has itself provided most useful information and experience with the special problems created by construction on permafrost.

More than one-third of the land area of Canada is underlain by perennially frozen ground. In all this northern area, the temperature of the ground, below the depth to which daily temperature-fluctuations are experienced, is 32° F. or colder. The depth at which freezing temperatures occur varies from a relatively few feet near the southern boundary to well over one thousand feet in the Arctic Archipelago. When the ground consists of solid rock, o of dry sand and gravel, the sub-freezing temperatures are of scientific interest but of little practical consequence. When, however, the frozen ground consists of water-bearing soil, and especially if the soil is silt (as is usually the case, in view of the recent glacial history of most of northern Canada) the practical consequences can be serious indeed i the natural temperature regime of the ground i disturbed.

It is to describe such conditions of terrain tha the word 'permafrost' has come into general and popular use within the past two decades. Philologically, objection can be raised to the name[1] particularly since its generally accepted use really implies its application to all perennially frozen ground and not just to frozen silt; but it appears to be oo late now to attempt to change this popular usage.

In natural circumstances, perennially frozen silt and other water-bearing soils will thaw out to shallow depths as the summer season progresses. Depths of thaw up to two, and sometimes even three, feet have been observed beneath the almost invariable surface vegetal cover, to which another popular name, muskeg', is usually applied. Re-freezing takes place apidly following the end of summer heat. The water thus released beneath the muskeg cover of so much of northern Canada is what makes summer overland travel so difficult and hazardous in this egion. The regular thawing and re-freezing is associated with the polygonal surface patterns frequently found in perennially frozen areas.

When it is necessary to carry out in the north engineering operations such as the building of roads and airports, and the erection of all but the smallest permanent structures, troubles may quickly develop when the ground is disturbed if it is found that the site is underlain by frozen silt. Once the natural vegetal cover is removed, more extensive thawing than usual will occur. Since the frozen silt will usually prove to be saturated or even super-saturated when thawed, and as it is usually slow draining, road and airport construction in permafrost can be extremely troublesome. Correspondingly, the heat ost from buildings can cause permanent and serious changes to the natural soil and ground temperature regimes, thus necessitating unusual foundation designs.

The first objective of the new research station at Norman Wells is to provide the necessary laboratory facilities and field-investigation equipment for the study of such practical building problems of the Canadian north, problems which have been multiplied n recent years as the development of the north has accelerated and as the standards used for northern buildings have been improved. Accurate study of soil conditions at proposed building sites is a first requirement. This has led to the development of special test-drilling techniques, such that cores of frozen soil can be obtained for study and analysis, and of somewhat unusual field-photographic procedure for the investigation of the exact ice formation n samples without recourse to elaborate (and costly) refrigerated equipment for sample storage and transport.

The new research station at Norman Wells will serve as a centre for this specialized field-research, the terrain near the station providing a most suitable area for test installations and investigations. The laboratory is fully equipped for the detailed study of the physical and mechanical properties of the soil content of samples of permafrost. Laboratory and workshop facilities will be used for the preparation of the extensive instrumentation required for the investigation of the ground-temperature regime in undisturbed areas and at the sites of engineering works.

The study of such practical problems is but one part of the assignment of this Northern Research Station, the other being a more general scientific investigation of permafrost as a natural phenomenon. Plans have been developed for permanent installations which will eventually demonstrate whether the permafrost of Canada is a static condition or one which is changing with time. The staff assigned to this work have, however, been diverted almost completely since the start of their work in 1952 (in temporary quarters) to the necessary study of permafrost at the existing town of Aklavik and to the extensive survey investigations carried out before the new town site was discovered and finally selected. Studies are continuing at both the new and the old sites and should eventually yield results of unusual significance.

Among other scientific projects in view is the drilling of a deep hole for the study of deep-ground temperatures[1]. This will be complementary to those already in use at Point Barrow, Alaska, and Resolute Bay, Northwest Territories. Investigation of temperatures in *pingoes* is already under way and other studies of the variations of ground temperature at shallow depths. With the new laboratory facilities now available, and the new town site for Aklavik well started towards its full development, it is hoped that the long-planned research into the more scientific problems of permafrost in northern Canada can soon be prosecuted as planned[2]. The Norman Wells station will be available for use by guest workers with the National Research Council. It is a satisfaction to be able to conclude this note by reference to the first such guest workers, two British geologists, who are visiting northern Canada on a special mission.

[1] Bryan, Kirk, *Amer. J. Sci.*, 224, 622 (1946).

[2] Legget, R. F., "Permafrost Research", *Arctic*, 7, Nos. 3 and 4, 153 (1954).

U.K. ATOMIC ENERGY AUTHORITY

SECOND ANNUAL REPORT

THE second annual report of the United Kingdom Atomic Energy Authority*, covering the year ended March 31, 1956, follows the pattern of the first annual report. The dominant feature of the year has been the great increase of interest and activity in the development of nuclear energy as a source of power for peaceful purposes, which has coincided with a considerable advance in the removal of security restrictions on information in this field. These questions and also the implications of the staff position in relation to the man-power situation in Britain and in regard to technological education are discussed elsewhere. For the rest, it may be said that generally the report presents a concise and readable picture of technical developments during the year, many of which have already been made known in the Press. The report, however, puts them in their proper perspective. Moreover, the Authority recognizes so clearly the importance of a clear public understanding of exactly what it is doing that it has supplemented the report with an admirable illustrated summary*, which should bring home to the

* United Kingdom Atomic Energy Authority. Second Annual Report for the period 1st April 1955–31st March 1956. Pp. iv+46. (London: H.M. Stationery Office, 1956.) 2s. 6d. net.

* Atom 1956: An Illustrated Summary of the Second Annual Report of the United Kingdom Atomic Energy Authority. Pp. 24. (London: H.M. Stationery Office, 1956.) 1s. 6d. net.

ordinary citizen the nature of the problems with which the Authority is faced and the magnitude of its operations.

During the past year, nuclear power has become for most countries a matter not of conjecture but of dates, and comparative costs and the increase in activity of industry in the United Kingdom and of governments and industry overseas constituted a new feature of national and international affairs. Nevertheless, there has been no reduction in the Authority's activities on the defence side. The nuclear weapons programme, and particularly the development of thermonuclear weapons, continued to have high priority, and the rate of increase of staff was higher in the Weapons Group than elsewhere in the Authority, the total staff of which increased from 19,895 in April 1955 to 23,973 in 1956. During the year, the Authority decided that the work of the Weapons Group, under the direction of Sir William Penney, should include responsibility for research into, and development of, nuclear reactors for military application.

As a measure of overseas interest in the British nuclear energy programme and of the Authority's overseas contacts, the report refers to visits to the Authority's establishments during the year by representatives of thirty-six countries. The new full-time member of the Authority appointed in October, Mr. W. Strath, is largely concerned with overseas atomic energy organizations, as well as with raw material procurement and the Authority's relations with industry. Construction of new capital facilities continued at almost all the Authority's establishments during the year; but Harwell has now almost reached the maximum size compatible with efficient management and the avoidance of unreasonable pressure on the facilities of the surrounding countryside. Research and development, however, continue to demand more scientific staff and working space, and the Authority is examining new sites with the view of setting up a further major research establishment to which new research and development projects could be directed. Additional net expenditure of £3,550,000 was required for 1955–56, beyond the estimate of £50,562,000 presented to Parliament in February 1955, mainly to implement the Government's decisions to develop thermonuclear weapons, to carry out a nuclear power programme and to increase the output of plutonium, for which purpose three new units of the Calder Hall type are to be built, one at Calder Hill and the others at Chapel Cross, near Annan. The net estimate for 1956–57 presented to Parliament in February was for £68,242,000.

The Authority has also faced a major task in establishing commercial accounting systems throughout the organization. A foreword to the balance sheet appended to the report points out that the whole of the cost of operation of factories by the Industrial Group is regarded as recoverable in the price of its products, and expenditure on research and design in aid of future projects is carried forward for later amortization and recovery. The whole of the cost of operation of the Research Group, less proceeds of sales of radioactive substances, electronic equipment and other income, is regarded as the cost of fundamental research in the nuclear energy field to be borne by the Exchequer. Under contract from the Ministry of Supply, the Weapons Group undertakes the production of components for weapons and research work in connexion with weapons; and the cost of operation of this Group, including that c other advanced research, less the amounts charge able to the Ministry of Supply for production an research, and other income, is regarded as a charg to be borne by the Exchequer.

The spate of new discoveries, most of them on th North American continent, has removed the dange of a world-wide shortage of uranium. For its curren uranium imports the Authority continued to depen on contracts placed by the Combined Developmen Agency on behalf of the Authority and the Unite States Atomic Energy Commission, and has receive the first shipment of concentrates from the mines a Rum Jungle and at Radium Hill, Australia. A extension of the contract for the supply of uraniu ore and concentrates from the Shinkolobwe mine i being negotiated and the output of uranium concentrates from the Transvaal and Orange Free Stat mines continues to grow. During the year, the firs contracts were signed for delivery of uranium direc to the United Kingdom, and steps were taken t foster an interest in uranium prospecting in th Central African Federation. Technical development in regard to materials noted in the report include among chemical methods of extracting uranium, th publication of an account of the ion exchange process in which work the Radiochemical Group of th Chemical Research Laboratory (Department c Scientific and Industrial Research) co-operated arrangements to create additional capacity for production of graphite in the United Kingdom an investigation of the production of special grades c graphite for future reactors, the change from calcium to magnesium in the reduction of uranium tetrafluoride to metallic uranium and the continued manufacture of fuel elements to meet the needs of Bepo an of the Windscale piles. Further sections of the gaseou diffusion plant at Capenhurst have been commissioned and the output of the plutonium-producin piles at Windscale has been further increased Steady progress has been made in the developmen of maintenance techniques for use inside the pil shield, thereby easing the severe limitation on desig and choice of equipment. Chemical processe developed at Harwell for the complete separation c the fissile uranium-233, fertile thorium and th radioactive fission products from neutron-irradiate thorium have been operated on a small pilot-plan scale.

The report gives some particulars of progress wit the prototype nuclear power station at Calder Hal and the fast breeder reactor at Dounreay, and satisfactory progress has been made with the Harwe swimming-pool reactor (named Lido) for researc and development related to the problem of shielding The heavy-water-cooled and moderated therma reactor, Dido, was expected to come into operatio towards the end of July 1956 and is to be used fo a limited amount of engineering loop work, an work has been commenced on the design and manufacture of special experimental equipment an devices for the production of isotopes and on th design and construction of the first of the engineerin loops to be installed in the heavy-water high-flu reactor, Pluto, to test the technology of advance reactor systems. While the first nuclear powe stations will be built away from heavily built-u areas, the Authority has set up a panel of its ow specialists with representatives of the electricity undertakings to consider the problems of the sitin of reactors.

The Authority's reactor research programme is further described in a separate chapter of the report. A substantial amount of work is still being done on the graphite-moderated gas-cooled reactors being designed by industry for the Central Electricity Authority, and several loops have been built to study the corrosion of carbon steels and stainless steels under the conditions likely to be experienced n pressurized-water reactors, while the use of organic liquids such as diphenyl and terphenyl as alternative to the water moderator and coolant is being investigated. Reactor physics and metallurgical and engineering investigations are being carried out on the alternative reactor using graphite as a moderator and liquid sodium as coolant. In addition to the organic system just mentioned, four other reactor ystems are being examined for attaining a much higher fuel-utilization by breeding: the fast reactor system; the homogeneous aqueous reactor system, which attempts to achieve breeding in the uranium-233–thorium system, with very low fuel costs; the liquid-metal fuelled reactor system, using a graphite moderator and enriched uranium dissolved in a liquid metal; and the high-temperature gas-cooled reactor system. Treatment of irradiated uranium by solution in acid and extraction with organic solvents continued to be a successful method for separating plutonium and recovering uranium for re-use on the ndustrial scale, and pilot-plant experience has been gained of the process for the extraction of uranium-233 from irradiated thorium. Work on the production of a controlled thermonuclear reactor, in which the two main problems to be solved are to bring a mixture of the light elements to a temperature in the region of 100 million deg. C., and to maintain this long enough for the energy released in nuclear fusion to exceed that required to heat the fuel, is still in the laboratory stage.

Besides occupational health problems, the Authority pays much attention to those of waste disposal, including measures to ensure full protection of the public from possible exposure to radioactive materials. Sales of radioactive isotopes steadily increased, totalling £483,000, rather more than half of which was for export; the number of consignments was 22,378 compared with 18,835 in 1954–55. The potential uses of radioactive by-products in industry is being actively explored by the Technological Irradiation Group of the Isotope Division, working in close co-operation with industry, and the biological application of irradiation in sterilization and mutation is being actively studied. Antibiotics which are normally destroyed by heat sterilization can be completely freed from bacteriological contamination by simple irradiation. Some 15,000 curies of cobalt-60 have been made and loaded into machines for cancer teletherapy and for industrial irradiation. Among new applications of radioactive isotopes may be mentioned the use of ammonium phosphate containing radioactive phosphorus to investigate the pollution of beaches by sewage; and the use of weak radioactive solutions to detect leaks in water mains and oil pipe-lines up to twenty miles in length.

During the year, 167 students attended the normal four-week course in the Isotope School and 104 attended special courses. The Reactor School at Harwell throughout the year gave training to staff from industrial firms on the construction and operation of nuclear reactors; and while the export of nuclear reactors will be the responsibility of industry, it will fall to the Authority to provide the necessary fuel elements. The Authority expects to be able to provide natural uranium fuel elements to match whatever volume of export business is secured in the foreseeable future. Up to the present, twenty-two licences have been granted to United Kingdom firms to use inventions owned by the Authority, three to United States firms, one to a firm in West Germany and one to a firm in France.

EFFECTS OF ATMOSPHERIC POLLUTION IN FORESTRY

DURING the recent Sheffield meeting of the British Association, the morning session on September 4 of Section K* (Forestry) was devoted o four papers on "Forestry in Industrial Areas, with special reference to Smoke Pollution".

Mr. E. M. Conder (Forestry Commission), in a ontribution on "Some Problems of Private Forestry in the Industrial Areas", pointed out that air pollution is not the sole cause of the lack of satisfactory oniferous tree growth in the immediate vicinity of arge industrial cities, for fire and theft are also esponsible in some measure. From experience in Lancashire, the Black Country, the Nottinghamshire oalfield, and parts of South Yorkshire, he considers ycamore, beech, elm and poplar the most successful imber-producing hardwood species, with other generally resistant but subsidiary species as follow: orse chestnut, birch, holly, rowan, whitebeam, ommon alder. Only the black pines (with particular mphasis on the Austrian variety) and, in certain circumstances, Japanese larch, can be recommended mong the conifers. Besides these there are few pecies to suggest, apart from monkey puzzle, yew nd perhaps the cedars and Lawson's cypress. Trials with *Pinus contorta* are as yet too young to provide conclusive material and, while Scots pine may be vigorous initially, subsequent development is poor. Mr. Conder suggested that, in high valleys and on hill slopes, trapping of injurious gases by prevalent low cloud may explain the serious effects at these sites. It was emphasized that in surveying pollution effects, attention must always be paid to the fertility of the soil and, among climatic factors, to the influences, in particular, of elevation and exposure.

Atmospheric pollution effects in Yorkshire were discussed by Mr. A. J. Grayson (Forestry Commission), who suggested that though pollution as generally viewed is deleterious, it may imply useful additions to the existing natural 'chemical climate' before the concentration of individual pollutants or combinations gives rise to injury. Historical evidence shows something of the extent to which changes of species in plantations are to be ascribed to the effect of coal-smoke pollution during the past century. However, the elucidation of the factors bringing about deterioration and even death is difficult since the production of smoke is matched by an increased need for timber, leading to preferential cutting, as well as, more recently, preferential selection of species. A physical basis of measurement of some of the common pollutants is desirable only in so far as biological assays are hedged with difficulties as to interpretation.

The stimulus for the investigation of country levels of pollution is provided by the need to afforest difficult sites on both sides of the Pennines on inhospitable soils exposed to a dull and harsh climate, where the choice of economic species is in any case restricted. The disentangling of pollution/exposure and pollution/fertility interactions (if either be possible) is the prime need. In the first place, Forestry Commission research has begun with the assessment of sulphur dioxide by the lead peroxide method. Similar levels indicated by this technique give no assurance that solid deposits will follow similar trends, and the variation in the ratio of water-soluble to insoluble matter collected in deposit gauges indicates the wide range of types of emission, as well as of the history of that emission. The disadvantages of the lead peroxide method may be in its manner of integration, so that in the absence of other observations a particularly highly concentrated visitation at a time of high plant susceptibility may pass undetected.

More fundamental is the question of the effect of prevalent high wind velocities on the rate of formation of sulphate. Two examples, one of moor top as opposed to valley stations in open country, the other of a gauge sheltered by a wood and contrasted with gauges on either side of the wood, suggest discrepancies which may not in fact reflect true differences of sulphur dioxide concentration. Fumigation experiments with sulphur dioxide, often of short duration, have usually been carried out in the past with concentrations of 1–100 times those averaged over a month occurring naturally, though occasionally concentrations in Nature may increase to the higher levels used in fumigation experiments. Mr. Grayson suggested that apart from species (and possibly strain), concentration, and period of fumigation, different ages of plant or plant organs should be treated in fumigation experiments, since field-observation suggests that atmospheric pollution effects are often most noticeable in trees after the grand period of height growth is finished.

A paper prepared by Dr. G. Scurfield (at present with the Commonwealth Scientific and Industrial Research Organization, Canberra) was read by the chairman, Mr. M. V. Laurie. Dr. Scurfield began by asking three questions: (i) Is there unequivocal proof that pollution effects are operating to reduce timber yield on certain sites? (ii) Given such sites, can we designate the pollutants causing the reduction in yield and, if so, can we define an upper permissible limit of concentration for the pollutants concerned? (iii) Given such pollutants, in what ways do they interfere with the developmental processes of the tree so as to cause a reduction in yield?

Observations of decline in vigour of tree growth from cities tend to support the contention that the effects of general pollution are cumulative and need not be accompanied by the production of visible leaf lesions. Many such observations are concerned with effects produced by 'general' atmospheric pollution after the contaminants have undergone considerable dilution and probably interaction. The effects produced by temporary and usually local increases are more certain, and have in a number of cases been checked by means of fumigation experiments. Field-symptoms have been also duplicated in experimen with hydrogen fluoride where this agent has bee suspected.

The different levels of pollution which evergree and deciduous species have to endure are brougl out in the typical annual sine curve of sulphu dioxide and smoke (which is of great chemical con plexity, but which contains a number of oth contaminants) in the vicinity of urban areas. Tl cumulative effect of a number of pollution cycles probably to reduce growth indirectly by acceleratin leaf abscission. Experiments to determine toleranc in known environmental conditions might be carrie out on the following bases: (i) using transplants the same soil but different pollution regimes, alon side meteorological stations so that any micr climatic differences between sites could be assessed indicator species (for which damage symptoms f specific pollutants have already been assessed) migh also be included; (ii) using growth chambers throug which 'screened' air could be passed, so that speci agents responsible for reduction in growth wou eventually be determined. Lastly, by using 'phyt tron' techniques, tolerances to combinations of tl variables might be determined. Such techniqu could also be used to assess the indirect effect soil fertility.

In answer to the second question posed, D Scurfield emphasized how necessary it is to avo the tendency to regard sulphur dioxide as the so gaseous pollutant. In addition to thirty gases liste by the Alkali, etc., Works Registration Act, 190 recent analyses have shown hitherto unsuspecte contaminants. Further, there are the chemical physical processes occurring after emission; f example, the reaction products of ozone and certa hydrocarbons. Radioactive isotopes, also, should n be ignored altogether. The permissible concentratio allowed to pass to the air are, so far as sylvicultu is concerned, largely arbitrary. Upper limits tolerance will wait on results through the specie ontogeny and under known conditions. When the are known, concentration limits must be reassess in relation to topography and atmospheric co ditions. Where inversions are liable to occur, f example, the ideal solution would be the regulati of rates of emission in accordance with the diffusi properties of the atmosphere at the time. Th thorough evaluation of sites from a meteorologic and atmospheric pollution point of view shou preferably be undertaken before planting.

Thirdly, with regard to the physiological pr cesses concerned, it may be said that the mo prominent effect of 'general pollution' is to cau premature leaf abscission. Organic sulphur con pounds may play some part in these phenomen Though abscission may not always be due to t same agent, some mitigation might be obtained l treatment with compounds so affecting auxin activi as to retard abscission. Effective elimination harmful sources will only be undertaken, said D Scurfield, if we emphasize the effects and if we ca point to the agents responsible.

Finally, Dr. P. F. Wareing (University of Ma chester), who explained that he was in part deputizi for Dr. J. K. A. Bleasdale, whose thesis on the decli of certain leys in the hill pastures of East Lancashi had shown valuable results, and for Dr. Scurfiel who had also worked at Manchester, proceeded amplify and clarify many of the points mentioned previous papers. In discussing what is the importa pollution factor, he pointed out that while good grounds exist for considering sulphur dioxide the main injurious agent, we have not yet determined that some of the accompanying products of coal combustion may not bring about injuries, such as have been described for pollutants resulting from the combustion of petroleum in Los Angeles. The work on fumigation with sulphur dioxide in greenhouse experiments involves only relatively short-term experiments at high concentrations. This provides no real simulation of the processes occurring in Nature. Dr. Wareing also stressed the fact that the most susceptible parts of plants are the leaves, so that evergreens, which retain their leaves during the winter when pollution is usually at the highest levels, are generally less resistant than deciduous species. Nevertheless, other factors must be of importance, since there are marked differences as between different species both among evergreen and deciduous plants.

Further elucidation was provided by Dr. Wareing in the discussion which followed. Mr. M. V. Edwards (Forestry Commission) brought matters down to earth in referring to the effects visible on some of the high upland plantations. Here similar symptoms of damage are noticeable on young trees where they are seriously exposed to 'clean' winds and those exposed on the South Pennines to smoke-laden winds. The design of experiments required to isolate the factors of pollution and exposure meets with very serious difficulties. The provision of shelter, for example, automatically means the bringing into existence of a different pollution regime. Mr. A. Bleasdale (Meteorological Office) said that if foresters working in this field need help from meteorologists, then they should be as detailed as possible in stating their requirements so that records could be used most effectively.

Both this discussion and the papers point to the great need for study of the cumulative effects in sylviculture of pollution, in addition to the determination of the toxic concentrations of individual contaminants and combinations of pollutants under known conditions.

A. J. GRAYSON

RESPIRATORY PIGMENTS

IN opening a discussion on "Respiratory Pigments" arranged by Sections D (Zoology), H (Anthropology) and I (Physiology) at the Sheffield meeting of the British Association, Prof. F. J. W. Roughton reminded his audience that eight years had passed since the Barcroft Memorial Conference on hæmoglobin had met at Cambridge, and said that they had been years of rapid progress, some of it stimulated by that Conference. In the discussion three groups interested in hæmoglobin were all represented: they were physiologists, who are concerned with its role in promoting gas exchanges in the animal body, biochemists interested in the mechanism and physical chemistry of the gas reactions, and biophysicists who find it an easily available and readily crystallized material already carefully studied and characterized physiologically.

The first paper, by Profs. Q. H. Gibson and F. J. W. Roughton, was concerned with the thoroughgoing application of Adair's intermediate-compound hypothesis to the equilibria and kinetics of the reactions of hæmoglobin with gases. Adair's original paper, published thirty-one years ago, suggested that combination of each hæmoglobin molecule with four molecules of gas takes place in four distinct stages, one gas molecule combining at a time to yield separate molecular species containing one, two, three or four gas molecules.

The general acceptance of Adair's hypothesis has been delayed by the failure of attempts to demonstrate the intermediate compounds spectroscopically, and because the equation giving the relation between oxygen tension and percentage saturation arising from the intermediate-compound hypothesis contains four constants—enough to allow any ordinary experimental equilibrium curve to be fitted within 0·5–1 per cent saturation by several sets of constants with widely differing values.

In recent years, Roughton and his co-workers at Cambridge have overcome the second difficulty by refining the methods used for determining the dissociation curve and extending them to the ranges 0–1 per cent and 98–100 per cent saturation, so that only one set of constants can be found to fit the experimental results. This work has shown that, for sheep hæmoglobin, there is a great increase in affinity for oxygen after three molecules have combined, the affinity for the fourth molecule being, at pH 9·1, 280 times greater than that for the first.

The kinetic work described in the same paper is an example of co-operative research carried on by several groups of workers. The problem was to determine numerical values of the four combination velocity constants for the reaction of reduced hæmoglobin with carbon monoxide. The experimental material, records of the change in concentration of reduced hæmoglobin with time, was obtained by the stopped-flow photo-electronic method, in Sheffield. The percentage saturation was found to within 0·5 per cent during the period from 5 to 100 msec. after bringing the reactants together, using a photomultiplier and cathode-ray oscillograph to follow the reaction. The results were then compared, by Dr. H. E. Daniels, of the Cambridge Statistical Laboratory, with solutions of the differential equations describing the reaction. These solutions were computed by the EDSAC electronic machine in the Cambridge Mathematical Laboratory. In this way the values of the individual velocity constants for the combination of successive carbon monoxide molecules were found, together with their standard errors. Here again, with sheep hæmoglobin at pH 9·1, it was found that a great increase in combination velocity took place after three molecules of carbon monoxide had combined, the fourth molecule combining some sixty to eighty times faster than the first.

Although the new results have allowed the unequivocal application of the intermediate-compound hypothesis to one kinetic case, much remains to be done, especially to extend the analysis to the physiologically interesting case of combination with oxygen, though the formidable difficulties of reckoning with eight independent kinetic constants may well delay a solution for some time.

Dr. V. M. Ingram followed with an account of recent progress in research on the structure of hæmoglobin by X-ray methods. The present position is that while projections of the molecule are available which tell us how much material lies in the line of sight in a given direction, more detailed information can only be obtained by making projections of thin slices of the molecule.

Certain specific groups have, however, been located by labelling them with heavy-metal atoms which show up on X-ray diffraction analysis. It has been found, in this way, that the —SH groups of horse hæmoglobin are arranged in close pairs. As Riggs in the United States has recently shown that the —SH and hæm groups have a close functional relationship, it is not impossible that they may be close to one another in the molecule.

Very recently a striking new advance has been made in the study of sickle-cell anæmia. In this condition the hæmoglobin differs from normal in the number of its —SH groups, its solubility and in the remarkable property of forming a gel on reduction. Dr. Ingram has now found, using a combination of paper chromatography and paper electrophoresis, that a peptide appears regularly among the products of tryptic hydrolysis of sickle-cell hæmoglobin which is not present in similar hydrolysates prepared from normal human hæmoglobin. As sickle-cell anæmia is the result of change in a single gene and is inherited in a strict Mendelian way, the possibilities of an increase in our understanding of the relation between genes and proteins synthesis are obvious.

After an interval, Prof. Q. H. Gibson described some applications of flash photolysis to the study of hæmoglobin kinetics. The observations, so far, have been made with a simple apparatus in which the solution to be examined is exposed to the photolysis flash in an integrating sphere and the changes in light absorption are recorded by means of a continuous light source, photocell, and cathode-ray oscillograph. The systems studied are arranged so that at equilibrium the chief compound present is carboxyhæmoglobin, which, as is well known, is sensitive to light. On firing the photolysis flash, this carboxyhæmoglobin is caused to dissociate, setting free reduced hæmoglobin. After the flash ends, the recombination of the reduced hæmoglobin with carbon monoxide or with other ligands forming compounds less stable than carboxyhæmoglobin can be studied.

One application of the method has led to a dramatic confirmation of the difference in kinetic properties between the different intermediate compounds of carbon monoxide with hæmoglobin. By reducing the power of the photolysis flash, partially saturated intermediates can be formed in the solution in calculable quantities. It is found that when large proportions of the intermediate $Hb_4(CO)_3$ are formed, the recombination reaction involving the addition of the fourth and last molecule of carbon monoxide to combine takes place up to sixty times faster than when only fully reduced hæmoglobin is present. It is satisfactory that such good agreement can be reported between the widely different approaches to the kinetic problem described at this meeting, since this rapid reaction was predicted from measurements of the upper end of the dissociation curve and the velocity of dissociation of the first molecule of carbon monoxide from fully saturated hæmoglobin.

Another application reported was to the study of hæmoglobins from invertebrates. Here the advantage of the flash method is its economy in material. This economy must now be approaching its highest possible degree, since the same material can be used repeatedly in duplicate experiments or in runs under altered conditions. It is interesting to reflect that in the thirty-three years since Hartridge and Roughton made the first measurements of the reaction velocity of hæmoglobin with gases, the pigment requirements have been reduced some 100,000 times. It is now readily possible to examine the hæmoglobin from a single specimen of *Arenicola*, say, or of *Chironomus*, but it would seem that several specimens of *Daphnia* would still be needed.

In the final paper of the meeting, Prof. F. J. W. Roughton described the application of some of the kinetic work to the problems of passage of gases from the alveoli into combination with the hæmoglobin. This process, at first sight deceptively simple, must in fact be split up into a number of component steps, each of which plays its part in determining the rate of the overall process. The gas molecules concerned must first diffuse through the alveolar membrane, then through the plasma to the erythrocyte, through the cell membrane of the latter, and finally through the interior of the cell until they meet a hæmoglobin molecule with a vacant gas-binding group.

It has now been possible to evaluate the importance of each of these factors in contributing to the final physiological result. It has been found that the resistance of the alveolar membrane and the resistance in the erythrocyte contribute about equally to the difficulty met with in the uptake of carbon monoxide or oxygen from the alveoli into combination with hæmoglobin. In the erythrocyte, the chemical combination reactions with oxygen and nitric oxide are so rapid that the actual rate of gas uptake is determined primarily by the rate of diffusion through the red-cell membrane and the interior of the cell modified only slightly by the rate of the chemical reaction. With the slower reaction of the displacement of oxygen by carbon monoxide, the rate of the chemical reaction already plays an important part; and when we come to consider the dissociation of carboxyhæmoglobin the picture is reversed, the chief rate-limiting factor now being the chemical reaction which is slow as compared with the rates of diffusion in the blood and across the membranes.

The new quantitative descriptions of the exchange processes in the blood and lungs have been applied to determine anew the diffusing capacity of the lung membranes and the volume of blood in the lung capillaries. The greater certainty about these processes should lead to advances in fields as diverse as clinical medicine, long-distance running, and in knowledge of how life is carried on at high altitudes.

OBITUARIES

Prof. Carl Neuberg

On May 30 Prof. Carl Neuberg died in New York at the age of seventy-nine. With Neuberg's death ended a succession of brilliant German organic chemists, born and trained in the last century and devoting their life-work mainly to the application of newly developed chemical methods to the study of the components of living matter, their composition, structure and metabolic changes; among them were Friedrich Wöhler, Justus v. Liebig, Felix Hoppe-Seyler, Adolf v. Bayer, Albrecht Kossel, Emil Fischer, Franz Hofmeister and Richard Willstätter.

Equipped with a broad knowledge of, and deep insight into, organic chemistry, possessed by a passionate interest in the material changes of living matter and endowed with a rare skill for devising methods suitable to a direct approach to the problem, Neuberg was one of the founders of modern biochemistry.

Born on July 29, 1877, at Hannover (Germany), he received his scientific training in the Universities of Berlin and Würzburg. In 1898 he joined E. Salkowski in the Chemical Division of the Pathological Department of the University of Berlin; in 1909 he was appointed head of the Chemical Unit of the Department of Animal Physiology at the Agricultural College, Berlin, and in 1913 he became assistant director of the Kaiser Wilhelm Institute for Experimental Therapy under August v. Wassermann, whom he succeeded in 1925. The Institute became one of the foremost centres of biochemical research. Although Neuberg had given signal service to his native country both in peace and in the First World War, he was forced by the Hitler regime to leave it in 1939. He found refuge in the United States, where he was at first research professor at the College of Arts and Sciences of New York University and then professor at the Brooklyn Polytechnic Institute and at the New York Medical College.

Neuberg's main contribution to science was the elucidation of the principal mechanism underlying alcoholic fermentation of sugar by yeast. This process, though the subject of violent controversy between the most illustrious chemists of the last century, remained an unsolved mystery until Harden and Young in London and the Neuberg school at Berlin entered the field. The first step in unravelling the integrated series of reactions by which the carbon chain of the sugar molecule is disrupted was the demonstration that pyruvic acid is readily and quantitatively transformed to carbon dioxide and acetaldehyde by a yeast enzyme named carboxylase. The next step was the trapping by sodium sulphite of the intermediary acetaldehyde in the course of glucose fermentation. The hydrogen becoming available through the formation of the carboxyl group of pyruvic acid, but deprived of its physiological acceptor acetaldehyde, was traced in glycerol, produced in stoichiometric quantity to the trapped acetaldehyde. The interpretation of these findings was given by Neuberg in a fermentation scheme the main features of which were: (1) dehydration and de-aldolization of one mole D-glucose to two moles of a 3-C-aldehyde assumed to be methylglyoxal, (2) oxidation of the ketoaldehyde to pyruvic acid, and (3) reduction of the decarboxylated pyruvic acid to alcohol.

The concept of alcoholic fermentation as the balanced sequence of an energy-yielding dehydrogenase reaction and a reaction in which a hydrogen acceptor derived from the first reaction combines with the hydrogen atoms released proved to be one of the most fruitful theories in the realm of fermentation and respiration. Neuberg demonstrated clearly that the end-products of sugar fermentation by yeast vary with the nature of the hydrogen-accepting system available. The ideal fermentation equation of Gay–Lussac is never verified because yeast on metabolizing sugar forms a variety of competing hydrogen-acceptors, their quality and quantity depending on the conditions imposed. Neuberg realized the key position of pyruvic acid in the metabolism of fungi and bacteria and ascribed the great diversity of products formed in the various types of fermentation mainly to the formation of a wide range of hydrogen-acceptors from pyruvic acid. It may be said with confidence that the production of pyruvic acid, isolated in high yield from fermenting sugar solutions by Neuberg in 1929, is the central stage of a carbohydrate degradation pathway very common in living cells; this central stage is preceded by phosphorylating and desmolatic steps and followed in respiration by the Krebs cycle, in fermentation (glycolysis) by reduction of pyruvic acid or a derivative thereof.

In addition to carboxylase, Neuberg discovered the enzymes β-glucuronidase, methylglyoxalase, phenolsulphatase, chondrosulphatase, polyphosphatase and metaphosphatase. His wide interest and experimental skill are documented by many other notable achievements. Among them are studies on the structures of raffinose, inositol and phytin, first non-enzymatic preparation of phosphorylated sugars and amino-acids, discovery of fructose-6-phosphate (Neuberg ester), first observation of the carboligatic reaction and synthesis of the various phosphoglyceric acids.

Neuberg's work has done much to shape present trends in biochemistry and his contributions to knowledge will long be remembered. In 1906 he founded the *Biochemische Zeitschrift* and edited no less than 278 volumes in the next thirty years. Among the many honours bestowed upon him were the Emil Fischer, Delbrück, Pasteur, Berzelius, Scheele and Leblanc Medals, and the Carl Neuberg Medal established by the American Society of European Chemists and Pharmacists in 1950. He received several honorary degrees, and was a member of many scientific academies. Of Neuberg may be said what he himself said at the funeral of his predecessor A. v. Wassermann in 1925: "He belonged to the small band of scientists who visibly moved the hand of the clock recording the advancement of science".

ALFRED GOTTSCHALK

Dr. Gunnar Dahlberg

DR. GUNNAR DAHLBERG, who died on July 25, was born in Lofta, Sweden, in 1893 and was educated in the University of Upsala, graduating M.D. in 1926. It was in Upsala where his career was spent, for he was director of the Statens Rasbiologiska Institut there from 1936 until his death. He was also dean of the Faculty of Medicine at Upsala during the critical year 1939–40 when Swedish mobilization faced the University with administrative problems, into which he threw his energies with enthusiasm as one of the leading Swedish intellectuals with uncompromising hostility to the Nazi challenge. From the start a vigorous critic of the Nazi creed, he was at all times a friend of the British cause when the Second World War became inevitable. In 1948 he received from Britain the King's Medal for Service in the Cause of Freedom in recognition of the part he played.

As a man of science, Dahlberg is remembered for his early work on twin resemblance, his pioneer publications on the genetical theory of inbreeding and more especially for his concept of the population isolate. Above all, he strove to develop human genetics as a branch of medical science dissociated from its discreditable associations with racialist propaganda. He edited a monumental semi-popular encyclopædia sponsored by the Swedish Red Cross Society. He was the author of an important book on vital statistics, "Sjukdomarna och Samhällhet", and also a popular book translated by Lancelot Hogben under the title "Race, Reason and Rubbish". In 1953 the *Acta Genetica et Statistica Medica* celebrated his sixtieth birthday by publishing a memorial volume to its editor.

Among Dahlberg's many honours were an honorary LL.D. of Aberdeen (1938) and a doctorate of odontology (*honoris causa*) of Stockholm (1955). He received the Alvarenga Prize of the Swedish Medical Association in 1929 and a prize award in 1933 from the King Oscar II Jubilee Fund. He is survived by his widow Stina (*née* Westberg), whom he married in 1919.

NEWS and VIEWS

Mathematics at the Imperial College, London: Dr. Abdus Salam

Dr. Abdus Salam, lecturer in the University of Cambridge, has been appointed to a University chair of mathematics at the Imperial College of Science and Technology, London. Dr. Salam is a brilliant mathematician with an international reputation in the field of theoretical physics. He has played an important part in the development of quantum electrodynamics and the various theories which have been formulated to interpret the properties of mesons and other recently discovered fundamental particles. His activities in these directions will be especially appreciated at Imperial College, where he will find colleagues with an active interest in the experimental side of such investigations. Dr. Salam received his early education at the University of the Punjab, where he took the M.A. degree in 1946. In 1948 he graduated at Cambridge and was awarded the Ph.D. degree of that University in 1951. In the same year he was elected to a research fellowship at St. John's College, Cambridge. Dr. Salam has previously held high appointments in mathematics. In 1951 he became professor of mathematics at Government College, Lahore, and in 1952 was appointed head of the Department of Mathematics in the University of the Punjab. Since 1954 he has been a lecturer in the University of Cambridge and acted as scientific secretary at the Geneva Conference in 1955 on the peaceful uses of atomic energy.

With the appointment of Prof. Salam, there are now four professors in the Department of Mathematics in the Imperial College, namely: Prof. H. Jones, who is the head of the Department; Prof. G. A. Barnard, professor of statistics; Prof. W. K. Hayman, professor of pure mathematics; and Prof. A. Salam, who will be concerned mainly with applied mathematics and mathematical physics.

Pan-American Foot-and-Mouth Disease Centre, Rio de Janeiro: Dr. W. M. Henderson

Dr. W. M. Henderson, deputy director of the Research Institute (Animal Virus Diseases), Pirbright, Surrey, has been appointed director of the Pan-American Foot-and-Mouth Disease Centre, Rio de Janeiro, Brazil, and is taking up his duties in January. This international centre began in 1951 as a Technical Co-operation Project of the Organization of American States. The operation of the Centre is the responsibility of the Pan-American Sanitary Bureau, which is the regional office of the World Health Organization. The work of the Centre is the training of national laboratory and field staffs responsible for the control of foot-and-mouth disease in the Americas, the provision of a field consultation and confirmatory diagnostic service and research. It is now intended to expand the research facilities and activities.

Dr. Henderson, who is forty-three, was educated at the Royal (Dick) Veterinary College and the University of Edinburgh and qualified in 1935. During 1936–39 he was assistant to Prof. George F. Boddie, professor of medicine in the Royal (Dick) Veterinary College, Edinburgh. In January 1939 he was appointed research officer to the Pirbright Research Institute to work on foot-and-mouth disease and other vesicular diseases of animals. When the post of deputy-director was created in 1955, his abilities were recognized by his selection for the post. During his seventeen years at the Institute, Dr. Henderson has made outstanding contributions to the advancement of knowledge on foot-and-mouth disease. He has been responsible for developing new methods which are now recognized as standard procedures for research on the disease and for the control of the preparation of vaccines. He was awarded the degree of D.Sc. of the University of Edinburgh for a thesis on the "Quantitative Study of Foot-and-Mouth Disease"; and the method of virus estimation with which this deals is now known as Henderson's method and is widely used in many research institutes.

First Companion Members of the Textile Institute

Under by-laws authorized by the supplemental royal charter granted to it last year, the Textile Institute is empowered to elect as companion members (Comp.T.I.) those of its members who in the opinion of the Council have substantially advanced the general interests of the textile industry. The Council has announced the first conferment of this honour to the following seven members, who will be formally admitted by the President at the Institute's convocation in Manchester on October 26: Mr. James Ewing, chairman and joint managing director of the Bradford Dyers' Association, Ltd.; Sir Ernest Goodale, chairman and managing director of Warner and Sons, Ltd., London, and past president of the Institute; Mr. H. G. Greg, chairman of R. Greg and Co., Ltd., Reddish; Sir John Hanbury-Williams, chairman of Courtaulds, Ltd.; Mr. J. A. Nasmith, vice-president of the Universal Winding Co., and a former chairman of Council of the Institute; Mr. S. F. Peshall, of N. Corah and Sons, Ltd., Leicester; and Sir Raymond Streat, chairman of the Cotton Board and past president of the Institute.

The Realm of the Nebulæ

It was the astronomer Edwin Hubble who said that the history of astronomy was a history of receding horizons. While research at the limit of distance remains as important as ever, developments during the past two decades have emphasized the necessity of studying the physical nature of the extragalactic nebulæ as well as their motions and distribution. This is exemplified by the articles in the September 1956 issue of the *Scientific American*, he whole of which is devoted to astronomy as elated to cosmology. The fundamental discovery of he two stellar populations has shed light on the volutionary history of a galaxy, and this has been einforced by studies of the origin of the chemical lements and of the nuclear processes which take lace in stars. Astronomers are now aware of the asic nature of interstellar material as the source of he bright stars of Population I, and when a collision f galaxies occurs the interstellar matter which they ontain is the seat of the optical and radio emissions hich are observed. A decision between evolutionary nd steady-state cosmologies is much to be desired; easurement of the red-shifts of more distant ebulæ, identification of additional distant colliding alaxies as radio sources, further investigations on he large-scale distribution of galaxies, all may ontribute to the decision. Observational programmes now in progress may indeed provide the ssential data for the solution of the cosmological roblem.

ccultations of Radio Sources by the Moon

A PAPER, by F. Link, entitled "Occultations des Radiosources par la Lune et Phénomènes Connexes" *Bull. Astro. Instit. Czechoslovakia*, 7, No. 1; 1956), eals with the possibility of occultations by the Moon f radio sources and shows the existence of a very arified lunar atmosphere. In an earlier publication 5, 112; 1954) Link directed attention to a series of uch occultations between the years 1955 and 1957, nd C. L. Seeger has also directed attention to the ame subject (*Trans. Int. Astro. Union*, 8; 1952). he investigation has more than an academic interest, nd Link refers to four matters which are of great nterest and importance: the exact determination of he positions of radio sources; the determination of he photometric profile of radio sources; the disovery of new feeble radio sources; and possible roofs of the lunar ionosphere. As the last-mentioned an modify the interpretation of the first three oints, it is dealt with first in the paper. Link oints out that different attempts based on the ptical properties of the lunar atmosphere have not o far led to definite results. Lyot and Dollfus, by easuring with the coronagraph the brightness in the icinity of the Moon's horns at the first quarter, stimated the superior limit of the density relative o that of the Earth's atmosphere at sea-level as 10^{-8} pproximately. Dollfus, continuing with the investiations and basing his research on the polarization f the light diffused by the hypothetical atmosphere f the Moon, obtained a limit of about 10^{-9}, while Kuiper, using the spectroscopic method to detect races of sulphur dioxide, gave the mass of a vertical olumn of this gas the upper limit 3×10^{-10} that of he terrestrial atmosphere. Other attempts by Lyot nd Dollfus by the method previously described did ot give such low limits. Link investigates the ubject, starting with the two factors that determine he existence of any ionosphere—terrestrial or lunar; hese are the presence of gases capable of being onized, and the ionizing solar radiation. Examining hese two factors on the Earth and on the Moon, his athematical investigations lead to the suggestion hat a lunar atmosphere of density 10^{-12} that of the errestrial atmosphere at sea-level might give observble phenomena such as the deviation of the rays nd the augmentation of their intensity. It is dmitted at the end of the paper that it is premature t present to pursue these general considerations, their aim being merely to direct attention to occultations of radio sources and the phenomena which can accompany them.

Water Resources of Great Britain

THE problem of water conservation and flood control in Britain is receiving increasing attention by the authorities concerned (see *Nature*, **176**, 1133; 1955) and, in particular, has become more widely recognized during the present year as a result of the contrasts of water shortage during a dry winter and much recurrent flooding in the course of a wet summer. The publication of the "Surface Water Year-Book of Great Britain, 1953–54" (pp. 117. London: H.M.S.O., 1956; 30*s*. net) is a welcome reminder of the work now in hand to assess the water resources of the country on a more scientific basis. This publication of the Ministry of Housing and Local Government and of the Scottish Office gives hydrographic statistics for British rivers, together with related rainfalls, for the year ended September 30, 1954, and is the first of the intended yearly issues covering periods of one water year. The two previous publications embraced eight years each, and the records were somewhat patchy and broken. The new annual issue will, it is hoped, ensure both uniformity and continuity. The new volume contains the flow records of a hundred and two stations, has the daily discharges of most, and includes discharge frequencies for certain selected stations. A new feature is the inclusion of natural water temperatures of the River Test in Hampshire and the River Avon in Somerset. It is hoped to extend these observations into a network of temperature-recording stations which will eventually provide standards of comparison to which intermediate observations, in place or time, may be related.

Standard Capacitors and their Accuracy in Practice

No. 13 in the series of "Notes on Applied Science" of the National Physical Laboratory, Teddington, which is on "Standard Capacitors and their Accuracy in Practice" (pp. 10. London: H.M.S.O., 1955; 1*s*. 3*d*. net), directs attention to the various factors which affect the performance of capacitors, both by virtue of their construction and by their method of use. The booklet is primarily concerned with capacitors designed for use as laboratory standards, and the information given is based on the wide experience gained in testing and using such instruments over many years at the Laboratory. Both air-dielectric and solid-dielectric capacitors are discussed, and separate sections deal with the inductance and resistance of capacitors and with the effects of leads on the measured values of the capacitances. Good-quality capacitors, whether with air or mica dielectric, it is concluded, provide a standard of reactance not greatly inferior in constancy to that of a good resistor, provided that proper precautions are taken in their maintenance and use. Clamped mica capacitors of between 0·1 and 1 μF. are probably the most stable, and if they are kept under moderate and uniform conditions of temperature and humidity the fluctuations about their mean values should not be more than ± 0·5 part in 10^4 on capacitance and ± 20 per cent on power factor, over a period of several years. The capacitance of a capacitor of simple geometric shape can be calculated from its linear dimensions and from the dielectric constant of the material between its electrodes, and thus in theory it should be possible to make an absolute standard of capacitance against which all other capacitors can be compared. However, absolute standards of inductance can be designed and constructed with considerably greater accuracy, and measurements of capacitance are ultimately based, in conjunction with a frequency standard, on the Campbell standard of mutual inductance which is the absolute standard of reactance at the Laboratory.

Catalogue of Nuclear Reactors

THE Chalk River Project of Atomic Energy of Canada, Ltd., with the co-operation of the Atomic Energy Research Establishment, Harwell, has prepared a "Catalogue of Nuclear Reactors 1955" (AECL No. 220; CRR-590. Pp. 60. London: H.M.S.O., 1955; 4s. 6d. net), which has been compiled from the unclassified literature and refers to reactors that are known to have reached criticality by July 1955. The catalogue includes reactors in Canada, France, Great Britain (BEPO, DIMPLE, GLEEP and ZEPHYR at Harwell and the two reactors at Windscale), Norway, Sweden, Switzerland, the United States (about forty reactors, including six at Arco, Idaho, and nine at Hanford, Washington) and the U.S.S.R. The details given for each reactor consist of brief notes covering six items—neutron speed; fuel configuration; kind of moderator; purpose (research, power, etc.); thermal power; and neutron flux—as well as constructional details and one or two useful references. Additions to, and revisions of, the catalogue will be prepared from time to time in order to keep the collection of data up to date.

Chemistry Films

A SPECIAL issue of the *Scientific Film Review* catalogues films on chemistry and allied topics (2, No. 2; June 1956). The list is derived from one compiled by the Scientific Film Association in 1949 and includes the appraisals then prepared by the Association's viewing committee. To the appraisals have been added films from many recent catalogues, one or two reviews and some foreign films. For the catalogue, chemistry has been widely interpreted so that no known film likely to be of use has been omitted. Among the sections for which films are included are agriculture, atomic physics, crystallography, laboratory techniques, industrial manufacturing processes, microscopy and public health.

International Abstracts of Biological Sciences

THE Council of Biological and Medical Abstracts, Ltd., has decided to change the title of its journal *British Abstracts of Medical Sciences* to *International Abstracts of Biological Sciences*. This decision has been brought about, first, by an extension of the scope of the *Abstracts* to a wider range of biological research subjects published in journals throughout the world, and, second, by the fact that the *International Abstracts of Biological Sciences*, with the co-operation of the specialist editors selected by the Institute of Scientific Information of the Academy of Sciences of the U.S.S.R., will include, as from the January 1957 issue, translations of important Russian papers abstracted in the *Referativny Zhurnal Biologii* (Soviet biological abstracts) and *Referativny Zhurnal Biologischekoi Khimii* (Soviet abstracts of biological chemistry), to be published simultaneously with their appearance in Russian. The *Abstracts* are published for the Council of Biological and Medica Abstracts, Ltd., by the Pergamon Press, of London and New York, on a non-profit-making basis, and the honorary editor is Dr. C. C. N. Vass. Since the Russian abstracts will have to be translated, the Council requires translators with knowledge o anatomy, animal behaviour, biochemistry, endocrinology, experimental biology, experimental medicine, microbiology, odontology, pathology, pharmacology and physiology, and would welcome offers o help. Terms of payment and other details can be obtained from Dr. C. C. N. Vass, c/o Pergamon Press Ltd., 4–5 Fitzroy Square, London, W.1, or 122 Eas 55th Street, New York 22, N.Y.

Political and Economic Planning

IN Broadsheet No. 400, entitled "PEP 1931–56" (*Planning*, 22, 141; July 23, 1956; 2s. 6d.), Politica and Economic Planning explains its purpose and methods of working, emphasizing particularly the dependence of its success on the anonymity of the groups and the insistence on the importance and nature of research in relation to public affairs. For each study it has brought together both experts skilled in various aspects of the subject under study and laymen chosen for their ability to ask the necessary questions and to hold the balance between conflicting specialists whenever necessary. For the most part, PEP has concentrated on research into the results of available research and into material and experience already gathered for other purposes, except where first-hand sample investigations have been essential. For the past two years, PEP has been engaged on two projects financed under the Conditional Aid Scheme for the Use of Counterpart Funds derived from United States economic aid. A report on the first, which will provide accounts of the work of particular trade associations and their relation with individual firms and public corporations, is due for publication later this year. The second consists of a survey of the employment entered by men graduating in a selected year, 1950, which is also to be published this autumn under the title "Graduate Employment", and a survey of the policy and practice of industrial undertakings in employing graduates. PEP is also engaged on two other major studies: one, expected to take three years, on adaptation in industry; and the other on family needs and the social services. The present broadsheet suggests that the fundamental strength of Political and Economic Planning is in its intellectua initiative and possession of the necessary qualities and resources to continue pioneering new fields and new techniques; but the report emphasizes the need for regular income and for more subsidies if the volume and quality of the work are to be maintained.

Training for Supervisors

"IF we are going to be really effective in world competition, then we must make for greater efficiency, and one of the ways of doing so is by having bette supervision." These are among the concluding words of a discussion between five people from different spheres of industrial life recorded in a booklet called "Training for Supervisors" which has been issued by the Ministry of Labour and Nationa Service. The five people—a training officer, genera manager, director, production superintendent and shop foreman—met to express their views on the conclusions of the 1954 Report of the Committee of Inquiry on the Training of Supervisors and relate these conclusions to their own experience in industry.

The group was in general agreement on three points. First, that the responsibility for training supervisors is one for senior management; second, that industrial training is ineffective if it is of a purely academic character; and third, it is no good giving the supervisor training if his status is not right in the firm. He must be regarded as a member of the management team. The booklet has been prepared in collaboration with the Central Office of Information and with the aid of a grant made available under the Conditional Aid Scheme for the Use of Counterpart Funds derived from United States economic aid. It is not for sale; but copies can be obtained on request from the Director of Public Relations, Ministry of Labour and National Service, 8 St. James's Square, London, S.W.1. The other booklets in the series deal with joint consultation in industry, the spreading of information in the factory and personnel selection.

Scientific Research at South African Universities during 1955

The fourth volume of the "Register of Current Scientific Research at South African Universities" covers research conducted during 1955 (pp. 341. Pretoria: Council for Scientific and Industrial Research). The investigations described are arranged under the name of the university department concerned, which is listed alphabetically according to its English name, with occasional subject cross-references. The actual information is given in the language in which it was received from the universities; but headings and sub-headings are in English only, and this year an English translation of the subject of research submitted in Afrikaans is included. Agricultural chemistry and agricultural engineering are indexed as sub-sections of agriculture, and all chemistry entries are entered under the one general heading of chemistry (inorganic, organic and physical). Academic degrees and full professional qualifications are given where these are ascertainable. The volume contains 545 entries.

Royal Scottish Museum, Edinburgh: Report for 1955

The annual report for 1955 of the Royal Scottish Museum, Edinburgh (pp. 16; from the Museum; 1956), is a record of steady progress, especially in the related work carried out for cultural and educational institutions. Following the example of the director, Dr. D. A. Allan, who has contacts both at national and international levels, members of the senior staff have made many personal contributions to a wide variety of educational and cultural organizations in the field of museum work. It is unfortunate that the long-needed lecture hall is still in the drawing-board stage.

Government Museum, Madras: Report for 1954–55

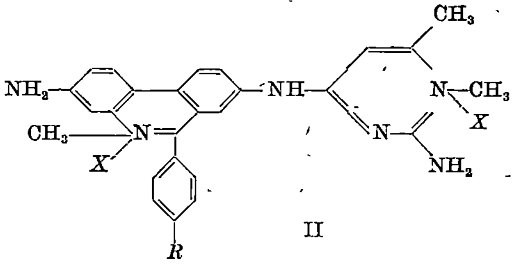
The annual report of the Government Museum, Madras, for 1954–55 (pp. 46+2 plates. Madras: Government Press, 1956) records the excellent educational work which is being undertaken by this progressive institution. Certain students in the University of Baroda have been given detailed instructions in museum methods, while other students of the University of Madras were provided with practical demonstrations in anthropology. Despite a limited staff, much preservation work has been carried out, especially in the chemical conservation section, where experiments were made concerning the electrolytic method for cleaning coins.

French Metallurgical Society

The French Metallurgical Society will hold its autumn meeting in Paris at the Maison de la Chimie during October 22–27. At the meeting the following awards will be presented: the Grand Medal of the Society, to Prof. R. F. Mehl for his work, in general, on metallurgy; the Sainte-Claire-Deville Medal, to R. Gadeau for his work on aluminium of high purity; and Rist Prizes, to F. Montariol and J.-P. Moreau. A special feature of the meeting will be a series of papers on non-destructive methods for the study and control of metals. Further information can be obtained from the Société Française de Métallurgie, 25 rue de Clichy, Paris 9e.

"Prophylaxis of Trypanosome Infections in Cattle"

Messrs. T. I. Watkins and G. Woolfe state that, in their communication under this title published in *Nature* of August 18, p. 368, they gave an incorrect structure for compound II. The correct structure is



II

Announcements

Mr. R. E. Glover, principal and dean of the Royal Veterinary College, has been appointed a member of the Agricultural Research Council in succession to Prof. G. R. Cameron, who has resigned; Prof. S. J. Watson has been appointed for a further term as a member of the Council and will continue as deputy chairman.

The fifth annual convention of the Scientific Instrument Manufacturers' Association will be held in Eastbourne during October 11–14, under the general theme of "Production 1957". There will be four panels on the following topics: general, optical and mechanical production; electrical and electronic production; research and development; and marketing. The guest speaker on the opening day will be Mr. Stanley J. Harley, of the Coventry Gauge and Tool Co., Ltd. Further information can be obtained from the Association at 20 Queen Anne Street, London, W.1.

A conference on "Gas Turbine Development", arranged by the Department of Engineering of the North Herts Technical College, Broadway, Letchworth, will be held in the College during October 20–21. There will be four papers, covering the development of the gas turbine in the following respective fields: industry; motor vehicles; ships; and aircraft. Further information can be obtained from the North Herts Technical College.

SCIENTIFIC CINEMATOGRAPHY IN GREAT BRITAIN

THE second Research Film Programme of the British Association, held at Sheffield on September 1, was opened by S. Bowler, vice-president of the Royal Photographic Society, by strongly supporting the idea of a central institute after the style of the German Institut für den wissenschaftlichen Film in Gottingen in order to raise the general standard of British research films. He was seconded by Dr. A. R. Michaelis, who had again organized the meeting on behalf of the Scientific and Technical Group of the Royal Photographic Society. Dr. V. G. W. Harrison was in the chair during the meeting, which was well attended by an audience numbering about 350 in the morning and more than 200 in the afternoon.

Outstanding among the work presented to the meeting were the two research films made by the strong team at the Chester Beatty Research Institute and University College, London. On behalf of the team, composed of P. C. T. Jones, K. Moreman (the cinematographer), D. M. Easty, M. Abercrombie and J. Santler, Dr. E. J. Ambrose introduced their film on "Interference Microscopy of Living Cells in Tissue Culture No. 2", in which epithelial cells were compared with certain carcinoma cells which develop from epithelium; interference cinemicrography in time-lapse frequency was employed throughout. This allowed not only a very clear appreciation of cytological phenomena but also often presented scientific material of great æsthetic beauty. He showed that, irrespective of their source of origin, epithelial cells formed very strong surface adhesions with each other, as distinct from carcinoma cells which moved quite independently, thus demonstrating a marked surface difference between these two types of cells.

Certain physico-chemical tests were carried out to substantiate this difference, and the negative electrical charge on the cell was measured in the presence and absence of various positive ions. The variations in the rate of movement of protein through the cell membrane in the presence of antiserum was also determined, and these changes were clearly seen in the film as rapid colour transformations in the cytoplasm of the compressed cells. The second research film from the Chester Beatty Research Institute was presented by R. J. Goldacre; it was entitled "New Aspects of Amœboid Movement". It was also recorded at time-lapse frequency, using partly phase-contrast and partly interference cinemicrography. Mechanical interference with the regulating mechanism of the polarity-conditioned locomotion of amœbæ led to the discovery of three new kinds of movement which were shown in the research film: first, rapid cytoplasmic oscillations with a frequency of 1–2 cycles per second and amplitude of 4–20 microns; secondly, cell rotation with suppression of noticeable cytoplasmic streaming and of locomotion; and thirdly, the transmission of contraction from one end of the cell to the other. In addition, interference cinemicrography was employed to investigate ingestion of phagocytosed prey by food vacuoles.

Bacterial swarming was the subject of a further interesting biological research film, presented by Drs. P. N. Cardew and H. Hughes, of the Wright-Fleming Institute and the Medical School, St. Mary's Hospital, London. It was called "The Swarming of *Proteus vulgaris*", and again time-lapse cinemicrography was employed. The growth of a single cell into a colony was followed, both on the plate and microscopically; the movements of abnormal long forms and details of swarming were clearly demonstrated. Further sequences dealt with the mutual interference of incompatible strains due to the production of primary toxic products and due to a second toxic influence, the accumulation of peroxide. That time-lapse cinemicrography is not confined to biological research topics was shown in the research film sent to the meeting by J. Newkirk, of the General Electric Company, Schenectady; it dealt with the growth, evaporation and phase-transformation of mercuric iodide crystals. The excellent use of colour in this film allowed an exceptionally clear understanding of the phenomena under investigation.

The interesting cinematographic technique of time-sampling was demonstrated in two films. The first, by J. Robertson, of the Tavistock Clinic, showed the behaviour of a two-year-old girl in hospital, when deprived of maternal care. At standard times during the day for regular intervals over 40-minute periods, the patient was filmed in order to obtain an objective record of her behaviour. Extracts from this scientific film, introduced by its author, showed clearly the marked difference in the child's behaviour when left to itself—fretting and depressed—and when playing with its mother during her visits—happy and contented. Next, Dr. P. Sainsbury, of the Westminster Hospital, presented his research film, "A Method of Measuring Spontaneous Movements by Time-Sampling Motion Pictures". He employed it as a quantitative technique for counting the gestural movements of his patients before and after leucotomy and of other patients with nervous tics; these movements are of a kind which cannot be counted individually. A signal-lamp was mounted out of view of the patient to flash at 5 or 2½ sec. intervals. Those intervals were counted as positive during which the specified movements occurred; when these movements were absent, the interval was scored as negative. Extracts from his research records were shown, demonstrating a decrease of gestural movements nine months after leucotomy. Further sequences dealt with the frequency of nervous tics of a number of patients during a variety of situations.

Colour schlieren cinematography at standard camera frequency was employed in the excellent film, "High-Speed Flow Around a Symmetrical Aerofoil", recently recorded by S. Beadle, of the Shell Film Unit at the Aerodynamics Division of the National Physical Laboratory, and introduced by A. Chinneck. Both at sub- and at super-sonic velocities, the movements of shock waves and the separation of the boundary layers were beautifully demonstrated, particularly when the air flow was increased from sub- to super-sonic velocities. The effect of changes of the angle of incidence of the aerofoil was also filmed. Cinematography at normal camera frequency has proved in the past of great value to record an experiment, which is unique, or difficult to repeat. A recent example of such use was the film "The Release of Cosmic Ray Balloons", made and introduced by J. H. Davies, of the H. H. Wills Physical Laboratory, University of Bristol. Balloon launchings extending over several years in Great Britain and abroad were filmed, and by careful analysis of these records it was possible to improve the technique considerably. The initial acceleration of the rising balloon could be reduced considerably by the use of a winch instead of employing many open-ended sandbags. Similarly, an undesirable mushrooming effect, leading to very high stresses in the envelope, could be eliminated by using a cord of undrawn nylon which stretched to several times its original length and thus allowed a gentle lifting of the heavy load.

High-speed cinematography was employed in three research films presented to the meeting. Wing Commander F. Latham, of the R.A.F. Institute of Aviation Medicine, Farnborough, began with unassisted escape from aircraft, showing the limitation of whole-body movements under sustained acceleration by comparing dummy and live-body trajectories on meeting high-speed slip streams at the commencement of free fall from aircraft exits. Camera frequencies up to 200 ft./sec. were used. The second stage, namely, of assisted escape from aircraft in the form of seat ejection, was similarly filmed and allowed a detailed physiological investigation of the tolerance of the human body to vertical impact acceleration and high-speed wind blasts. "Experiments of Sideways Launching" of ships was the next film to employ high-speed cinematography. It was extremely well recorded by C. A. Guthrie, of the Central Photographic Section of the National Physical Laboratory, often under most trying conditions. Scientific direction of this work was the responsibility of D. J. Doust, and the film was introduced by R. Silverleaf, both of the Ship Division of the National Physical Laboratory. The main problems concerned the possibility of capsizing due to insufficient stability, structural damage, and hull pressure due to impact. Full-scale launchings were filmed, sometimes from several different camera positions at the same time, and similarly model experiments with 1/18 scale models were recorded. From such experiments and these films, the performance of a variety of hull forms at launching can now be predicted and dangerous conditions of stability, way-end velocity and static drop can be avoided.

The only industrial research film presented at the meeting also employed high-speed cinematography, at a camera frequency of 1,000 ft./sec. It was made in colour and introduced by J. Underwood, of the Guest, Keen and Nettlefolds Group Research Laboratory. It dealt with "Flame Movement in an Open Hearth Furnace during Tapping" and was taken to investigate the causes of local overheating; from the resulting records it was possible to direct the research into profitable channels. During tapping the furnace is tilted, and from the research films made during this process, it became clear that the flame was not homogeneous, that patches of unburnt oil remained, and that the existence of turbulent edges showed undesirable changes of the aerodynamic conditions.

A number of comments may be submitted in this report. Out of the eleven presented, only one research film would find undisputed international acclaim—that introduced by Dr. Ambrose. Apparently only one research worker, Dr. Sainsbury, has used scientific cinematography in a metrical manner and has derived quantitative data from his research film; the majority of those presented could have been submitted to frame-analysis and would have yielded a mass of scientific information, completely lost by mere projection and visual inspection of the film. In nearly all cases a professional photographer or cinematographer was employed in the production of each film; yet much could be said in detailed criticism. These comments are strong support for the creation of a central institute from which advice, comment and specialized equipment could be obtained.

However, the general picture is encouraging and in the years to come may lead to an improved position. There can be little doubt that the aims of the organizers of this meeting were fulfilled by presenting a selection of the best research films available to an audience of scientists at the British Association. A third meeting is planned for September 7, 1957, at Dublin, and the hope can only be reiterated in this article that all those who have made new research films in the meantime will present their results; the films should be submitted to either the Scientific and Technical Group of the Royal Photographic Society or to the Scientific Film Committee of the British Association. A. R. MICHAELIS

CLIMATOLOGY IN THE SERVICE OF MAN

AT the Sheffield meeting of the British Association, Section E (Geography), under the presidency of Prof. A. Austin Miller, of the University of Reading, devoted a day to a series of contributions on "Climatology in the Service of Man", which might well be regarded as a very appropriate development following the presidential address (summarized in *Nature*, September 1 p. 474).

Prof. G. Manley opened by directing attention to the growing economic significance to Britain of the fact that we now import about 4 per cent of our fuel as coal or its equivalent. This is about equal to the difference in the requirement of fuel for heating purposes imposed by a severe season as compared with a mild one—the season comprising the months September–May. Variations in demand show an approximately linear relationship with the accumulated deficit of mean monthly temperature below a value which he took as 57° at sea-level. Official statistics of annual means back to 1866 have already been used in studies of variations in fuel demand; but for England and Wales monthly means are only available from 1901. Prof. Manley stated that his purpose was to extend our knowledge of the vicissitudes; he showed that a table of monthly means (*Quart. J. Roy. Met. Soc.*, 1953) giving representative values for the past 250 years now provides a reasonable index of the probable fluctuations of the heating requirement for the greater part of Britain. He directed attention to the occurrence in late Victorian times of the combination of a severe winter with a protracted cold spring, which if repeated would set up demands in excess of any seasons so far experienced this century, in which 1916–17 and 1950–51 gave the highest values. The highly irregular incidence of severe seasons gives as yet little reason for supposing that a protracted cold season such as occurred in the

1880's may not occur at any time. The need for further climatological research assumes greater urgency in view of our precarious fuel position.

Mr. M. Parry, of the University of Reading, followed with an appropriate reminder of the factors governing heat losses from a house. His remarks were based on studies made by the Building Research Station. Using the standard technique of degree-days, he then presented useful data from Reading, Bath and Nottingham to show the differences in fuel requirement likely to arise between houses of similar type, within and without the built-up area. Making further allowances for the wind factor, local variations of the order of 25–30 per cent in the annual fuel bill can be expected. Urban studies were rewarding.

Dr. Alice Garnett directed the attention of the audience to a variety of published studies in regard to atmospheric pollution, and went on to demonstrate the unpleasant—indeed disturbing and potentially lethal—accumulations which might be set up in certain parts of the Sheffield area, where a number of gauges have been established. Here she made effective use of maps indicating the association with local relief. She drew emphatic conclusions regarding the need for very close study of the problems which might arise from the siting of new 'industrial zones' in an area with such well-marked relief and a day-and-night outpouring of smoke.

Miss E. M. Frisby, who is working with a well-known commercial advisory and consultant organization in the United States, summarized the way in which climatological information can be presented for the use of various clients engaged, for example, in building construction in remote country, or in the processing of food crops. The comment was made that in Britain such provision of information is a public service.

The afternoon papers were primarily concerned with evaporation. Mr. G. Melvin Howe (Aberystwyth) demonstrated maps of seasonal water surplus and deficit, based on the Thornthwaite formulæ, for England and Wales. Clarity in cartographical representation is a valuable service which the geographer can and does render; a comment, however, might be that the representative character of the fundamental statistics used might be questioned in view of the local characteristics of stations to which Mr. Parry had earlier directed attention. Mr. S. Gregory (Liverpool) re-emphasized the need for water storage and conservation. In reminding the audience that since H. R. Mill geographers had taken little interest in rainfall, he summarized the type of work already done and stressed the need for further cartographical studies, especially in the north of England, where industrial demand for water is rising much more rapidly than was forecast.

Prof. B. J. Garnier, of Ibadan, brought in a welcome contribution from overseas. Irregular incidence of the short bursts of intense rainfall in Nigeria, coupled with very high evaporation, seldom much less than 4 mm. daily, explain why a slight deficiency is quickly felt. He showed how in relatively well-watered country irrigation may nevertheless be very valuable, especially as the increase in the population will soon necessitate more intensive production of food.

Mr. J. L. N. Sibbons (Sheffield), at the end of the session, taxed the non-mathematical part of the audience; he gave a carefully reasoned demonstration of the difficulty of determining the potential loss of moisture under specified climatic conditions. He showed that the assessment of evaporation-losses by the Thornthwaite method breaks down in certain unusual climates. From another point of view he showed that Penman's approach is also open to some criticism; and, taking account of Sir Graham Sutton's work, he proposed equations which would give better estimates. This was a bold and well-reasoned paper in an exacting field, and it is to be hoped that Mr. Sibbons's ideas will find outlet in print; at least one expert from the Meteorological Office was observed to be engaged in animated comment on the equations on the board.

The papers were varied, and served at least one useful purpose, in that they showed the value, as a shorthand summary of results and as a stimulus to discussion, of well-drawn maps and diagrams, although at times the observational basis may be open to question. Many in the audience were perforce little acquainted with the numerous specialized studies now forthcoming from various sources and research groups. The critically minded geographer can render a useful service in assembling and filtering such material. The geographical approach, moreover, can be illuminating, in that the results of scientific investigations can be related to a particular area and tested by the members of the audience against their own direct field-experience and observation elsewhere.

INTERNATIONAL UNION OF FOREST RESEARCH ORGANIZATIONS

CONGRESS IN OXFORD

The Twelfth Congress of the International Union of Forest Research Organizations was held in Oxford during July 7–14 under the presidency of Prof. Aldo Pavari, of Florence. At this, the first occasion on which the Union had held a Congress in Britain, about 250 delegates attended, from forty-two different countries. The Union, which was founded in 1890, is an association of forest research institutes, including universities, industrial research stations and State institutes, and its main purpose is to advance research into forestry problems. Originally a Union of Central European stations, it has steadily expanded until it now has members in all parts of the world; it is still attracting new recruits, and among recent accessions are the Academy of Sciences of the U.S.S.R. and the research stations of the Forest Service of the United States.

Most of the meetings of the Congress were held in the Imperial Forestry Institute; but the opening and closing ceremonies took place in Regent's Park College, Oxford. The Congress was formally opened by the Minister of Agriculture, Fisheries and Food, Mr. D. Heathcoat Amory, who spoke about forest policy in Great Britain and the place which research has taken in recent developments. He mentioned that much of the earlier effort was devoted to establishing crops of trees on land which had carried no tree growth for centuries; after about thirty years of effort, many of the problems of establishment have been solved, and British research workers are now turning their attention to the problems of managing forests. Work study and mechanization are being dealt with, and much interest is being taken in the effect of trees on the soil. Mr. Amory also referred to research into the qualities and properties of timber, a subject most essential to foresters, who must never lose sight of market requirements.

The work of the Congress was carried out in Sections, of which there are nine, each dealing with a different subject, and discussions continued during the week, except for a break on July 12 when delegates visited Rothamsted Experimental Station, the Forest Products Research Laboratory at Princes Risborough and the Forestry Commission's Research Station at Alice Holt, near Farnham.

The section leaders, who continue in office between Congresses, are responsible for keeping in touch with all the research workers in their respective fields of action, for circulating information of interest to members of their Section and for initiating action when this is necessary. The Section on Forest Influences, under Sir Harry Champion, of Oxford, dealt with two main subjects: the effects of shelter belts on agricultural and horticultural crops and on livestock; and the effect of forest growth on water supplies. On shelter, it was recommended that there should be an expansion of research into the influence of different types of shelter-belt on crop yields, using modern statistical methods wherever possible; in this work, closer contact with those engaged in plant and animal husbandry is of great importance. More information is needed on the effect of tree roots on agricultural crops under various conditions, on the shelter effect of scattered trees and groups of trees on pasturage and on the influence of systems of shelter belts on regional climates. The effect of forest cover on water supply is a difficult subject to treat experimentally, and the Section recommended the setting-up of a working party to study research methods and procedures. Attention was directed to the lack of comparative watershed data from the more tropical dry or seasonally dry regions, and the need was stressed for a study of the theoretical foundations and the practical application of the concept of evapo-transpiration. The Section also asked member institutes to pay more attention to research on forest influences in the humid tropics.

Under Prof. A. de Philippis, of Florence, the Section on Site Factors dealt with plant communities and their importance to practical forestry. With the help of phytosociological methods, there are many problems which can be solved quickly as, for example, the improvement of indigenous stands, the acceleration of forest successions, the conversion of forests to more favourable sylvicultural types, and the choice of species for forest plantations. The Section recommended that rules of international application should be drawn up for uniform methods of forest mapping and for uniform procedure in classifying and naming forest communities.

Dr. C. Syrach Larsen, of Denmark, and the Section on Forest Plants, spent some time in a discussion on teak, as a result of which further work on the flowering of this tree was called for as well as provenance trials. There was some discussion on the selection of stands and single trees for seed production and tree breeding, subjects in which there is at present a wide interest. Some countries, among them Great Britain, have started to compile registers of individual trees and of crops of trees which are suitable sources of seed, and the Section recommended that countries which had not started on this work should begin forthwith. Subjects to which special attention should be paid before the next Congress are methods for the mass production of seed, the place of the Mexican pines in sylviculture and provenance types of Douglas fir.

The Section on Sylviculture, under Prof. H. Leibundgut, of Zurich, dealt with methods of classifying trees and spent some time in discussing how to assess the effect of various methods of tending forest crops on growth and quality. The wide field of practical sylviculture was also dealt with.

Dr. H. van Vloten, of Wageningen, leader of the Section on Forest Protection, dealt with research into population dynamics and discussed virus diseases of insects of importance in forestry. The possibility was also examined of securing international co-operation in making trial plantations of important tree species in several continents in order to study resistance to diseases and pests.

The Section on the Study of Growth, under Prof. Y. Ilvessalo, of Helsinki, considered the methods of studying yield and growth in forest crops, the variations in yield arising from climatic factors and the determination of the amount of timber which may be cut. It was agreed to form a working-group to examine the possibility of standardizing methods of measurement and to consider how best to circulate information on instruments used in forest mensuration.

Prof. J. Speer, of Munich, presided over the Section on Forest Economics, which dealt mainly with costs in forest operations. In this field, terminology is of importance if the performance in one country is to be compared with that in another, and the Section decided to study this subject with the view of clearing up the obscurities which exist at present. It was also agreed to promote further studies on interest, which plays an important part in the long-term calculations common in forestry, and on the productivity of forest labour. This last item touches closely on the work of the Section on Operational Efficiency, which met under its leader, Prof. U. Sundberg, of Stockholm. In this Section, the two principal subjects which were discussed were medical and physiological problems in forest work, on which much research has recently been done in Sweden, and transport in the forest in relation to the efficiency of operations.

The Section, under J. Campredon, of Paris, which is concerned with the properties and uses of timber discussed the influence of site and of provenance on the quality of the timber, and recommended further research in this field in conjunction with ecologists, geneticists and physiologists. It was also decided that fresh studies should be made of methods of sampling for the qualitative study of timber.

Immediately before the Congress, the Committee on Bibliography, a body in which the Union and the United Nations Food and Agriculture Organization are jointly concerned, met under the chairmanship of Prof. E. Saari, of Helsinki. This Committee has encouraged the use of the Oxford Decimal System of Classification for Forestry and is arranging for its translation into various languages. It is also participating in the preparation of a multilingual forest terminology, and is promoting co-operation between a large number of national and regional centres of forest bibliography; the three international centres are in Oxford, Reinbek and Washington, D.C.

Towards the end of the Congress, the senior delegate from Poland, Prof. M. Kreutzinger, of Warsaw, announced that the Polish Government had decided to offer Great Britain a breeding pair of

European bison for scientific study. The bison in Poland suffered much during the two World Wars, and it is reassuring to learn that stocks of this fine forest animal are slowly building up again. Prof. Kreutzinger stated that at present there are eighty-four bison in Poland reasonably represented by sex and by age and that the annual crop of calves is now about fourteen.

The Union elected Mr. James Macdonald, director of research and education of the Forestry Commission, Great Britain, to be president in succession to Prof. Pavari, whose term of office expires at the end of this year. Dr. van Vloten was elected vice-president. The Permanent Committee of the Union was enlarged, and now consists of the following members: Dean C. F. Korstian (Duke University, North Carolina); A. Oudin (Nancy); Prof. M. Kreutzinger (Warsaw); Dr. K. L. Aggarwal (Dehra Dun); Dr. V. L. Harper (Washington, D.C.); Prof. M. Näslund (Stockholm); Prof. A. Uzcategui (Venezuela); Prof. M. Ohmasa (Tokyo); Prof. A. Horky (Vienna); Prof. T. Bunusevac (Belgrade); and a representative, yet to be appointed, of the Institut National pour l'Étude Agronomique du Congo Belge. The Union accepted an invitation from the Government of Austria to hold its next Congress in Vienna.

After the Congress at Oxford, about a hundred and forty of the delegates took part in study tours, which lasted for a week and of which seven were conducted in different parts of Great Britain. During these tours an attempt was made to show the visitors as much as possible of the research in forestry and closely allied subjects which is proceeding at the present time in Great Britain, to inform them of the major problems still awaiting solution and to give them an impression of the variety of conditions in the woodlands and forests in the country.

J. MACDONALD

SELECTION OF MANAGERS

AT the annual general meeting of Unilever, Ltd., the whole of Lord Heyworth's speech was devoted to the way this organization is managed. The Unilever organization is an Anglo-Dutch partnership operating several hundred companies in more than forty different countries; a manager is one to whom is entrusted, at whatever level, the supervision or direction of others. There are altogether some 22,600 managers in Unilever, out of a total labour force of about 270,000; managers form 8 per cent of the total. Inside the general pattern the proportion of managers to the whole varies from one part of the business to another, and from one country to another.

At one end of the scale are the plantations in Nigeria and the Cameroons, where both the country and the operations are still comparatively simple. Here the managers form only about 3 per cent of the whole. In Indonesia, on the other hand, where there is a business producing both detergents and edible fats, the proportion of managers has risen to 6 per cent. In the United Kingdom, with operations in detergents, edible fats and other foods, oil-milling and toilet preparations, the proportion of managers to the total labour force reaches 11 per cent; in Holland with the same range of operations, it is about the same. In the highly sophisticated conditions of the United States, where Unilever interests embrace detergents, toilet preparations, foods and oils and fats, the managers form 15 per cent of the total of the employees. The pattern that emerges is that the higher the degree of mechanization and the more sophisticated the environment, the higher will be the ratio of managers required.

The managers fall into three main categories. At the base of the pyramid there are the junior managers, numbering about 16,400. Of these there are some 5,000 in Great Britain and 800 in Holland. This category includes the foremen and supervisors. Next comes the large class of middle and senior managers, totalling about 6,000. At the apex is the top management, the two or three hundred people who take on themselves the decisions which make or mar the success of the business as a whole. The only test applied to determine a man's suitability to enter the managerial ranks is that of merit. No particular social or educational background is demanded. An increasing proportion of prospective managers have had a university education; but Lord Heyworth forecasts that in future, as to-day, many Unilever managers will be men who came in at one of the lowest levels, who "came up the hard way" and whose qualities of leadership were developed after they had joined the business.

Selection is a matter in which decentralization is essential. In general, it is left to the individual companies and local managements throughout the world to do their own selection, whether from within their existing ranks or by recruitment from outside. They can, and do, draw upon the common fund of knowledge and experience which has been accumulated by the personnel divisions at the Company's headquarters; as a result, the technique of selection everywhere conforms more or less to a common pattern.

One basic principle is that the qualities of the potential recruit are assessed not merely by individual interview but also by seeing him perform as one of a group; he can show whether he possesses such obviously desirable qualities as intelligence, common sense, organizing ability, and the ability to get on with others. Some men are picked primarily for their specialist knowledge, and special attention is paid to developing their general management ability in the business. The man must have the germ of leadership within him, however; it seems to be more difficult at the stage of initial selection to detect this germ in the technical man than in the non-scientist. For the man reading science at the university to-day the curriculum is so specialized, and so much time has to be spent in the laboratory and lecture room that special attention may have to be paid to help him to broaden his outlook. From Unilever experience it is known that technological skill and management ability are far from incompatible.

The most important training is that which is done individually and on the job, and this must be flexible and selective. There is no general scheme of training into which everyone will fit. Training should be tailored to measure and not ready-made. Immediately, or after a short settling-in period, a man is given a job, and in that job he starts to learn the art of being a manager. This training of the men under them is a vital part of the work of all managers, and the man who neglects it or regards it as a waste of time is unlikely himself to reach the heights.

To this basic training on the job, courses provide a most valuable reinforcement, and in these post-war years this form of training has been greatly extended. Unilever courses are of two main kinds.

There is the general course, primarily designed to give a man the broad picture of industry and its economic background and to tell him something of Unilever as a whole.

The second category, the more specialized courses, are mainly devoted to teaching a particular technique such as production study, accountancy, advertising, or some technical process.

For more senior managers the opportunity may arise of going to an outside institution such as the Administrative Staff College at Henley, Nijmegen in Holland, and the advanced courses available at such places as the Harvard School of Business Administration in the United States. People are sent to all these places, sometimes to that in their own country, sometimes abroad. Then there are the courses run by universities, summer schools of business and the like, lasting three or four weeks. Industry should make a contribution, not only by ensuring that the quality of those whom it sends as students is high, but also by seconding first-class men to assist on the instructional side. If the universities are going to develop the teaching of business administration, Lord Heyworth would favour the experiment of seconding the university teacher to industry for a year or two, and so giving him an inside view of how industry works before he returns to the university to teach.

There are certain obvious advantages in possessing a corps of managers trained up in the business, professionals who at the start of their working life have made industry in general and Unilever in particular their chosen career. But there are always the dangers of inbreeding—the tendency to rest content with things as they are and to play safe, to follow precedent, to play down initiative and originality and to keep one's nose so closely to the Unilever grindstone as to let change and development in the outside world pass by unnoticed.

It may be that more interchange from one business to another at senior levels would be no bad thing. Pension rights are sometimes a difficulty, and these should not be used for fettering a man to his present job with chains of gold. In the United States, it has become the accepted pattern for a man to move upwards by switching from one business to another without suffering any stigma of disloyalty or careerism.

COURSES IN HIGHER TECHNOLOGY

THE White Paper on Technical Education which was presented to Parliament in February indicated that the annual output from advanced courses at technical colleges should be increased as soon as possible from 9,500 to 15,000 and that, as industrial techniques develop, refresher courses would be essential to provide opportunities to enable industrial personnel to keep up to date. The London and Home Counties Regional Advisory Council for Higher Technological Education hopes that, by stimulating colleges to provide special courses in branches of engineering, science, chemistry, management, production and commerce, it is making a contribution to the country's need. These are described in a recent bulletin*. The purpose of the bulletin is to give publicity to special advanced courses held in London and the surrounding counties which do not regularly appear in college calendars or prospectuses as part of a grouped course or as subjects offered for endorsement on Higher National Certificates. They are as a rule part-time (usually evening) courses; but full-time courses which are specially arranged and are not of longer than three months' duration are also included. Short courses organized by the University of London are also described in the Bulletin.

Since the issue of the first Bulletin in August 1950 many thousands of employees have attended the courses advertised. The Council forms a link between education and industry, and requests from industry for further courses on topics of interest will be gratefully received and carefully considered.

Among the courses offered are the chemistry and technology of cosmetics, analysis of power units by the use of non-dimensional plotting, microwave techniques and measurements, pulse techniques, restrictive practices and monopolies, rate processes in solids, aerofoil theory and supersonic dynamics, and electronics for biologists.

EARTHQUAKES IN KERN COUNTY, CALIFORNIA, DURING 1952

IT is probable that no earthquake in history has been studied in the field by so many people as was the Arvintehachapi (magnitude 7·7) earthquake of July 21, 1952. This earthquake, one of the greatest three in Californian history, occasioned a series of aftershocks in the southern San Joaquin Valley, 220 of which, up to the end of June 1955, attained magnitude 4 or greater (Bull. 171 of the Division of Mines, Department of Natural Resources, State of California; by 36 authors and 16 Co-operating Agencies; pp. 283; November 1955). The focus of the shock was at lat. 35° 00′ ± ¾′ N., long. 119° 01′ ± 1¼′ W., depth about 15 km., and it occurred at 11h. 52m. 14·2s. ± 0·13s. The epicentre was near the eastern end of Wheeler Ridge on the Whitewolf steep reverse fault. This thrust has a strike N. 50° E. and is rather more than thirty-two miles in horizontal extent. B. Gutenberg has calculated that at the focus the fault plane has a dip of about 60°–66° towards E. 50° S. and that the slip along the fault at this depth when the earthquake happened was roughly up towards north in the upper (south-eastern) block relative to the lower (north-western) block. The vertical component of the slip was about 1·4 times that of the horizontal, the horizontal component corresponding to a relative movement north-east in the upper block and south-west in the lower block.

Surface measurements were made by triangulation by officers of the United States Coast Guard Service. Horizontal movements were small, and the Bear Mountain block moved north-east about two feet. Some fifteen miles south of Bakersfield the differences in elevation were 3–4 ft., the area to the south being uplifted and the area to the north lowered. The sharpest break was six miles south of Arvin, at Comanche Point. According to J. P. Buwalda and Pierre St. Amand, the earthquake did not develop a simple clean-cut trace along the fault, like the strike-slip ruptures on the San Andreas fault near San Francisco in 1906 and in the Imperial Valley in 1940, or like the dip-slip scarps on the Sierra Nevada fault along the Alabama Hills in Owens Valley in 1872, or like the fault along the east side of Pleasant Valley, south of Winnemucca, Nevada, in 1915. Instead, a complex pattern of ruptures in a zone along the fault, a half-mile or more in width, was formed. The faults were sometimes made apparent by mole-track pressure ridges. According to Hugo Benioff the volume of strained rock was $7 \cdot 3 \times 10^{19}$ cm.^{3}, the average strain prior to the shock $8 \cdot 7 \times 10^{-5}$, average stress 26 kgm. cm.$^{-2}$, purely elastic strain-energy density $6 \cdot 6 \times 10^2$ ergs cm.$^{-3}$ and creep-strain energy about 5×10^2 ergs cm.$^{-3}$.

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* Bulletin of Special Courses in Higher Technology, including Management Studies and Commerce, 1956–7. Part 1: Autumn Term 1956. Pp. 82. (London: London and Home Counties Regional Advisory Council for Higher Technological Education, 1956.) 1s. 6d.

Frank Neumann and W. K. Cloud measured the maximum ground acceleration recorded on an accelerograph of the U.S. Coast Guard Survey at Taft, thirty-five miles from the area of greatest intensity, as 0·22 *g* for a wave of period 0·22 sec. They believe that the maximum acceleration in the central area, where the intensity on the modified Mercalli Scale was 9, may have been between 0·35 and 0·5 *g*. For comparison, in the Imperial Valley earthquake of 1940, an acceleration of 0·34 *g* was registered at El Centro, four miles from the area of maximum intensity. A full account of structural damage and the lessons to be learned from it are given in the bulletin.

PROTEIN METABOLISM, RESPIRATION AND GROWTH

A SYNTHESIS OF RESULTS FROM THE USE OF ^{14}C-LABELLED SUBSTRATES AND TISSUE CULTURES

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THE proximate causes of growth and differentiation represent a great unsolved problem, while the mechanism of protein synthesis and the ability of units of the cell for self-duplication still defy explanation. To understand both normal and abnormal (cancerous) growth, the over-riding need is for greater knowledge of why cells grow by division and by enlargement. For the investigation of these broad problems, plant-tissue cultures are very suitable, and especially if cultures which are rapidly growing by random proliferation may be contrasted with similar cultures which merely remain in a state of rest, or relative inactivity. In the differences between the same tissue in these two states must be clues to many unsolved problems.

These conditions are well met by the use of small (3-mgm.) tissue explants from the secondary phloem of the carrot root, cut so far (1–2 mm.) from the cambium that cell division in the root has virtually ceased. Such tissue explants are exposed to a liquid nutrient medium under aseptic conditions which accurately reproduce their growth[1–4]. The more familiar nutrients, organic and inorganic, supplied in relative bulk, or at the level of requirement of the familiar vitamins, as in standard media for plant tissue cultures, permit only very slow growth by cell division or sluggish growth by cell expansion. However, when the nutrient media are supplemented by growth factors present in coconut milk (a fluid that typically nourishes an immature embryo), rapid growth by cell division ensues, leading to a proliferating mass of relatively small cells. Thus this tissue system may be placed, reversibly and at will, in the condition of comparative rest or of rapid cell division. Moreover, the induction of growth is evidently due to the stimulus of specific substances which supplement the nutrients in the basal medium. Therefore, the metabolic characteristics of growing and non-growing cells may be contrasted.

The extent of the coconut milk stimulus to cell division may be seen from the following. An initial carrot-tissue explant (about 3 mgm.) contains approximately 23–25 thousand cells. During the first three or four days of contact with the culture medium, even if this contains coconut milk, the explant tends to increase more by enlargement than by cell division; but, thereafter, the number of cells in the culture increases very rapidly, reaching approximately 200,000 in about seven days and approximately 340,000 in about twelve days. In this large number the cells so produced remain very much smaller than their counterparts in the original tissue and they are also very much smaller than the cells of similar tissue explants which remain in media unsupplemented by coconut milk and in which their rate of cell division is by comparison slow. (After twelve days in a normal basal tissue culture medium the number of cells per explant increases to about 31,000.)

The effects of the coconut milk are now attributable to certain specific substances. Some of these have been isolated from the coconut milk itself and obtained in the crystalline form, although they are not as yet fully identified (compounds *B*, *C* and *F* of Shantz and Steward[5,6]). Some, as for example compound *A* of Shantz and Steward[7], have been both isolated and identified (1,3-diphenylurea), and still others, obtained both from coconut milk and other sources such as the immature fruits of *Aesculus*, have been generally identified as belonging to a definite class of chemical substances, for example, the leucoanthocyanins[8]; and still other synthetic substances (benzthiazolyloxyacetic acid) have been found to be unexpectedly effective in stimulating cell division in this tissue system[8]. 6-Furfurylaminopurine (the substance 'kinetin' of Skoog, Miller *et al.*[9]) is apparently not a naturally occurring substance but is derived from nucleic acid by the action of heat, etc.; this substance causes cell division in carrot tissue in the presence of indoleacetic acid, but not nearly to the extent of coconut milk.

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The present article is a résumé of work carried out on carrot-tissue explants placed, by the use of coconut milk, in the conditions of rapid growth and also, by withholding it, retained in the conditions of very slow growth. The general plan was to find the different ways in which the tissues use certain ^{14}C-labelled compounds, supplied exogenously as substrates for respiration and protein synthesis. However, quite unexpected conclusions could also be drawn, and these have a very direct bearing on the differences between fast-growing cells on one hand and the slow-growing cells on the other; they also bear upon the specific effects of the substances, natural or synthetic, that induce growth by cell division.

Experimental Design

The entire experiment was carried out on a uniform population of carrot-tissue explants from the same root. In a pre-period of seven days the explants were allowed to establish the two contrasted states desired, namely, the growing state in presence of coconut milk and the relatively non-growing state in its absence. At this point the exogenous treatments with the radioactive substrates were given, and their effects were followed over the ensuing five days, tissue samples being obtained at approximately daily intervals. In this way the effects of each substrate were determined and their time course observed. At each sampling period the following observations were made: (1) The fresh weight of the tissue explant. (2) The total amount and specific activity of the respired carbon dioxide evolved during the period. (3) The tissue was extracted with alcohol, and upon this extract subsequent chromatographic and radioautographic observations were made. (4) The alcohol-insoluble portion of the tissue was hydrolysed and the resultant extract was again subjected to subsequent chromatographic analysis. (5) The external solution was analysed to determine the change in the radioactivity which had occurred.

By the application of paper chromatographic methods combined with appropriate procedures of radioautography, the following determinations were made: (1) All the identifiable nitrogen compounds present in both the alcohol-soluble extract and the acid hydrolysate of the alcohol-insoluble material were determined quantitatively. This was done using a phenol/collidine–lutidine system. For each of these constituents, eluted from the paper, the total radioactivity was determined, and the specific activity was calculated. (2) A similar procedure on the same chromatogram was applied to the sugars, fructose being determined separately, glucose and sucrose combined as one sample.

Combining the data from the growth of the tissue cultures and the analytical data, one can calculate the *total amounts* of each constituent present in a tissue explant at a given time and thus determine the absolute changes which occurred with time as a consequence of the experimental treatments. The radioactive substrates supplied singly in trace amounts to the media of both growing and non-growing tissue were as follows: (1) ^{14}C-uniformly labelled glucose obtained biosynthetically from tobacco leaves by Dr. P. V. Vittorio, of Queen's University, Kingston. (2) Uniformly labelled ^{14}C-glutamine obtained biosynthetically from Swiss chard leaves by one of us (R. G. S. B.). (3) Uniformly labelled ^{14}C-γ-aminobutyric acid obtained from the glutamine by use of a suitable decarboxylase preparation, this conversion being carried out by one of us (E. W. Y.).

In the choice of these substrates the ideas were as follows. The use of ^{14}C-labelled sugar was expected to show the extent of the direct use being made of glucose in the processes of respiration leading to evolution of carbon dioxide and also the ease with which this sugar enters into other concomitant metabolic reactions, such as those of protein synthesis. Glutamine looms large in all modern ideas of plant nitrogen metabolism and it was regarded as a most likely point of departure for protein synthesis: by the use of ^{14}C-labelled compound it was expected that this could be traced. Since its discovery, γ-aminobutyric acid has been regarded as a possible decarboxylation product of glutamic acid[10]. The experiment offered the opportunity to test whether the γ-aminobutyric acid merely acted as an alternative source, by carboxylation, of glutamic acid, or indeed, whether the tissue could utilize this substrate at all.

Role of γ-Aminobutyric Acid in Relation to Glutamine

γ-Aminobutyric acid in higher plants has been thought to arise by decarboxylation from glutamic acid[10]. However, the radioautographs and the specific activity data, etc., show very clearly that when γ-aminobutyric acid is supplied to the tissue it passes readily to glutamic acid and glutamine and then into other nitrogenous substances. On the other hand, when ^{14}C-glutamine is supplied the conversion to γ-aminobutyric acid is slight and even negligible after 100 hr. One must therefore regard γ-aminobutyric acid, now known to be of very frequent occurrence free in plants, not merely as a waste or decarboxylation product of glutamic acid, but rather as a substance which is en route to glutamic acid and glutamine. Whatever the method of its use or synthesis, γ-aminobutyric acid is now to be regarded as an important metabolite capable of donating both carbon and nitrogen in the active metabolism of growing and non-growing plant cells[11].

For purposes of the comparisons required, the basis to which the analytical data were calculated was the individual tissue explant. Proceeding in this way the *total amount* of each metabolite present in a single culture was recorded, or calculated, so that the absolute changes of these substances with time could be determined. Owing to the rigorous control achieved under the experimental conditions it was possible to carry out all these various processes with gratifying accuracy.

Specific Activity of Tissue Metabolites and its Interpretation

When first recorded, the total radioactivity present in a given substance in the tissue was represented not merely in the units 'total counts per minute' but as the equivalent weight (μgm.) of carbon with the same activity as that of the source: the specific activity of the carbon in the compound therefore becomes the percentage of the carbon present in the compound which had the same activity as the source. Thus the specific activities of the compounds present in the tissue are always represented by percentages of the specific activity of the source supplied. However, it became evident that it was possible for a compound in the tissue to have a specific activity *greater* than the metabolite within the tissue from which it must have been derived. Re-evaluating this situation, we became impressed by the following facts.

Since the cell is a heterogeneous system, it is entirely possible for two immiscible metabolic pools to co-exist and to contain the same substrate, which may be subject to different reactions or to similar reactions proceeding at different rates. Thus, it may arise that a given compound may be subject in a given time to increase from one source and decrease from another; that is, there may be both entry and withdrawal from the total complement of this substance in the cell. Thus, carbon of high specific activity may be entering the substrate in question in one cellular phase, while carbon of low, or zero, activity is either entering or leaving that same substance in another phase. Since on analysis the two phases become mingled, the average specific activity of the compound in the cell as a whole may bear no direct relationship to its place in a metabolic sequence of events.

To clarify such situations, the additional information that is required is the *specific activity* of the carbon which is in transit *to and from the metabolite in question.* In order to obtain this, the following data were necessary: (1) the change in a given period in the total carbon contained in the metabolite in question; (2) the change in the same period in the activity contained in the metabolite in question.

From this, by dividing (2) by (1), the specific activity of the carbon *in transit* may be determined. Thus, throughout the investigation it was found necessary to record changes in the metabolites in the following way: (1) the change in the total carbon present in the metabolite (Δ total C); (2) the change in total activity, recorded by its equivalent of carbon ($\Delta \text{ C} \equiv$ activity); (3) the specific activity of the carbon appearing in, or disappearing from, the pool of the substance in question, recorded as a percentage of the specific activity of the carbon in question

$$\left(\frac{\Delta \text{ C} \equiv \text{activity}}{\Delta \text{ total carbon}} \times 100\right)$$

The utility of this form of analysis may be illustrated by some of the results obtained with reference to glutamine and glutamic acid; these are summarized in Table 1.

From Table 1, it is not surprising that the glutamic acid actually present in the tissue achieved during the period had nearly the same activity as the carbon source which was supplied. It is more surprising, however, that the glutamic acid derived from glutamine actually had higher specific activity than the glutamine contained in the tissue. This obviously means that there is a non-radioactive pool of glutamine in the tissue; but the other conclusion which follows is that the glutamic acid in the tissue must have been derived from the active pool of glutamine, not from the inactive pool. Thus the two pools of glutamine must have been separated in the cell. From the last column in Table 1, it is apparent that two-thirds of the carbon involved in the *change* in glutamine content of the tissue came from an active source and one-third from an inactive source, whereas the corresponding figure for glutamic acid is obviously anomalous. The carbon involved in the metabolic change of glutamic acid during the period apparently came from a source which had a specific activity more than twice that of the ultimate source of the activity in question. The anomaly referred to in connexion with glutamic acid is but one of several types of anomalous result that are encountered under this mode of procedure. Such anomalies are of the following kinds in which the metabolic change may seem to have been mediated by (1) carbon far richer in activity than its actual source, (2) carbon far less active than that actually supplied, (3) by carbon of an infinitely high activity, or (4) by carbon of an activity that appears to be arithmetically negative. Obvious explanations which cover these various type situations are:

Table 1. FREE GLUTAMIC ACID AND GLUTAMINE IN THE FAST-GROWING CARROT TISSUE SUPPLIED WITH ^{14}C-GLUTAMINE DURING PERIOD 1 (0 to 22 hr.)

Tissue metabolite	Specific activity of C*	Δ Total C†	$\Delta \text{ C} \equiv$ Act.‡	$\frac{\Delta \text{C} \equiv \text{Act.§}}{\Delta \text{ Total C}} \times 100$
Glutamine	66	261	175	67
Glutamic acid	99	19	44 3	233

* As per cent of specific activity of the carbon in the supplied glutamine.

† Change in μgm. of carbon in the metabolite present in 10 explants.

‡ Change in μgm. of carbon of the same activity as the source to account for the change in total activity in the metabolite.

§ The apparent specific activity, as a percentage of that of the source, of the carbon in transit to the metabolite.

(1) This refers to a situation in which there is concurrent disappearance of the inactive compound from one cellular phase while it is increasing in the radioactive form in another. This leads to the apparent use of carbon of a specific activity higher than the source.

(2) In this situation the specific activity appears to be less than that of the source: this could arise either by dilution of the active compound by the inactive metabolite, or else by the concurrent appearance of the inactive compound synthesized in one phase while it is increasing in the radioactive form in another.

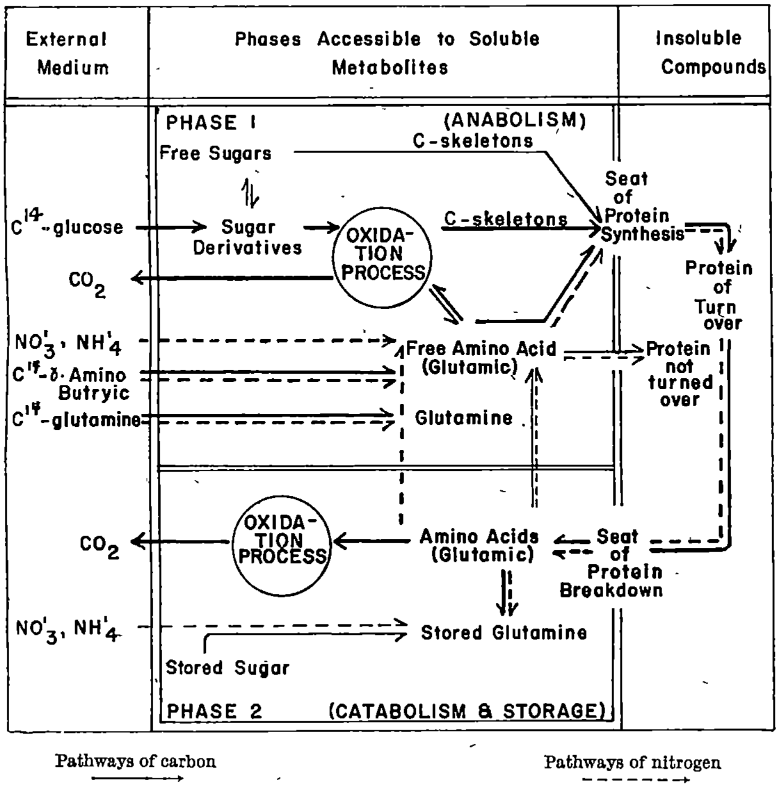
(3) Here the carbon involved in the reaction appears to have been of infinitely high activity: this must imply that there is no net change in the metabolite in the cell as a whole, although there has been synthesis of the radioactive compound in one phase with concurrent disappearance of its inactive form from another phase.

(4) This situation is one in which the carbon involved in the metabolic reaction during the period appears to have negative activity. This anomaly results when there is a decrease in the metabolite in the cell as a whole, during a period in which some radioactive synthesis occurred, or again by a greater increase of the inactive compound in the cell than there is decrease of the radioactive compound in the cell.

While there is nothing intrinsically new in these ideas, the merit of this method of formulation is that the unusual and anomalous events become immediately obvious so that they can be subjected to further analysis and interpretation. In one way or another, all the type situations indicated above were encountered in the experiments in question, and this compels the interpretation of the data in ways which take account of the separation of the metabolites in different phases in the cell and the existence, in these phases, of concurrent and different reactions.

Interpretation of the Respiring, Synthesizing Cell in Terms of Separate Phases or Compartments

The entire body of data may be comprehended in terms of the scheme which is illustrated in Fig. 1.



Pathways emphasized by the experimental treatments are indicated by heavy lines

Fig. 1. Diagram to illustrate the main metabolic pathways in cultured carrot tissue explants

Comment on this scheme will be in two parts: first, the novel features will be stressed; and second, sufficient data will be given to indicate how it rests on experimental evidence.

(1) An important, though certainly not new, feature of the scheme is the idea that protein participates in respiration and contributes to the carbon dioxide. This idea, probably first stressed by Gregory and Sen[12], has also been used for explaining certain characteristics of tissue slices[13,14].

(2) The scheme is based upon the recognition that the cellular organization provides for different phases in which compounds may exist without equilibration and may participate in distinct metabolic reactions. In phase 1 the emphasis is on anabolism and protein synthesis; in phase 2 the emphasis is on catabolism, protein breakdown and storage. In both these phases oxidation processes are conceived to occur with the ultimate formation of carbon dioxide. The oxidation processes in both phases may well involve the same enzymatic systems, the distinctive feature of phases 1 and 2 being rather the accessibility of the enzymes to the products of protein breakdown on one hand (No. 2) or to the seat of protein synthesis on the other (No. 1). At this stage no attempt is made to identify the phases with known morphological features, or even to recognize a degree of geographical separation beyond that which is imposed by selective accessibility of particular substrates to the enzymes in question. In other words, there are areas within the cell which are specialized for these particular metabolic functions.

(3) The scheme recognizes that amino-acids and amides, when they are supplied exogenously, or arise from protein breakdown, are separated in the cell, and active protein synthesis is thus relatively independent of the pool of free amino-acids and amides. In these circumstances, protein synthesis is not visualized as the mere condensation of the *free* amino-acids; but carbon skeletons, largely derived from sugar, condense with nitrogenous groups (for example, from glutamine and glutamic acid), and these are embodied in the protein molecule at the seat of synthesis. If amino-acids are intermediates in this synthesis, then these molecules may not occur free and they do not permeate the cell as a whole.

(4) The scheme also recognizes that continuous turnover of proteins takes place, but that different moieties of the cell proteins may participate therein to a different degree. It is the pace of protein turnover that determines, by supplying nitrogen-free residues, the rate of carbon dioxide evolution by this pathway (phase 2).

The main lines of experimental evidence which led to the formulation of Fig. 1 are summarized below and illustrated by some representative data shown in Tables 2 and 3.

(1) The scheme depends first upon the fact that separate metabolic phases exist in the cell. This

Table 2. SPECIFIC ACTIVITY OF THE CARBON IN THE COMBINED AMINO-ACIDS DERIVED FROM VARIOUS ^{14}C-LABELLED SUBSTRATES, PERIOD 5 (109 hr.)

Amino-acid in protein	^{14}C-labelled substrates supplied		
	^{14}C-glucose	^{14}C-glutamine	^{14}C-γ-aminobutyric
Glutamic acid	46	28	8·5
Aspartic acid	43	22	10·2
Alanine	50	2·5	—

Table 3. SPECIFIC ACTIVITY OF THE CARBON IN THE RESPIRED CARBON DIOXIDE AND IN THE COMBINED AMINO-ACIDS DERIVED FROM ^{14}C-LABELLED COMPOUNDS

Period 2 (22–40 hr.). Periods 4 and 5 (61–109 hr.)

^{14}C substrate	Specific activity in sugar in tissue		Specific activity of combined glutamic acid		Specific activity of respired carbon dioxide	
	Period 2	Period 4–5	Period 2	Period 4–5	Period 2	Period 4–5
Glucose—rapidly growing tissue	40–55	71	N.D.	46	46	74
Glucose—slowly growing tissue	26–29	48	low	46	34	76
Glutamine	0	1·4	22	28	18·4	24·6
γ-Aminobutyric	0	1·1	2·3	8·5	7·7	14·1

conclusion follows from the type of evidence presented in Table 1, of which a salient example is as follows: The specific activity data require that there is a source of storage glutamine which is distinct from, and does not mingle with, the glutamine that passes via glutamic acid and other amino-acids into the protein. The specific activity of glutamic acid in the tissue is found to be higher than that of glutamine, which is compatible with a source of inactive glutamine in the cell. Also, the specific activity of the free glutamic acid is approximately that of its source and it is found to remain consistently high throughout the course of the experiment. Therefore, if there is any other glutamic acid that arises during the course of metabolism this must occur elsewhere, for it cannot mingle with the radioactive glutamic acid that is incorporated into the protein; moreover, any such inactive glutamic acid must be rapidly converted to some other form, for example, glutamine.

Since the production of radioactive glutamic acid from the ^{14}C-glutamine supplied has been identified with protein synthesis in phase 1, then the production of inactive glutamine after protein breakdown, which, as indicated, must take place in a separate phase, is therefore identified with phase 2. By the same token, any glutamic acid that arises by protein breakdown also appears in phase 2, and protein breakdown, in contrast to synthesis, is also identified with phase 2.

(2) The specific activity of the free amino-acids in the tissue is not related to the activity of the amino-acids in the protein. Without giving the detail, the specific activities of the amino-acids which acquire ^{14}C-label in the protein tend to be about the same, whereas the specific activity of the free amino-acids vary from one compound to another. The results also show that ^{14}C-glucose was more effective in labelling the protein amino-acids even than such ^{14}C-labelled nitrogen compounds as glutamine and γ-aminobutyric acid. In fact, ^{14}C-labelled glucose actually labelled glutamic acid in the protein more effectively than did ^{14}C-labelled glutamine, which gave rise directly to glutamic acid (see Table 2). Therefore, this is the sort of evidence which leads in Fig. 1 to the suggested use of carbon skeletons, mainly derived from sugar, as the chief source of carbon in the protein synthesized. Furthermore, this feature emphasizes that the anabolic metabolism of glucose to protein is mainly associated with phase 1.

(3) Fig. 1 is also built on the presumption that protein turnover must take place. This conclusion follows because the amount of radioactivity incorporated into certain protein amino-acids, with due regard to the amount of protein synthesized and the specific activity of the carbon source, could not be accounted for apart from alternating protein breakdown and re-synthesis. This point will be discussed later.

(4) The specific activity of the carbon in the evolved carbon dioxide tends to run parallel to the specific activity of the carbon in the protein; but it does not vary directly as the activity of the carbon in sugar; this is especially true of tissue treated with ^{14}C-glutamine and ^{14}C-γ-aminobutyric acid. When the tissue was treated with ^{14}C-labelled glucose, there was a tendency for the specific activity of the carbon in the carbon dioxide to reflect that in the sugar, but in fact it often exceeded this, especially in the later periods of the experiment; but here again the specific activity of carbon in the carbon dioxide reflected that in the protein. All this evidence indicates that part of the carbon dioxide be derived from an alternative source to sugar, and this source may well be protein. However, despite the evidence of protein turnover, there was no conspicuous accumulation of the freed amino-acids; specifically, glutamic acid could not have accumulated (see (1) above), though some glutamine did arise from protein breakdown. Presumably, therefore, the amino-acids that arise from protein breakdown are freely utilized as to their carbon in respiration and as to their nitrogen for re-synthesis of protein.

(5) Whereas some of the amino-acids which arise from protein breakdown might be regarded as re-available for protein synthesis by drift from phase 2 to phase 1, the results require that this could not have occurred appreciably for glutamic acid. Since the conclusions with respect to protein turnover are based on results of radioactivity, this transfer might have occurred with some of the amino-acids which never acquired ^{14}C-label during the experiment; but it could not have occurred to any great extent with respect to those amino-acids which did become so labelled. Also, some of the inactive glutamine which accumulated in phase 2 could have been derived from exogenous sources of nitrogen and from non-radioactive stored sugar. However, this could not have occurred from the sugars present in phase 1 to an appreciable extent, for this would be incompatible with the specific activity data.

(6) When the formation of metabolically active protein is accentuated during growth its synthesis is intimately related to the stimulus to respiratory activity. This will be discussed below.

(To be continued)

[1] The presence of Prof. E W. Yemm, of the University of Bristol, England, as a Visiting Rockefeller Fellow in the Department of Botany at Cornell University provided the occasion for a re-investigation of the use of glutamine and γ-aminobutyric acid by plants and especially by carrot tissue cultures. The facilities for the experiments employing tissue cultures, with and without coconut milk, under the standardized conditions which are required were already well established in this Department and, with the assistance of Miss K. Mears, these facilities were being used in a variety of investigations supported by the National Cancer Institute of the U.S. Department of Health, Education and Welfare. At the planning stage the role of glutamine had been discussed by one of us (F. C. S.) with Prof. G. Krotkov, of the Department of Biology, Queen's University, Kingston, Ontario, and to his interest in the problem we owe the supply of the ^{14}C-labelled substrates which were used. One of us (R. G. S. B.) from the laboratory at Queen's University undertook the responsibility for the radioactive measurements, leading to the specific activity determinations of the various metabolites studied. The necessary chromatographic separations and the use of quantitative paper chromatography and radioautography were carried out in the Department of Botany at Cornell University, and in this work we wish to acknowledge the help of Dr J K. Pollard, Mr. David Margolis and Mrs. Greenwood, all working with one of us (F. C. S.).

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Interactions of Ribonucleotide Polymers with Tobacco Mosaic Virus Protein to form Virus-like Particles

THE purified protein and ribonucleic acid constituents of tobacco mosaic virus can be combined *in vitro* to form infectious nucleoprotein rods which resemble the original virus in size and shape and which have their nucleic acid surrounded by protein as in the virus[1]. Although the viral nucleic acid is necessary for infectivity, the formation of rods seems to depend on an inherent property of the viral protein; the latter can be aggregated in the absence of nucleic acid to form cylindrical tubes which superficially resemble the virus[2] but possess no infectivity. When the viral nucleic acid is present, it occupies a region within the tube and apparently serves to 'cement' the protein sub-units together, since the nucleoprotein particles are stable at *p*H values higher than those at which the protein tubes disintegrate[2]. This cementing function might be thought to depend on some property specific to the nucleic acid of tobacco mosaic virus. In order to investigate such a possibility, we have studied the interactions of the viral protein with several widely differing artificial and natural ribonucleotide polymers.

The artificial polymers were gifts from Dr. S. Ochoa and had been prepared by the action of *Azotobacter vinelandii* polynucleotide phosphorylase on various nucleoside diphosphates[3]. They comprised four single-nucleotide polymers containing, respectively, adenylic, cytidylic, uridylic and inosinic acids; and two 'mixed' polymers: adenylic-uridylic acid polymer and a polymer containing the four nucleotides adenylic, guanylic, uridylic and cytidylic acids. From chemical end-group determinations[4], the approximate mean numbers of nucleotide residues per chain have been found to be: adenylic-polymer, 270 residues; adenylic-uridylic-polymer, 120 residues; and adenylic, guanylic, uridylic, cytidylic-polymer, 30 residues.

Two preparations of yeast ribonucleic acid were also tested. One sample, having a molecular weight of the order of 10^5, was a gift from Dr. F. Worthington Allen[5]. The other yeast nucleic acid was prepared by dialysing a commercial sodium nucleate (Schwartz Laboratories, Inc.) against distilled water and collecting the material which passed through the dialysis tubing. A nucleic acid prepared in this way would be expected to consist of chains of the order of five residues in length[6].

The following mononucleotides were also tested as controls: (1) adenosine 5′ diphosphate; and (2) a mixture of the three adenosine monophosphates (2′-, 3′- and 5′-) prepared by mixing 3 parts yeast adenylic acid with 2 parts adenosine 5′ phosphate.

In the reaction mixtures, a solution containing 2 mgm./ml. tobacco mosaic virus protein (prepared by Dr. H. Fraenkel-Conrat[1]) and about 1 mgm./ml. nucleic acid or mononucleotide was brought to 0·03 *M* in acetate by the addition of 3 *M* acetate buffer at *p*H 6. The mixtures were allowed to stand overnight at about 5° and were then dialysed two or more times against distilled water which had been adjusted to *p*H 7·6 ± 0·2 by the addition of sodium hydroxide. Finally, they were centrifuged for 45 min. in a field of $10^5 g$ and the pellets were resuspended in 'Pyrex'-distilled water for examination with the electron microscope.

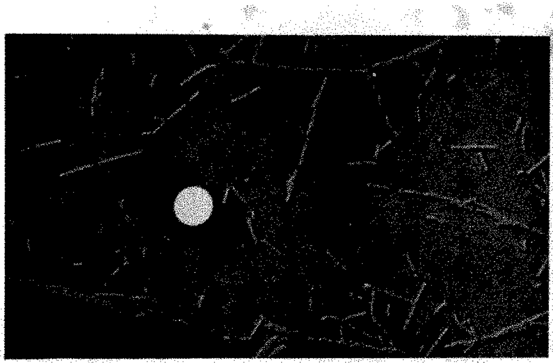

Fig. 1. Nucleoprotein rods made with tobacco mosaic virus protein and a high-molecular weight polymer of uridylic acid. The rods are of the same apparent width as tobacco mosaic virus particles. Included for size comparison is a spherical particle of polystyrene latex having a diameter (260 mμ) nearly equal to the length (300 mμ) of the normal virus particles. × 25,000

All preparations containing any of the nucleotide polymers were found to be aggregated into rods of the same apparent width as tobacco mosaic virus but of various lengths (Fig. 1). The distributions of rod-length appear, from preliminary observations, to be much the same for all the polymers and to be therefore independent of the molecular weight and composition of the ribonucleic acid. The protein without nucleic acid could be made to form similar rods by lowering the *p*H to 6, but all such controls became disaggregated during the dialysis and yielded relatively small centrifugal pellets consisting of disk-shaped particles with central holes[7]. Likewise, the preparations containing mononucleotides failed to yield rods in the pellets.

Ultra-violet absorption measurements of the resuspended pellets indicated that the rods consisted of nucleoproteins resembling tobacco mosaic virus in nucleic acid content. After clarifying several of the resuspensions with alkali (0·01 *M* sodium hydroxide in the presence of 0·06 per cent sodium dodecyl sulphonate), diluting and neutralizing, absorption spectra were obtained which could be graphically resolved into the spectra of the separate protein and nucleic acid components. (Appropriate component spectra were obtained from solutions of the protein and nucleic acids which had been subjected to the same clarification treatments as those used with the nucleoproteins.) These analyses were done for the adenylic- and uridylic-polymer nucleoproteins and for the nucleoprotein made with the high-molecular weight yeast nucleic acid. In each case, the nucleic acid appeared to constitute about 4 per cent of the mass. Direct phosphorus and nitrogen determinations on one sample of adenylic-polymer nucleoprotein indicated a nucleic acid content of approximately 6 per cent The nucleoproteins further resembled tobacco mosaic virus in that incubation with ribonuclease caused no appreciable hydrolysis of the nucleic acid component.

Several of the pellets, resuspended in equal volumes of water, were rubbed on the leaves of various plants to test their ability to produce disease symptoms. The nucleoprotein inocula contained about 0·5 mgm. protein per ml. Those containing adenylic-polymer and adenylic, guanylic, uridylic, cytidylic-polymer were compared with the resuspended pellet from the protein control on opposite half-leaves of *Nicotiana glutinosa* and a variety of *N. tabacum* containing the *N. glutinosa* gene for the production of local lesions (Holmes[8]). None of the preparations gave local lesions on *N. glutinosa*. On the Holmes variety the mean numbers of tobacco mosaic virus lesions per half-leaf were; protein alone, 0·28; protein plus adenylic-polymer, 0·25; protein plus adenylic, guanylic, uridylic, cytidylic-polymer, 0·05. The lesions can be accounted for by a very small virus contamination in the viral protein preparation. (Comparable numbers of lesions are produced by inocula containing tobacco mosaic virus at a mass concentration 10^{-6} times that of the nucleoprotein solutions used here.) No symptoms were produced on *N. tabacum*, var. Turkish, *N. sylvestris*, *Lycopersicum esculentum* or *Datura meteloides*. Preparations containing cytidylic-, inosinic- and uridylic-polymers were tested only on the Holmes variety and also gave no more lesions than could be accounted for by the virus contamination in the protein.

The failure of these nucleoprotein particles to cause disease symptoms is consistent with the current idea that the biological action of a nucleic acid depends on the exact arrangement of its nucleotide residues. The present results indicate, however, that this arrangement may have little to do with the ability of a ribonucleic acid to form stable, organized complexes with protein. In view of the great diversity in the length and composition of the polymers tested, one might conclude that any ribonucleic acid (but not a mononucleotide) would interact with tobacco mosaic virus protein in the same way.

We are grateful for the advice and help of Prof. Robley C. Williams.

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Solubilization of Water-insoluble Mucopolysaccharides and a New Method for the Preparation of Blood-Group Substances

STUDIES of native secretions or tissue extracts which contain mucopolysaccharides are frequently difficult because, after isolation and partial purification, a considerable part of the mucopolysaccharide in the original material has become insoluble in water or saline.

This particular change in solubility occurs during the recovery from human and animal tissues and secretions of mucopolysaccharides which possess specific serological properties characteristic of the ABO and 'Lewis' blood group systems. These materials have been most frequently isolated by extracting dried native cyst fluids or tissue extracts with 90 per cent liquid phenol[1], whereas tissues are subjected to peptic hydrolysis to release the specific substances before extraction with phenol[2]. Blood-group materials from either source are mostly found to be insoluble in 90 per cent phenol; but if soluble, as they sometimes are after treatment with pepsin, they are readily precipitated from this solvent with low concentrations of ethanol. The accompanying proteins are soluble in 90 per cent phenol and are readily eliminated.

It is found, however, that group-specific mucopolysaccharides prepared in this way frequently yield material which is only partly soluble in water or saline. Sometimes the water-insoluble moiety constitutes the major part of the substance obtained and in consequence the method of isolation must be considered unsatisfactory. Paramucin, a material of considerable interest as a source of human blood-group substance, occurs naturally as a water-insoluble gel; it is the 'trembling jelly' type of mucin first described by Mitjukoff[3]. Large amounts occur in certain ovarian cysts; but it cannot be brought into solution until partially hydrolysed with acid or alkali, procedures which must be avoided if the original immunological properties of the material are to be preserved. Similarly, serological investigations of human saliva for purposes of certain genetical studies[4] must be made on the whole of the serologically reactive components in the native secretions, and the results must be considered unsatisfactory if only part of the specific mucopolysaccharide complexes contained in the test fluid are soluble in saline and thus available for examination. Water-insoluble forms of the mucopolysaccharides are frequently produced during purification, storage at low temperature and by heat treatment to remove free protein, to inactivate enzymes or to maintain sterility.

It is known that water-insoluble materials of this kind can sometimes be solubilized in strong solutions of urea or certain inorganic salts, like potassium thiocyanate; but in our experience removal of the peptizing agent by dialysis usually results in the recovery of a material which has no greater solubility in water or saline than the starting substance.

It has now been found that these different kinds of water-insoluble mucopolysaccharides can be rendered soluble in water by treatment with ficin, an enzyme preparation from fig latex. When the water-insoluble materials are treated in buffer at *p*H 7 with 0·1–1 per cent by weight of purified ficin, activated with potassium cyanide or cysteine and versene, they dissolve rapidly to yield clear, viscous solutions which retain their blood-group specific characters unimpaired. Group substances obtained after ficin treatment of the water-insoluble materials derived from pseudomucinous ovarian cysts possess the same composition and group-specific serological properties as do substances which are insoluble in phenol and soluble in water obtained from the same cyst material by the usual technique[2]. Prolonged (48 hr.) treatment of purified group substances, isolated without the use of ficin, with large amounts (5–10 per cent w/w) of purified ficin yield materials which show no obvious change in chemical composition or destruction of their original (ABO) group specificity. However, the solubility of the resulting materials in 90 per cent phenol, their lower viscosity and their behaviour in the ultracentrifuge, reveal that the preparations are more polydisperse and have a smaller average molecular size, although remaining electrophoretically homogeneous at *p*H 8. The physical properties of these materials are being studied with our colleague, Dr. R. A. Kekwick, and the underlying process which brings about solubilization of the water-insoluble mucopolysaccharide materials is being further investigated. The lysozyme component of the commercial ficin does not bring about the solubilization of the substances studied.

An alternative procedure which does not involve the use of phenol for the isolation of the specific blood-group substances is long overdue as, with one exception[5], almost all the group-specific mucopolysaccharides described in the literature which have been thoroughly examined by chemical, physical and immunochemical methods have been treated with phenol at some stage in their preparation[6]. The stability of the group substances on treatment with ficin and the powerful proteolytic activity of this enzyme preparation on many proteins prompted us to examine the possibility of using ficin as a means of removing the non-specific protein in native cyst fluids and saliva, and thus allow the specific substance to be recovered from them by dialysis and simple fractionation from aqueous solution by inorganic salts or organic solvents. By the use of ficin it is possible to carry out rapidly at *p*H 7 the isolation of the group-specific materials from tissues and secretions, and the resulting serologically active mucopolysaccharides recovered have the same qualitative composition as, and similar analytical figures to, the materials isolated by the usual phenol-extraction technique. Occasionally cyst fluids have yielded active group materials which possess higher nitrogen values (10–11 per cent) and lower fucose contents (6–7 per cent) than those obtained by the phenol method. Full details of the solubilization of water-insoluble mucopolysaccharides and the alternative method for the preparation of group-specific substances will be given elsewhere.

We wish to thank the Nuffield Foundation for generous financial support. One of us (J. V. M.) is in receipt of a grant from the Medical Research Council.

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Independent Requirements for 'Crithidia Factor' and Folic Acid in a Trypanosomid Flagellate

THE trypanosomid parasite of mosquitoes, *Crithidia fasciculata Anopheles* strain (*ATCC* 11745), when grown in a defined medium[1], required for growth unusually high levels of folic acid. In the presence of 'crithidia factor' (an unconjugated pteridine), much lower concentrations of folic acid supported growth; indeed, at times a separate folic acid requirement was not demonstrable[2,3]. Our collaborators at the American Cyanamid Co. have identified the crithidia factor in human urine as 2 : NH_2,4 : OH,6-dihydroxypropyl pteridine[3]. In our experiments reported here, both the 6-dihydroxypropyl and a partially purified sample of the 6-trihydroxypropyl pteridine (generously supplied by Dr. E. L. Patterson) were used.

Table 1. BYPASS OF FOLIC ACID BY THYMINE FOR THE GROWTH OF *Crithidia fasciculata*

Additions	2 : NH_2,4 : OH,6-trihydroxypropyl pteridine* (mμgm./ml.) None	0·1	1·0	100·0
None	0·04†	0·06	0·08	0·12
Folic acid 0·3 mμgm./ml.	0·04	0·05	0·04	0·60
,, 1·0 ,,	0·04	0·16	0·56	0·80
,, 3·0 ,,	0·04	0·80	1·00	0·93
,, 30·0 ,,	0·04	—	—	—
,, 0·1 μgm./ml.	0·42	—	—	—
,, 0·3 ,,	0·78	—	—	—
,, 0·6 ,,	0·90	—	—	—
,, 1·0 ,,	1·00	—	—	—
Thymine 10·0 μgm./ml.	0·04	0·34	0·79	—
,, 30·0 ,,	0·04	0·78	1·02	—

* A 20-fold lower concentration of 2 : NH_2,4 : OH,6-dihydroxypropyl pteridine could, for each value, be substituted for the trihydroxypropyl derivative.

† Growth expressed as optical density.

By methods previously described[1,2], and with the use of the two pteridines, we have shown that (*a*) both folic acid and crithidia factor are required for growth of *C. fasciculata*; and (*b*) when folic acid is bypassed by supplying thymine, preformed crithidia factor is indispensable (Table 1). Folic acid, when it is the sole source of pteridines, then functions in its usual role in 1-carbon metabolism and is a precursor of a class of pteridines which has an independent function.

There are indications of connexions between riboflavin and pteridine-containing vitamins: (*a*) it has been suggested that *Eremothecium ashbyii* may accumulate a pteridine[4]; (*b*) grasshopper eggs produce a pteridine which replaces riboflavin for the growth of several lactobacilli; the riboflavin content of the eggs decreases as the pteridine content increases[5]. Results with *C. fasciculata* show that while high levels of riboflavin are required when folic acid is the sole source of crithidia factor, in the presence of preformed crithidia factor plus low concentrations of folic acid, riboflavin is spared (Table 2); these results account for the earlier observation[6] that thymine in the presence of high levels of folic acid (when folic acid is the sole source of pteridines) spares riboflavin. Folic acid was not spared by thymine. This may mean that the cleavage of folic acid to yield unconjugated pteridines was not enhanced by thymine.

The wide distribution of crithidia factor in Nature—it is contained in yeast[2], *Drosophila* eyes[7], liver[2,6] and human urine[3]—invites speculation on the

Table 2. SPARING OF RIBOFLAVIN BY CRITHIDIA FACTOR

Additions	Riboflavin (mμgm./ml.) None	10·0	100·0
None	0·04	0·05	0·08
Folic acid 30·0 mμgm./ml.	0·04	0·09	0·09
,, 100·0 ,,	0·04	0·24	0·61
,, 300·0 ,,	0·04	0·47	0·89
,, 1·0 μgm./ml.	0·04	0·76	1·18
Thymine 30·0 ,,	0·04	0·05	0·12
Pteridine* 10·0 mμgm./ml.	0·03	0·12	0·26
Pteridine 10·0 ,, plus folic acid 6·0 ,,	0·03	0·97	1·24

* 2 : NH_2,4 : OH,6-trihydroxypropyl pteridine was used in this experiment.

occurrence of growth-factor requirements in other organisms which are satisfied by unconjugated pteridines.

It is not known whether in higher animals folic acid satisfies a multiple requirement. Might such a requirement comprise, besides folic acid itself, a requirement for a pteridine of the crithidia-factor type ?

An enzyme in coliform bacteria cleaves folic acid and its analogues to simple pteridines[8]. The observation that mammalian liver is rich in crithidia factor raises the question of the source of unconjugated pteridine in animals: Does it originate by cleavage of folic acid in the gut or elsewhere, or does it have some other dietary precursor ?

Fig. 1 shows a scheme for the biosynthetic interrelationship among folic acid, riboflavin and crithidia factor. 'Compound *X*' represents the intermediate(s) connecting riboflavin and folic acid pathways.

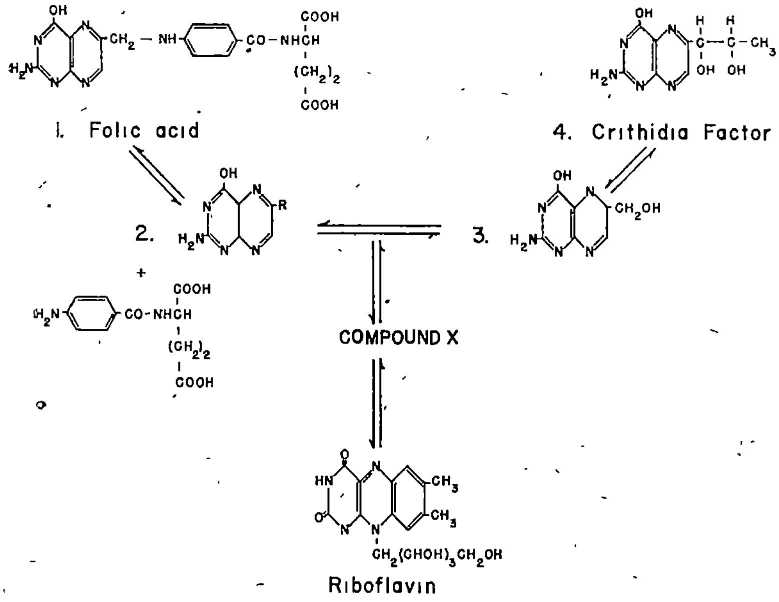

Fig. 1. Proposed scheme of interrelationships of folic acid, riboflavin and crithidia factor. Compound 3 has some crithidia factor activity

This work was assisted by grants from the Rockefeller Foundation, the American Cyanamid Co., the Loomis Institute and the American Cancer Society, on the recommendation of the Committee on Growth, U.S. National Research Council. One of us (H. A. N.) holds a Dazian Foundation Fellowship.

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Erythrocytin : an Inhibitor of 8-Hydroxyquinoline ('Oxine') derived from Erythrocytes

8-Hydroxyquinoline ('oxine'), a powerful antibacterial *in vitro*, and 7-allyl-3-aza-oxine are reported to be without chemotherapeutic effect in mice[1]. Their *in vitro* bacteriostatic effects were considerably reduced in the presence of intact, but not of lysed, mammalian erythrocytes[1]. We have now investigated this *in vitro* inactivation of oxine to determine whether it is caused by uptake of the drug by erythrocytes, chemical transformation, or by the liberation of an oxine-inhibiting substance.

Solutions of oxine in normal saline at pH 7·3 were found to lose their antibacterial effect if incubated with washed erythrocytes of many mammalian species, although nearly all the added oxine was shown to be still present in the solutions. A typical experiment using washed rat erythrocytes is described below.

To a solution of oxine (10 ml. containing 0·1 mgm./ml.) in normal saline free from heavy metals at pH 7·3 was added 1 ml. of normal saline free from heavy metals containing 4,000 million washed rat erythrocytes and the system incubated for 1 hr. at 37° C. The cells were then separated by centrifuging. The supernatant was devoid of bactericidal activity, and dilutions (1 in 20) in distilled water, in 0·01 *N* sodium hydroxide, and in distilled water containing an equimolar proportion of ferrous ammonium sulphate were found to exhibit ultra-violet absorption spectra identical with those shown by solutions of oxine under comparable conditions. The spectra indicated that only about 15 per cent of the added oxine had been removed by the erythrocytes, and the rest was unchanged and capable of co-ordination with ferrous ions in a normal manner.

Extraction of the supernatant with chloroform yielded a solid possessing the normal antibacterial activity of oxine and which, as a solid mull in 'Nujol', gave an infra-red spectrum identical with that given by oxine. The remaining aqueous solution was aerated overnight to remove the dissolved chloroform. Solutions prepared by dissolving oxine in this liquid were devoid of antibacterial action; however, heating at 100° C. for 2 min. followed by the addition of oxine yielded solutions with normal antibacterial properties.

Incubation of erythrocytes with normal saline as reported above, but in the absence of oxine, gave supernatants which did not inactivate oxine. Saline solutions of oxine were not inactivated upon incubation with lysed erythrocytes or with washed leucocytes.

The results demonstrate that the inactivation of oxine by erythrocytes is due to the liberation (or production) upon incubation of the cells in presence of the drug of a thermolabile inhibitor which we propose calling 'erythrocytin'. The apparently normal metal-chelating properties of the 'inactivated solutions' are of interest, because it has been suggested that oxine owes its antibacterial action to its ability to penetrate the bacteria as a 2 : 1 complex with iron (or copper) and exert its toxic effects as the 1 : 1 complex[2]. It is possible that erythrocytin might be effective in blocking the penetration of the oxine-iron complex.

We are grateful to Mr. A. A. Vahora for carrying out some of the experimental work, and to Mr. R. Branch for the infra-red determinations. The investigations are being continued, and a full account of the above and other related observations will be published elsewhere.

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Bactericidal Action of Oleic Acid against *Mycobacterium avium*

There have been many investigations of the bactericidal action of unsaturated fatty acids against tubercle bacilli[1]; but the mechanism of the effect still remains obscure. I have examined the action of oleic acid on *Mycobacterium avium* (Takeo strain) by Warburg and Thunberg's method, colony count and electron microscope.

The effect of oleate on the colony count was investigated by the ordinary plating method using 'Tween'-agar medium[2], in relation to the concentration and the contact period (Table 1). The cells were killed almost completely after contact with 10^{-3} *M* oleate for 30 min., and with 10^{-4} *M* oleate the viable cells were reduced to 7 per cent. This bactericidal effect was found to depend on the concentration of oleate and the time of contact, and the action was not reversed by washing the treated cells with distilled water.

On the other hand, the oxygen uptake was abnormally enhanced by 10^{-4} *M* oleate, and it was strikingly inhibited below the endogenous uptake by 10^{-3} *M* oleate. With the cell-free crude extract, a different mode of curve was obtained (Fig. 1). The reduction of methylene blue was enhanced by 10^{-5} *M* oleate, and it was inhibited by 10^{-2} *M* oleate. This inhibition was not reversed by washing the treated cells with distilled water; but the cells were able to reduce the dye after grinding them in a ball mill.

From these observations it may be assumed that the bactericidal action of oleate is [illegible] with the surface structures of the cel[illegible] further confirmed by examination in the electron microscope. After treating the cells with 10^{-3} *M* oleate for 60 min., some of their surface structures were disintegrated and their cytoplasmic contents were projected outside the cells. By treating the cells with 10^{-3} *M* oleate, electron-transparent loci were developed, which were located just inside the cell surface; and these seemed to be different from the electron-transparent bodies caused by the intense electron bombardment[3].

Table 1. Bactericidal Effect of Ol[illegible] centration and Perio[illegible]

Contact period	[illegible]
[illegible]	[illegible]

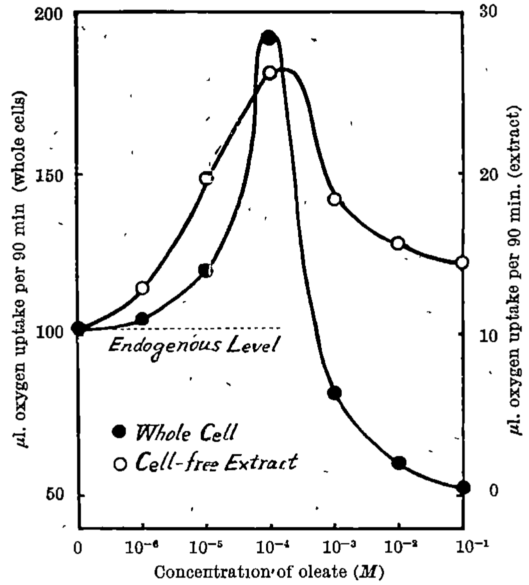

Fig. 1. Effect of concentration of oleate on the oxygen uptake of whole cells and of the cell-free crude water extract

Thus I think that oleate may act at some surface loci of the cell structures, so disintegrating them. Then respiration and reduction of methylene blue are inhibited irreversibly, and the cells are killed.

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Progesterone in the Placentæ of Domestic Animals

Progesterone has been isolated from the pre- and post-partum human placenta[1]. It has been assumed, therefore, that it is this placental contribution that enables ovariectomy to be performed during pregnancy without an ensuing abortion. In the mare, cow, ewe and bitch the ovaries may be removed at progesterone[2]. It has also been demonstrated recently that ovariectomy performed on pregnant ewes had no effect on the levels of 'progestin' in the blood, as measured by the Hooker–Forbes bio-assay technique, and the levels in fact continued to rise throughout pregnancy in a manner comparable to that seen in sheep with intact ovaries[3].

The purpose of this study was an attempt to confirm the presence of progesterone in placental tissue by chemical means. Fresh placentæ were obtained from a number of sources, and at various stages throughout pregnancy. They were frozen immediately after collection, and stored in polythene bags at -15° C. until they could be assayed.

The extraction procedure consisted of mincing about a kilogram of the frozen tissue, mixing the mince with sand and kieselguhr, and then pressing it in a small hydraulic press. This yielded about 700 ml. of press-juice, which was hydrolysed in the cold with $0 \cdot 6\,N$ sodium hydroxide and extracted with ether. On evaporating the ether extract to dryness, about a gram of a yellow fatty residue was obtained. This was treated with Girard's reagent *T*, and the crude ketonic fraction thus separated was put through a nine-tube counter-current distribution system of methanol and light petroleum, with a partition coefficient of 1 for pure progesterone. The three central tubes of this system should theoretically contain 71 per cent of the progesterone initially present, whereas most of the other ketosteroids remain in the end tubes. The contents of each tube were then taken to dryness, the material dissolved in absolute ethanol, and examined in an ultra-violet spectrophotometer (Unicam). By measuring the optical density of the solution at 240 mμ, it was possible to obtain a rough estimate of the concentration of progesterone. The ethanolic solutions from the central three tubes were then pooled and concentrated to a small volume for chromatographic analysis. This was carried out on paper strips in a methanol/ligroin system at 37° C. for 2 hr.; using this procedure, progesterone had an R_F value of 0·55. The spots were detected by ultra-violet contact photography, and those with the same R_F value as progesterone were eluted from the paper and re-examined in the spectrophotometer.

By this method it has been possible to detect in the placenta of the mare several hundred micrograms per kilogram of press-juice of a substance which appears to be identical with progesterone, in that it has the same partition coefficient, the same R_F value, the same ultra-violet absorption spectrum and the same infra-red spectrum. As a check on the method, one post-partum human placenta was also assayed, and progesterone was detected readily.

On the other hand, using the same procedure, it has not been possible as yet to detect any progesterone in the late-term placentæ of the cow, ewe, sow or bitch. If, in fact, progesterone is not produced by the placenta in these species, it will be interesting to study the mechanism for the maintenance of pregnancy after ovariectomy, and to investigate further the reported biological activity of cow placental extracts and of blood from pregnant ovariectomized duction of the hormone, or for its selective concentration from the maternal circulation.

I am indebted to Dr. R. K. Callow for carrying out the infra-red analysis, and to Dr. T. Mann and Dr. W. H. Pearlman for helpful advice.

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Site of the Chorioallantoic Inhibitor of Influenza Virus Hæmagglutinin

THE chorioallantoic inhibitor of influenza virus hæmagglutinin is destroyed during the multiplication of influenza virus in the allantois[1–3]. It is not, however, destroyed by *V. cholerae* receptor-destroying enzyme inoculated into the allantoic cavity[4], and only partly destroyed when the chorioallantois is exposed to the enzyme *in vitro*[1,4]. Because of this inaccessibility to receptor-destroying enzyme the inhibitor has been taken by most workers to be inside the allantoic cells and therefore potentially an index of the intracellular action of influenza virus enzyme. For example, the finding that massive inocula of virus inactivated by ultra-violet do not destroy the inhibitor has prompted the suggestion[2] that infecting particles lose their enzyme on entering the cell, the only virus enzyme to occur inside cells being that of progeny particles.

Recently, in the course of an investigation of the structure of the allantois, a technique was found for stripping pieces of allantoic endothelium from the chorioallantois. This made it possible to find out if the allantoic cells, even though they constitute less than a tenth of the mass of the chorioallantois, do in fact provide most of the inhibitor. Strips of allantois and the corresponding areas of membrane, free of allantois, were collected from a nine-day embryo. The two tissues were ground, suspended in equal volumes of saline and titrated for inhibitor against heated *LEE* virus[1]. By this test the inhibitor content of the allantois was found to be about one-sixteenth that of the rest of the chorioallantois. A technically easier route to the same result lay in comparing the inhibitor titre of the chorioallantois with that of the allantois covering the yolk sac; large pieces of the latter, containing no major blood vessels, can be stripped off the yolk sac easily and consist of the continuous sheet of allantoic cells backed by only a thin l[illegible]oderm. In several such comparisons [illegible] was found to contain 10–40 times [illegible]a for area, as the allantois. [illegible] per cent of the inhibitor in [illegible]olk sac was shown to be [illegible]n of receptor-destroying enzyme the allantoic cavity. It has yet to be shown: first, that there is any inhibitor inside allantoic cells, and secondly, if there is inhibitor inside the cells, that it is destroyed during virus multiplication.

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Precocious Puberty in Rats with Hypothalamic Lesions

It has recently been found[1] that ferrets, normally anœstrous during winter, become œstrous in January and February within 3–4 weeks after electrolytic lesions have been made in the anterior hypothalamus. The hypothesis was advanced that some hypothalamic mechanism may normally inhibit the pituitary secretion of follicle-stimulating hormone in sexually quiescent individuals, for example, (*a*) during the anœstrum of seasonally breeding animals and (*b*) during infancy. Interference with such a mechanism by destruction of hypothalamic tissue might promote the secretion of follicle-stimulating hormone and so induce sexual activity. The suggestion that inhibition of follicle-stimulating hormone secretion is normally exerted during infancy has now been tested on a series of immature rats.

Seventeen 14- or 15-day old females of an inbred Lister strain were used. Electrolytic lesions intended to be immediately posterior to the optic chiasma were made in nine, and eight were sham-operated. The animals were examined regularly post-operatively and the day of opening of the vaginal orifice (which is an index of the occurrence of puberty) recorded. Two lesioned rats reached puberty at 30 days of age and four at 33 days. The vaginal orifice of one sham-operated animal also opened at 33 days. In a comparable group of twenty-six normal rats only one animal had reached puberty at 33 days while the average age for puberty was 41 days (S.D. ± 3·7). Examination of the reproductive tract when the rats were killed at 34–35 days of age confirmed that reproductive maturity had been achieved. Ovulation was found to have occurred in the ovaries of five of the six rats in which the onset of puberty was hastened. Histological studies upon the site of the lesion are in progress.

These findings, together with those on the ferrets, seem to support the hypothesis of a mechanism which inhibits follicle-stimulating hormone residing in the anterior hypothalamus. In man, it has been suggested[2] that such a mechanism is located in the posterior hypothalamus.

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Levels of Thyrotrophic and Gonadotrophic Hormones in the Blood of Mature and Immature Female Rabbits

Ten female rabbits were used in this experiment, three immature, three œstrous and four pseudopregnant. The rabbits were rendered pseudopregnant by electrical stimulation of the uterine cervix with a 4·5-V. tetanic current. They were then kept until the eighth day, when the corpus luteum is fully developed[1]. The reproductive state was confirmed by histological examination of the ovaries.

The levels of thyrotrophic and gonadotrophic hormones in the blood of these rabbits were determined by the use of one-day-old chicks[2]. The chicks were injected daily with a subcutaneous injection of 0·50 ml. of plasma for five days. They were then killed by ether 24 hr. after the last injection.

The thyrotrophic hormone level was indicated by its effect on the weight of the thyroid of male chicks, as shown in Table 1. The thyrotrophic hormone in the blood of rabbits is higher during œstrus than during the stages of immaturity or pseudopregnancy. Similar results were obtained in the rat[3].

Table 1. Average Weights of Thyroid and Testes of Chicks injected with Plasma from Immature, Œstrous and Pseudopregnant Rabbits

Treatment	No. of chicks	Average weight of thyroid (mgm./100 gm. body-weight)	Average weight of testis (mgm./100 gm. body-weight)
Control	4	6·11 ± 0·45*	29·46 ± 4·62
Immature	6	6·36 ± 0·47	40·30 ± 2·37
Œstrous	8	11·64 ± 0·73	52·54 ± 4·30
Pseudopregnant	10	9·30 ± 0·53	53·73 ± 4·29

* Standard error.

The gonadotrophic hormone level was indicated by its effect on the weight of the testis of chicks. The gonadotrophic hormone in the blood of mature rabbits (œstrous and pseudopregnant) was higher than that in the immature animal. Lauson *et al.*[4] showed that the gonadotrophic hormone content of the rat pituitary drops rapidly at puberty. They suggested at the time that this may be due to an increased outpouring of the hormone into the blood stream. This view is confirmed by the results obtained in the present investigation. The œstrous and pseudopregnant rabbits did not show a significant difference in the levels of gonadotrophic hormone in their blood. The assay method used did not allow a differentiation between the levels of follicle-stimulating hormone and luteinizing hormone factors.

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Mode of Infection of the Nervous System in Poliomyelitis of the Chick Embryo

Inoculation of a chick embryo-adapted MEF_1 strain of poliomyelitis virus into the yolk sac of chick embryos produces an infection which causes lesions like those observed in primates infected with poliomyelitis[1]. Preliminary studies did not reveal the exact mode of spread of the virus from the yolk sac to the nervous system. The present experiments were designed to elucidate this point by correlating the distribution of histological lesions with the concentration of virus in various tissues during the early stages of infection after introduction of poliomyelitis virus by the yolk sac and by the intravenous routes.

Two groups comprising a hundred seven-day, and ninety-five eight-day old white Leghorn embryos were inoculated by the yolk sac and intravenous routes, respectively, with 200,000 and 16,000 mouse *LD*50 units of virus, derived from the 44th egg passage in the series *R* 382 of the chick embryo-adapted strain of MEF_1 poliomyelitis virus[2]. Eggs were incubated at 36° C. and live embryos were harvested at frequent intervals for estimation of the virus in the tissues[1], and for histological study. Embryos were fixed in Bouin's solution and serial coronal sections were made of the entire central nervous system, posterior root, sympathetic and cranial nerve ganglia. All pilot slides made at intervals of 9–29 sections were examined; where lesions were found in a nucleus or ganglion without changes in the corresponding ipsilateral or contralateral ganglion or nucleus, every serial section through the apparently unaffected structure was examined.

Specific lesions of the nervous system, similar to those which have been described in poliomyelitis of the chick embryo[1], were first noted 66 hr. after yolk sac, and 48 hr. after intravenous, inoculation of virus (Table 1). The distribution of lesions was independent of the route of inoculation; but the onset and progress of the pathological changes were considerably accelerated when virus was administered by the intravenous route (Table 1). The Gasserian and spinal ganglia and the nuclei of the sixth and seventh cranial nerves were affected early and frequently. Neuronal cytolysis in the trigeminal ganglion preceded detectable changes in the nucleus of the fifth cranial nerve (Nos. 1–4; 2*A* and 3*A*). On several occasions, no lesions could be found in the geniculate ganglion when severe neuronal degeneration was present in the ipsilateral facial nucleus (Nos. 2, 4, 5, 6, 9; 1*A*–3*A*). In three embryos spinal ganglia were affected and the cord was normal (Nos. 1, 2 and 2*A*). Changes in the jugular ganglion preceded those in the vagal nucleus and the ganglion nodosum (Nos. 5, 6; 1*A* and 2*A*). Lesions were observed on the olfactory bulb 92 hr. after yolk sac infection and 48 hr. after intravenous inoculation of virus. The cœliac ganglia were not affected.

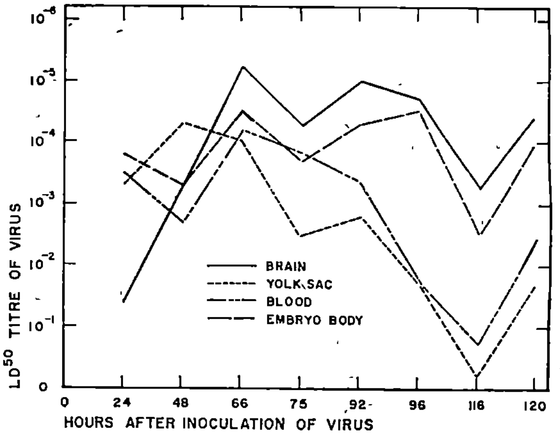

Fig. 1. Distribution of virus in embryos inoculated with 200,000 mouse *LD*50 units of MEF_1 poliomyelitis virus by the yolk sac route. Note the increase in concentration of virus in the yolk sac and the drop in virus titre of the blood and body fractions between 24 and 48 hr. The titre of the blood rose again when that of the brain reached a peak at 66 hr.

Virus which was introduced into the yolk sac multiplied there and initiated a viræmia (Fig. 1); the virus concentration in the brain rose to a maximum 66 hr. after inoculation (Fig. 1), at which time lesions were first noted in the nervous system. When the virus was inoculated into the blood stream, rapid uptake by the nervous system may be inferred from the high virus titre of the brain and low titre of the blood after 24 hr. (Fig. 2); this was confirmed by the earlier development of lesions in this group (Table 1). The more rapid evolution of the disease which followed intravenous infection, the similarity in the distribution of lesions after introduction of virus by either route and the early involvement of unrelated ganglia and nuclei suggest that virus entered the nervous system at several points directly from the blood stream.

Table 1. Distribution of Specific Lesions of the Nervous System in Chick Embryos infected with MEF_1 Egg-adapted Poliomyelitis Virus

Route of inoculation	Embryo No.	Hr. after inoculation	Cranial nerve nuclei and ganglia								Spinal cord	Root ganglia	Other lesions (ref. 1)
			V		VI	VII		X					
			Nuclei	Ganglia	Nuclei	Nuclei	Ganglia	Nuclei	Jugular ganglia	Ganglia nodosa			
Yolk sac	1	66	—	*RL*	—	—	—	—	—	—	—	*RL*	—
	2	75	—	*RL*	*L*	*L*	—	—	—	—	—	*RL*	—
	3	75	—	*RL*	—	—	—	—	—	—	*RL*	*RL*	—
	4	92	—	*L*	*R*	*R*	—	—	—	—	*RL*	*RL*	*R*
	5	92	*RL*	*RL*	*RL*	*R*	—	*R*	*RL*	—	*RL*	*RL*	*RL*
	6	96	*RL*	*RL*	*RL*	*RL*	*L*	*RL*	*RL*	—	*RL*	*RL*	*RL*
	7	96	*RL*	*RL*	*RL*	*RL*	*RL*	*RL*	*RL*	*R*	*RL*	*RL*	*RL*
	8	116	*RL*	*RL*	*RL*	*RL*	*RL*	*RL*	*RL*	*RL*	*RL*	*RL*	*RL*
	9	116	*RL*	*RL*	*RL*	*RL*	*L*	*RL*	*RL*	*RL*	*RL*	*RL*	*RL*
	10	120	*RL*	*RL*	*RL*	*RL*	*RL*	*RL*	*RL*	*RL*	*RL*	*RL*	*RL*
Intravenous	1*A*	48	*RL*	*RL*	*RL*	*RL*	—	*RL*	*RL*	—	*RL*	*RL*	*RL*
	2*A*	75	—	*RL*	*RL*	*L*	—	—	*L*	—	—	*RL*	*RL*
	3*A*	120	—	*RL*	*RL*	*R*	—	—	—	—	*RL*	*RL*	*RL*

R or *L*, lesions present on right or left side; —, lesions absent.

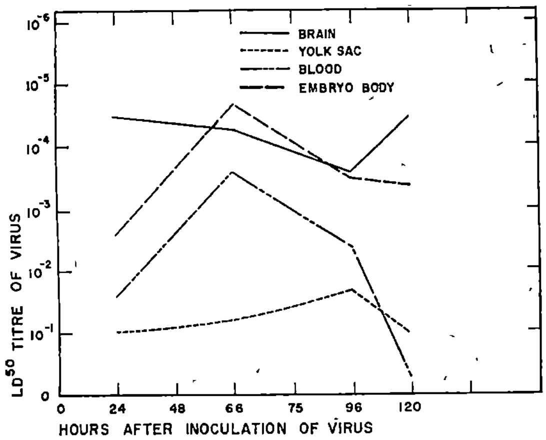

Fig. 2. Distribution of virus in embryos after intravenous inoculation of 16,000 mouse *LD*50 units of *MEF*$_1$ poliomyelitis virus. Note the high virus titre of the brain and low blood titre at the onset. The viral concentration in the body fraction paralleled that of the blood at a slightly higher level. Only small amounts of virus were demonstrable in the yolk sac

The complete results and a more detailed analysis of these experiments will be published in full at a later date.

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Function of the Red Muscle in Fish

During investigations of the vitamin contents of different organs from the tunny (*Thunnus thynnus*)[1], samples from the deep-seated red muscle as well as from the neighbouring ordinary muscle were analysed for niacin, riboflavin, pantothenic acid, vitamin B_{12} and thiamine. The results revealed an interesting relative distribution. With the exception of niacin, which showed a slightly higher value for ordinary muscle, the red muscle contained several times more of the other B-vitamins than the ordinary muscle.

These findings were followed up by investigations of other species. Samples were taken from the ordinary white muscle as well as from the lateral muscle (musculus lateralis superficialis) of several teleosts. The elasmobranch porbeagle (*Lamna cornubica*) has also been included in the investigations. This shark has a distinct red muscle section situated in the middle of the white muscle at both sides of the frontal part of the vertebræ. Some representative results are given in Table 1.

The results showed that, apart from niacin, all the other B-vitamins investigated are present in much higher concentrations in the red than in the ordinary muscle, and further that the general distribution in the red muscle is similar to the values found in the liver.

Chemical analysis revealed that in most fishes the red muscle has a much higher fat-content than the neighbouring ordinary muscle; the values of the present samples from mackerel, herring and halibut were about 27–29 per cent. Muscles with such high fat-contents are scarcely suited for strenuous and continued activities. Assuming the red muscle is the less active, it would be expected that under the anaerobic conditions which prevail during the death struggle, the breakdown of glycogen and the formation of lactic acid would be less in the red than in the neighbouring ordinary muscle. Analysis of the red and the neighbouring ordinary muscle in frozen tunny gave the following interesting values: 1 per cent and traces respectively of glycogen, 0·8 per cent and 1·6 per cent respectively of lactic acid.

The red muscle thus contains relatively high concentrations of the B-vitamins, and also myoglobin[2] and cytochrome *c* [3], which are all part of the enzyme system carrying out oxidative metabolism. It therefore may be concluded that the red muscle is able to carry out similar synthetic processes as those taking place in the liver. If we further consider the relatively frequent high fat-contents in the red muscle, and the fact that the white muscle contains no myoglobin and low contents of the B-vitamins except for niacin, it is likely that the main purpose of the red muscle is not muscular work, but that it functions as an organ.

The exceptional results for niacin, which on an average for the species discussed here was found in equal concentration in both muscles, are in agreement with the special function of this vitamin as part of coenzyme I. This coenzyme plays an important part in carbohydrate metabolism during muscular activity, as well as in several dehydrogenase systems in tissues from different organs. Several enzyme studies are therefore in progress.

Finally, consider the presence of the red muscle in relation to the normal activities of the species. The anatomical situation of the red muscle prevents it taking part in the main muscular work. Further, of the species investigated, the tunny, as a very active and fast-swimming fish, has the highest pro-

Table 1. Vitamin Contents of Liver, Red Muscle and Ordinary Muscle from some Species of Fish

Species	Sample of	Niacin (μgm./gm.)	Pantothenic acid (μgm./gm.)	Riboflavin (μgm./gm.)	Vitamin B_{12} (μgm./gm.)	Thiamine (μgm./gm.)
Tunny (*Thunnus thynnus*)	Liver	87	26·0	46·0	3·10	3·7
	Red muscle	100	32·8	7·9	0·38	4·3
	Ordinary muscle	122	5·0	1·5	0·047	2·5
Mackerel (*Scomber scombrus*)	Liver	79	33·3	11·3	0·52	4·0
	Red muscle	97	30·0	13·8	0·11	3·7
	Ordinary muscle	107	3·8	1·6	0·015	0·2
Halibut (*Hippoglossus hippoglossus*)	Liver	30	9·0	7·0	0·89	2·5
	Red muscle	31	5·2	2·5	0·05	0·35
	Ordinary muscle	44	3·6	0·6	0·009	0·40

portion of red muscle. Next come mackerel and herring, which also move rapidly in shoals. On the other hand, halibut, as a flat fish, has less and a paler red muscle. Further considerations along these lines give the same general relation between activity and the extension and pigmentation of the red muscle in different species.

A fuller account of this work will be published later.

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Production of Haploid Plants of Marrow-stem Kale

HAPLOID maize plants have been obtained in frequencies varying between 0·02 and 0·3 per cent by examining seedlings from plants, homozygous for recessive seedling-colour marker genes, which have been pollinated by plants homozygous for dominant marker genes[1]. In marrow-stem kale (*Brassica oleracea* L. var. *acephala* D.C.), it has been found that non-hairy first leaf is recessive to hairy first leaf. Five plants, homozygous for the recessive gene, non-hairy, and obtained from inbreeding a single selection (plant 220), were pollinated in the bud stage by a single plant (31/11), which was homozygous for the dominant gene for hairy first leaf and which was also a first-generation inbred plant. As is shown in Table 1, a total of 2,674 seedling plants were examined and four non-hairy plants were found.

Table 1

Female parent	Male parent	No. seed sown	No. germ.	Per cent germ.	No. hairy	No. non-hairy	No. haploids
220/2	31/11	285	269	95	269	–	–
220/4	31/11	474	295	62	295	–	–
220/6	31/11	240	238	99	237	1	–
220/9	31/11	952	885	93	884	1	1
220/12	31/11	1,006	987	98	985	2	1
	Total	2,957	2,674		2,670	4	2

When these four non-hairy plants came into flower, three had sterile pollen and two of these had much smaller flowers than normal diploid kale. Measurements of stomata showed that the two with small flowers also had relatively small stomata, 22μ and 23μ long, as compared with 28μ long in normal diploid plants.

Cytological examination of pollen mother cells confirmed that the two plants were haploids with a chromosome number of $2n = 9$. A preliminary examination of fifty-four cells at first metaphase showed thirty-eight cells with no bivalents, twelve with one and four with two. The presence of these bivalents is interesting since it has been suggested from the occurrence of secondary pairing of bivalents that the true basic number in the genus *Brassica* is 6, and that in *B. oleracea* itself "three of the six basic chromosomes are present in duplicate, the other three but once each"[2]. The bivalent frequency would also appear to be higher than that in haploid *Brassica campestris* ($2n = 10$), where only occasional cells with one loosely paired bivalent were seen[3].

The occurrence of the two non-hairy plants, which are not haploids, may be due either to accidental self-pollination, diploid egg cells of the female parent functioning without fertilization, spontaneous doubling of original haploid embryos, or mutations in the pollen of the male parent. It may be possible to show that the last hypothesis is the correct explanation by determination of the self-incompatibility allelomorphs present in the two diploid non-hairy plants.

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Epidiopatra hupferiana Augener from the North-East Pacific

THE little-known polychaete genus *Epidiopatra*, belonging to the family Eunicidae, was set up by Augener[1] in 1918 to contain two species, *E. hupferiana* and *E. drewinensis*, both collected off the west coast of Africa. No other species has since been added to the genus. The only subsequent record of either species is that of *E. hupferiana* from South Africa by Monro[2] in 1930. Both Augener's and Monro's specimens were dredged on muddy or sandy bottoms and, in Augener's case, mention is made of their inhabiting tubes.

Capture of a specimen of *E. hupferiana* in a plankton tow, from 100 ft. to surface, in Hecate Strait, British Columbia, seems worthy of record. It was taken by Mr. R. J. LeBrasseur, of this Station, in June 1955. The specimen is small (about 12 mm. long) ; but the characters are unmistakable. The generic characters are essentially those of the better-known Eunicid genus *Diopatra*, except that tentacular cirri are entirely absent and there is a very limited number of branchiferous segments. In all technical details the specimen agrees completely with Augener's and Monro's descriptions of *E. hupferiana*.

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Two Unifactorial Characters for which Man is Polymorphic

IT has been recognized for many years that humans excrete methanethiol (methyl mercaptan) after eating asparagus, and it has been assumed that this character is universal[1,2]. We have found, however, that while some subjects excrete detectable amounts of methanethiol after ingesting only three or four sticks of asparagus, no significant amount of the compound appears in the urine of others after ingestion of as much as a pound of asparagus. Biochemical investigations of this metabolic difference are being made in collaboration with Dr. P. W. Kent. Nencki's[1]

Table 1

Parental phenotypes	Families tested	Children Excretors	 Non-excretors	Total
Exc. × exc.	1	1	1	2
Exc. × non-exc.	4	5	7	12
Non-exc. × non-exc.	4	0	11	11

identification of the odorous substance in urine as methanethiol has been confirmed by isolation of the corresponding silver mercaptide.

In a random sample of 115 individuals, forty-six were found to be excretors of methanethiol after eating asparagus and sixty-nine were found to be non-excretors. Limited familial data suggest that the excretor character is controlled by a single, autosomal, dominant gene. The offspring of different mating types are summarized in Table 1.

The second character which we have investigated is the appearance of a distinct red coloration in the urine after eating moderate quantities of beetroot. This has been regarded as a rare anomaly occasionally confused with hæmaturia in medical practice. However, in a random sample of 104 subjects, ten reported that they were distinctly positive for this character; another small survey brought to light four matings in which both partners were positive. The six children of these matings are all positive; this result would occur by chance less than once in a million times, and it therefore suggests strongly that the character is controlled by a single, autosomal, recessive gene. Other family data, which accord with this interpretation, are included in Table 2.

The order of frequency of this character implies that about 43 per cent of the population are heterozygous for the gene; hence the expected proportion of non-excretors to excretors in the progeny of cross-matings is just over 3 : 1. As it happened, in both the families tested the non-excretor parent was known to be heterozygous for the gene and the 1 : 1 ratio expected in such back-crosses was obtained. However, the expression of this character appears to be somewhat variable. Most positive subjects develop a typical red urinary pigmentation whenever they eat beetroot; but in a minority the red pigment appears only intermittently, sometimes being replaced by a dark-brown pigment. The red pigment in urine has the same absorption spectrum as the water-soluble beet pigment, betanin, described by Pucher and colleagues[3], which appears to be a polyhydroxyphenolic glucoside containing two atoms of nitrogen per molecule. The brown pigment sometimes found in urine may represent a decomposition product of this rather unstable compound. Dr. R. B. Fisher kindly allows us to quote his finding that the beet pigment is readily absorbed in isolated rat intestines. If betanin is absorbed in all human subjects, its appearance in the urine of about 10 per cent presumably reflects an inability on their part to metabolize the compound. When tested, two excretors of betanin showed no difference from other subjects in glucose re-absorption in the renal tubules.

Table 2

Parental phenotypes	Families tested	Children Excretors	 Non-excretors	Total
Exc. × exc.	3	6	0	6
Exc. × non-exc.	2	2	2	4
Non-exc. × non-exc.	6	2	14	16

It seems that both these characters fall within Ford's definition of polymorphism: "The occurrence together in the same habitat of two or more distinct forms of a species in such proportions that the rarest of them cannot be maintained by recurrent mutation"[4]. If our interpretation of the genetics is correct, in the samples quoted the frequency of the gene controlling methanethiol excretion after eating asparagus, which we propose naming *As*, is 0·23, and the frequency of the gene controlling excretion of beet pigment, for which we propose the symbol *bt*, is 0·31. The fact that these genes and their allelomorphs have remained common in human populations suggests that they are being, or have been, maintained in equilibrium by selective forces which confer an advantage on the heterozygotes. The nature of these forces is at present unknown; but it is possible that, as has already been shown in some blood-groups and hæmoglobin variants[5], the various genotypes differ in respect of susceptibility to disease.

These unifactorial characters identify two additional loci on human chromosomes and should prove of value in tests of genetic linkage.

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Anopheles hyrcanus as a Vector of Filariasis in West Bengal

In a recent epidemiological investigation of the filariasis problem in West Bengal, we have frequently detected the Indian form of the species *A. hyrcanus* var. *nigerrimus* as the vector of filariasis, like its counterpart, *A. hyrcanus* var. *sinensis*, in China and Dutch East Indies[1]. It occurs throughout the entire zone from Narayangarh to Ramnagar, covering the four police areas of Belda, Egra, Contai and Ramnagar in the Midnapore District, excepting, however, a single occasion when bancroftian infection was noted in *Culex fatigans* from the suburbs of Contai. Finger blood of residents in every locality of this zone taken at night during the months February–April 1956 showed a mixed infection of microfilariæ of both *Wuchereria bancrofti* and *Wuchereria malayi*, with the latter predominating.

It is generally known that filariasis in India caused by *W. bancrofti* is transmitted by *Culex fatigans*, whereas that caused by *W. malayi* is carried by *Mansonioides annulifera* and to a lesser degree by *M. uniformis* and a few other allied species[2]. Among the anophelines found casually infected in Nature, mention may be made of *A. philippinensis*[3]; but never before has *A. hyrcanus* been incriminated as a natural carrier in India, although the species along with several other anophelines has long been known as a suitable intermediate host of the parasites under experimental conditions[4].

Investigations are progressing and a report embodying further details will be published elsewhere.

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[1] Feng, L. C., *Chinese Med. J.*, Supp. I, 345 (1936).

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Marking of Tsetse Flies for their Detection at Night

Most tsetse field-work so far has been based on day-time observations of active flies. If work is to be done on resting flies, it will be advantageous to have an easy method of locating them. It is known[1] that mosquitoes can be dusted with non-toxic materials which fluoresce in ultra-violet light at night, and using this method, mosquitoes can be watched at a distance of about 10 ft. The insects are not sensitive to ultra-violet radiations.

Much experience has been gained of marking the thorax of tsetse with oil paints in the field[2], and this method of applying the fluorescent paints would have many advantages. Luminous paint of the type that shines without excitation by ultra-violet radiation proved (*a*) poisonous to tsetse and (*b*) to give too feeble a glow to be useful under field-conditions.

B.T.H. 'Dayglo' (silica-based organic dyes in ethyl cellulose) powders mixed with a binder and solvent produced a satisfactory paint and were used in a series of tests on house and tsetse flies. The ultra-violet lamp used was worked off 230 volts a.c. It is of interest to note here that a source of ultra-violet radiation has been developed which can be worked off a 6-volt battery. Paint was applied with a sharpened match-stick on the centre of the thorax, covering it without fouling head or wings.

At 15 ft., treated flies shone brilliantly in the ultra-violet beam and the maximum range was 20 ft. The lamp produced much visible light, and the maximum range might well be increased by filtering out the glare. 'Dayglo' paints, when excited by ultra-violet radiation, have a visible glow from 8 ft. in daylight. The ultra-violet light does not appear unduly to disturb *Glossina morsitans*.

Thus there appears to be a promise of success for locating tsetse flies at night by painting the thorax with non-toxic materials which fluoresce under ultra-violet light.

These experiments were carried out in the Department of Entomology at the London School of Hygiene and Tropical Medicine, and I should like to thank Dr. Bertram for allowing the use of the facilities of his Department, Messrs. W. H. Potts and E. F. Whiteside for help and the British Thomson-Houston Co., Ltd., for the supply of materials and demonstration of ultra-violet sources.

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Mortality in the Sheep Ked, *Melophagus ovinus* (L.), caused by *Trypanosoma melophagium* Flu.

The sheep ked is an obligate blood-sucking ectoparasite of sheep ; its life-history is well known and has been described by various authors, notably Evans[1]. Hoare[2] has described the life-history of *Trypanosoma melophagium* Flu. and its relation to the ked. The crithidial stage of the flagellate is a normal inhabitant of the midgut of the insect. Crithidia are attached by their flagella to the epithelium of the posterior half of the midgut, and small numbers may be found in the gut lumen. Small masses of the metacyclic, or infective, stage may be seen adhering to the wall of the iliac bulb (rectum) or free in the contents of the bulb.

At the Lethbridge Laboratory, large numbers of keds have often been seen to die on sheep as a result of blockage of the posterior midgut by large masses of crithidia. The gross symptoms of impending death are usually (*a*) swelling of the abdomen, (*b*) development of a reddish-pink colour over the entire insect (indicating escape of sheep's red-blood cells from the gut into the hæmolymph), (*c*) change in colour from brown to white of the iliac bulb, which is distended, violently contracting, and clearly visible through the dorsal integument.

Internally, although the anterior midgut is distended with undigested blood, the posterior midgut is emptied of digestive contents between the pyloric valve and the mycetome. Microscopically, in this region are seen, in addition to crithidia attached to the gut wall, masses of crithidial rosettes that are packed into the lumen. Smears of the iliac bulb contents show large numbers of metacyclic forms mixed with excretory products from the Malpighian tubules. The tubules themselves appear greatly distended ; but rarely do they contain any stages of trypanosomes.

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Survival of Normal Rabbits after Appendectomy

The majority of the lymphoid tissue in the alimentary canal of normal rabbits is in the appendix, which in fact contains about a half of the total body complement[1]. It forms an active lymphoepithelial system[2] which interchanges bacterial and tissue cells with the gut lumen.

Different aspects of this process have been shown to have immunological[3] and nutritional significance (ref. 1 and unpublished observations on absorption of radioactive bacteria) ; but I have not found any publication on the results of curtailing them by

Table 1

No.	Initial weight (gm.)	Date of appendectomy	Date of death	Weight at death (gm.)
32	4.11.52 2,335	10.11.52	23 5.56	2,950
34	4 11.52 2,305	not operated	killed 23.5.56	2,650
36	4.11.52 3,160	13.11.52	26.8.55	3,650
37	13.11.52 3,333	not operated	16 1.53	3,620

appendectomy. I have done this on several dozen rabbits, and they are apparently unaffected by it. Table 1 shows the result of a small controlled survival experiment on stock adult albino rabbits maintained at Guy's Hospital Medical School, which confirms this impression.

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Some Properties of Extracted Protochlorophyll Holochrome

MANY leaf pigments have very different spectral, solubility and physiological properties when in the leaf from those shown when they are extracted and dissolved in organic solvents. Because of this, the pigments in the leaf are assumed to be bound to other substances, probably proteins. This combination has been termed holochrome[1]. As the derivation indicates, the word means complete pigment and designates the pigment as it is combined in the leaf.

In etiolated leaves, protochlorophyll holochrome is transformed by light to chlorophyll-*a* holochrome, whereas isolated protochlorophyll itself is not so transformed (cf. ref. 1). Recently, protochlorophyll has been extracted from dark-grown leaves with glycerine[2] and with buffer solutions[3] in a form that is transformed to chlorophyll *a* by light. This result indicates that protochlorophyll can be separated from the leaf in its holochromatic form. We have endeavoured, therefore, to isolate and characterize the minimum unit of the protochlorophyll complex which can carry on this photochemical transformation.

A partial isolation of an active protochlorophyll complex has been accomplished as follows: bean seedlings (*Phaseolus vulgaris*, var. Blue Lake, Ferry-Morse Seed Co.) were grown in a dark room at about 20–22° C. The etiolated leaves (10 gm.) 10–12 days old were ground in a mortar for 10 min. with 30 ml. of a solution of glycine (0·1 *M*) and potassium hydroxide (0·05 *N*) at *p*H about 9·6. The grinding was done in a dark cold room at about 6° C. The liquid was squeezed through a fine-woven cloth and centrifuged at 10,000 *g* for 15 min. The supernatant was pressed through a French–Milner homogenizer[4] with a pressure of 20,000 lb./sq. in. The homogenate was centrifuged for 1 hr. at 10,000 *g* and the supernatant dialysed in Visking tubing overnight against glycine buffer. The dialysed extract was centrifuged in a Spinco Model *L* centrifuge at 40,000 r.p.m. (approximately 93,000 *g*) for 3 hr.

The pellet contained a much greater proportion of the active protochlorophyll than did the supernatant. The pellet was dissolved in a portion of the glycine buffer solution. This required thorough stirring and standing for several hours. Illumination of the dissolved pellet produced chlorophyll *a* (cf. Fig. 1). Sedimentation analysis of this solution by means of a Spinco Model *E* ultracentrifuge showed the presence of two well-separated boundaries (cf. Fig. 1, inset) with sedimentation coefficients of about 4 and 16 Svedberg units respectively. The faster-moving of these boundaries was correlated with the active protochlorophyll complex. Sedimentation diagrams of the extract made before obtaining the pellet showed a much greater proportion of the slower-moving boundary than did those of the resuspended pellet (cf. Fig. 1, inset).

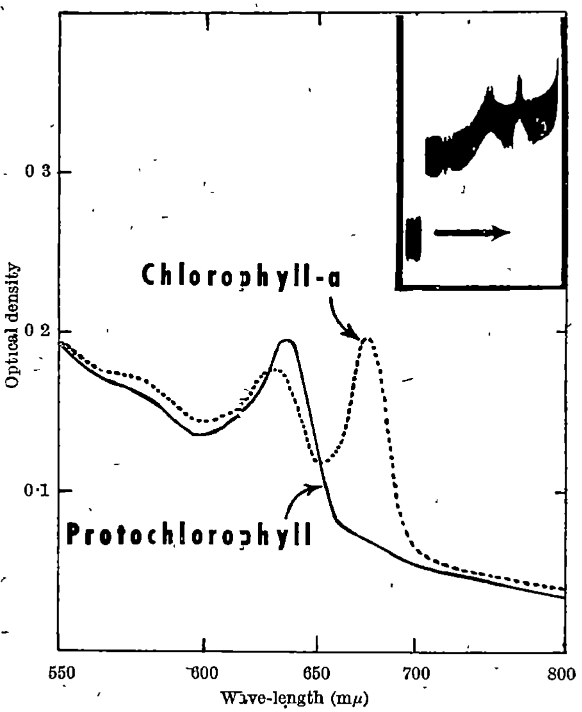

Fig. 1. Absorption spectra of the dissolved pellet, obtained by centrifuging at 40,000 r.p.m. a dialysed extract of etiolated bean leaves before (solid line) and after (broken line) being illuminated. Inset: Sedimentation pattern at 50,740 r.p.m. in synthetic boundary cell Leading boundary is associated with the photo-transformed material; the trailing peak is near the initial synthetic boundary

In the analytical ultracentrifuge, the solutions were of necessity illuminated. The following observations, therefore, relate to the derived chlorophyll-*a* complex.

No obvious heterogeneity in particle size was indicated, since the spreading of the leading boundary during sedimentation was not extensive and appeared to be symmetrical. The sedimentation coefficients (s_{20}) obtained for several preparations, and measured at different stages of preparation, ranged from 15·3 to 16·2 Svedberg units. The boundary showed no artificial sharpening, nor did its rate of movement depend significantly on the concentration of the solution. Comparison of the s_{20} values with those published for various globular proteins suggests that the molecular weight of this protochlorophyll complex is about 400,000.

In other experiments, subsequent to dialysis against glycine buffer, the extract was further dialysed rapidly against several changes of distilled water and then lyophilized. The solid obtained was slightly yellow and was readily dissolved in aqueous solutions above *p*H 6. Such solutions exhibited the characteristic absorption spectrum in the red of protochlorophyll holochrome and, after being illuminated, that of chlorophyll-*a* holochrome. In the blue region of the spectrum the characteristic absorption of these pigments was not distinguishable owing to the presence of yellow pigments. The solid material was stable for months when kept in a darkened cold-room. Obviously, no diffusible co-factor is necessary for this photo-conversion.

The lyophilized solid material did not give up its protochlorophyll when extracted with absolute acetone. When aqueous acetone was used, however, the pigment was extracted.

Although the particles containing the active protochlorophyll have not been isolated in pure form, various tests indicate that they consist largely of protein.

From these experiments it may be concluded that a fraction has been separated from etiolated leaves which contains particles of uniform size that possess properties similar to those of native protochlorophyll holochrome in respect to spectral absorption, pigment solubility, and photo-conversion to chlorophyll-*a* holochrome.

In a recent issue of *Nature*[5], J. W. Lyttleton directed attention to two cytoplasmic protein fractions of leaves which had been obtained by Wildman and his co-workers[6]. These fractions possessed sedimentation coefficients, s_{20}, of 3–4 and 16–17 Svedberg units respectively. Lyttleton's own results suggested that the faster-moving fraction "is found only in photosynthesizing tissue or in tissue which is capable of photosynthesis after it is exposed to light". It is instructive to note that we have obtained two similar fractions from etiolated bean leaves, and that the faster sedimenting of these contains protochlorophyll attached in such a way as to be converted by light to chlorophyll *a*. This observation likewise suggests a role for this fraction in photosynthesis.

We are grateful to the Chemistry Department of Stanford University for making available the Spinco centrifuges for this work. During the first part of this investigation, one of us (D. W. K.) was associated with the Chemistry Department of Stanford University as a Fellow of the U.S. Public Health Service.

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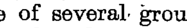
Occurrence of the Methylene-dioxy Bridge in the Phenolic Components of Plants

The methylene-dioxy bridge  $\left(\begin{smallmatrix}-\mathrm{O}\\ -\mathrm{O}\end{smallmatrix}\!\!>\mathrm{CH_2}\right)$ is a common feature of the structure of several groups of plant alkaloids and occurs also, though less commonly, among natural phenolic substances. Geissman and Hinreiner[1], in a recent review of natural phenols, list twenty-four different substances containing the methylene-dioxy bridge; fourteen of them are C_6—C_3 type and all are characterized by a generally high degree of methylation of hydroxyl groups in the molecule; indeed, none of them bears a free hydroxyl in the ring that bears the bridge. The alkaloids are similarly characterized by a high degree of methylation of phenolic hydroxyl groups[2]. Botanically, the methylene-dioxy phenolic substances are distributed widely but not haphazardly, for they occur in six families of Polypetalae (Anonaceae, Magnoliaceae, Rutaceae, Leguminosae, Rosaceae and Umbelliferae), three of Apetalae (Myristicaceae, Lauraceae and Piperaceae) and one of the monocotyledons (Orchidaceae). Of these families, Lauraceae and Piperaceae are much the most abundant sources, and it seems from this (as from the occurrences in Magnoliaceae, Rutaceae, Umbelliferae and Myristicaceae) that there may be some relationship between aromatic properties and the occurrence of the bridge. It may be significant, too, that of the eleven families of plants which have yielded methylene-dioxy alkaloids, no fewer than four occur in the above list of phenolic-bearing families (Anonaceae, Rutaceae, Leguminosae and Piperaceae[2]).

In a general survey of phenolic substances in the leaves of plants, Bate-Smith[3,4] recommends the use of a toluene/acetic acid/water solvent for chromatography; this solvent has the useful property of immobilizing the commoner natural phenols except the cinnamic acids (ferulic, sinapic and *p*-coumaric) and the related coumarins (scopoletin and umbelliferone). Of these substances, ferulic acid, R_F 0·25, is the most mobile, so that the lower portion of the chromatogram is commonly empty. Occasionally, however, leaf extracts are encountered which yield blue spots giving violet or green fluorescence under ultra-violet light, that run in advance of ferulic acid. Apart from the uncommon 7-methoxycoumarin, herniarin, which, we are informed (personal communication from Dr. E. C. Bate-Smith), has R_F 0·9 approximately in the toluene/acetic acid/water solvent and has a deep-violet fluorescence under ultra-violet light, it is very difficult to make any plausible guesses as to their identities.

It now seems that the occurrence of methylene-dioxy bridges may furnish at least a partial explanation of these fast-moving spots. In support of this statement are the following experimental results. 3 : 4-Methylene-dioxy cinnamic acid was prepared from piperonal by a Dobner condensation (Johnson[5]; melting point 234°–36° (uncorr.); Johnson gives melting point as 233° (corr.)). It gave the following R_F values (corrected by R_M values to known standards run on the same paper[3]): in the Forestal solvent (hydrochloric acid, 10/acetic acid, 100/water, 30), 0·93; in toluene/acetic acid/water (40 : 10 : 50), 0·86; in butanol/acetic acid/water (40 : 10 : 50), 0·89. Under ultra-violet light, it fluoresced dull violet; it was light blue in acid vapour and faded until almost invisible in ammonia. It did not react with diazotized *p*-nitroaniline, whereas herniarin gives a yellow colour with this reagent[6]. A substance which agreed precisely in its R_F in all three solvents and in its ultra-violet fluorescence colours was found in the leaves of *Piper tuberculatum*. If these results be accepted as provisional proof of identity, then this is at once the first record of natural occurrence of the substance and a demonstration of the nature of one of the uncommon fast-moving phenolics in plant extracts. It is surely significant that it occurred in the Piperaceae—the plant, indeed, was chosen for investigation on the basis of the introductory remarks made above. A limited survey of the leaves of plants representing families in which methylene-dioxy bridges are known to occur yielded the following results (numbers of 'fast phenolic' spots in the toluene/acetic solvent are given in brackets):

Family	Results
Magnoliaceae :	*Magnolia grandiflora* (0)
Anonaceae :	*Canangium odoratum* (0) ; *Monodora grandiflora* (0)
Rutaceae :	*Murraya exotica* (4) ; *Citrus aurantifolia* (1) ; *Citrus paradisi* (1)
Umbelliferae :	*Eryngium foetidum* (0)
Lauraceae :	*Persea gratissima* (0) ; *Cinnamomum camphora* (0)
Piperaceae :	*Piper tuberculatum* (2) ; *Piper marginatum* (3) ; *Piper nigrum* (0) ; *Pothomorphe peltata* (0) ; *Peperomia pellucida* (0)

Thanks are due to Dr. E. C. Bate-Smith for advice and for the gift of authentic specimens.

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The Practical Synthesis of I-Phenazinol

Considerable interest has been aroused in 1-phenazinol because of its relatively high antibiotic activity, as brought out in numerous reports, such as in that by Zweig[1]. The methods generally advocated for its preparation, however, are not very satisfactory. Thus the procedures of Surrey[2], and of Hegedüs[3], are time-consuming, while the preparation through pyocyanine obtained from *Pseudomonas pyocyanea* cultures suffers from low yield of the pyocyanine[1]. Poor yield, in this instance of the intermediate 1-methoxyphenazine, also hampers the preparation of 1-phenazinol given by Yoshioka[4].

It has been found that two procedures, already well known in the literature, can be conveniently combined to give a practical means of preparing 1-phenazinol. Phenazine, now readily available by purchase or by synthesis[5], is combined with dimethyl sulphate to produce the quaternary salt, and from this pyocyanine is formed by McIlwain's photochemical synthesis[6]. The pyocyanine, without being isolated, is then converted to 1-phenazinol by the method of Wrede and Strack[7].

The details of the procedure are as follows.

Preparation of 5-methylphenazinium methyl sulphate (phenazine methosulphate). For the sake of completeness, what is essentially the method of Kehrmann and Havas[8] is detailed here. A solution of 25 gm. of phenazine in 125 c.c. of nitrobenzene was heated to about 130° and when it had cooled to 120° it was immersed in an oil-bath heated to 115°. Then, all at one time, 35 c.c. of freshly distilled dimethyl sulphate was added, with stirring. The stirred mixture was kept at 105–10° for five minutes, then removed from the bath. Spontaneous precipitation on cooling gave 35 gm. of bright orange crystals, after removal of adherent nitrobenzene by anhydrous ether.

Conversion to 1-phenazinol. A solution of 4·3 gm. of the unrecrystallized methosulphate in 3·5 litres of distilled water[6] was exposed in an open flask to sunlight through a window for three days, during which the Sun was unclouded for about two-thirds of the time. Then a solution of 80 gm. of sodium hydroxide in about 250 c.c. of water was stirred in, and the reaction mixture allowed to stand for 16 hr. Filtration through fine porosity paper and one extraction with ether were then employed to remove the phenazine and other by-products of the reaction. The aqueous solution was next made faintly acid with glacial acetic acid, and extracted twice with ether. Evaporation of the ether left 1·5 gm. of crude 1-phenazinol. This was purified by slow vacuum sublimation at about 0·1 mm. from an oil-bath at 115°, giving 1·1 gm. of 1-phenazinol, shrinking at 158·6°, and melting at 159–160° (corr.). The yield of the pure product is 33 per cent, based on the phenazine, and 40 per cent, based on the methosulphate.

(To determine the effect of lessening the large volume, 4·3 gm. of phenazine methosulphate was dissolved in 1 litre of water, and subjected to the same treatment as was given to the more dilute solution. In this instance only 0·94 gm. of crude 1-phenazinol was obtained. It was not determined whether longer exposure to sunlight would increase the yield from this more concentrated solution.)

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Observation of Atmospheric Sodium in Absorption

Nearly twenty years ago, the presence of sodium in the upper atmosphere was found by the observation of the *D* lines in twilight[1]. Attempts to deduce the amount of sodium in the layer suffer from an unknown correction for self-absorption[2]. It is therefore of interest to try to observe the sodium by its absorption; but this is difficult with sunlight because of the strong Fraunhöfer lines originating in the Sun itself. An attempt was made by Sanford[3] using the star α Virginis as a source; here the stellar and interstellar *D* lines are shifted by the Doppler effect so that they do not interfere. He found a faint line which may have been telluric *D*1, and deduced a corresponding upper limit of $1\cdot0 \times 10^{10}$ atoms/cm.^{2} for the 'thickness' of the layer, as we may call it.

To observe the telluric absorption in sunlight an instrument is needed giving high resolution and little stray light. We have achieved these by making use of resonance scattering by sodium vapour at a temperature of about 150° C.; the scattered light is recorded by a photoelectric spectrometer[4] which separates the two *D* lines. The system is calibrated by means of light from a tungsten lamp, which, of course, has no absorption lines. The result is a value of the intensity at the bottom of each *D* line as a fraction of the nearby continuum. Between noon and sunset the path-length through the sodium layer varies by a factor of 2–3, depending on the season. A slight decrease in the residual intensities was in fact observed. Two tests showed that the effect was due to sodium rather than water vapour, which has many lines in the yellow. The variation in $D1$ was less than that in $D2$ by a factor averaging 0·59, which compares well with the expected 0·50. A large drop in the absorption was found in April compared with January and February; this agrees with the behaviour of sodium observed in twilight[2] but disagrees strongly with the behaviour of water vapour.

The thickness of the sodium layer was found from the slope of a plot of logarithm of intensity against relative path-length. Eleven of these from the months December, January and February gave thicknesses between 2·5 and 8·3 × 10^9 atoms/cm.^{2}; twilight observations give about 3 × 10^9. Two in April gave 1·06 and 0·88 × 10^9 atoms/cm.^{2}, in good agreement with twilight observations. It may be concluded that twilight intensities are lowered appreciably by self-absorption in winter but by no more than a factor of about 2.

The plots may be extrapolated to zero path-length to give the residual intensity of the solar D line, averaged over the whole of the Sun's disk. Our results are (5·9 ± 0·46) per cent for $D1$ and (5·06 ± 0·24) per cent for $D2$, in fair agreement with previous work[5].

This research was sponsored by the Geophysics Research Directorate of the Air Force Cambridge Research Center, Air Research and Development Command, under Contract AF19(122)–152.

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Hydrogen Isotope Exchange

There appears to be some confusion[1–3] in the derivation and application of certain relationships featuring the separation factor for hydrogen (H) and deuterium (D) chemical-exchange processes.

(1) *Derivation of equations.* Consider the following general reaction involving chemical exchange between isotopes I and I'. Let only n_2 of the total n_1 atoms of I and I' in the compound with A be exchangeable, that is, n_4 atoms of I are fixed, and assume that the concentration of I' is very small:

$$\underset{(a)}{AI_{n_4}I_{n_2}} + \underset{(b)}{BI_{n_3-1}I'} \rightleftharpoons \underset{(c)}{AI_{n_4}I'_{n_2-1}} + \underset{(d)}{BI_{n_3}} \qquad (1)$$

where $(n_4 + n_2) = n_1$.

If a, b, c and d ($d \gg b$ and $a \gg c$) denote the concentrations of the respective molecular species in the reaction, the equilibrium constant K_s is given by:

$$K_s = \frac{c.d}{a.b} \qquad (2)$$

The separation factor α may be defined by the ratio,

$$\alpha = (I'/I)_A/(I'/I)_B \qquad (3)$$

but this requires amplification. Thus, the value α_1 based on the total number of I, I' atoms present in compound A is different from the value α_2 based on only the exchangeable atoms. For the former case (which is the more useful since experimental analysis usually includes all atoms I and I') it is seen from equation (1) that,

$$(I'/I)_A = \frac{c}{a(n_4+n_2)+c(n_4+n_2-1)} \rightarrow \frac{c}{a(n_4+n_2)}$$

$$(I'/I)_B = \frac{b}{dn_3+b(n_3-1)} \rightarrow \frac{b}{dn_3}$$

which in combination with equations (2) and (3) give

$$\alpha_1 = \frac{c.d.n_3}{a.b.(n_4+n_2)} = \frac{n_3}{n_1} . K_s \qquad (4)$$

Similarly, α_2 may be obtained as:

$$\alpha_2 = \frac{n_3}{n_2} . K_s \qquad (5)$$

Clearly, if all sites in compound A are exchangeable, that is, if $n_4 = 0$, then α_2 will be identical with α_1; and if the distribution of I and I' be uniform, then α_2 (by definition) will be close to unity.

The equilibrium constant in the above equations may be replaced by the quantum statistical relationship:

$$K_s = \left(\frac{\text{Reactants}}{\pi\sigma} \Big/ \frac{\text{Products}}{\pi\sigma}\right) . f(\nu) \qquad (6)$$

where π is the multiplication operator, σ is the symmetry number (which for any one of the molecules taking part is the number of equivalent orientations in space that that molecule can assume as the results of simple rotation) and $f(\nu)$, which generally tends to the value unity when heavy molecules and moderate temperatures are considered, is a function of the vibrational frequencies.

(2) *Equivalence of position.* It has been assumed that all sites in compound A which partake in exchange are identical. If these positions are not equivalent, for example, if different types of bond or force constant are involved (as in equation 6), then the equations are not strictly applicable.

(3) *Molecular symmetry.* Molecular symmetry is of no importance in deriving equations (3) and (5), and only the numbers of similar sites available for, or excluded from, exchange are concerned[4]. Thus, the equation presented by Gold and Satchell[1], namely:

$$\alpha_2 = \left(\frac{\text{Products}}{\pi\sigma} \Big/ \frac{\text{Reactants}}{\pi\sigma}\right) . K_s \qquad (7)$$

does not represent the general case. Only if both the n_2 exchange sites in the molecule and the molecule $AI_{n_4}.I'_{n_2}$ itself are symmetrical (for example, the three H atoms in ammonia or the two H atoms in aniline) is equation (7) identical with equation (5). In many instances, this condition is not satisfied. For example, by use of a suitable substituent, a nuclear mono-substituted aniline may be obtained which although asymmetrical still possesses two identical amino-group hydrogen atoms capable of exchange. It can be seen that, in this case, equations (5) and (7) differ by a factor of two.

(4) *Application: simple cases.* Consider reactions of the type,

$$AH_{n_4}H_{n_2} + HDO \rightleftharpoons AH_{n_4}H_{n_2-1}D + H_2O \qquad (8)$$

Under mild conditions at 25° C., it has been found[2] for amyl alcohol ($AH_{n_4}H_{n_2} = C_5H_{11}.OH$) that

$\alpha_1 = 0\cdot0912$, and for phenol[3] ($C_6H_5.OH$) that $\alpha_1 = 0\cdot1824$. On applying equation (4), both these results give $K_S = 0\cdot55$ (expected from equation (6) for asymmetric molecules), and from equation (5), assuming only the hydroxyl-H atom exchangeable, the corresponding value of α_2 is $\alpha_2 = 1\cdot10$ (see section (1) above). It is seen that for mono-functional cases[1] $\alpha_2 = 2K_S \simeq 1\cdot0$.

For benzene[3], where six identical H atoms are capable of exchange, equations (4) and (5) give $\alpha_1 = \alpha_2 = K_S/3 = 1\cdot0$.

Values of α_1 are of significance in preparing labelled compounds or in separating hydrogen from deuterium. For example, in the above cases, a D/H ratio equal to that of the water can be obtained in the benzene, whereas only a tenth of this ratio can be secured in the amyl alcohol.

(5) *Application : nuclear aromatic exchange.* Under certain conditions, a substituted benzene compound, for example, phenol, may exhibit slow nuclear deuteration in addition to rapid exchange of the functional hydrogen atom (in this case, the hydroxyl-hydrogen atom) and it is required to know what positions are being affected.

In sections (1) and (4) above, it was shown that $\alpha_2 = f(\nu) \simeq 1\cdot0$ for H/D exchange at certain O—H and C—H positions (compare S—H bonds[1]). If it is assumed that substitution of benzene has little effect upon the vibrational frequencies (see sections (1) and (2) above), then α_2 will remain equal to unity for the H/D distribution in the nucleus of the deuterated phenol. Thus, after methylation to yield the nuclear-deuterated anisole ($AH_{8-n_3}.D_{n_3}$), that is, elimination of the deuterated hydroxyl group, a value of α_1 of $0\cdot342$ is obtained[3]. From this figure, K_S is $1\cdot37$ (compare ref. 1) and, assuming $\alpha_2 = 1\cdot0$, the corresponding value of n_3 is $2\cdot74$; hence, three nuclear positions (presumably the *ortho-* and *para-* sites) are capable of exchange.

It should be noted[3] that, in these operations, it is α_2, and not α_1 or K_S, which is placed equal to unity.

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Deformations of Metal Surfaces under Normal and Inclined Loads

THE purpose of this communication is to offer an explanation of why oxide and other protective films, as measurements of electrical resistance[1] and transfer[2] have shown, are less disrupted when two metal surfaces are loaded together normally than when the loading has a tangential component and the surfaces slip. The suggested explanation is that under normal loading, even though the surfaces be permanently dented, there is a surface layer of material which is not plastically deformed, whereas if the loading be sufficiently inclined the plastic deformation extends to the surface.

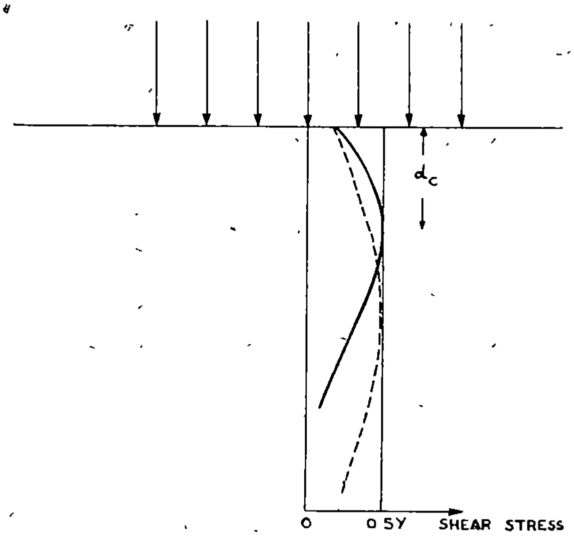

Fig. 1. The variation of the shear stress with depth when the loading is normal

It is a result of the theory of the contact of elastic bodies in circumstances of normal loading[3] that the stress responsible for plastic yielding, which will here be taken as the maximum shear stress, has a value proportional to the mean pressure over the area of contact and occurs at a depth proportional to a dimension of that area. The variation of the shear stress with depth is illustrated in Fig. 1. The full line indicates the shear stress at the limiting normal load for elastic conditions, P_C. Plastic deformation is imminent at a point d_C beneath the surface where the maximum shear stress has reached half the yield stress (Y) of the material. Let it be assumed that when the load exceeds P_C the nature of the stress field remains the same, in particular that the maximum stress still occurs at a depth proportional to the pertinent dimension of the contact area, and that because of the flow, the maximum of the shear stress is limited to $0\cdot5\,Y$. The variation of shear stress with depth which then exists is illustrated by the dotted line in the figure. Clearly, as the load, area of contact and therefore the depth of the point of maximum stress increase, the stresses in the region from the surface to the depth d_C decrease. Consequently, this region is always protected from plastic yielding and there is a surface layer which is not plastically deformed.

Poritsky[4] has calculated the stresses which exist in cylinders making line contact when the loading is inclined. Under purely normal loading the shear stress perpendicular to the line of contact is zero at the surface while with a sufficient tangential component this stress is very close to the maximum shear stress. In the latter circumstance an undeformed surface layer is not to be expected.

It follows from the above argument that the protective surface films are less disrupted when the loading is normal; indeed, they may not be broken at all. In addition to providing an explanation of the resistance and transfer experiments already referred to, this also affords an explanation of the lack of adhesion between normally loaded metal bodies when their surfaces are contaminated[5] and provides a reason why a tangential force is needed to induce the formation of welds[6].

Direct metallographic evidence of the undeformed layer has been obtained from mild steel disks run together at a load in excess of that which they could carry elastically. This evidence will be published elsewhere[7].

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Angular Distribution of Submarine Daylight in Deep Water

In an important paper of 1945, H. H. Poole[1] considers the assumption, suggested in fact by experiments, that at a certain depth in the sea an equilibrium is reached below which the angular distribution of the luminance is constant and independent of the surface-lighting, and the decrease of luminance is an exponential function of the depth characterized by a coefficient of extinction less than (or equal to) the coefficient of total absorption in sea water for a parallel beam. I have recently studied again the problem of the penetration of light in the sea[2], starting from the 'equation of transfer' of the radiation in a scattering medium, and I have found by this theoretical method the existence of an equilibrium condition; the results obtained by an approximate solution of the equation of transfer, in the deep layers, are in good agreement with those given by the direct method of Poole at equilibrium.

Poole's computations used the assumption of isotropic scattering for sea water; this assumption leads to results of simple mathematical form, but unfortunately it is disproved by the reality, as is seen both from the conclusion of Poole and the direct measurements[3]. I have compared these values with those obtained by my method, starting from the assumption of a scattering function with a forward maximum, which corresponds approximately to the actual scattering due to large transparent particles. Adopting the notation of Poole, c is the coefficient of total absorption (true absorption and scattering) for water, sc the coefficient of absorption due to scattering (both for a parallel beam), and kc the coefficient of vertical extinction for radiation at equilibrium in the sea; for the chosen scattering function, the coefficient of scattering in a direction at an angle θ with the direction of incidence is $\frac{sc}{4\pi}[1 + 1\cdot73\,P_1(\cos\theta) + P_2(\cos\theta)]$, where P_n is the Legendre polynomial of order n. If U is the illumination measured by a plane photometer facing downwards, V the illumination measured by a plane photometer facing upwards, and H the illumination measured by a cylindrical photometer with its axis vertical, Figs. 1 and 2 show the variation of k and of the ratios U/V and H/V with s. The curves in full lines are reprinted from Poole's paper and correspond to the isotropic scattering; the dotted curves are deduced from my computations for the scattering function given above.

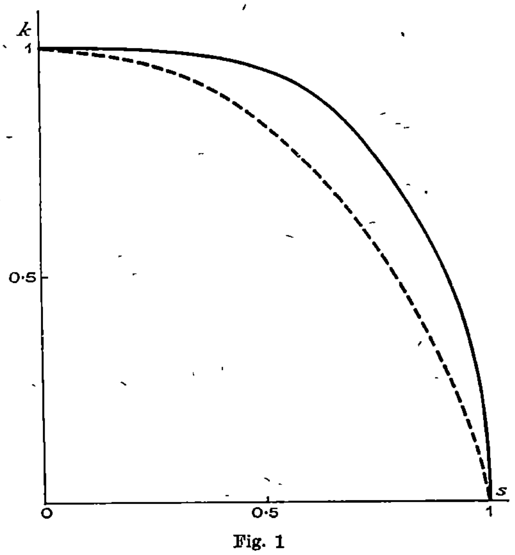

Fig. 1

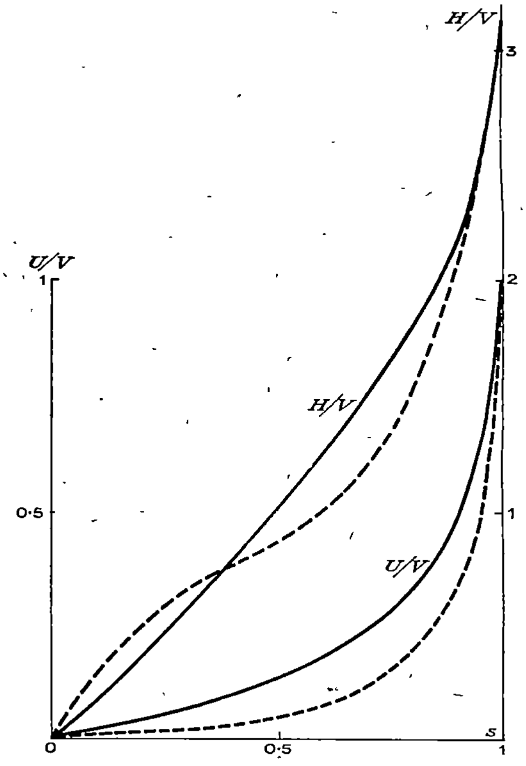

Fig. 2

In his paper, Poole gives some experimental measurements[4] of U/V, and H/V, from which he deduces, by means of curves, two values of s, respectively called s and s'. These results are given in Table 1, together with values of s and s' deduced from my curves; the latter figures are in much better agreement among themselves. So it seems, as was foreseen by Poole, that a scattering function

Table 1

Measurements	Isotropic scattering		Scattering with forward maximum	
	s	s'	s	s'
C_1	0·275		0·53	
C_5	0·189	0·42	0·44	0·47
C_4	0·176	0·40	0·42	0·43
C_3	0·169	0·37	0·40	0·37
C_6	0·167	0·40	0·40	0·44
C_7	0·123	0·40	0·35	0·43

with a large forward maximum corresponds much better to reality than an isotropic scattering.

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New Zealand Coals

IN the past twenty years many hundreds of ultimate analyses and many thousands of proximate analyses of New Zealand coals have been made in accordance with British Standard Specifications at the Coal Section of the New Zealand Dominion Laboratory. A preliminary study of these analyses shows that New Zealand coals, varying in rank from peat to semi-anthracite (the anthracites are contact-metamorphosed lignites), almost all belong to a restricted range of coal type different from that of British and North American coals of Carboniferous age.

New Zealand's principal coal seams are of early Senonian to early Oligocene age, but a few Miocene coals are also worked and thin seams occur in younger beds, even as young as early Pleistocene. The rank of the coals, however, appears to be a function neither of age nor of intensity of deformation, but rather of depth of burial.

The seams are usually particularly low in ash, frequently with less than 2 per cent. Coals with high or moderate sulphur contents are widely distributed, the sulphur content bearing a close relation to the stratigraphic distance from marine beds (cf. Wellman[1]). Fig. 1 is a graph, in which the percentage of carbon is plotted against the percentage of hydrogen, for coals with not more than 0·6 per cent sulphur and 7·0 per cent ash, and shows also the 'coal band' for New Zealand coals, extended tentatively to peats. Some of the low-rank coals (in particular some of those with 65–70 per cent carbon) contain abundant resin, with consequent high hydrogen contents, so that some analyses fall above the band. Adjustment of analyses of high- and medium-sulphur coal to a sulphur-free basis cannot be made by the commonly used Parr formula, as the sulphur is almost exclusively organic. Accordingly, these coals are not shown on Fig. 1; but preliminary examination of the analyses shows that most fall within the coal band based on low-sulphur coals.

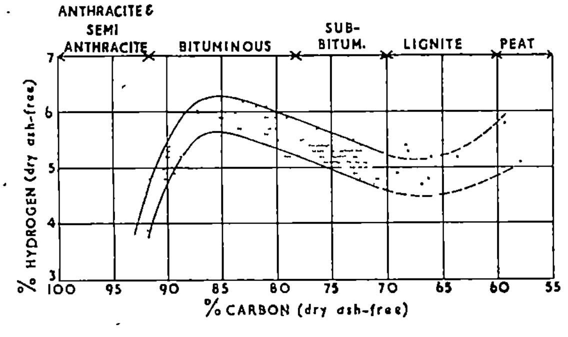

Fig. 1. The New Zealand coal band; coals with not more than 0·6 per cent sulphur and 7 per cent ash

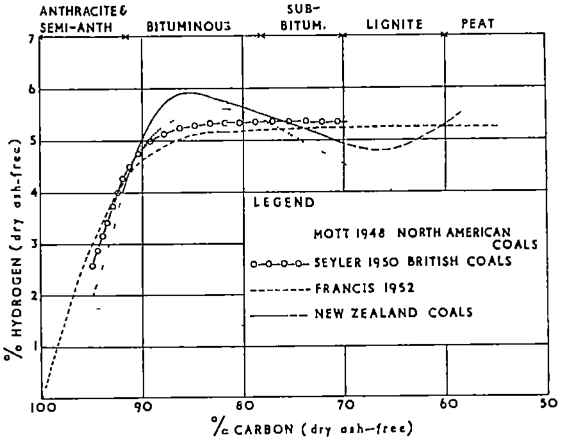

Fig. 2. Mean lines for coal bands of various authors

In Fig. 2 the mean line for the New Zealand coal band is compared with the mean lines adopted by Mott[2] for North American coals, Seyler[3] for British 'bright' coals, and Francis[4] for 'mean ulmins'. These lines trace the metamorphic development of coals of particular types from peat to anthracite. Mott found that those British coals with high durain contents require a subsidiary band of slightly lower hydrogen content than his band for North American coals, but that the difference diminishes with increasing rank; he thus acknowledged that coals of different types would fall in different bands. Likewise, Francis showed different theoretical development curves for perhydrous ulmins and sub-hydrous ulmins.

The scarcity or lack of Carboniferous coals of sub-bituminous, lignite and peat ranks made it necessary for Seyler to extend his coal band from bituminous to lower ranks on the assumption that the mean hydrogen percentage is nearly constant. Francis' theoretical development curve produces a similar result. Mott's coal band, deduced from Carboniferous, Cretaceous and Tertiary coals, shows an increasing hydrogen content from low-rank lignite to bituminous coal; and the New Zealand coal band, based on coals averaging higher hydrogen contents, shows a comparable, though smaller, increase. Thus Seyler's and Francis' theoretical paths of development for coals of low rank do not appear to be borne out in practice.

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Geological Survey,
P.O. Box 2110,
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New Zealand.
April 17.

[1] Wellman, H. W., *N.Z. Geol. Surv. Bull.*, 45, 100 (1952).

[2] Mott, R. A., *J. Inst. Fuel.*, 22, 2 (1948).

[3] Seyler, C. A., Coal Petrology in "Progress in Coal Science" (Butterworths, London, 1950).

[4] Francis, W., *J. Inst. Fuel*, 24, 15 (1952).

African Pleistocene Pluvials and European Glaciations

THE most recent book on African prehistory by Mlle. H. Alimen[1] continues to adopt the theory of three pleistocene pluvials and two interpluvials. Her field-work having been mainly in the Sahara, this must be taken as her considered interpretation of phenomena in this part of Africa.

About 1950, however, Leakey in East Africa proposed to divide the Second or Kamasian Pluvial into two[2], thus postulating four pluvials and three interpluvials. This had the advantage of appearing to correspond with the four glaciations and three interglacials of the northern hemisphere. But while the Second Northern Interglacial was longer and warmer than the other two, Mortelmans in the Congo[3] and van Riet Lowe and other workers in South Africa could not find evidence that Leakey's Second African Interpluvial was as severe as the Third, and it still seemed to be a minor oscillation which scarcely justified dividing the Second or Kamasian Pluvial. In 1952 Leakey[4] stressed the faunal break in East Africa during the Second Pluvial, in order not only to justify but also to emphasize the severity of the interpluvial which he had postulated.

Whatever may have happened in the southern hemisphere, it would indeed be surprising if the great ice-sheets in the northern hemisphere did not have a marked effect on climate in low latitudes, at least as far as the equator. To-day, explanations of the pleistocene ice-ages fall into two principal groups: the Simpson group, which postulates changes in radiation emitted by the Sun, and the Milankovich group, which evokes changes in insolation of certain parts of the Earth, especially high latitudes. It is not possible here to examine these theories in detail; suffice it to say that, according to Simpson, temperatures will fluctuate correspondingly in both hemispheres and in all parts of the Earth, whereas according to Milankovich there is no necessary correlation between the hemispheres.

Africa is the only continent straddling the equator where a sufficiently detailed chronology of the pleistocene may be established to test these theories; for human cultures provide probably more sensitive zone-fossils than any biological remains. Very recent researches in West Africa have thrown some light on these problems, and suggest that Alimen's sequence of three and not four pluvials applies not only in the Sahara but also as far as the Guinea coast. Four years ago I began to amass evidence for the Gold Coast[5] of a severe Last Interpluvial corresponding in aridity and in date with the Last Interpluvial of the Congo and South Africa; as in South-West Africa[6], it is not contemporary with but later than the Last Northern Interglacial. There is no clear evidence of an interpluvial within the Second Pluvial, to correspond to the Second Northern Interglacial. So long as this evidence was confined to the coast, though it countered the Simpson type theories, it could be reconciled with the Milankovich type; for greater cold in Antarctica, for which both Milankovich and his successors[7] produce evidence, would intensify the Benguela Current, cool the South Atlantic Ocean, and inhibit rainfall as far as the Gulf of Guinea and over most of the southern part of Africa.

Evidence I have obtained mostly in the last few months from lat. 8–12° N. in the Gold Coast, Togo, Dahomey and especially Nigeria suggests that the Milankovich theory also is untenable. These regions lie north of the Guinea forest and beyond the reach of local marine conditions; their climates should *a priori* be completely northern.

Nearly all the valleys over this area have a similar cross-section. From the gently undulating peneplain there descend very mature slopes. About half-way down, these are rejuvenated with a marked scarp. At the point of rejuvenation there is usually an accumulation of rolled pebbles, and some pebbles are found on the mature slopes, but not as far up as the peneplain. These phenomena have in many cases been dated by artefacts. The rejuvenations belong to the Last Pluvial; the pebble-concentrations mark the valley-bottoms of the Last Interpluvial. Among the pebbles are found numerous rolled pebble-tools, which can scarcely be as late as the Second Pluvial, contemporary with the Chellean and Acheulean cultures. They should belong to the First Interpluvial, and seem to have been dropped on valley-floors about the level where pebbles are observed to start on the mature slopes. There are thus three phases of erosion and two halts, but no indication of an interpluvial during the Second Pluvial.

Secondly, from the distribution of cultures in West and South Africa, it appears that during pluvials man was washed out of the valleys and took refuge on the highlands, whereas in the interpluvials he was forced into the less-parched lowlands. The only highlands in West Africa are the Nigerian plateau and parts of the Togo mountains. The distribution of palæolithic cultures is shown in Table 1.

Table 1

Climatic stage	East African name	Lowland zone: Gold Coast, Togo, Dahomey, Lower Nigeria	Highland zone: Upper Nigeria, ? parts of Togo
First Pluvial	Kageran	—	—
First Interpluvial		Pebble-tools	—
Second Pluvial	Kamasian + Kanjeran	Very little Acheulean	? Chellean, Acheulean abundant
Second Interpluvial		Sangoan	A little Sangoan in Togo only
Third Pluvial	Gamblian	Late Sangoan and probable hiatus	Middle Stone Age
Post-pleistocene dry phase		Very late Middle Stone Age	—

There is no indication of a break during the Second Pluvial or of occupation of the lowland zone. In South Africa there is a minor break at this point. Late Chellean is rare in the Transvaal and abundant in Natal; but it was not arid enough for wind-blown dust to accumulate as it did in the First and Last Interpluvials and in the post-pleistocene dry phase.

Thus it appears that, perhaps as far as 25° N. (according to Alimen), there is a pleistocene sequence of three and not four pluvials, and the Second Pluvial contains a minor dry phase. This sequence cannot be made to correspond with the European glaciations, so the climatic explanations not only of Simpson but also of Milankovich are untenable. The archæologists must now pass the problem back to the meteorologists, and ask them to reconsider it.

O. Davies

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Achimota,
Gold Coast.
May 1.

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[1] "Préhistoire de l'Afrique" (see especially, pp. 173, 234).

[2] "Olduvai Gorge"; "Study of Pleistocene Climatic Changes in North-East Angola".

[3] For example, *Problèmes d'Afrique centrale*, 18, 9 (1952).

[4] C.R. Second Panafrican Congress on Prehistory, 293.

[5] *ibid.*, p. 259; *Notes africaines*, p. 65 (1954); and several papers not yet published.

[6] *South African J. Sci.*, 277 (1955).

[7] van Woerkom, in Shapley, "Climatic Change", 147.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, October 8

Institution of Post Office Electrical Engineers (at the stitution of Electrical Engineers, Savoy Place, Victoria Embanknt, London, W.C.2), at 5 p.m.—President's Address—"Fifty Years Telecommunications" (Jubilee Meeting).

British Ornithologists' Union (in the Lecture Hall, British iseum (Natural History), Cromwell Road, London, S.W.7), at 15 p.m.—Presidential Report on the Plans for the Centenary of e Union, to be followed by a General Discussion. 6.0 p.m.—Annual ientific Meeting.

British Society for the History of Science, Philosophy of ience Group (in the Joint Staff Common Room, University College, wer Street, London, W.C.1), at 5.30 p.m.—Dr. G. J. Whitrow: ome Reflections on the Philosophy of Science of Sir Edmund hittaker". (Chairman's Address.)

Society of Chemical Industry, Plastics and Polymer Group t 14 Belgrave Square, London, S.W.1), at 6.30 p.m.—Mr. E. B. iomas and Dr. D. Finlayson: "Production and Properties of Cellulose iacetate".

Tuesday, October 9

Society of Chemical Industry, Agriculture Group (at the yal College of Science, South Kensington, London, S.W.7), at .45 a.m.—Meeting on "Polyphenols in Soils and Plants".

University College, London (in the Anatomy Theatre, Gower reet, London, W.C.1), at 1.15 p.m.—Prof. E. G. Turner: "The ead Sea Scrolls and the Hellenistic World".*

Zoological Society of London (at the Zoological Gardens, Regent's rk, London, N.W.1), at 5 p.m.—Scientific Papers.

Institution of Electrical Engineers, Measurement and ontrol Section (at Savoy Place, London, W.C.2), at 5.30 p.m.— . Denis Taylor: "The Measurement of Radioactivity" (Chairman's ldress).

Royal Aeronautical Society (at 4 Hamilton Place, London, W.1), 7 p.m.—Mr. A. Stepan: "The Pressure Jet Helicopter".

Wednesday, October 10

Physical Society, Colour Group (in the Lecture Theatre of the ghting Service Bureau, 2 Savoy Hill, London, W.C.2), at 3.30 p.m. Dr. B. H. Crawford: "Lippmann Photography and Interference lters"; Dr. S. Hesselgren (Sweden): "A Colour Classification stem based upon Phenomenological Experiments".

Society of Chemical Industry, Food Group (at 14 Belgrave uare, London, S.W.1), at 6.45 p.m.—Mr. D. M. Ireland: "The iromatographic Determination of Sugar and Oligosaccharides in arch Hydrolysates"; Miss Ruth Bennett and Dr. J. B. M. Coppock: 'he Natural Ageing of Flour".

Royal Institute of Chemistry, London Section (joint meeting th the Isleworth Grammar School Scientific Society, at the eworth Grammar School, Ridgeway Road, Isleworth), at 7 p.m.— . A. E. Werner: "The Scientific Examination of Paintings".

Royal Society of Tropical Medicine and Hygiene (at Manson ouse, 26 Portland Place, London, W.1), at 7.30 p.m.—Dr. H. A. id: "Sea Snake Research".

Thursday, October 11

University College, London (in the Anatomy Theatre, Gower eet, London, W.C.1), at 1.15 p.m.—Dr. P. A. Sweet: "The Births d Deaths of the Stars".*

Institution of Naval Architects (in the Weir Lecture Hall, Upper Belgrave Street, London, S.W.1), at 4.45 p.m.—Dr. J. F. lan: "Yacht Testing".

Friday, October 12

Iron and Steel Institute (by arrangement with the British on and Steel Research Association, at 4 Grosvenor Gardens, ndon, S.W.1), at 10 a.m.—"Corrosion" Meeting.

British Mycological Society (in the Large Physics Lecture eatre, Birkbeck College, Malet Street, London, W.C.1), at 11 a.m.— eting on "Mycology and Forestry".

Biochemical Society (at the National Institute for Medical search, Mill Hill, London, N.W.7), at 2 p.m.—Scientific Papers.

North East Coast Institution of Engineers and Shipbuilders the Lecture Theatre of the Mining Institute, Newcastle-uponne), at 6.15 p.m.—Opening General Meeting. Presidential Address Mr. R. C. Thompson.

Royal Institute of Chemistry, London Section (at the Richnd and East Sheen County Grammar School, Park Avenue, East een, London, S.W.14), at 7.30 p.m.—Dr. Norman Booth, Dr. ancis Aylward, Mr. T. McLachlan and Miss Mamie Olliver: "Careers Chemistry".

South Place Ethical Society (at Conway Hall, Red Lion Square, ndon, W.C.1), at 7.30 p.m.—Mr. Fred Hoyle: "The Time Scale the Universe" (47th Conway Memorial Lecture).

Friday, October 12—Saturday, October 13

Faraday Society, Colloid and Biophysics Committee (at the Manson Hall, Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1)—Informal Discussion on "Nucleic Acids and Nucleo-Proteins: Structure and Function".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant, Grade B (graduate, with research or industrial experience), in Chemistry—The Principal, Derby and District College of Technology, Normanton Road, Derby (October 13).

Assistant Lecturer in Mathematics—The Registrar, University College of North Staffordshire, Keele (October 15).

Lecturer or Assistant Lecturer in Pure Mathematics—The Secretary, The University, Exeter (October 15).

Senior Lecturer or Lecturer in Extractive Metallurgy, School of Mines and Industries, Adelaide, South Australia—The Agent-General and Trade Commissioner, South Australia House, Marble Arch, London, W.1 (October 18).

Research Chemist (with a first- or second-class honours university degree (or equivalent) in chemistry or biochemistry and satisfactory postgraduate experience in physical or organic chemistry, or biochemistry) in the Department of Agriculture's Peatland Experimental Station at Glenamoy, Co. Mayo—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (October 19).

Assistant Lecturer (with special interests in the field of historical geography) in Geography—The Registrar, University College, Singleton Park, Swansea (October 20).

Soil Surveyors with the New South Wales Department of Agriculture, for duties which will include the carrying out of soil surveys in any part of N.S.W., the preparation of data and draft maps from surveys, laboratory work, etc.—The Agent-General for New South Wales, 56 Strand, London, W.C.2 (October 22).

Lecturer in Mathematics; and Assistants in Mathematics—The Secretary of University Court, The University, Glasgow (October 31).

Lecturer in Physics at Fourah Bay College, Sierra Leone—The Secretary, Advisory Committee on Colonial Colleges, 1 Woburn Square, London, W.C.1 (October 31).

Senior Lecturer or Lecturer (preferably with experience and research interests either in the application of modern inorganic and physico-chemical principles to analytical chemistry, or in the field of geochemistry) in Analytical Chemistry at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, October 31).

Professor, Senior Lecturers (2) and a Lecturer, in the Department of Chemistry and Chemical Technology, University of Natal, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (November 8).

Lecturer in Physics—The Registrar (Room 9, O.R.B.), The University, Reading (November 12).

Chair of Chemistry in Birkbeck College—The Academic Registrar, University of London, Senate House, London, W.C.1 (November 13).

Lecturer in the Department of Botany at the University of Cape Town, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Cape Town, November 15).

Lecturer or Assistant Lecturer in Physics at Makerere College, University College of East Africa—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (November 30)

Assistant (Grade B) in the Department of Mathematics, Bradford Technical College—The Director of Education, Town Hall, Bradford.

Assistant, Grade B (preferably with an honours degree and teaching, research or industrial experience), in Physics—The Clerk to the Governors, Mid-Essex Technical College and School of Art, Market Road, Chelmsford.

Assistant Lecturer in Biology—The Secretary, Royal Free Hospital School of Medicine (University of London), Hunter Street, London, W.C.1.

Assistant Lecturer (with an honours degree in agricultural botany or botany, and a special interest in plant pathology) in Agricultural Botany—The Bursar, Royal Agricultural College, Cirencester.

Assistant (preferably with some botanical training) for supervising plots of wheat—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

Chemist (honours graduate with at least three years research experience) for studies of the properties of coal extracts and of the halogenation of coals and allied materials—The Assistant Secretary, British Coal Utilization Research Association, Randalls Road, Leatherhead, Surrey, quoting Ref. C.64.

Electronics Technician, to take charge of a new electronics workshop for constructing and maintaining laboratory equipment—The Registrar, The University, Nottingham.

Librarian—The Director of Research, British Rubber Producers' Research Association, 48 Tewin Road, Welwyn Garden City, Herts.

Physicist (with an honours degree in physics or equivalent qualification) with the Radiological Protection Service (M.R.C. and Ministry of Health), at Sutton, to carry out special investigations into problems associated with radiological protection, for example, the extent of the hazard involved in the present-day use of ionizing radiations—The Director, Radiological Protection Service, Downs Nursery Hospital, Sutton, Surrey.

Physicists or Physical Chemists (with a good honours degree in physics or chemistry, and preferably some research experience) for both fundamental and technological research projects—The Appointments Officer, British Rayon Research Association, Heald Green Laboratories, Wythenshawe, Manchester 22.

POLYMER CHEMIST, to work on the physical properties of irradiated polymers—The Establishment Officer, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting Ref. 639/34.

SENIOR LECTURER IN PHYSIOLOGY AND PHARMACOLOGY at the Technical College, Bradford—The Director of Education, Town Hall, Bradford.

SENIOR SCIENTIFIC OFFICER/SCIENTIFIC OFFICER (with a first- or second-class honours degree in physical chemistry or physics, and experience in infra-red spectroscopy and a good knowledge of the interpretation of spectra) to join a team engaged on research in the field of spectroscopy—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting Ref. 1207/34.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Royal Institute of Chemistry. Lectures, Monographs and Reports, 1956. No. 2: Biological Synthesis of Carbohydrates. By Dr. Maurice Stacey. (Third P. F. Frankland Memorial Lecture.) Pp. ii+18. (London: Royal Institute of Chemistry, 1956.) 3*s*. 6*d*. net. [257

British Steel Castings Research Association. Third Annual Report, 1956. Pp. ii+25. (Sheffield: British Steel Castings Research Association, 1956.) [257

Aero Research Technical Notes. Bulletin No. 161 (May, 1956): Experiments on Composite Models with Applications to Cemented Joints. Pp. 10. (Duxford: Aero Research Limited, 1956.) [257

Department of Scientific and Industrial Research. Report of the Food Investigation Board with the Report of the Director of Food Investigation for the year 1955. Pp. vi+76. (London: H.M. Stationery Office, 1956.) 4*s*. net. [257

Library Association Pamphlet No. 2: The Regional Library Systems. By P. H. Sewell. Second edition, revised with the assistance of P. W. Plumb. Pp. 71. (London: Library Association, 1956.) 7*s*. (5*s*. to L.A. members). [277

Rothamsted Experimental Station, Harpenden. (Lawes Agricultural Trust.) Report for 1955. Pp. 256. (Harpenden: Rothamsted Experimental Station, 1956.) 8*s*. 6*d*. [277

Planning. Vol. 22, No. 400 (23 July 1956): PEP 1931–56. Pp. 141–156. (London: Political and Economic Planning, 1956.) 2*s*. 6*d*. [277

Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences. No. 667, Vol. 239 (25 July 1956): Biology and Physics of Locust Flight. 1: Basic Principles in Insect Flight—a Critical Review. By T. Weis-Fogh and Martin Jensen. 2: Flight Performance of the Desert Locust (*Schistocerca Gregaria*). By T. Weis-Fogh. 3: The Aerodynamics of Locust Flight. By Martin Jensen. 4: Notes on Sensory Mechanisms in Locust Flight. By T. Weis-Fogh. Pp. 415–585. (London: Royal Society, 1956.) 55*s*. [277

The Geological History of Brecknock. By F. J. North. (Reprinted from *Brycheiniog*, Vol. 1 (1955).) Pp. 75+2 plates. (Cardiff: National Museum of Wales, 1956.) 4*s*. 6*d*. [317

Department of Scientific and Industrial Research. Report of the Road Research Board with the Report of the Director of Road Research for the year 1955. Pp. iv+96+8 plates. (London: H.M. Stationery Office, 1956.) 5*s*. net. [317

Training for Supervisors. (The "True Story" Series.) Pp. 28. (London: Director of Public Relations, Ministry of Labour and National Service, 1956.) [317

Institute of Navigation. Observational Errors. By E. W. Anderson and J. B. Parker. Pp. ii+28. (London: John Murray (Publishers), Ltd., 1956.) 5*s*. [317

Kodak School of Industrial and Engineering Radiography. Pp. 16. (Ruislip: Kodak Limited, 1956.) [317

Bulletin of the British Museum (Natural History). Entomology. Vol. 4, No. 7: A Study of African Chironomidae. By Paul Freeman. Pp. 285–366. (London: British Museum (Natural History), 1956.) 20*s*. [317

Proceedings of the University of Durham Philosophical Society. Vol. 12, No. 12: A Preliminary Account of the Variation in *Dibunophyllum bipartitum* (McCoy) from the Carboniferous Middle Limestone Group of Northumbria. By Dr. G. A. L. Johnson. Pp. 128–135. Vol. 12, No. 13: Observations on the Flora around Reiff, Rhu More, Wester Ross, 1953. By D. Morgan. Pp. 136–140. (Durham: University of Durham Philosophical Society, 1956.) [317

Department of Scientific and Industrial Research. Summary of Progress of the Geological Survey of Great Britain and the Museum of Practical Geology for the year 1955, with Report of the Geological Survey Board and Report of the Director. Pp. iv+87. (London: H.M. Stationery Office, 1956.) 4*s*. 6*d*. net. [88

Torquay Natural History Society. Transactions and Proceedings for the year 1954–55. (Vol. 12, Part 1.) Edited by F. C. Barnes and F. Sherwill Dawe. Pp. 40+2 plates. (Torquay: Torquay Natural History Society, 1955.) [88

Other Countries

University of Illinois: Engineering Experiment Station. Bulletin No. 433: A Design for Non-Sticking Plug and Ring Gages and Locators. By Prof. Lawrence E. Doyle, Bernard R. Better and Prof. Bei Tse Chao. Pp. 28. 45 cents. Bulletin No. 434: Warm Air Perimeter-Loop and Perimeter-Radial Systems in a Basementless Residence. By Herbert T. Gilkey, Prof. Robert W. Roose and Morris E. Childs. Pp. 20. 30 cents. (Urbana, Ill.: University of Illinois, 1956.) [277

Studies on Explosives with Lined Cavities. By Dr. Sampo
Singh. (Special number of the *Defence Science Journal*, Vol. 5, No
July 1955.) Pp. ii+169–274. (New Delhi: Defence Science Organ
tion, Ministry of Defence, 1956.) [

United Nations. Economic Developments in the Middle E
1954–1955. (Supplement to World Economic Survey, 1955.)
viii+151. 1.50 dollars; 11*s*.; 6.50 Swiss francs. Economic Deve
ments in Africa, 1954–1955. (Supplement to World Economic Sur
1955.) Pp. vii+100. 1 dollar; 7*s*.; 4 Swiss francs. (New Yo
United Nations; London: H.M. Stationery Office, 1956.) [

The Snellius Expedition in the Eastern Part of the East In
Archipelago 1929–1930, under the Leadership of P. M. Van B
Vol. 2: Oceanographic Results. Part 5: The Bottom Water. Cha
2: Temperature. By P. M. Van Riel. Pp. v+60+8 plates. (Leid
E. J. Brill, 1956.) Paper bound, 15 guilders; Cloth bound,
guilders. [

Observatoire de Paris: Section d'Astrophysique a Meu
Cartes Synoptiques de la Chromosphère Solaire et Catalogue
Filaments de la Couche Supérieure. Vol. 1, Fascicule 10: Relevé
Statistiques de Complément Relatifs aux Années 1931 a 1944. Pp.
Vol. 2, Fascicule 1: Années 1945–1946–1947. Pp. 241. (Meud
l'Observatoire, 1955 et 1956.) [

Canada: Department of Mines and Technical Surveys. Geolog
Survey of Canada. Bulletin 28: Pelecypoda of the Ottawa Forma
of the Ottawa–St. Lawrence Lowland. By Alice E. Wilson.
v+102+9 plates. 50 cents. Memoir 280: Uppermost Cretace
and Paleocene Non-Marine Molluscan Faunas of Western Albe
By E. T. Tozer. Pp. v+125+9 plates. 1 dollar. Memoir 281: Str
graphy and Palaeontology of the Interlake Group and Stone
Formation of Southern Manitoba. By Colin W. Stearn. Pp. iv+16
16 plates. 1 dollar. (Ottawa: Queen's Printer, 1956.) [

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(Organe officiel de la Société Internationale d'Ethnopsychol
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Annuel: 4 numéros par année, plus les numéris spéciaux, un
1500 francs. Pp. 96. (Tanger: Dr. Charles Pidoux, 37 Ave
Menendez y Pelayo, 1956.) [

Transactions and Proceedings of the Geological Society of So
Africa. Vol. 58, containing the Papers and Discussions prese
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Some Aspects of the Geomorphology of Central and Southern Afr
By F. Dixey. (Alex L. du Toit Memorial Lecture, No. 4.) Pp. iii+
(Johannesburg: Geological Society of South Africa, 1956.) [

Colony of Mauritius. Meteorological Observations and Clim
logical Summaries. Vol. 1954, Part 7, July. Pp. 12. Vol. 1954, Par
August. Pp. 12. Vol. 1954, Part 9, September. Pp. 12, Vol. 1
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Vol. 1954, Part 12, December. Pp. 12. (Port Louis: Governm
Printer, 1955.) [

Coryndon Memorial Museum, Nairobi. Annual Report for 19
(1: Chairman's Report. 2: Curator's Report.) Pp. 20+2 pla
(Nairobi: Coryndon Museum, 1956.) 1*s*. net.

Universidad Nacional de Tucuman: Instituto de Fisica
Matematica. Publicacion No. 707: Hiperones Neutros y Carga
Por A. Battig. Pp. 60+5 plates. (San Miguel de Tucuman: Unive
dad Nacional de Tucuman, 1955.)

Department of Agriculture, Jamaica. Investigations, 1954. (Bulle
No. 54, New Series.) Pp. vi+130. (Kingston: Government Prin
1955.) 3*s*. 6*d*.

United States Department of Agriculture. Leaflet No. 368:
Alfalfa Weevil—How to Control It, Revised edition. Pp. 8. (Washi
ton, D.C.: Government Printing Office, 1956.) 5 cents.

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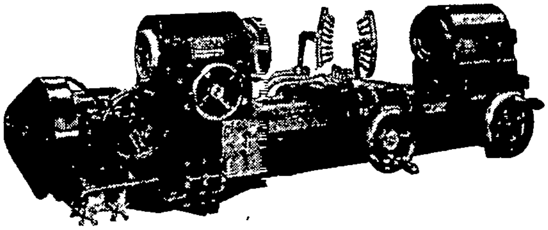

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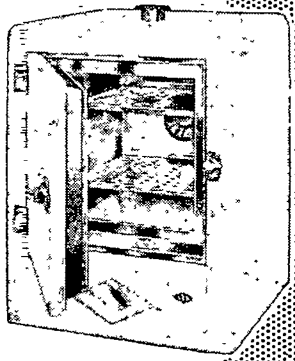

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Australian Scientific Liaison Office,
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INDUSTRY AND TECHNOLOGICAL TRAINING

IN recent years the role of the research associations in Britain in providing the industries they serve with trained scientific and technological staff has been increasingly recognized and was indeed the subject of a private conference in London in November 1953, which was attended by members of the Advisory Council for Scientific and Industrial Research, the chairmen and directors of the research associations and some representatives of the universities. Although the discussions at this conference covered a wide field, they were concerned more with the relations between the universities and technical colleges and the research associations than with those between the latter and industry. The contribution of the research associations to technical, and more especially to technological, education has since received much attention, and may well become even more important with the increasing stress laid upon the 'sandwich system' in the White Paper on Technical Education and elsewhere.

This contribution is essentially one made from within industry. It could assist, for example, the university-trained scientist to acquire technical knowledge or technological skill which he would find difficult to obtain either in the smaller firm or even in the best-equipped college of technology. It needs to be remembered in discussing the expansion of technological or technical education that there are limits to the acquisition of such knowledge before entrance to industry, limits set by the nature of the technical skill or knowledge concerned and by economic factors, quite as much as by the curriculum of a college or university. The point has been well made at some of the conferences with the universities arranged by the Federation of British Industries, but without its full implications being brought out as clearly as is done by Prof. Hyman Levy in the challenging article "The Chaos in Scientific Recruitment" which he contributed to the *Rationalist Annual* of 1956. Levy argues that if we are to meet the demands for trained man-power which a modern industrial community makes, we must solve the problem of providing for the transition to the scientific or theoretical side of those whose scientific ability or desires only develop after practical experience of industrial or commercial life. To do this we must have a clear understanding of the outlook and experience of the young factory worker, and Levy suggests that an extension of the scope, at once educational, technical and scientific, of the considerable scientific establishments or research laboratories which most of the larger industries already possess, would provide the basis for what is needed.

Prof. Levy is undoubtedly right in insisting that industry must accept a larger share of the responsibility for initiating and developing the institutions that are required to supply the trained man-power that a modern technological community needs; but while he does not attempt to outline the details of a definite scheme, the extent to which it can and should be given within industry requires rather more consideration than it has yet received. To some extent the attention given to automation in recent months has helped here, for it has been obvious that some of the techniques involved can only be acquired within industry. This has also been very noticeable in the development of nuclear energy. In spite of the great activity in nuclear physics at the universities, the Atomic Energy Authority has had to assume, through its Reactor School at Harwell and its Isotope School, a major share of responsibility for providing industry with the staff it requires if it is to take its full part in exploiting the commercial applications of nuclear energy. In its second annual report, the Authority stated that it was considering what expansion should be made in its training facilities, particularly for scientific and technical staff, in the light of the White Paper on Technical Education.

This aspect of technical education—that of the training given within industry—was rather overlooked in the two debates in the House of Commons on July 25 and August 2. In the former, indeed, Mr. F. Peart emphasized that technical education cannot be divorced from the general educational system, and Sir David Eccles stressed the importance of collaboration between the technical colleges and the modern secondary schools. It was suggested by Mr. J. Hall that there might be a tendency to overlook the part of the grammar schools in the production of first-class scientists and that the Ministry might be differentiating too rigidly between technical and scientific training on one hand and grammar school training on the other; but apart from an incidental reference by Mr. Hubert Ashton, the co-operation of industry was scarcely mentioned, even by Mr. A. Skeffington in opening the adjournment debate on technical education on August 2 and referring to the sandwich courses. Mr. Dennis Vosper, Parliamentary Secretary to the Ministry of Education, who replied in both debates, agreed that the means of financing sandwich courses is at the moment difficult and said that the Minister would be issuing advice about the financing of students in such courses. He gave figures showing increases in the numbers of students taking sandwich courses, and said that the signs for the coming year are of further increases. The fall in numbers attending full-time degree courses was largely due to the decrease in further educational training schemes and the general decrease in pressure on the universities and technical courses in recent years. He said he has no evidence that the provision of technical colleges and the supply of teachers and of students are not, in fact, keeping pace one with another. The number of technical State scholarships has been increased to 150 and the Minister is prepared to increase this figure if the number of students is forthcoming.

In neither debate was convincing evidence adduced that the increase in fees for non-vocational courses in further education is unjustified or likely to be detrimental, but the discussion would have been a good deal more realistic in the light of considerations advanced by Mr. J. Wellens in his recent book "Education and Training in Industry"*. Mr. Wellens is concerned with current practice in what he describes as industrial training—the training which industry gives to its new entrants at the level of craft or staff apprentices, to its operatives, or to those destined to be supervisors, foremen or managers. He reviews such practice with three aims. First, to set down a system which could reasonably and currently be regarded as basic; second, to propound the doctrine of integrated training; and third, to indicate the necessity of a framework of organization which will permit and promote the efficiency of training.

Mr. Wellens writes from the point of view of a 'training officer' in industry, with responsibility for seeing that an adequate supply of correctly equipped employees is available at all times and at all levels in the organization. He is aware, too, that this should be done so as to provide a balanced, contented and efficient labour force, one with an immediately available pool from which promotions can readily and adequately be made, yet not so large that frustration or wastage easily arises. He is aware, too, of the implications of automation, with its growing demand for more highly trained technicians and for technologists of a very high order, while that for the manual worker decreases.

If this is to be achieved, the training officer must do much more than operate a routine training system. He must see industry as a way of life, not merely as a means of earning a livelihood. He must be able himself to make some creative contribution, and however suited the educational system of the country may be for providing the quality of recruits required, he should be capable of formulating precisely the further contribution which industry must supply, and securing from the management the conditions in which that training can most effectively be given.

Mr. Wellens begins by formulating the general principles which should normally govern any training scheme. Its purpose should be clearly defined, and also the relation between the training department and the personnel department. It should be recognized that something more is needed than the inauguration of facilities for training, and that training is a continuous process but nevertheless not the prime concern of industry; and while the purpose of training should not be narrow, it must be judged according to the way in which it furthers the primary purpose of industry.

Three further principles are particularly important, not merely because their neglect often brings training into disrepute, but equally because of their relevance elsewhere in the field of technical education. Training, Mr. Wellens points out, does not give men an automatic right for preference in promotion. Three factors are involved: technical knowledge, practica experience and personality. All three are in some measure indispensable. Again, he insists on the importance of consultation. Training officers do not operate in a vacuum. Further, training is concerned with future rather than present needs, and a training officer must have vision and imagination and be wel abreast of modern practices and trends.

All these three principles are important in planning the expansion of technical and of technological education. The last is one of the essential reasons why at the higher levels some training must always be given within industry rather than in a college of technology, however well equipped it may be. It is not merely the cost of equipment that makes it difficult for the latter to be thoroughly up to date All three principles are supported, as is Mr. Wellens's insistence both on the importance of regarding all training as a unity and of an appropriate organization within which training can be effected, by the recent report on management succession from the Acton Society Trust and by Lord Heyworth's recent observations on training for management, when he also insisted on the importance of co-operation between industry and the universities and that an essential part of such training must be given within industry and indeed on the job itself.

That is indeed recognized by Mr. Wellens, for although much of his book is concerned with the training of apprentices and operatives and stresses the need for fresh thinking about the appropriateness of existing practice to modern conditions—on the part of the trade unions as well as of management and educational institutions—in his chapters on university study and scholarship schemes and on management training he discusses just those problems of the university graduate in industry and the provision of a steady supply of managers of high ability with which Lord Heyworth and the Acton Society Trust were concerned. The principles which Mr. Wellens advocates could go far to assist the effective utilization of the university graduate in industry and the elimination of that serious wastage on which the Acton Society Trust laid such stress in its report. Wastage will only be eliminated if there is a definite plan within a firm for developing managerial talent as well as discovering it; and while it is clear that the training officer can play a big part here, Mr. Wellens does not overstress that part. He emphasizes rather that the solution is to be found in terms of organization rather than in terms o educational technique.

There are two points to be noted here. First, there is room for further inquiry into the personality aspects of management rather than the academic aspects. The Acton Society Trust has by no means exhausted the subject, and there is room for further studies by the Trust as well as by the British Institute of Management. Second, while Mr. Wellens agrees that an essential part of training for management must be given on the job, he is careful to point out that such training involves forethought and deliberate effort on the part of the principal concerned, as wel as careful control and organization and guidance. It must be planned training just as much as if it were given in an educational establishment.

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* Education and Training in Industry. By John Wellens. Pp. x + 142. (Manchester: Columbine Press, 1955.) 17s. 6d. net.

Mr. Wellens does not attempt to forecast the fundamental form which training for management in Britain may assume when, and if, it becomes stabilized. He displays the broad field over which cooperation is required between industry, the trade unions, the universities and the colleges of technology. He indicates the need for fresh thought as well as for definite organization, and his book is a stimulating contribution in that direction which should not be neglected either by those responsible for shaping the expansion of technical or technological education, or by those concerned with the organization of training within industry itself.

While, however, Mr. Wellens recognizes the main factors involved and the ways in which a wide outlook and broad general education could be encouraged at the different levels, on one key problem he scarcely comments, namely, the provision of teachers. This is a vital matter in the development of sandwich courses, in the expansion of technical education and in the organization of training in industry itself along the lines which Mr. Wellens suggests. It could well be true that there are sections of industry where much more could be done by way of co-operation with the universities or the colleges of technology, in the release of staff as part-time lecturers, as well as in the organization of its own training schemes; but it must be remembered none the less that there are limits to what industry as such can do. Training, as Mr. Wellens rightly points out, is a subordinate and not a primary function of industry.

The supply of teachers, especially of science and technology, thus remains a key problem in the development of training within industry, as it is also in the expansion of technical and technological education. The co-operation of industry may help to alleviate the situation at some points but scarcely to remove the existing shortage. Moreover, very careful thinking and organization will be required if the scientific establishments of industry—and especially its research establishments—are to undertake the educational responsibilities which Prof. Levy suggests. Admittedly, the teacher derives inspiration from close association with the advancement of knowledge; but it is by no means certain that the way in which teaching and research are at present associated is the most effective for teaching or for research. It may well hinder, as Dr. R. Coulborn pointed out twenty years ago, the development of the valuable personal relation between teacher and student, turn the energy of the undergraduate into work for which he is unsuited and which he is unlikely ever to use, as well as waste the time of the teacher and obstruct his own original thinking or research.

It is rightly being urged that the technical colleges and colleges of technology in Britain should be staffed and equipped so as to permit more original research in technical fields being undertaken, and it is true that they could often help industry considerably in this way. Both here and in the research associations, however, there is need for further inquiry and thought, not merely as to the type of problems which could be investigated in this way, but also as to the exact relation between research and teaching. Here, and in the universities also, this question needs to be re-examined in the light of the principle that scarce material must be used with forethought and economy; and it could well be that further critical and unprejudiced inquiry could point to ways in which more effective use could be made of the limited numbers of teachers of science and technology in Britain, as well as in turning larger numbers of promising students into such fields and training them more efficiently and speedily.

NAPHTHALENESULPHONIC ACIDS AND STEROIDS

Elsevier's Encyclopaedia of Organic Chemistry
Edited by Dr. F. Radt. Series 3: Carboisocyclic Condensed Compounds. Vol. 12*B*: Naphthalene. *A*. Compounds Containing One Naphthalene Nucleus. Sulphonic Acids: SO_3H in Side Chain; One SO_3H in the Nucleus. Pp. 4841–5686. (1955.) £21 10*s*.

Vol. 14, Supplement. Steroids: Substituted Monohydroxyl Compounds; Polyhydroxyl Compounds. Edited by A. Georg, with the assistance of M. Georg-Plant, Dora Stern and J. Meyer. Pp. 1869*s*–2214*s*. (1956.) £9 10*s*.

(Amsterdam: Elsevier Publishing Company; London: Cleaver-Hume Press, Ltd.)

THESE two parts in "Elsevier's Encyclopaedia of Organic Chemistry" take their respective volumes a stage nearer completion. In the first the literature is stated to be covered up to 1944 and the literature concerning the structure of compounds up to 1955, while in the second the coverage is up to 1946 with reference to papers on structure and configuration up to 1955. As might be expected, in view of the subjects treated, references to publications of the past decade are more abundant in the second of these parts than in the first.

Naphthalenesulphonic acids and their amino- and hydroxy-derivatives are, to the dyestuffs chemist, among the most important derivatives of naphthalene, and this part of Vol. 12*B* deals with such compounds containing one sulphonic acid group and also with azo dyes related to them. In regard to the latter, it is useful to find references to their numbers in the "Colour Index" and in "Farbenstofftabellen", and it is also to be noted that the lists of references include not only titles of scientific periodicals but also some of the more important patent specifications and such well-known monographs as those of Fierz–David and of Venkataraman. True to the traditions of the "Encyclopaedia", interesting information about biological properties is scattered through the part; thus, there is reference to the plant growth-promoting action of such compounds as the sulphonic acid analogue of 1-naphthylacetic acid; we read that 2-naphthol-6-sulphonic acid is only moderately toxic to body lice; and there is a brief digest of the voluminous literature on the biological properties of congo red. A useful feature is the list of trivial names of naphthalenesulphonic acids and their derivatives. This includes also the compounds with more than one sulphonic acid group, which are not otherwise dealt with in this part. It is valuable to have so much information about the sulphonated naphthalene derivatives arranged in such compact and easily accessible form, even though much of the material is already summarized in monographs and other publications.

The Supplement to Vol. 14, on steroids, "comprises the halogen and nitrogen substituted monohydroxylated compounds with one OH in the ring system, and all polyhydroxylated compounds, having at least one OH in the ring system, with or without halogen or nitrogen substituents". Hence there is included the addition products of sterols with halogens and halogen acids, the nitro-, amino- and azo-derivatives of the sterols, the œstradiols, œstratriols and diols and triols of the androstane, pregnane, cholestane and ergostane series. Configurations are given so far as they are known, and the work will be an invaluable compendium to those interested in steroid chemistry. There are the usual tables of physical constants of the more important groups of compounds, references to physiological properties, usually œstrogenic or androgenic activity, and the part is liberally supplied with editorial footnotes clearing up points of obscurity or confusion in the original literature.

Both parts reach the standard of excellence of production to which users of "Elsevier's Encyclopaedia" are now well accustomed. J. W. COOK

REACTIVITY OF COLLAGEN

The Chemistry and Reactivity of Collagen

By K. H. Gustavson. Pp. ix+342. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1956.) 8 dollars.

DR. K. H. GUSTAVSON was awarded the Grand Gold Medal by the Royal Swedish Academy of Technical Sciences in 1955 for his pioneering contributions, which form the background to the present monograph. A knowledge of the chemistry and reactivity of the fibrous protein collagen is of fundamental interest to workers in the fields of biochemistry, medicine and leather technology. The book gives an able review of widely dispersed information in the light of the modern theories of protein reactions. Special attention is given to reactions which form the basis for the processing of skin prior to tanning and for the making of gelatin.

After a general survey of the chemistry of proteins, including the methods for estimating the terminal groups, a clear picture of the composition of collagen in terms of amino-acids is given, along with a discussion of their sequence. The parts played by X-ray techniques, electron microscopy and birefringence in revealing the architecture of this protein are lucidly discussed, showing the developments which have occurred since 1940 when W. T. Astbury put forward his original model for the configuration of the polypeptide chain.

The amphoteric ionic structure gives rise to many of the properties of the collagens. The charged centres of the protein zwitterion exist in electrostatic balance with each other at the isoelectric point. The methods for the determination of the latter are discussed critically, and it is shown that its location with hide collagen is a function of the alkali pretreatment. Acids and bases disturb this balance, and the reactions which occur are examined in detail because they are of fundamental importance for the understanding of the general reactivity of collagen. The meanings of the various titration curves are clearly explained.

The cohesion of the collagen molecule is, of course, one of its characteristic features. This is due to electrovalent salt links and hydrogen bonds, but the desirability of increasing our very limited knowledge of the distances between the reactive groups is rightly emphasized. The significance of this structural restraint is clearly explained in discussing the Procter–Wilson extension of the Donnan effect in connexion with osmotic swelling. The lyotropic effects of neutral salts, urea, weak acids and phenols are shown to be intimately connected with hydrogen bonding.

The various aspects of the thermal shrinkage of collagen and connective tissues are adequately discussed with reference to the different types of collagen. The shrinkage temperature measures the hydrothermal stability. Tanning agents increase its value due to the formation of cross-linkages. The reactivity of collagen is profoundly influenced by the inactivation of its amino and carboxyl groups, and a comprehensive account of the relevant researches in this field is given. The splitting of proteins into peptones, polypeptides and amino-acids by proteolytic enzymes is vitally important when they are used for nourishment. It is also an important reaction in their decomposition when they undergo putrefaction. The effects of proteinases on native and tanned collagen are therefore discussed. The final chapters deal with the problem of unhairing, the conversion of collagen into gelatin and some physicochemical aspects of its reactions with tanning agents, which includes an account of the contributions of the monolayer technique to the problem of tannage.

The monograph is most interesting to research workers in the field of collagen and will serve as a useful book of reference for many years to come. It covers the literature up to late in 1954, and the views of the various investigators are on the whole well covered. The index is good, but there are a considerable number of typographical errors. Those who are not specialists will, however, find it difficult to read because the descriptions of the experimental methods are very brief and it is assumed that the reader is familiar with the underlying theory.

DONALD BURTON

AMERICAN COLOUR TELEVISION

Color Television Standards

Selected papers and records of the National Television System Committee. Edited by Donald G. Fink. (McGraw-Hill Television Series.) Pp. xii+520. (London: McGraw-Hill Publishing Company, 1955.) 64s.

THIS book is a sequel to "Television Standards and Practice" (1943) by the same author, the latter comprising information produced by the first nine panels of the then recently formed National Television System Committee in the United States. This Committee had been allocated the task of formulating suitable standards for monochrome television transmissions so that the Federal Communications Commission could accept them officially. The first Committee, which formulated the monochrome standards, issued a set of volumes comprising 2,000 pages, while the second, the findings of which are summarized in the volume under notice, issued a number of volumes totalling 4,100 pages. This work was the result of co-operation between more than thirty organizations comprising the greater part of the American radio and electronics industry. It is perhaps interesting to note that, whereas the formulation of monochrome standards required 2,000 pages, the formulation of colour standards, which of course are based on monochrome, required *in toto* 6,000 pages—three times the number required for monochrome. Does this ratio depend upon the fact that ideal colour television requires the transmission of three times the information needed for monochrome ?

The book is divided into ten chapters and two appendixes. Chapter 1 covers the later history of colour television and includes a useful set of questions and answers and references to appropriate parts of the book. Chapter 2, which the serious reader is recommended to read first, includes a very clear description of the American colour television signal specifications. A considerable proportion of the information contained in this chapter may be found in the *Proceedings of the Institute of Radio Engineers*, 42, No. 1 ; January 1954. Chapter 3 contains an abbreviated description of some subjective tests which have already been described in greater detail (*Proc. Inst. Rad. Eng.*, 30, No. 8 ; August 1952), and a lengthy set of questions and answers which is worth while reading if only to gauge the extent of disagreement which still exists with regard to many fundamental subjective questions relating to human vision.

Chapter 4 (which begins on p. 102 and not on p. 212 as shown in the list of contents) is entitled "The Color Video Signal" and contains a large number of technical monographs of the National Television System Committee, nearly all of which have been published elsewhere (*Proc. Inst. Rad. Eng.*, 30, No. 8, August 1952 ; and 41, No. 7, July 1953). The serious student of colour television will find this chapter of immense value, as it covers most of the theoretical and practical work which led to the formulation of the American colour television signal specifications.

Practically all Chapter 5, "The Color Synchronizing Signal", is taken up by the excellent mathematical study, "Color-Carrier Reference-phase Synchronization Accuracy in N.T.S.C. Color Television", by Richman ; once again, this paper has appeared elsewhere (*Proc. Inst. Rad. Eng.*, 42, No. 1 ; 1954).

Chapters 6, 7 and 8 will interest mainly those responsible for television broadcasting and transmitters, as well as members of committees charged with advising governments and official bodies as regards the choice of a colour television system for their respective countries. Chapter 9 will again interest those connected with television broadcasting, but here work connected with electronic masking is described and this may well be of interest to members of the photographic industry.

Chapter 10 will be a source of constant reference for engineers dealing directly with colour television problems, especially in connexion with standardization and use of appropriate terminology.

Appendix 1 is intended as a description of National Television System Committee colour television in non-technical terms and might well be read by those who have administrative rather than technical duties to perform in connexion with colour television. Appendix 2 contains, in abbreviated form, some of the information to be found in Chapter 2.

This book will be used primarily as a work of reference by engineers directly concerned with colour television. It may also be read by students of the subject, but in this case it is recommended that serious study of the book should be preceded by the reading of a suitable introduction to colour television. The book presents an excellent example of the application of fundamental physical principles to a practical problem and therefore, although principally a book for engineers, it may well find favour among physicists.

The author, Donald G. Fink, was for many years editor of the well-known American journal *Electronics* and is at present a member of the board of directors of the Institute of Radio Engineers in the post of editor. In his capacities as editor of the Proceedings of the first National Television System Committee (1940–41), vice-chairman of the second Committee (1950–52), chairman of Panel 12 (Colour System Analysis), and director of research of the Philco Corporation, he has acquired a very extensive knowledge of both monochrome and colour television, and is undoubtedly well qualified to produce this authorized compendium of the eighteen volumes produced by the second National Television System Committee (1950–53). R. D. A. MAURICE

THE WEST INDIAN FAMILY

The Negro Family in British Guiana

Family Structure and Social Status in the Villages. By Dr. Raymond T. Smith. (International Library of Sociology and Social Reconstruction.) Pp. xvi + 282 + 8 plates. (London : Routledge and Kegan Paul, Ltd. ; New York : Grove Press, Inc., in association with the Institute of Social and Economic Research, University College of the West Indies, Jamaica, 1956.) 28*s.* net.

THE Caribbean region has been neglected by British anthropologists, partly for financial reasons and partly because of a legitimate concentration of interest on the study of non-European societies with a distinctive culture of their own. Interest in the region was awakened largely through the social policy introduced at the end of the Second World War, and public interest in the structure of the family is largely concerned with its relevance for such policy. Census figures have revealed that, in the poorer strata of the Negro population, a high proportion of children are born out of wedlock and a considerable number of conjugal unions are not legally sanctioned. They have been held to reinforce the middle-class myth of Negro immorality and promiscuity, and historical explanations of these alleged characteristics have been sought both in the values and modes of behaviour which became customary under slavery and in those which the Negroes brought with them from Africa.

Dr. R. T. Smith begins by challenging the initial assumption. From his intensive study of three Guianese villages, he concludes that there is no significant difference, in terms of the obligations recognized between the partners and towards their children, between marriage and the extra-legal domestic unions which he calls 'common-law marriage'. 'Common-law marriage' is simply the standard pattern for the lower class. A 'common-law wife' has herself no legal claims on her consort ; but he is legally liable for the support of his children as a husband is. Though the point would not affect his main argument, it might be interesting to know how far maintenance orders are in fact sought and enforced; Dr. Smith writes almost as if he was asserting that the courts provide a watertight system.

Of course marriage, as the middle- and upper-class pattern, carries with it associations of higher status; but for that very reason it is not sought after by everyone. Persons who are seeking to raise their status will marry, others will not do so although they could well afford the expense of the celebration and the generally higher standard of living popularly associated with a married household.

In addition to producing the first fully documented study of the Negro family in the Caribbean, Dr. Smith has made some valuable contributions to general theory. He is the first explicitly to tackle the problem which must constantly arise now that anthropologists are transferring their attention from social units which can be treated as total systems to localities the boundaries of which are geographical rather than social. The Guianese village is wholly dependent politically and economically on the wider system of which it forms a part, and, what is more significant, the characteristic features of household and family are explicable only in terms of the place of the village population in the total structure. Thus the problem itself dictates how far the investigator must go outside the geographical boundaries of the sub-system selected for study.

Dr. Smith decisively rejects explanations in terms of the cultural background—that is, in effect, of history—though he recognizes that the synchronic study must cover the period of time necessary for household or family to pass through its full three-generation cycle of development. Space does not permit discussion of all the original ideas in this stimulating book.

L. P. MAIR

PREVENTIVE PSYCHIATRY

Emotional Problems of Early Childhood

Edited by Prof. Gerald Caplan. Pp. xiv+544. (London: Tavistock Publications, Ltd., 1955.) 42s. net.

THIS book is the result of a symposium under the auspices of the International Institute of Child Psychiatry. Its theme is "The Child under Six", and its main headings are: psychosis in early childhood; problems of preventive psychiatry; the relation of physical and emotional factors; and problems of mother–child separation and hospitalization. A representative selection of twelve case-histories deals in great detail with the various aspects of diagnosis, treatment and prevention, each case being followed by a discussion by experts on the particular problems involved. Contributors and members of the discussion groups were drawn from different countries; but the majority came from the United States. In addition, there are reports on relevant research in progress in which the fundamental concepts, general principles and methodological problems arising from the material are discussed.

The book makes absorbing reading, whether it is the case of the mother who, following her husband's suicide, began to identify her fifteen-months old son with his dead father, causing severe disturbance in the child's development; whether it is the one of pseudo-deafness and retardation in a child who was abandoned by his mother at two months and was moved fourteen times before he was two; that of a four-year old of 'atypical development' who spoke his own language and frightened his parents by acting and gesticulating in an unusual way; or that of a mother whose child would not eat.

Case-histories, interviews and clinical observations afford a glimpse into the complicated nature of emotional problems in the very young child and their ramifications involving the family and the wider environment. They also reveal the difficulties of dealing with these problems in a constructive and planned way by teams of psychiatrists, psychologists and social workers as well as by the numerous social agencies; any of these may be the prime mover in a particular case.

The editor has more or less rewritten the different contributions, and the book reads as a coherent whole.

Apart from its intrinsic value, this work may teach us several lessons. For one thing, it demonstrates the fact that research in child psychiatry and clinical psychology must be based on the thoroughly investigated and well-authenticated individual case, presented in its broadest setting and in minute detail. The emphasis will have to be on description for a long time to come, with theoretical conclusions drawn tentatively, without attempting to generalize. For another, it shows the importance of closest co-operation within the team at all stages as well as of a fair degree of elasticity as to who should direct the case. Rigid rules (such as that the psychiatrist should invariably be in charge; or that mother and child should not be seen together or by the same person)—still prevalent in many child-guidance clinics—seem a disadvantage while our knowledge and experience in this field is still limited and inconclusive.

Both child psychiatry and child psychology emphasize the importance of early childhood experiences for later development; and it is perhaps in the field of the preventive mental health service that we can benefit most in considering the conclusions of this book. Preventive health services in child welfare have made great progress since the Second World War. Expectant mothers and new-born babies get all the physical care medical science regards as essential and beneficial. All stages of feeding, cleanliness, teething, weaning, etc., are carefully prepared and watched over by doctors, clinics and nurses. But no comparable measures are taken in the province of mental development. It is left to the child-guidance clinics to diagnose and treat emotional disturbances at a time when they are already well established and have become, as it were, part of the child's mental make-up. Although there is a growing tendency to refer children under school age to clinics, this is usually done when the symptoms have become too troublesome for the family. The logical course of development would be to introduce certain psychological observations in routine interviews at child-welfare clinics, in pediatric interviews and nursing practice, and to follow up any signs suggesting undue retardation or a potential source of disturbance. The work of Gesell, Ruth Griffiths, and others, proves that this is practicable; and the number of known instances of diagnoses of, say, mental defect when, in fact, they were cases of early schizophrenia, or retardation due to neglect, rejection or separation in early childhood, should make it seem highly desirable.

This is a book that will give ample food for thought to both specialist and layman.

MARTHA VIDOR

RECONSTITUTION OF TOBACCO MOSAIC VIRUS COMPONENTS

By Prof. BARRY COMMONER, JAMES A. LIPPINCOTT, GEORGIA B. SHEARER, ELLEN E. RICHMAN and JIA-HSI WU

Henry Shaw School of Botany, Washington University, St. Louis, Missouri

CHEMICAL explanations of genetic activity call for correlations between the biological activities and specific chemical attributes of a genetic agent. This requires that the components responsible for an agent's several biological activities be separated from each other and from inactive material, and presupposes that the active components will withstand such treatment without undue loss of genetic competence.

In 1947 Schramm reported the first efforts to obtain information of this type from experiments with tobacco mosaic virus. In a series of fifteen reconstitution experiments with mixtures of previously separated tobacco mosaic virus protein and nucleic acid, he experienced two instances of apparently successful recovery of infectivity. However, because of the slight effects obtained and the fact that most experiments were not successful, Schramm declined to consider the phenomenon established[1]. Following subsequent improvements by Schramm of the method of releasing tobacco mosaic virus protein from the virus[2], Fraenkel-Conrat and Williams[3] and Lippincott and Commoner[4] reported the results of independent investigations which led to consistent success in reactivating mixtures of virus ribonucleic acid and Schramm's 'protein a' (prepared by mild alkaline treatment of tobacco mosaic virus). In both cases, the reactivated material was only of marginal infectivity, being no more than one-hundredth as active as authentic tobacco mosaic virus. This fact appeared to preclude extensive use of the reactivation phenomenon as a means of determining the biochemical basis of the genetic activity of the virus. This article describes the partial solution of this problem, and some experiments concerning the relationship between the composition and biological activity of nucleoproteins artificially reconstituted from tobacco mosaic virus protein and nucleic acid.

Tobacco mosaic virus is a hollow rod. Small protein units are arrayed in a flat spiral; nucleic acid strands are in a concentric zone in the rod[5]. When the virus nucleoprotein is treated at pH 10·5 for about 3 hr. in the cold the protein sub-units become dissociated, and may be recovered as separate low molecular weight entities. This preparation may be freed of residual virus by ultracentrifugation and of dissociated ribonucleic acid by adsorbing the latter on a column of modified cellulose ('Ecteola *SF*')[6]. Virus ribonucleic acid may be prepared by the method of Cohen and Stanley[7], and purified by ultracentrifugation and alcohol precipitation.

Low molecular weight protein isolated from tobacco mosaic virus in the manner just described will polymerize (at pH 6, or in 28 per cent ammonium sulphate) to form hollow rods resembling those of ordinary tobacco mosaic virus in size and shape. Such nucleic acid-free rods, like the original low molecular weight protein, are not infectious. Schramm finds that when tobacco mosaic virus is partially degraded with alkali, some of the product consists of virus rods containing intact threads of nucleic acid, which retain an interrupted coat of protein at intervals along their length[8]. Such material appears to be infectious, though weakly so. When these particles are treated with ribonuclease, the enzyme is able to attack the denuded portion of the nucleic acid and the rod breaks and becomes devoid of infectivity[8].

This information suggests some possible causes for the low level of infectivity exhibited by the products of the reconstitution procedures employed in the initial investigations by Fraenkel-Conrat and Williams, and by Lippincott and Commoner. From what is known about the behaviour of tobacco mosaic virus protein and ribonucleic acid, the reconstitution process may be expected to produce: (*a*) polymerized protein lacking nucleic acid, (*b*) nucleoprotein comprising nucleic acid completely coated with protein, and (*c*) nucleoprotein particles in which the protein coat contains small faults. All three types of products may be approximately equivalent in sedimentation behaviour and, without special degradation procedures, will appear to be identical in the electron microscope. However, of these components, only the particles with entire protein coats may be expected to be equivalent to tobacco mosaic virus in infectivity.

With these considerations in mind, an effort has been made to improve the completeness and specificity of the interaction between virus protein and nucleic acid in reconstitution experiments and thereby to enhance the infectivity of the product. Consideration of the probable reaction kinetics suggests the following conditions for optimum formation of active nucleoprotein from tobacco mosaic virus protein and ribonucleic acid.

(1) Reaction mixtures should contain relatively low concentrations of nucleic acid and protein. Joint polymerization is linearly related to reactant concentrations, while self-aggregation of protein (and of nucleic acid) depends on a higher power of the concentration.

(2) To enhance the thermodynamic activity of the reactants, they should be relatively insoluble in the solvent chosen for the reaction mixture.

(3) To avoid gaps in the protein coat of the nucleoprotein polymer, accretion of protein units around the ribonucleic acid should ideally proceed from a single starting point rather than from multiple protein 'seeds'. This requires that reaction mixtures contain relatively low molar ratios of protein to nucleic acid. Nevertheless, the molar ratio of protein : nucleic acid in the virus nucleoprotein is about 2,000 : 1 (the nucleic acid being considered a single molecule) and the reactants need to enter into the product in this proportion.

To reconcile these conflicting demands, protein is added in small amounts over an extended period of time to a relatively low concentration of virus ribonucleic acid dissolved in a medium (28 per cent or

Table 1. INFECTIVITY OF NUCLEOPROTEIN RECONSTITUTED FROM TOBACCO MOSAIC VIRUS (TMV) PROTEIN AND NUCLEIC ACID BY VARIOUS METHODS

Experiment No.	Reactants		Conditions			Nucleoprotein recovered μgm	Total No. of lesions[d]	Equivalent infectivity[e]; μgm TMV	Specific infectivity; per cent of TMV standard[f]
	Protein μgm.	Nucleic acid μgm.	Solvent	Final volume ml.	Protein addition[c]				
1 *A*	4,500	70	*p*H 6 buffer	7	gradual	526	137	3	0·6
1 *B*	4,500	70	28% $(NH_4)_2SO_4$	105	gradual	1,166	3,182	64	5·5
1 Control	4,500	—	—	—	—	—	3	—	—
1 Control	—	70	—	—	—	—	0	—	—
2 *A*	4,980	89	28% $(NH_4)_2SO_4$	80	immediate	1,183	8,172	53	4·5
2 *B*	4,980	89	28% $(NH_4)_2SO_4$	105	gradual	781	7,643	50	6·3
2 Control	4,980	—	—	—	—	—	19	—	—
2 Control	—	89	—	—	—	—	7	—	—
3 *A*	4,230	76	28% $(NH_4)_2SO_4$	80	immediate	1,200	5,846	53	4·4
3 *B*	4,230	76	28% $(NH_4)_2SO_4$	105	gradual	918	7,590	65	7·1
3 *C*	4,230	76	28% $(NH_4)_2SO_4$[b]	75	gradual	933	9,933	85	9·1
3 Control	4,230	—	—	—	—	—	44	—	—
3 Control	—	76	—	—	—	—	8	—	—

The results of three separate reconstitution experiments. Reactants were prepared as described in the text, the nucleic acid being used immediately after being centrifuged out of 66 per cent ethanol. Nucleic acid was dissolved in the indicated solvent, and protein in aqueous solution was added either immediately or gradually. Simultaneously, sufficient ammonium sulphate was added to maintain the indicated concentration. The temperature was 4° C. throughout. (*a*) Controls were treated in the same way as the mixtures, the material yielded being finally inoculated on leaves of *N. glutinosa*. (*b*) In experiment 3 *C* nucleic acid was dissolved in 62 per cent ammonium sulphate, the concentration of which was gradually reduced to 28 per cent as the protein solution was added. (*c*) Gradual addition of protein was accomplished in eleven portions over a 3-hr. period, except in experiment 1 *A*, in which a 24-hr. period was employed. (*d*) All preparations inoculated on twenty leaves of *N. glutinosa*. In experiments 3 *A*, 3 *B* and 3 *C* only 1/5 of the nucleoprotein was inoculated. In all other cases, all the recovered nucleoprotein was inoculated. (*e*) Equivalent infectivity is determined from the quotient: (lesions from sample/lesions from tobacco mosaic virus standard) × amount of tobacco mosaic virus standard. Tobacco mosaic virus standards (4 μgm.), inoculated on twenty leaves of *N. glutinosa*, yielded 249 lesions in Exp. 1, 774 lesions in Exp. 2, 2,932 lesions in Exp. 3. In all cases, standards and experimental samples were inoculated on randomized groups of the same batch of detached leaves which were maintained in water at 24° C. and constant illumination during lesion formation. (*f*) Specific infectivity (as percentage) is determined from quotient: (equivalent infectivity of sample/amount of nucleoprotein in sample) × 100

more ammonium sulphate) in which the protein is relatively insoluble.

Table 1 compares the results of a reconstitution method based on these considerations with the infectivity of reconstituted nucleoprotein prepared by the earlier technique. Whereas the earlier procedure (experiment 1 *A* in Table 1) yields nucleoprotein less than 1/100 as infectious as actual tobacco mosaic virus, the newer method yields a product which may approach one-tenth of the infectivity of tobacco mosaic virus. These experiments also provide data which firmly establish the authenticity of the reconstitution process: the number of lesions yielded by reconstituted material is about a thousand times greater than the number produced by the uncombined starting materials.

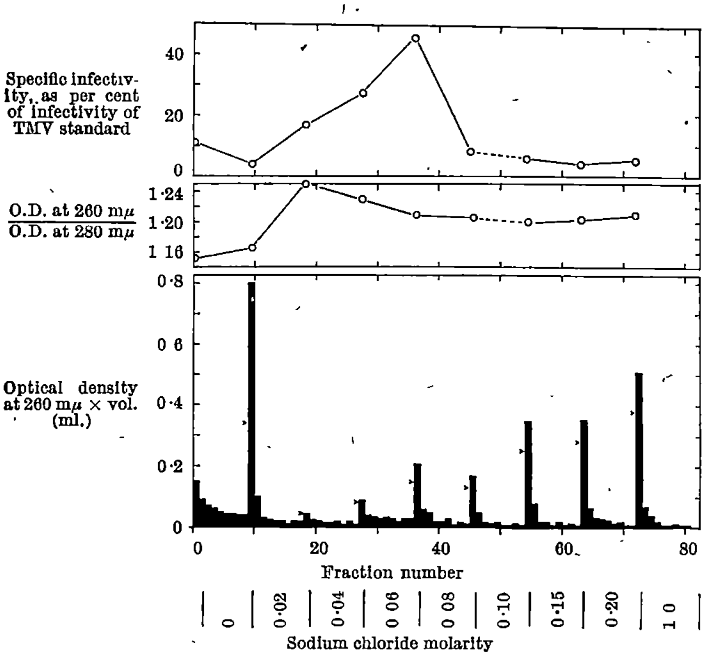

Fig. 1. Fractionation of 6·77 mgm. of reconstituted nucleoprotein by elution from a column containing 182 mgm. of 'Ecteola *SF*'. Eighty-six per cent of the original nucleoprotein was recovered. Elution was accomplished with successively higher concentrations of sodium chloride in 0·01 *M* phosphate buffer, *p*H 7, collected in 2 ml. fractions. The initial 2 ml. fraction obtained after each solvent change was ultracentrifuged to precipitate high-molecular weight nucleoprotein, the amounts recovered being indicated by the arrows. The uppermost and centre curves show, respectively, the specific infectivity (relative to the lesion count given by a standard tobacco mosaic virus solution on opposite halves of *N. glutinosa* leaves), and the ratio of optical densities at 260 mμ and 280 mμ of the nucleoprotein recovered from these initial fractions. The specific infectivity of the original nucleoprotein was 6 per cent of the tobacco mosaic virus standard

The preceding results imply that the gross product of a reconstitution experiment is a heterogeneous population of nucleoprotein entities which differ with respect to nucleic acid content, the completeness of their protein coats and infectivity. This suggests that a fractionation process based on the relative accessibility of the ribonucleic acid of the reconstituted particles might also serve to concentrate the most infectious components. Fig. 1 shows the results obtained when reconstituted material with an original specific infectivity of 6 per cent is adsorbed on an 'Ecteola *SF*' column, and fractions are eluted by successive additions of increasing concentrations of sodium chloride in 0·01 *M* *p*H 7 phosphate buffer. The nine fractions recovered from the column differ in stability, in relative nucleic acid content (as shown by the ratios of optical densities at 280 and 260 mμ), and in infectivity. As expected, the bulk of the material is very low in infectivity. The relatively small fractions eluted with 0·04–0·10 *M* sodium chloride contain most of the infectivity of the original material. The 0·08 *M* sodium chloride eluate comprises nucleoprotein which is about 45 per cent as infectious as ordinary tobacco mosaic virus.

A fractionation comparable to that just described has also been carried

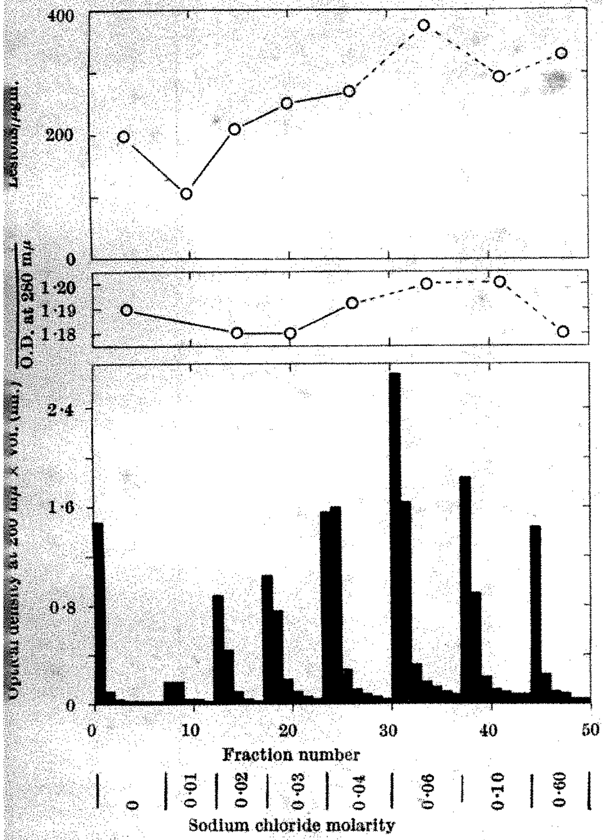

Fig. 2. Fractionation of 8 mgm. of ordinary tobacco mosaic virus on a column containing 500 mgm. of 'Ecteola *SF*'. Elution procedures were as described in the legend for Fig. 1. The fractions collected with each solvent were pooled and the high molecular weight material collected by ultracentrifugation. The two upper curves refer to this material. Total recovery was 96·5 per cent of the original virus

out with the original stock preparation of natural tobacco mosaic virus. The results, which are summarized in Fig. 2, show that ordinary tobacco mosaic virus is heterogeneous with respect to elution behaviour, infectivity and nucleic acid content (ratio of 260 mμ : 280 mμ optical densities).

Comparison of Figs. 1 and 2 shows that the composition of the nucleoprotein populations that comprise natural tobacco mosaic virus and the reconstituted material differ significantly. The major fractions in ordinary tobacco mosaic virus are eluted by 0·04–0·10 *M* sodium chloride; but these fractions represent minimal components in reconstituted nucleoprotein. In both cases, the most infectious nucleoprotein is found in the fractions eluted by 0·06–0·08 *M* sodium chloride. The remaining fractions contribute rather little to the total infectivity of reconstituted nucleoprotein, but in tobacco mosaic virus these fractions are only moderately less infectious than the major component.

This heterogeneity is reflected in the biological properties of reconstituted preparations. An unusual number of aberrant symptoms have been observed in *Nicotiana tabacum* plants systemically infected with single lesions derived from reconstituted nucleoprotein. These include: (*a*) 'strap leaves', leaves reduced to midribs only; (*b*) bright yellow mosaic; (*c*) pale green mosaic followed by necrosis in the mosaic areas; (*d*) circular necrotic lesions on the inoculated leaf. None of these symptoms was found among a comparable number of plants from the same culture generation inoculated with single lesions derived from ordinary tobacco mosaic virus.

These observations suggest that the manipulations incident to the isolation of tobacco mosaic virus protein and nucleic acid and to the reconstitution process may alter the genetic competence of the virus components. Results recently reported by Gierer and Schramm[9] indicate that the biological activity of the virus is at least in part due to its ribonucleic acid. It has been shown that the ribonucleic acid isolated from tobacco mosaic virus is partially dissociated into fragments of variable size, which can be fractionated by elution from 'Ecteola' columns[10]. It is to be expected, therefore, that the nucleic acid which is incorporated into nucleoprotein particles during the reconstitution process may represent fragments of virus ribonucleic acid or various combinations of such fragments, as well as substantially intact virus nucleic acid.

Accordingly, an effort has been made to fractionate the components which occur in preparations of tobacco mosaic virus nucleic acid, and to incorporate them separately into reconstituted nucleoproteins. Ribonucleic acid was prepared in the usual manner and fractionated on an 'Ecteola *SF*' column according to the method of Bradley and Rich[10]. Three fractions, obtained by this procedure, were concentrated by precipitation in 66 per cent ethanol, redissolved in water and polymerized with tobacco

Table 2. INFECTIVITY OF NUCLEOPROTEIN RECONSTITUTED FROM TOBACCO MOSAIC VIRUS (TMV) PROTEIN AND FRACTIONS OF TMV NUCLEIC ACID

Nucleic acid fraction	Reactants[a]		Nucleoprotein recovered μgm.	Nucleoprotein tested μgm.	Total No. of lesions[c]	Equivalent infectivity; μgm. TMV[d]	Specific infectivity; per cent of TMV standard[e]
	Protein μgm.	Nucleic acid μgm.					
(1) Entire, unfractionated	8,580	94	935	750	833	4·75	0·51
(2) 0–0·15 *M* NaCl eluate	13,000	223	1,610	1,290	75	0·44	0·03
(3) 0·15–0·25 *M* NaCl eluate	3,250	130	270	216	28	0·16	0·06
(4) 0·25–0·30 *M* NaCl eluate	1,742	49	105	84	31	0·37	0·38
(5) None (control)[b]	8,580	—	—	—	0	—	—
(6) Unfractionated (control)	—	94	—	—	2	—	—

The nucleic acid (1,543 μgm.), after being precipitated in 66 per cent ethanol, was adsorbed on a column containing 0·5 gm. of 'Ecteola *SF*' and eluted with increasingly stronger sodium chloride solutions in 0·01 *M* phosphate buffer, *p*H 7. About 31 per cent of the nucleic acid was recovered in the sodium chloride eluates, the remainder being removable from the column with alkali. The fractionation required about 8 hr. The unfractionated aliquot was held for this time before reaction with protein; this probably accounts for the relatively low infectivity of the product as compared with the results reported in Table 1. (*a*) Nucleic acid was dissolved in sufficient 28 per cent ammonium sulphate to yield solutions of approximately 1 μgm. of ribonucleic acid per ml. Protein was added gradually over a 3-hr. period. (*b*) Controls were treated in the same way as the mixtures, and the material yielded finally inoculated on *N. glutinosa* leaves. (*c*) All preparations tested on twenty randomized leaves of *N. glutinosa*, except preparation (4), which was tested on ten leaves. (*d*) Equivalent infectivity is determined from the quotient: (lesions from sample/lesions from tobacco mosaic virus standard) × amount of tobacco mosaic virus in standard. In this experiment, 2 μgm. of standard tobacco mosaic virus inoculated on twenty leaves of *N. glutinosa* produced 438 lesions. Other infectivity procedures were as described in Table 1. (*e*) Specific infectivity (as percentage) is determined from the quotient: (equivalent infectivity of sample/amount of nucleoprotein in sample) × 100

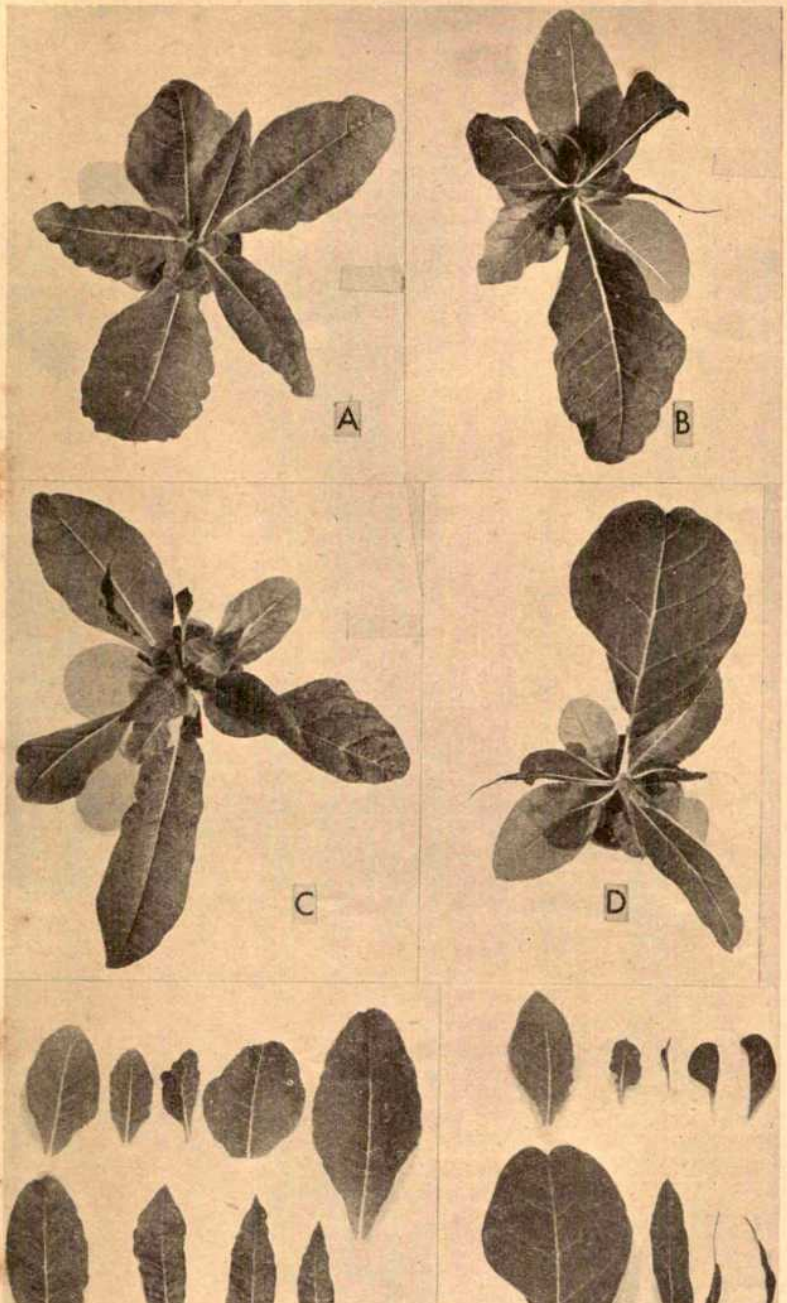

Fig. 3. The effects of infection with reconstituted nucleoprotein prepared from a fraction of tobacco mosaic virus nucleic acid eluted from an 'Ecteola *SF*' column between 0·15 and 0·50 *M* sodium chloride. The photograph shows four plants of the same culture generation two months after being inoculated, respectively, with a single lesion derived from ordinary tobacco mosaic virus (*A*), and with three separate lesions produced by the reconstituted nucleoprotein (*B*, *C*, *D*). Photographs *E* and *F* represent leaves of comparable serial position removed from plants *A* (tobacco mosaic virus) and *D* (reconstituted nucleoprotein), respectively. In *E* and *F*, the most basal leaf is in the upper left-hand corner of the photograph

mosaic virus protein by the method already described. The results are shown in Table 2. In each case the reconstitution process yielded a high molecular weight nucleoprotein (absorption maxima at 260 mμ; minima at 250 mμ; ratios of optical densities at 260 mμ and 280 mμ, 1·17–1·30). These products exhibited infectivity, which varied in level according to the ribonucleic acid fraction employed to form the nucleoprotein.

Lesions produced on leaves of *N. glutinosa* by nucleoprotein derived from various ribonucleic acid fractions eluted from 'Ecteola' columns have been employed to infect a number of plants of *N. tabacum*. Among these plants are some which show symptoms that depart significantly from those ordinarily associated with tobacco mosaic virus infection. Examples are shown in Fig. 3. In these plants apical growth is severely suppressed, and leaf blades become greatly reduced or are absent. The plants contain large amounts of infectious nucleoprotein, which upon being inoculated into White Burley or Turkish tobacco plants induces symptoms like those found in the original infected plants.

In two separate experiments, highly aberrant floral symptoms were found among the plants inoculated with single lesions derived from reconstituted nucleoprotein produced with a ribonucleic acid fraction eluted from 'Ecteola' columns between 0·25 and 0·30 *M* sodium chloride. The infected flowers show a scattered mottling in pigmentation rather than the sharp-edged 'breaks' characteristic of flowers infected with ordinary tobacco mosaic virus, and are remarkably transformed in shape. Uniform and symmetrical suppression of lateral extension of the petals gives rise to a deeply cleft, fringed corolla. Although plants infected with ordinary tobacco mosaic virus sometimes produce flowers with irregularly distorted corollas[11], symmetrical transformations do not occur.

The foregoing results show that reconstitution of tobacco mosaic virus protein and nucleic acid provides experimental opportunities suitable for investigations of the chemistry of genetic competence. The virus nucleic acid, which is at least in part responsible for the genetic specificity of the virus, will withstand isolation procedures without losing its activity. The reconstitution process, while yielding heterogeneous nucleoprotein, is amenable to procedures which enhance the specificity of protein–nucleic acid interaction. By these means and by suitable fractionations it is possible to obtain reconstituted nucleoprotein which has an inherent infectivity approaching that of natural tobacco mosaic virus. Thus, the process appears to be capable of yielding preparations which are sufficiently infectious to enable valid correlations between composition and biological activity.

There is evidence that both the physical and genetic integrity of the virus nucleic acid is disrupted during the process of extraction. As a result, at least some of the nucleoprotein reconstituted from virus nucleic acid and from isolated nucleic acid fractions appears to be genetically different from the original virus.

With further attention to these effects, the reconstitution phenomenon may provide a means for correlating the biological attributes of the virus with the composition of its component parts.

We wish to acknowledge the valuable suggestions made by Dr. Otto Redlich, of the Shell Development Co., in connexion with the kinetics of the reconstitution process. The work reported in this paper was aided by a grant from the National Foundation for Infantile Paralysis, and by a grant from the Rockefeller Foundation.

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THE STRUCTURE AND GROWTH OF WOOL

A SESSION of Section D (Zoology) of the British Association meeting at Sheffield was devoted to "The Structure and Growth of Wool and other Animal Fibres"—a symposium that might well have been held jointly with Section M (Agriculture). The subjects of the papers presented ranged from "Fleece Growth", through the detailed consideration of various aspects of individual fibre growth, to the chemical and physical structure of the wool fibre.

Dr. A. B. Wildman (Wool Industries Research Association), whose opening paper, "Fleece Growth", was read by Mr. H. B. Carter, stated that there is developing in Great Britain an increased awareness among sheep farmers of the importance of supporting wool biological research, and applying its results. He said that, briefly, the objectives of research into the biology of wool are to provide knowledge whereby the quality and quantity of any particular type of fleece may be improved. Progress can only be made if wool improvement is clearly defined. This depends on the breed of sheep, district, and flock being considered. For example, in one flock wool improvement may be defined as "the increase of average fleece weight, with maintenance of reasonable fleece uniformity in fibre thickness and other important fleece characteristics". In addition, careful thought must be given to the way such improvement may be realized in a reasonable time.

If, for example, the objective is to raise average fleece weight, then the heritability of fleece weight in the breed in question must be considered. If fleece weight is strongly inherited, then selecting for high fleece weight would give an improvement reasonably quickly. But if this character is weakly inherited, only breeding animals must be selected, particularly the rams, whose progeny have given high fleece weights. Research such as this, based on carefully controlled mating and accurate observation of fleeces at various ages, might be termed 'breeding research'. Dr. Wildman said that there is, however, a second broad category of biological wool investigation, namely, 'fleece or fibre growth research', and he went on to indicate some of the facts about fleece development. The first wool follicles to be formed in the fœtus are known as primary follicles; those formed later are secondaries. The primaries are characterized by the 'possession' of a sweat gland in addition to the sebaceous glands found associated with both the primary and secondary follicles. The primary follicles are all developed before birth, and form follicle groups with their more numerous associated secondaries. Although many secondary follicles are developed before birth, they continue to be developed for some time afterwards, at any rate in British breeds. It was the development of secondary follicles that Dr. Wildman particularly considered, because the densest fleeces often have a higher proportion of secondary follicles, that is, a greater secondary to primary (*S*/*P*) follicle ratio. He outlined the results of investigations designed to show whether environment affects the number of secondary follicles formed, that is, the *S*/*P* ratio, bearing in mind that there are genetic differences in mature *S*/*P* ratio between breeds and within breeds.

Schinckel[1], working with Merinos in Australia, found that single lambs had a higher *S*/*P* ratio at birth than twin lambs. Ryder[2] found a positive correlation between *S*/*P* ratio at birth and body weight at birth in Cheviot lambs with body weights ranging from 8 to 14 lb.; and Dr. Wildman said he had found a similar relation between *S*/*P* ratio at birth and body weight at birth in Romney Marsh lambs with birth weights ranging from 5½ to 15 lb. Thus lambs that suffer nutritional penalty during fœtal life tend to have a lower *S*/*P* ratio at birth. The next question was: Are there any influences between birth and weaning time which affect mature *S*/*P* ratio ? In the Cheviots it was found that mature *S*/*P* ratio is correlated with body weight at birth, and Dr. Wildman showed a scatter diagram illustrating a lack of positive correlation between gain in *S*/*P* ratio and gain in body weight from birth to weaning. With the Romneys, however, a scatter diagram of *S*/*P* ratio at 90 days plotted against birth weight showed a slight trend towards a positive correlation with lambs over 10½ lb., but none with lambs weighing less than this; and when gain in *S*/*P* ratio was plotted against gain in body weight, a slightly positive relation was found. Breeds therefore differ in this respect, and Dr. Wildman thought that part at least of the explanation of this difference between the Romney and the Cheviot may be due to a longer developmental period of secondaries in the Romney. In the Cheviot the follicle population may mature early, and had probably reached the upper genetic limit for the breed before the total number of follicles could be affected by small environmental and nutritional conditions.

Dr. M. L. Ryder (Wool Industries Research Association) then presented a paper entitled "The Blood Supply to the Skin and Wool Follicles of Sheep". He said that there were two main reasons for making a study of the blood supply to the skin. First, it was possible that some explanation for regional variations in the fleece might be found in the blood supply to the skin. The term regional variation is used for describing the difference, for example, between the fine wool of the shoulder and the coarse wool grown on the hinder parts of a sheep. Such variation is hereditary, and in fact no explanation for it was found in the blood supply. Secondly, as more and more experiments showed the extent to which the diet of the sheep can cause the wool to vary, it became important to know the way in which nutrients reach the wool follicle. Such variation was indicated in Dr. Wildman's paper; but one perhaps more obvious difference appears as change in diameter along the length of the fibre.

The first stage of the investigation was to dissect lambs in order to trace the main vessels leading to the skin, which was found to be supplied by numerous small arteries evenly distributed over the body. These vessels enter a network which can be seen on the under surface of a skin after removal. The density of this net was not found to vary greatly in different body regions or between breeds of sheep. Thus, the way in which blood reaches the skin was discovered; but no anatomical differences were found in the blood supply that would account for differences in fleece growth, either over the body or between breeds. This vessel network on the under surface of the skin is the dermal network lying at the base of the dermis.

There are two more networks within the skin and parallel to the skin surface. These are the mid-dermal vessels, lying about one-third of the depth of the skin below the surface, and the outermost net beneath the epidermis. The wool follicles are supplied from the two inner nets, the dermal and mid-dermal vessels.

The immediate supply to the follicle consists of a basket-like net of capillary vessels surrounding the lower third of the follicle, and others which enter the papilla beneath the growing point of the fibre. Blood seems to rise to the peak of the papilla first, and the larger the papilla the more vessels it contains. The surrounding network terminates at the level at which the fibre has become keratinized, and there is a part on one side of the follicle, immediately above the bulb, where the vessels are denser than anywhere else. This may have some association with the bilateral structure of the fibre, which in turn is thought to be connected with the crimp of wool.

Dr. L. Auber (Wool Industries Research Association) followed with a paper on the "Comparison of Development of Fibres and Related Structures". Dr. Auber stated that fibrillary origin is common to all horny structures produced by the epidermis of 'higher vertebrates'. The simplest structure is stratum corneum, from which flat reptilian scales appear to be the immediate derivatives. Cellular elongation and parallel orientation of fibrillary cell-contents occur in certain reptilian scales, the cortex of bird feathers, and mammalian fibres (wool and all types of hair). Both feather barbs and fibres tend to develop axial strands known as medullæ, which are characterized by turgidity during their differentiation and by vacuolization in their fully formed state. On fibres, and usually also on feather barbs, flattened layers of surface cells are found; in fibres they constitute the well-known overlapping cuticular scales.

Feathers and fibres have apparently originated independently although the function of both is thermal insulation. Histochemically, however, they have much in common; this is revealed by their staining reactions. The cortex in both structures tends to pass through successive phases of affinity for acid, basic and nitro dyes, but the medulla stains only with acid dyes. In fibres the progress of differentiation of the cortex varies between species, whereas the progress in feathers follows the general development of the barb from the obverse to the reverse. In wool the keratinization starts at one side, and the progress across the fibre is termed segmental, whereas in straight fibres the progress is periphero-axial, proceeding concentrically. The so-called shield hairs of many aquatic mammals show deviations from periphero-axial progress. In the beaver, for example, the keratinization starts on one side, but does not proceed directly across the fibre: it first spreads around the surface of the cortex.

Mr. H. B. Carter (Agricultural Research Council's Animal Breeding Research Organization) considered the fleece again with a paper entitled "The Determinants of Fleece Structure in the Merino and its Crosses". He said that among several hundred breeds of sheep in the world, the Merino group is perhaps the most important. This group constitutes about one-fifth of the estimated world sheep population and produces about one-third of the world's natural wool supply. During the past two centuries no other breed or group of breeds has been so extensively used for crossing. The distinctive basis of the Merino's fleece structure is a dense follicle population in which the follicle groups tend to be larger than those of any other breed. These large follicle groups are associated with high S/P follicle ratios the values of which range from 5 to 45 secondaries per primary follicle. In all other breeds not obviously related to the Merino the extreme range of S/P ratio is roughly from 2/1 to 10/1. Cross-breeding with the Merino, therefore, tends more than anything else to increase the fibre population of the fleece provided Merinos with large follicle groups are used.

In cross-breeding, the Merino tends to modify fleece structure by reducing wool fibre thickness, fibre length, medulation, and the output of water-soluble skin secretions even when these characteristics are strongly expressed in the breeds with which it is crossed. Conversely, it tends to increase not only fibre population density but to enhance the expression of skin wrinkles and folds, and the output of sebaceous (mostly ether-soluble) skin secretions. All these characters in the cross-breds tend to have values intermediate between the parental breeds. Characters associated with the follicle group in the skin appear to have moderate to high heritability values and hence may respond well to direct selection. The biological origin of the prototype Merino is still obscure, and Mr. Carter stressed the importance of solving in genetic terms the problem of the origin of the very large follicle group which seems to be a special feature of Merino types. Its solution could help greatly in clarifying the aims and practice of sheep breeding for the improvement of wool production.

Dr. F. Happey (Technical College, Bradford) took the audience abruptly from sheep to molecules by presenting a paper entitled "The Fine Structure of the Protein Fibres". This dealt with physical studies of the structure of protein molecules. Dr. Happey said it is clear that any advances made in the elucidation of their complex nature have only been achieved by considering their aggregations in conjunction with those of other related long-chain molecules. In polypeptides the specific properties appear to depend upon the sequence of the amino-acids in the chain, and the folding of the molecule. It appears from X-ray diffraction pictures that there is structural similarity between synthetic and natural polypeptides.

When the stabilizing S—S link of wool has been broken by oxidation, about 90 per cent of the fibre can be dissolved in weak alkali, leaving an insoluble matrix. The soluble phase can be regenerated and the resulting filaments are usually in the alpha configuration. This appears to confirm the findings from synthetic polypeptides that the alpha form is not necessarily a product of specific biosynthesis[3]. The same physical methods have shown a web structure in the wall of the human intervertebral disk. Here the protein is made up of crossed sheets of collagen fibrils which form a cylindrical elastic membrane enclosing, ideally, a gelatinous matrix of collagen and polysaccharide to form a 'shock absorber'. In conclusion, Dr. Happey said that he had tried to show the breadth of the application of physico-chemical methods to fibrous materials. We are, however, still on the fringe of the biophysical problem of protein structure. The physicist, he said, is well aware of his limitations and needs to be constructively criticized by the biologist to ensure that he does not miss the fundamentals in a mass of classical biological data. Nevertheless, such collaboration is achieving progress in this vital study of the proteins.

M. L. Ryder

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RECENT ANTARCTIC RESEARCH

A LARGE audience attended the joint symposium on "Antarctic Research" held by Sections C (Geology) and E (Geography) of the British Association in the Firth Hall, University of Sheffield, on September 4.

Sir Raymond Priestley, who acted as chairman, emphasized three aspects of the progress of geological research in the Antarctic. First, he noted the extreme good fortune of the early expeditions, the bases and journeys of which were situated in those parts of the continent where many of the key horizons were accessible. In consequence, the outlines of Antarctic palæontology and palæoclimatology had been traced before 1915 and later exploration had little modified the conclusions deduced from these early discoveries.

Secondly, Sir Raymond noted the absence of important economic discoveries apart from the early finds of thin coals in the Permo-Carboniferous Beacon Sandstone of the Ross Dependency. He emphasized the necessity of luck in finding chance outcrops containing ore deposits, but ventured to predict that the exposures of the Basement Complex on the western shores of McMurdo Sound, which is the proposed site of the New Zealand base for the Trans-Antarctic Expedition, might prove to be the most promising locality for seeking metalliferous ore deposits.

Sir Raymond Priestley then emphasized the burden placed upon the field scientist by the routine commitments of expedition life. He noted the necessity for the geologist to travel many miles to examine outcrops at the end of a strenuous day's travelling; for the surveyor to lose sleep in order to obtain astronomical observations.

Sir Raymond's principal criticism of British expeditions during the past thirty years was their failure to provide a full-time and competent cook for each party. He noted the grave disadvantages which arose when a scientist was forced to interrupt his programme in order to take his share of the cooking. The present writer supports this criticism, having, in two years, spent twenty-eight weeks cooking at the expense of all other activities.

Sir Raymond emphasized the financial difficulty which nearly every expedition has faced in attempting to publish the results of its field-work. In contrast, he noted the establishment of the Falkland Islands Dependencies Survey Scientific Bureau in 1950 as a determined effort to integrate the different studies carried out by this Survey during the post-war decade.

Sir Raymond Priestley then introduced Dr. V. E. Fuchs, the leader of the 1955–58 Trans-Antarctic Expedition.

Dr. Fuchs emphasized that although the first voyage of the *Theron* had established the base known as 'Shackleton' in Vahsel Bay, the field party has so far accomplished little scientific work. Indeed, the loss of the chemicals for generating hydrogen when the sea-ice broke up during the autumn had been a grievous setback which would delay the radiosonde programme for a whole year.

He spoke at length about the proposed scientific programme and showed how this would dovetail with the prime object of the transcontinental journey. Dr. Fuchs noted the value of aircraft for reconnaisance, for depot-laying and as a safety factor in Antarctic travel, but emphasized the limited value of observations from aircraft without adequate ground control. The prime scientific aim of the mechanized trans-continental party will be the maintenance of continuous seismic and gravity traverses across the inland ice to measure the thickness of the ice and ascertain the underlying topography.

It is hoped that much of the more specialized glaciological and physiological research will be carried out at the 'Advance Base' which it is hoped may be established some three hundred miles south of Vahsel Bay. Precise plans will, however, depend upon the accessibility of the inland ice. The flights of the Auster aircraft from Vahsel Bay last summer led to the discovery of an extensive mountain range about two hundred miles south of 'Shackleton'. Dr. Fuchs suggested that the possible continuity of this range with the mountains of Dronning Maud Land and its supposed extension towards Graham Land may considerably modify the plans of the Expedition. Although this difficult mountain terrain might be crossed by parties using dogs or man-hauling, this country might prove impassable to tracked vehicles. The presence of these mountains on the direct route southwards might necessitate a detour of several hundred miles.

Dr. Fuchs then showed a number of colour slides illustrating the voyage through the Weddell Sea and the establishment of the base at Vahsel Bay. Although he discussed some of the problems of navigation through heavy pack-ice, the writer suggests that Dr. Fuchs tended to minimize the difficulties of approaching Vahsel Bay. The *Theron* is only the fourth ship to reach the Filchner Ice Shelf, the annual variations of pack-ice in the Weddell Sea are still little known and the success of the Trans-Antarctic Expedition still depends primarily upon the ice conditions in the Weddell Sea next summer.

The third contribution to the symposium was made by Dr. R. J. Adie (Department of Geology, University of Birmingham), who read a paper entitled "Geological Research in Graham Land".

Dr. Adie briefly reviewed the state of knowledge about the geology of Graham Land before the field investigations of the Falkland Islands Dependencies Survey commenced in 1944. He showed a series of maps which demonstrated the extent of the researches of earlier expeditions and then showed a remarkably complete geological map resulting from the post-war journeys. Dr. Adie summarized, in turn, the characteristics of the various formations which have been studied. These include: (1) The Archaean Basement Complex of Marguerite Bay. (2) The Trinity Peninsula Series of north-east Graham Land, comprising greywacke facies sediments which suffered cataclastic deformation in pre-Jurassic times and thermal metamorphism around the Andean intrusions of early Tertiary age. (3) Mesozoic sedimentary rocks of north-east Graham Land and Alexander I Land which have yielded abundant fossils. These range in age between Middle Jurassic (Hope Bay) to Upper Cretaceous (James Ross Island). The Upper Jurassic–Lower Cretaceous conformable succession in Alexander I Land is contemporaneous with a period of igneous activity in Marguerite Bay. (4) Tertiary igneous rocks which are represented by the Andean granite-gabbro suite (constituting at least 90 per cent of the peninsula); this is considered to have an Early Tertiary age, followed by at least two lava and three volcanic phases in Miocene times.

Dr. Adie was able to demonstrate that the recent work of the Falkland Islands Dependencies Survey has further reinforced the belief of Suess that the Graham Land peninsula is linked with the Andean fold range by the Scotia Arc. Dr. Adie was unable to provide any new evidence to show the relationship of Graham Land with the rest of Antarctica.

Dr. Adie was followed by Dr. D. H. Maling (Department of Geography, University College of Swansea), with a paper entitled "Some Geographical Results of the work of the Falkland Islands Dependencies Survey".

Dr. Maling reviewed the work of the Survey since its inception as a small naval operation in 1944. By means of a series of diagrams he was able to show how the size and interests of the Survey had grown from two bases, manned by fourteen men in 1944, to ten bases with seventy-six men in 1956. He further showed that the total effort of the wintering parties represented 339 man-years and subdivided these figures to represent the work done in the different branches of research at the different bases. In particular, the routine work at the smaller bases received special emphasis.

Dr. Maling was able to show that the meteorological observations of the Survey were of prime importance because these had been made at every base throughout its occupation. There are now several bases where nine or more years of continuous observations have been maintained. The value of such climatic data is considerable for, with the exception of the long-established stations at Laurie Island, South Orkneys, and Grytviken, South Georgia, there were formerly no places in Antarctica where observations had been made for more than two consecutive years. To-day we have a clear idea of the range and variability of the climate of Western Graham Land.

In addition, the relatively close network of stations in the South Shetland Islands and West Graham Land allowed synoptic analysis of the weather in Drake Passage and the Falkland Islands Dependencies. Nevertheless, Dr. Maling introduced a note of caution in the interpretation of these observations. Not one of the Falkland Islands Dependencies Survey bases could be said to have good meteorological exposure. Surface winds, in particular, were considerably affected by local topography and this added to the difficulty of drawing reliable synoptic charts. In view of these difficulties, it is a matter for regret that radiosonde ascents were not made from any of these bases until 1955.

Dr. Maling then turned to other routine observations carried out at each base. He noted that there was now a considerable amount of information about the seasonal movements of sea-ice and the dates of winter freezing of the sea. The analysis of this would have great practical value and would reinforce the summer observations made by the whaling fleets in the open ocean. He regretted the almost complete absence of any routine glaciological work and emphasized that useful observations could be made at every base with relatively limited equipment. With the exception of 1949, when observations of glacier regime were made in both the South Shetland and South Orkney Islands, there were scarcely any quantitative figures for accumulation and ablation.

Dr. Maling then considered the state of topographical surveying in the Falkland Islands Dependencies. The outlines of the main island groups and the coast of western Graham Land were surveyed before the War and, indeed, much of the remaining country had been seen from the air before 1940. Nevertheless, the earlier surveys were largely coastal surveys, and Falkland Islands Dependencies Survey surveyors have made detailed topographical maps of the peninsula and the interior of many of the larger islands. In particular, three important sledge journeys, made during 1946 and 1947, carried accurate ground survey from Hope Bay to the western edge of the Filchner Ice Shelf throughout the length of eastern Graham Land, which was hitherto unmapped. There are, however, many places where the existing surveys are inadequate and the methods by which these areas might be mapped depend upon the accessibility of the Graham Land plateau from the coast. Although aerial photography might appear to provide the quickest method of completing the work, the unreliable weather of the Antarctic inevitably causes difficulty and delay. The lack of success of Hunting Aerosurveys, Ltd., during their first season's operation from the South Shetlands, was largely owing to the bad flying weather during January and February 1956.

Dr. Maling concluded by stating that the work of the Falkland Islands Dependencies Survey is concentrated upon routine observations and careful systematic investigation of the more accessible parts of the Dependencies rather than seeking to make dramatic discoveries in the continental interior. To a certain extent, this policy has been dictated by the political expediency of maintaining continuous residence ; but, from a scientific point of view, such a policy is most desirable, for the continuity of routine observations cannot be achieved in any other way. In this sense, much of the work of the Survey has the same monotonous unspectacular quality as the patient marine research of Discovery Investigations between the Wars.

Dr. Maling was followed by Mr. H. H. Lamb, of the Meteorological Office, who spoke on "Winds and Weather" in the Antarctic. Mr. Lamb's work on the synoptic meteorology of the whole continent is inevitably conjectural owing to the paucity of observations in east Antarctica. Nevertheless he has been able to compile synoptic charts for the summer months when whaling fleets are active, and these charts show much greater variability in the pressure systems than has hitherto been acknowledged. Indeed, the glacial anticyclone of Hobbs is largely mythical and although high-pressure systems occur over east Antarctica for perhaps 85 per cent of the year, these tend to break down and frontal activity affects all parts of the continental interior. Mr. Lamb noted that the high-pressure systems seldom develop sufficiently to move northwards and block the general westerly circulation along the polar front, but it is possible that since his examples were largely based upon summer observations, this feature may be more common in winter. He further noted the asymmetrical arrangement of pressure around the continent and observed that there may be a semi-persistent trough line which lies between the Weddell Sea and Ross Sea. He ventured to predict that if the trans-continental party were forced to travel westward of their direct route, they might be confronted with persistent head winds.

Mr. Lamb then discussed possible reasons for abnormal wind speeds in certain parts of Antarctica. He showed some maps which expressed the frequency of gales in different parts of the continent and showed that the persistent Adelie Land gales could only be caused by some topographical effect. He attributed this to 'frontal funnelling' or the concentration of air-flow between a mountain barrier and frontal surface. Observations in Greenland and comparison with the local winds of the Mediterranean suggest that abnormally high winds may be caused for a considerable distance downwind of the mountains, and he concluded that the gales experienced in Adelie Land may well result from an unrecorded mountain range in the continental interior.

The paper by Dr. W. Campbell Smith (British Museum (Natural History)), entitled "Some Geological Results of the Expeditions to South Victoria Land up to 1914", was taken as read, owing to lack of time.

D. H. Maling

ANTI-OXIDATION

THE importance of antioxidant chemistry to technology was emphasized by the fact that during the British Association meeting in Sheffield, on August 31 a full morning session of Section B (Chemistry) was devoted to papers on this subject. Quite apart from its fundamental value in understanding oxidation processes, the advances in the field of the chemistry of antioxidants have played an important part in the development of high-performance petrols and lubricating oils, in the prevention of oxidative deterioration of rubbers and plastics, in the preservation of foodstuffs and in other processes in which air oxidation gives rise to undesirable effects.

The session was opened with an introductory paper by Prof. C. E. H. Bawn, who reviewed the fundamental concepts and the chemistry of the types of molecules which readily undergo antioxidation in the liquid state in air or in solution at ordinary temperature. Recent research, he said, has been particularly successful in providing a clear picture of the course of the oxidation reaction, and certain generalizations have emerged from this work. The more important of these are that the oxidation occurs by a chain reaction which may be initiated either by oxygen or a catalyst and that the reaction of oxygen occurs without the breaking of the O—O bond to form a hydroperoxide. The reaction chain has been established to be of the following type :

$$\begin{array}{ll}
\text{Initiation} & R\text{H} \rightarrow \text{free radical } R \\
\text{Propagation} & \left\{\begin{array}{l} R + \text{O}_2 \rightarrow R\text{O}_2 \\ R\text{O}_2 + R\text{H} \rightarrow R\text{OOH} + R \end{array}\right. \\
\text{Termination} & \left.\begin{array}{l} R + R \rightarrow \\ R + R\text{O}_2 \rightarrow \\ R\text{O}_2 + R\text{O}_2 \rightarrow \end{array}\right\} \text{inactive products}
\end{array}$$

in which RH = hydrocarbon, aldehyde, etc.

The decomposition reactions of the initially formed hydroperoxide are the source of many diverse substances such as aldehydes, esters, acids, alcohols, etc., some of which are responsible for the development of undesirable properties. For example, rancidity of fats is usually attributed to the formation of aldehydes ; the modification and deterioration of rubbers and plastics, which is manifest by a change in mechanical properties, is a result of oxidative scission of the high-polymer molecules by radicals formed in the hydroperoxide decomposition reaction.

Salts of heavy metals, which are widely known to promote oxidation, are usually present in minute amounts in processed or refined materials and act by decomposing the hydroperoxide into free radicals ; for example :

$$R\text{OOH} + Me^{2+} \rightarrow R\text{O}_2 + \text{H}^+ + Me^+$$
$$R\text{OOH} + Me^+ \rightarrow R\text{O} + \text{OH}^- + Me^{2+}$$

The function of the antioxidant is to inhibit or retard the oxidation reaction, and this is attained either by interruption of the reaction chain leading to hydroperoxide formation or by influencing the hydroperoxide decomposition reactions in such a way as to form products which no longer act as chain initiators. The most commonly used antioxidants are substances which react with the transient RO_2 radicals. These compounds usually, although not invariably, possess a readily removable hydrogen atom, and one of the principal reactions by which antioxidant effects are achieved is:

$$RO_2 + AH \rightarrow ROOH + A$$

The radical A formed from the antioxidant AH is unable to continue the chain reaction and disappears either by reaction with itself or another RO_2 radical. Much evidence supports this mechanism for a number of phenols and amines, which are the two main types of compounds used as inhibitors. The structure of the phenol or amine has a considerable influence on its effectiveness as an inhibitor, and many features of the reaction are still not fully understood. The pro-oxidant effects of trace metals mentioned above may be overcome by addition of substances which chelate with the metal ion and render it inactive.

The problems associated with particular aspects of the use of antioxidants in industry were presented in three papers dealing respectively with the food industry (Dr. C. H. Lea), the oil industry (Mr. C. N. Thompson) and the rubber industry (Mr. J. T. Watts).

Dr. Lea said that many constituents of food such as unsaturated fats, fat or water-soluble vitamins, colouring and flavouring matters react with atmospheric oxygen during the period between preparation and consumption. In the plant or animal these processes are kept under control by a complicated enzymatic process, but in the dead tissues or in food processed from them degradative reactions occur. These reactions, which are believed to occur via a peroxidic mechanism similar to that mentioned above, lead to the spoilage of foods. Although this tendency is opposed by natural antioxidants associated with the foodstuff, many of these materials are removed during processing and refining. The natural antioxidants—of which phenols constitute the largest number—are of particular importance to the food industry, and many have been isolated and identified. Of these, tocopherols (vitamin E) are best known and occur widely in vegetable and animal fat-containing tissues. Other naturally occurring phenolic antioxidants include dihydrocaffeic acid, flavones, tannins and catechol derivatives. Many acidic substances such as citric or phosphoric acids, which themselves possess no antioxidant activity, influence very considerably the activity of phenolic inhibitors either already present or added to food. Such 'synergists' include cephalin, ascorbic acid and other organic acids.

It was pointed out by Dr. Lea that the requirements for a successful antioxidant for use in food are very strict, in that in addition to producing a useful degree of stabilization it must be non-toxic before and after oxidation, be adequately dispersable and must impart no colour, odour or flavour. The conditions are attained after prolonged and extensive testing and even then a very wide margin of safety is specified. Only in recent years has the use of chemical antioxidants been approved in Britain, although their use is extensive in certain countries abroad and particularly in the United States.

In discussing the use of antioxidants in the oil industry, Mr. Thompson said that during the past twenty or thirty years, advances in the field of antioxidants have played a vital part in the great strides made in the development of high-performance oil products. As judged by the papers published on the subject, the amount of research work on antioxidants has continued to increase steadily over this period, and the pace was virtually uninterrupted during the Second World War.

About ten million pounds' worth of antioxidants is used every year in petroleum fuels and lubricants to ensure that they have adequate oxidation stability for the jobs that they have to do. This amounts to nearly 50,000 tons per annum, more than 90 per cent of which is used in lubricants. There are many kinds of antioxidant. The type selected for use in a particular product depends on the nature of the oil product itself, and on the conditions of oxidation likely to be met in service; for example, operating temperatures and amount of contact with air and engine or equipment parts made of copper and iron, which are powerful catalysts of oxidation. Tiny amounts of antioxidants can effectively reduce or completely stop oxidation for long periods, fifty-fold improvements in stability being common.

Two or more kinds of antioxidant may be used together in an oil product to combat the various oxidation influences. The amounts needed vary greatly with the severity of service requirements. The petroleum industry manufactures an enormous number of oil products, and great care has to be taken to ensure that the best oil product/antioxidant combination is available for each of a wide variety of purposes. This is achieved by making use of the knowledge that has been gained in recent years of antioxidant behaviour. For example, different oil products do not respond equally well when the same antioxidant is added to them, and some can be improved in their oxidation-resistance much more than others. Moreover, the effectiveness of some antioxidants varies enormously according to the conditions under which oxidation is occurring. An antioxidant which is superior to others under one set of conditions may not be the best in different circumstances.

Studies involving the assessment of antioxidant activity during the service life of an oil product are valuable in indicating oil-change periods or the need for better products to withstand the more severe conditions to be expected in the future. Extensive field-trials are imperative to supplement laboratory experiments. As to the future trends, the jet engine will impose new demands on the oxidation stability of both lubricants and fuels. It is expected, for example, that in supersonic aircraft capable of 1,500–2,000 m.p.h., the fuel may have to be used to provide not only the power but also the cooling that will be necessary to overcome the thermal barrier.

In introducing the subject of the use of antioxidants in the rubber industry, Mr. Watts referred to the wide range of materials both synthetic and natural which are now available to the industry, and to the basic methods of processing and vulcanization. The important antioxidants now in general use belong to two groups of chemicals, namely, (*a*) amines and their derivatives, and (*b*) phenols and their derivatives, the essential difference in performance of the two types being in the degree of staining imparted to the vulcanizate. He summarized the properties of the amine derivatives as regards their behaviour towards natural ageing, heat ageing, flexing, staining and metal impurities in terms of the broad classification of ketone–amine condensates, aldehyde–amine condensates and secondary aromatic amines. Phenols and their derivatives are mainly of interest on account of the low degree of staining which they impart to the vulcanized rubber. Copper salts, in small amounts, are usually introduced into rubber via the raw materials or in processing, and since these salts are powerful oxidation promoters, it is essential to use copper inhibitors to ensure satisfactory service use of the rubber. Heat and light increase the rate of oxidation, the effect of heat being an increase in stiffness and a decrease in elongation, while light causes crazing due to the production of an inelastic skin. It is essential to add suitable antioxidants to delay these effects. Also the use of anti-flex cracking antioxidants is one of the most important branches of rubber chemicals, their importance arising from the demands of the tyre industry. Amines and their derivatives such as phenyl-β-naphthylamine, diphenyl-*p*-phenylene diamine and dimethoxy phenylene diamines are effective antioxidants for the purpose.

Ozone in minute quantities is one of the most powerful agents for producing cracks in strained rubber, and the concentration normally present in the atmosphere is sufficient to produce cracking. Various methods have been proposed for overcoming this problem, such as the use of wax or varnish film on the rubber. Phenylene diamines in concentrations of 2–4 parts for 100 parts rubber hydrocarbon have been claimed by the Americans to give good protection against ozone. These are used together with other antioxidants. C. E. H. Bawn

NEWS and VIEWS

Psychology at Reading: Prof. M. D. Vernon

Dr. M. D. Vernon, who has been appointed to succeed Prof. R. Oldfield (*Nature* of June 16, p. 1109) in the chair of psychology in the University of Reading, has not only gained an international reputation among students of visual perception as an experimenter, but also has had long and wide experience of psychological work in the field, particularly in industrial and social connexions, and in the study of children. A scholar of Newnham, she was placed in Class I of the Natural Science Tripos and started research in the Cambridge Psychological Laboratory under Mr. (later Sir Frederic) Bartlett in 1922. She remained at Cambridge until 1946, as a member of staff, at first of the Industrial Health Research Board and later of the Medical Research Council. Her earlier work was chiefly in the field of industrial psychology, in which her father, the late Dr. H. M. Vernon, is remembered as an outstanding pioneer. From 1927 onwards she was engaged in a series of studies of visual perception, of uncommonly solid and coherent character. Apart from the scientific value of her findings, these set a standard of patience and rigour which her students and colleagues could not fail to appreciate. During the same period she produced two major works, "Visual Perception" (1937) and "Further Studies of Visual Perception" (1952), the sound scholarship of which have guided and helped those of like interest everywhere. She joined the Department of Psychology at Reading as lecturer in 1946, and became reader in 1956. Dr. Vernon has performed numerous and varied services to her colleagues and her subject, notably as assistant to the editor of the *British Journal of Psychology* during 1932–48, as president of the Experimental Psychology Group during 1952–54, and as president of the Social Psychology Section of the British Psychological Society during 1948–49. Her active interests, backed by full experience in teaching, research and administration, promise a fruitful development of the Reading Department along the catholic yet distinctive lines impressed upon it by the first holder of the chair, Prof. A. W. P. Wolters.

Organic Chemistry in Sydney: Prof. C. W. Shoppee, F.R.S.

The appointment is announced of Prof. C. W. Shoppee to the chair of organic chemistry in the University of Sydney, in succession to Prof. A. J. Birch. Prof. Shoppee's earliest researches were carried out in 1923 at the Imperial College of Science and Technology, London, under Dr. C. K. Ingold, with the nominal direction of the late Sir Jocelyn Thorpe. In 1924, he accompanied Prof. Ingold to the University of Leeds, and in 1928, after having held an 1851 Senior Studentship, was appointed to the staff of that University. In 1939, he was elected to a Rockefeller Research Fellowship, which he chose to hold in the Laboratory of Prof. T. Reichstein at the University of Basle. In 1944 he was appointed to a readership in chemistry in the University of London, tenable at the Royal Cancer Hospital, and, in 1948, to the chair of chemistry in the University of Wales, at University College, Swansea.

Prof. Shoppee is distinguished for his contributions to organic chemistry, and especially for his work in collaboration with Prof. Reichstein on the hormones of the adrenal cortex, which led to the establishment of the detailed structures of these physiologically important compounds. At the Chester Beatty Research Institute (Institute of Cancer Research: Royal Cancer Hospital), he applied his special knowledge of the microchemical and chromatographic investigation of natural products to problems of the isolation and identification of endogenous carcinogenic substances present in human tissues. In the steroid field, Prof. Shoppee rapidly gained an international reputation, and his later work involved application of the newer conceptions of the mechanism of organic reactions to the determination of chemical configuration in natural products, an ultimate aim being to illuminate the highly specific relationship between molecular configuration and physiological activity. These aims he has continued to pursue at University College, Swansea, where he has been successful in building a vigorous school. In collaboration with Dr. K. W. Sykes (now professor of physical chemistry at Queen Mary College, London), he was able to promote work on high-temperature kinetics, and more recently has introduced fundamental and applied infra-red spectroscopic studies in association with Dr. H. E. Hallam, and, finally, the complementary study of Raman spectra, in association with Dr. D. A. Long. Prof. Shoppee was elected to the fellowship of the Royal Society in March of this year.

E. B. Wilson (1856–1939)

One of the most distinguished of pioneer experimental embryologists, Edmund Beecher Wilson was born in Geneva, Illinois, a hundred years ago on October 19, 1856. He was educated at Antioch College, Ohio, at the Sheffield Scientific School, Yale, and at Johns Hopkins University, where he obtained the Ph.D. in 1881. In 1885 he became professor of biology at Bryn Mawr College, Pennsylvania. After spending a year in Europe, where he worked with Theodor Boveri at Munich and with Hans Driesch and C. Herbst at the Naples Zoological Station, Wilson was invited by Henry Fairfield Osborn in 1891 to take the post of adjunct professor in the newly established Department of Zoology at Columbia University, New York; he was appointed Da Costa professor of zoology there in 1914. In his first important work, "The Development of Renilla" (*Phil. Trans. Roy. Soc.*, 1883), he made skilled use of serial sections, which were just coming into practice. "The Cell Lineage of *Nereis*" (1892) aroused the interest of American workers in this field of research. In 1901 Wilson showed that accessory asters (T. H. Morgan's "cytasters") form in fertilized *Sphaerechinus* eggs under the influence of hypertonic sea water. From 1903 onwards he concentrated his attention on the chromosomes, particularly on their behaviour during the maturation of the germ-cells, and one of his graduate students, W. S. Sutton, pointed out that the manœuvres of the chromosomes furnish the mechanism for Mendel's two laws of heredity. Wilson's book, "The Cell in Development and Heredity" (1896, third ed. 1925), rapidly became a classic. Of the numerous honours that he received it may be mentioned that he was a foreign member and Croonian Lecturer of the Royal Society, gold medallist of the Linnean Society, and president of the New York Academy of Sciences, the American Academy of Arts and Sciences, and the Society for Experimental Biology and Medicine. A scientist who combined to a remarkable degree artistic workmanship with balanced judgment, and a quiet, cultured gentleman, Wilson died on March 3, 1939, at the age of eighty-three.

L. G. Groves Memorial Prizes and Award

The L. G. Groves Memorial Prizes and Award, given annually from a grant of money placed at the disposal of the Air Ministry in 1946 by Major Keith Groves, J.P., and Mrs. Groves, of Maughold, Isle of Man, in memory of their son, Sergeant Louis Grimble Groves, a meteorological observer who lost his life on a weather flight in 1945, have been awarded this year as follows: *L. G. Groves Prize for Aircraft Safety:* Wing Commander F. Latham, of the R.A.F. Institute of Aviation Medicine, for research into the physiological factors involved in the abandonment of aircraft and in particular the effects of explosive ejection upon the human body; *L. G. Groves Prize for Meteorology:* F. H. Bushby, senior scientific officer, Meteorological Office, Dunstable, where as a member of the forecasting research team of the Napier Shaw Laboratory, Dunstable, he has worked with marked success on dynamical problems and especially on the applications of the equations of fluid dynamics to forecasting, using electronic computing machines; *L. G. Groves Award for Air Meteorological Observers:* Flight Sergeant J. D. Moyes, for meritorious work while serving as an air signaller on meteorological duties with No. 202 Squadron, having completed some 220 meteorological flights totalling nearly 2,000 flying hours.

Proposed Expansion of the La Jolla Campus of the University of California

At a meeting of the Regents of the University of California, held in Berkeley last August, it was decided to expand the University's campus at La Jolla, near San Diego in southern California, including also the Scripps Institution of Oceanography at La Jolla which has been a part of the University since 1912. The Regents agreed that the expansion should take place gradually over a period of years and that it should be based on the growth of the existing facilities at La Jolla for undergraduate instruction and advanced work in mathematics, physics, chemistry and the earth and biological sciences. In this way it is hoped that the rapidly increasing human and material resources of the southernmost part of California will be more fully marshalled for the betterment not only of the University but also of the State of California and the United States generally. In welcoming the new plan, the director of the Scripps Institution, Dr. Roger Revelle, said that the expansion of the University's activities in the San Diego region can be expected to bring great material and cultural benefits to every part of the community; the development will necessarily have to be carried out carefully and slowly, and generous private endowments and ample public funds will be necessary.

Siemens–Ediswan Research Laboratories

Plans have recently been made for new Siemens–Ediswan Research Laboratories which will serve the research activities of Siemens Brothers and Co., Ltd., and of Edison Swan Electric Co., Ltd., the scope of the work being the whole field of telecommunications and various aspects of cable research. It has been decided to erect a group of buildings on a 3½-acre site at Harlow, at the junction of Edinburgh Way and No. 1 Avenue. The first stage of the building plan, which it is hoped to complete in two years, includes three single-story laboratories and one three-story block containing entrance hall, conference room, lecture room and library, as well as laboratories and offices. This will provide accommodation for a total staff of 100–150. Later stages are envisaged in which the three-story building will be increased to five stories, the single-story buildings will be increased to two, and at least three additional structures will be erected. It is not proposed to concentrate the whole of the research staff at Harlow. Sections of the Laboratories will continue to operate near the main factories at Woolwich, Sunderland and Lydbrook. Dr. G. W. Sutton, director of research and education, Siemens Brothers, Woolwich, has been appointed director of the new laboratories.

Land Utilization of Cyprus

Geographical Publications, Ltd., have published a Land Utilization Map of Cyprus in the World Land Use Survey, directed by Dr. L. D. Stamp. The map constitutes an excellent record of the use made of the Island's land about 1949 and, unless great changes are made quickly, it is likely to stand for several years more. The generalizations necessitated by the use of a short key and by the scale of the map (4 miles to 1 inch) tend to simplify the picture unduly, and it says much for the ingenuity displayed in the preparation of the map, for it is not an easy matter to determine the land use and plot the data from a study of about 10,000 air photographs. Those who know Cyprus will be aware of the meaning to be attached to such mixed categories as "tree and other perennial crops with unimproved grazing land"; but those who do not are liable to draw incorrect conclusions unless they have been forewarned. The Island's land is about equally divided between crop land and unimproved grazing land and forest together, which says much for the persistence and patience of the Cypriots who cultivate the land, often with simple implements, and also for the work of the Forestry Department which has been enabled, by legislation and other methods, to do so much for the re-establishment of the forests. Changing age-old methods of cultivation and overcoming fragmentation of holdings makes the Agricultural Department's task more difficult. The map is well produced, and clearly printed so that detail can be seen without difficulty.

Distribution of Mistletoe

A SHORT account of the way mistletoe is distributed is given by D. J. Cove in *The Starfish*, the journal of the Association of School Natural History Societies (No. 9; July 1956). The inquiries started in the Bishop's Stortford district and have now developed into a national survey. Tentative conclusions show that mistletoe is mainly found in old trees and indicate that man, rather than birds, is the chief agent in distribution. On the larger trees, mistletoe tends to grow near the apex of the crown, or towards the sides, where it is beyond the easy reach of man. One possible explanation for this, which does not involve man, is that the light is too weak in the centre of the tree for photosynthesis in mistletoe to take place. Another explanation is that the birds distributing the seeds tend to frequent the outer parts of the tree's canopy. It is evident from the records submitted that, although *Viscum* grows on a wide range of hosts, distribution through this range is very uneven. Of the thirteen families involved, the Rosaceae alone account for nearly 70 per cent of the infested plants; and apple trees are the commonest hosts by far (42 per cent). Records of host-plants which are particularly worth noting include *Parrotia*, silver fir and, in view of its association with mistletoe at the festive season, holly. In spite of all that one reads about the attention paid by Druids to mistletoe growing on oak, only a single case of an infested oak has been reported. The present survey has produced some circumstantial evidence in support of the existence of 'strains' differing in the range of hosts they infest. More records will be needed before firm conclusions can be made about the validity or otherwise of these 'strains'.

New Zealand Forest Service: Report for 1954–55

THE annual report of the Forest Department of New Zealand, covering the period April 1954–March 1955 (pp. 103. Wellington: N.Z. Forest Service, 1955), commences by commenting on the remaining indigenous forests of the country which, after being completely ignored during the great exotic coniferous campaign of the earlier years of this century, have been receiving attention for some years. They are sylviculturally necessary as an insurance against widespread devastation of the exotic forests by disease or fire, in addition to being a source of invaluable specialist timber. A long-term objective for this indigenous forest is to bring as much as possible as soon as possible into a state of greatest productivity. Until recently, it was considered that conservation was best served by complete control of the indigenous cut. This has proved impracticable. The approach is now to be sylvicultural, and this is of considerable interest. The area is to be regenerated, artificially or naturally, with the main native forest timber species—the kauri, the podocarps and the beeches. Practice in Queensland, Australia, and research in New Zealand offer evidence that kauri can be artificially established as a productive crop. The good conifers have been subject to intensive study, and new management methods begun. The beech forest, so long neglected, shows great promise under management, and beech timbers are now widely used and respected. An interesting introduction is a Forest Biology Survey for the purpose of detecting population build-ups of any forest organism; thus outbreaks of insects or disease may be dealt with in their early stages.

Zoological Nomenclature

THE International Commission on Zoological Nomenclature will start to vote, as from February 24, 1957, on the following cases involving the possible use of its plenary powers, full details of which have already been published (*Bull. Zool. Nom.*, 12, Pts. 6–8; August 24, 1956): (1) *alligator* Blumenbach, 1779 (*Lacerta*), suppression, to protect *mississipiensis* Daudin [1801–1802], (*Crocodilus*) (cl. Reptilia); (2) *Campsicnemus* Haliday, 1851, validation (cl. Insecta, order Diptera); (3) *Elaphella* Bezzi, 1913, and *Lophiotherium* Gervais, 1850, validation (cl. Mammalia); (4) *verrucosa* Sars, 1901 (*Alona*), validation (cl. Crustacea, order Cladocera); (5) *Candona* Baird, [1846], designation of type species for and *Herpetocypris* (emend. of *Erpetocypris*) Brady and Norman, 1899, validation (cl. Crustacea, order Ostracoda); (6) *Conchoecia* (emend. of *Conchaecia*) Dana, 1849, validation of and designation of type species for (cl. Crustacea, order Ostracoda); (7) *Anchisauripus* Lull, 1904, and *Otouphepus* and *magnificus* (*Otouphepus*), both of Cushman, 1904, suppression (cl. Reptilia Theropoda [Ichnites]). Comments should be sent as soon as possible to the secretary to the Commission, Francis Hemming, 28 Park Village East, Regent's Park, London, N.W.1.

Folk-Lore

THE note in *Nature* of September 8, p. 522, on *Gwerin*, the new journal of folk-lore, ends with the sentence: "There is, indeed, room for a journal devoted to folk-lore, and all will wish the new venture every success". It has been pointed out to the Editors that this might give the impression that *Gwerin* is the only periodical devoted to folk-lore. This, of course, is not the case, for the periodical *Folk-Lore*, the quarterly journal of the Folk-Lore Society (c/o University College, Gower Street, London, W.C.1), has been in existence since 1878 and is still an excellent publication (often referred to in *Nature*) which deals with every aspect of folk-belief, tradition, custom and folk-lore research both in Great Britain and elsewhere.

Oversea Service Division, Colonial Office

THE following appointments have recently been made in the Oversea Service Division, Colonial Office: H. Bailey (agricultural officer, Gambia), agricultural officer, Northern Region, Nigeria; J. D. A. Harris (agricultural officer, Sierra Leone), senior agricultural officer, Western Region, Nigeria; H. P. Burgess (conservator of forests, Western Region, Nigeria), chief conservator of forests, Western Region, Nigeria; J. A. G. Ellis (assistant conservator of forests, Gold Coast), senior assistant conservator of forests, Gold Coast; M. T. Horwood (senior assistant conservator of forests, Gold Coast), conservator of forests, Gold Coast; T. W. Hussey (senior assistant conservator of forests, Federation of Nigeria), conservator of forests, Federation of Nigeria; A. L. Roxburgh (assistant conservator of forests, Eastern Region, Nigeria), senior assistant conservator of forests, Eastern Region, Nigeria; G. J. Wiley (laboratory technologist, Department of Veterinary Services, Kenya), zoologist (entomology), Department of Veterinary Services, Kenya; F. Wilson (field officer, East Africa Trypanosomiasis Research Organization, East Africa High Commission), field officer, Veterinary Department, Uganda; Miss J. A. K. Abel (assistant statistician, Gold Coast), statistician, Gold Coast; E. C. Innerarity (statistician, Jamaica), senior statistician, Jamaica; P. S. L. Benton, specialist assistant, Agricultural Department, Northern Region, Nigeria; R. Briggs, agricultural officer, Somaliland; G. B. Cliff, C. A. Jackson and J. M. Suttie, agricultural officers, Kenya; I. R. Jensen, irrigation engineer, Agricultural Department, Northern Region, Nigeria; A. M. MacDonald, P. J. Myers and M. A. Owen, agricultural officers, Tanganyika; E. C. Patterson, agricultural officer, Aden; H. Rostron, agricultural officer, Nyasaland; C. B. Sykes, agricultural officer, Northern Region, Nigeria; M. J. van den Heuvel, pest infestation control officer, Produce Inspection Service, Northern Region, Nigeria; P. C. Kimber, assistant conservator of forests, Tanganyika; P. J. Sheldrake, assistant conservator of forests, Sierra Leone; R. H. Watson, assistant conservator of forests, Uganda; R. K. Evans, geologist, Nyasaland; E. Robinson, geologist, Jamaica; A. C. Hayward, process microbiologist, Colonial Microbiological Research Institute, Trinidad; E. C. Hislop, scientific officer (plant pathologist), Tanganyika; J. B. Roberts, scientific officer (organic chemist), Colonial Microbiological Research Institute, Trinidad; W. Bruce, veterinary research officer, Kenya; G. D. Paine, veterinary officer, British Guiana; P. H. S. White, veterinary officer, Northern Rhodesia.

Announcements

The Herbert Spencer Lecture for 1956 of the University of Oxford will be delivered by Sir Edward Bullard on December 4, at noon, his subject being "The Interior of the Earth".

Miss Mary George, principal information officer, Ministry of Agriculture, Fisheries and Food, has been appointed director and secretary of the Electrical Association for Women in succession to Dame Caroline Haslett.

Dr. Edward Wenk, jun., has been appointed chairman of the Department of Engineering Mechanics of the Southwest Research Institute, Texas. He is an authority in the fields of stress analysis, naval architecture and building design and construction, and was formerly head of the Structures Division of the David Taylor Model Basin, Washington, D.C.

Prof. G. P. Wright, Sir William Dunn professor of pathology in the University of London at Guy's Hospital Medical School, and Denis Hill, senior lecturer in clinical neurophysiology, Maudsley Hospital, London, and physician and lecturer in psychological medicine at King's College Hospital, London, have been appointed members of the Medical Research Council. The Earl of Limerick and Sir Geoffrey Vickers have been reappointed for a further term of office.

An international conference on rock magnetism, under the auspices of the International Council of Scientific Unions, will be held during November 1–3 in the Imperial College of Science and Technology, London, with Prof. P. M. S. Blackett as chairman. Those wishing to attend should write before October 18 to Dr. J. A. Clegg, Department of Physics, Imperial College, London, S.W.7.

The National Institute of Agricultural Botany is holding its Crop Conference for 1956 in Cambridge at the Union, Bridge Street, during December 12–13. The general theme will be "The Choice of Seed by Farmer and Grower", and sessions will be devoted to the seed testing service, vegetable crops, and wheats for the farmer to grow and sell. Further information can be obtained from the Secretary of the Institute at Huntingdon Road, Cambridge.

The French Society of Metallurgy is holding its annual "Journées Metallurgiques d'Automne" in the Maison de la Chimie, 28 rue Saint-Dominique, Paris 7e, during October 22–27. Further information can be obtained from the Société Française de Métallurgie, 25 rue de Clichy, Paris 9e.

The Fullers' Earth Union, Ltd., a member of the Laporte Group of Companies, has offered a scholarship to the Chemistry Department at the Imperial College of Science and Technology, London, to support and develop research in progress within the Department on the chemistry of clays. The studentship, which is of the value of £350 a year plus fees, is held in the first instance by Mr. G. S. Perry, who will study the intercalation of organic mixtures by clay minerals and the efficiency of such minerals in chromatographic separations.

The B.B.C. is presenting one or two research scholarships each year of £385 per annum to university graduates in electrical engineering or physics, to enable them to work for a higher degree at any university in the United Kingdom. The scholarships are for two years in the first instance, and are limited to male British subjects. The subject for research must be in fields of telecommunications or physics having an application to sound or television broadcasting. The Corporation has awarded one research scholarship only this year, to Mr. P. C. J. Hill (University of Birmingham), who will work in the Department of Electrical Engineering, Imperial College of Science and Technology, under the supervision of Dr. D. Gabor.

Reference was made in *Nature* of September 29 to the separate publication of Appendix III of the 1956 issue of the "Yearbook of the Universities of the Commonwealth". This appendix gives the number of overseas students in British university institutions. The corresponding Appendix III for the 1957 issue of the "Yearbook" has now been issued. This shows that for the academic year 1955–56 the total number was 9,723 (8,467 men, 1,256 women), as compared with 9,050 in 1954–55.

Erratum. In the review entitled "Techniques and Theory of Molecular Beams" by Dr. E. H. S. Burhop (*Nature*, **178**, 608; 1956), the name "Rutherford" should read "Retherford". We regret this error.

HIGH-TEMPERATURE RESEARCH

SYMPOSIUM AT THE UNIVERSITY OF CALIFORNIA, BERKELEY

A SYMPOSIUM on "High Temperature: a Tool for the Future" was held on the campus of the University of California, Berkeley, California, during June 25–27. This meeting was sponsored by the Stanford Research Institute and the University of California. Most of the 600 attending the symposium were from the United States; but other countries were also represented.

The subjects were dealt with in three major categories, one each day, namely: methods for reaching high temperatures, materials for containing high temperatures, and processes occurring at high temperatures. The chairmen for the three-day meeting, successively, were Dr. Nevin K. Hiester, of Stanford Research Institute, and Profs. Alan W. Searcy and Leo Brewer, of the University of California. To pinpoint the discussion further, each of the major divisions—methods, materials and processes—was divided into three areas for discussion by separate panels, a panel consisting of a leader and three others. Thus virtually every aspect of high-temperature research was discussed in thirty-six short papers and in the answers to questions from the floor, in addition to the luncheon address by Dr. Theodore von Kármán, chairman of the Advisory Group for Aeronautical Research and Development, North Atlantic Treaty Organization, whose subject was "Aerodynamic Heating—the Temperature Barrier in Aeronautics".

The opening discussion of several practical methods of obtaining high temperatures by producing images of a heat source covered both optical and mirror furnaces in many different arrangements, employing arcs, flames and the Sun as sources. One of the most novel furnaces was described by Dr. Joseph M. McGreevy, head of the Optics and Nucleonics Branch, Material Laboratory, New York Naval Shipyard. He described a radiant panel consisting of specially developed, long lamps with closely wound tungsten filaments supported in quartz by molybdenum disks. He reported heating a specimen with such a bank of lamps at a rate of 27 cal./sq.cm./sec. with a rather uniform spatial distribution of the heating-rate.

Dr. McGreevy also described another method of heating by direct radiation. In this, oxygen and aluminium rod are fed into the furnace, in which a pool of molten aluminium floats on a lake of aluminium oxide previously formed during the run. Because of the movement of the aluminium pool, this has been termed the skating-sun furnace. Combustion takes place in the cloud of aluminium vapour just above the pool of aluminium, which provides an irradiance of nearly 20 cal./sq.cm./sec. near the furnace with a temperature of about 3,200° K.

Dr. Wolfgang Finkelnburg, of the Siemens-Schuckertwerke Research Laboratory, described the use of high-intensity electric arcs by which temperatures up to about 53,000° K. have been obtained.

Dr. Finkelnburg outlined the particle composition of gases at temperatures from about 2,000° K. to millions of degrees. Of considerable interest was his description of a supersonic plasma jet produced by expanding a water-vapour arc, burning under 50 atmospheres pressure, through a DeLaval nozzle along the axis of the anode.

Of great interest was the discussion by Dr. Heinz Fischer, of the Cambridge (Mass.) Research Center, of electrical discharges of short duration by which temperatures of 250,000° K. have been achieved. He also mentioned the work reported in the U.S.S.R. of reactions, employing similar techniques, to touch a million degrees K.

As a background for the discussion of materials of interest at elevated temperatures, Dr. John C. Fisher, of the General Electric Co., presented a comprehensive analysis of the various mechanisms for failure in metallic materials exposed to heat. He presented the idea that high-temperature failure due to cavitation fracture may be controllable by suppression of the intergranular sites at which nucleation of the cavities occurs.

Several speakers pointed out that ceramic materials often show a reasonable amount of ductility at temperatures near their melting points. In particular, Prof. Earl R. Parker, of the University of California, cited several experimental phenomena that indicate the possibility of producing ductile ceramic metals. He showed motion pictures of experiments in which cakes of ice treated with surface-active agents were bent 15° before failure. A better knowledge of the influence of surface conditions on mechanical behaviour may lead to the development of ductile ceramic materials.

Progress in development of strong thin ceramic coatings was outlined by S. W. Bradstreet, of the Armour Research Foundation. Among the more interesting new techniques is that of flame spraying, which deposits a cohesive layer of oxide on a metal with little heating of the surface.

Some processes already under investigation require the use of materials near the melting points of the most refractory solids. Prof. J. T. Norton, of the Massachusetts Institute of Technology, directed attention to the fundamental chemical factors which result in materials of very high melting points. He demonstrated that high-melting materials can be divided into two distinct classes. The first class is characterized by saturated electronic pair-bonding. It includes such materials as silicon carbide and aluminium nitride. The other class consists of compounds of certain transition elements with such non-metals as carbon, silicon and boron. Prof. Norton believes the predominant factor in producing this second class of materials is a filling of the *d* shells of the metal atoms. He suggested that boron phosphide might prove a useful refractory of the first class and that ternary compounds, such as Ta–C–Si compounds, might yield new high-melting materials of the second class.

Because the efficiency of all types of nuclear reactors can be increased by raising the operating temperatures, the importance of the effects of high-energy radiation and fission-product accumulation on high-temperature structural materials is obvious. Because present reactor designs involve rather moderate temperatures, almost no work has been done so far on the behaviour of materials at high temperatures in the presence of nuclear fission. There is some information on the effects of radiation on different types of materials at room temperature, however. This information was summarized by Dr. Clifford Weber, of the General Electric Company.

The effects of high pressures on the structure and properties of refractory materials were discussed by both Dean S. S. Kistler, of the University of Utah, and Dr. H. T. Hall, of Brigham Young University. Most startling of their comments was the fact that the melting point of certain refractories has been raised more than 1,000 deg. C. upon application of pressure. On the other hand, with substances that decrease in volume as they melt, the melting point is depressed by pressure. For example, germanium, under pressure, melts at a temperature 600 deg C. less than without pressure.

Although the details of the recently publicized successes in the manufacture of diamonds could not be disclosed, Dr. H. T. Hall, who was associated with that work, discussed some of its general aspects. In this he gave a striking example of the power of theoretical examination of high-temperature problems. He discussed a calculation demonstrating that known thermodynamic data for graphite and diamond and known kinetic data for conversion of diamond to graphite prove the impossibility of converting graphite to diamond in any temperature-pressure range achievable by conceivable means now possible for the investigation of phenomena that occur at pressures of 200,000 atmospheres and temperatures as high as 500° C.

Dean Kistler spoke of certain interesting resemblances of boron nitride to graphite. He directed attention to the fact that, from fundamental considerations, a cubic form of boron nitride with mechanical properties similar to diamond may be expected. The significance of such a possibility is obvious inasmuch as no known material has a hardness between that of boron carbide (2,700 Kroop K_{100}) and diamond (6,500). Dean Kistler held out the hope that a number of completely new materials may be formulated and produced, quite possibly with attractive high-temperature characteristics. As an example he remarked that a new form of silica has been produced simply by compressing quartz above 80,000 atmospheres. Cœsite was also mentioned by Hall as another modification of silica, produced by direct conversion from quartz heated to 2,000° C. at about 100,000 atmospheres pressure.

Dr. George Duvall and Dr. Milton C. Kells, of Stanford Research Institute, as well as Prof. B. H. Sage, of the California Institute of Technology, mentioned shock waves and high-speed nozzles as useful sources of high-temperature kinetic data. Reactions with half-times as low as five microseconds can be studied in shock tubes. A shock tube can yield a temperature of 11,000° K. in less than 12 μsec. High-temperature jets are being actively investigated as commercial sources of gases, such as acetylene.

Progress with the technique of melting and refining metals suspended in space by electromagnetic fields to avoid contamination with container walls was reported by I. E. Campbell, of the Battelle Memorial Institute, and J. C. R. Kelly, of the Westinghouse Electric Corporation. Kelly pointed out that the levitation-melting technique may also be useful for determining the surface tension of molten metals.

The Berkeley meeting made it clear that reactor and jet-engine development will continue to provide a tremendous impetus to research on high-temperature materials, and that high-temperature chemical processing is likely to witness spectacular expansion. It also demonstrated the comparative paucity of information in the high-temperature field. This was underlined by an example given by Kistler. He pointed out that, although silicon carbide is one of the oldest and best known synthetic high-temperature products, we still do not understand such things as the effects of furnace atmospheres on the rate of its formation, the factors determining whether the cubic or hexagonal form of the compound will be produced, or the effects of impurities on such important properties as conductivity, oxidation resistance, and grinding characteristics. Clearly, much remains to be done.

The papers given by the members of the various panels, with answers to the many questions put from the floor, are being printed and are expected to be issued about October 30; copies will be available from the Public Relations Department, Stanford Research Institute, Menlo Park, California (price 5 dollars each).

CHROMOSOME PROBLEMS

A CONFERENCE on chromosomes was held in the Landbouwhogeschool, Wageningen, Holland, during April 16–19, Profs. H. J. C. Tendeloo and R. Prakken being chairman and secretary respectively. The programme consisted of seven lectures with discussions.

Prof. E. Heitz (Tubingen) spoke first on chromosome structure in the nucleus, during mitosis and meiosis.

There are five different types of structural elements recognized in a chromosome: the spiral, the chromomeres, the centromere (primary constriction, kinetochore), the secondary constrictions (SAT-zones) and the heterochromatine. Four of these are directly (heterochromatin) or indirectly (the spiral, the centromere, the SAT-zones) demonstrable in the nucleus. These serve as proof of the individuality of the chromosomes within the nucleus.

The essential element of every chromosome, the spiral, which is tightly coiled during metaphase and anaphase, uncoils during telophase and gives rise, after the calymma has disappeared, to the thread-like structure of the nucleus. This structure has been observed in the living state and can also be demonstrated in the nucleus after fixation.

Often, certain parts of chromosomes do not uncoil during telophase and probably do not lose their calymmatic substance. Since such heterochromatic pieces occupy defined positions within the chromosomes, they can be recognized as more or less compact and highly coloured pieces in their respective positions.

Since rather large pieces of the chromosome on both sides of the centromere are often heterochromatic, the position of the centromere can be demonstrated in the proximal part of the young nucleus.

Chromomeres themselves (that is, compact, small and nucleal positive pieces within the anucleal uncoiled zygotene or pachytene chromosome-fibres seen during meiosis) cannot be demonstrated in the somatic nucleus, although heterochromatic pieces may be mistaken for them.

Secondary constrictions can be recognized in the nuclei by means of their function. They condense the nucleoli during telophase. Since the number and position of every secondary constriction are definite, the number and position of the nucleoli, in the young nuclei at least, correspond to the number and position of the secondary constrictions.

There are many indications that the major spiral contains a minor spiral. Furthermore, there are many reasons to suspect the existence of a third, perhaps molecular, spiral, running in the minor spiral, for example, the enormous length of the fibrils in the giant Dipteran chromosomes may thus be explained.

In addition, there are many indications that during anaphase there are already present two daughter spirals, at least. Electron-microscopic studies have shown that a sub-light-microscopical spiral is probably the basic element of every chromosome. If so, the known spiral should be composed of a bundle of different ultraspirals. Nevertheless, it is premature to seek a connexion between the proposed helical structure of deoxyribonucleic acid and the chromosome spiral.

Prof. H. D. Springall (University College of North Staffordshire) discussed the chemical structure of proteins and nucleic acids.

The study of an organic natural product follows the pattern: (1) isolation; (2) proof of purity; (3) estimation of molecular weight, and, if a macromolecule, molecular size and shape; (4) analysis; (5) degradation; (6) synthesis; (7) if a macromolecule, study of the configuration of structural elements within the molecule.

The application of this sequence of studies to proteins and nucleic acids is very difficult because of their very high molecular weights, and their fragility and intractability. The methods devised were briefly discussed and the results summarized.

(1) *Proteins.* These consist fundamentally of polypeptide chains of α-amino-acid residues (of about 19 different kinds). These chains are helical, most of them probably related to the 3·6 residue helix of Pauling. The helical chains are disposed in linear patterns in the fibrous proteins, and are folded into compact globular molecular shapes in the more soluble globular proteins.

The penetration of modern methods into protein structure is indicated by the analytical and degradative work which has established the complete structural framework of insulin (Sanger) and the complete synthesis of the nonapeptide amide hormones, oxytocin and vasopressin (du Vigneaud).

(2) *Nucleic Acids.* The building units of these are a few purine and pyrimidine N-bases; the sugars, ribose or deoxyribose (giving rise to ribo- or deoxyribo-nucleic acids); and phosphoric acid. There are many theoretically possible modes of assembly of these diverse and polyfunctional components. The natural scheme involves the linkage (*a*) (β-glycosidic) of an N-base to a sugar (to give a nucleoside), (*b*) (ester) of phosphoric acid to the sugar component of a nucleoside (to give a nucleotide) and (*c*) of nucleotides by phosphate diester formation via the 3′- and 5′-sugar positions. The polynucleotide chains in deoxyribonucleic acid are arranged in twin helices about a dyad axis (Watson–Crick). The arrangement in ribonucleic acid is not known.

Synthetic work on nucleic acids is of extreme difficulty and has not yet gone beyond dinucleotides (Todd).

(3) *Nucleoproteins.* The general structure of these substances, especially the viruses, was briefly considered.

Prof. T. Caspersson (Stockholm) spoke on the cytochemistry of the nuclear elements.

The lecture gave a summary of the early cytochemical studies of the metabolism of the cell nucleus, mainly carried through by aid of ultra-violet ultramicrospectroscopy. The central point had been the study of the role of the polynucleotides. Especial attention was given to the conspicuous changes in the protein content of various nuclear structures during mitosis and during the interphase, the functional stage of the cell.

In the latter part of the lecture it was pointed out that at a certain stage these studies were virtually entirely blocked by a series of technical difficulties, mainly arising when dealing with the protein components. This situation led to a comprehensive investigation aiming at development of the methods in different directions. Very recently major advances in this field have been reported and thus the cytochemical problems concerned in cell nuclear metabolism can now be attacked in a novel and hitherto inaccessible way. The technical procedures were not presented in any detail as very few data on chromosomes, gained with the new techniques, are, as yet, available. These are discussed, for example, in Cold Spring Harbor Symposia in Quantitative Biology, 1956.

Mr. N. W. Pirie (Rothamsted) dealt with the recognition, distribution, and action of nucleic acids.

There is no unequivocal way to recognize nucleic acid that has not been isolated. Methods depending on the determination of phosphorus extracted by different procedures can be confused by other phosphorus compounds; methods depending on the precipitation of the bases and determination of nitrogen are even more fallible; methods depending on the determination of ultra-violet absorption can be misleading both because of the presence of other substances with a similar absorption spectrum (for example, ascorbic acid) and also because of the effects of orientation. Feulgen staining for aldehydes is a more trustworthy method of recognizing deoxyribonucleic acid than any of the methods for ribonucleic acid; but here, too, there are difficulties.

The use of nuclease preparations increases the precision of these determinations; but their value depends on the demonstration, rather than the assumption, that the preparation is free from other relevant enzymes. Lack of action can be due to inaccessibility of the nucleic acid or to the presence of inhibitors. There is little evidence for the occurrence of free nucleic acid; but the nature of the linkage to proteins and other materials is obscure and probably diverse. This fact need not complicate histochemistry, because the techniques of fixation generally denature the protein and liberate any bound nucleic acid; but it complicates attempts to interpret the mode of action of nucleic acid, for the acid may be an artefact. There is some evidence for changes analogous to denaturation in nucleic acids; if such a phenomenon exists it extends still more widely the already ample possibilities for isomerism and specificity.

Deoxyribonucleic acid tends to be confined to the nucleus but is often found elsewhere, for example, egg-white and viruses, and may not have been looked for carefully. Ribonucleic acid is present nearly everywhere in organisms though it is often concentrated in regions such as microsomes and the bacterial cell wall. Not all deoxyribonucleic acid is present as genes: What is the status of the common generalization that all genes are deoxyribonucleic acid? *A priori* this seems unlikely. Similarly, regions of high metabolic activity are often rich in ribonucleic acid: Are regions of protein synthesis characteristically richer still? It is surprising that there seems to be so little deoxyribonucleic acid–ribonucleic acid interconversion, and that actions such as the stimulation of polysaccharide and enzyme synthesis have been found so seldom.

Prof. A. Gustafsson (Stockholm) spoke on regularities and intentional control of mutation processes in plants.

From comparative experiments on barley, using X-rays, neutrons and specific chemical compounds as mutation-inducing agents, Gustafsson and his collaborators conclude that chromosome breakage and consequent X_1 sterility can be induced in barley by certain specific compounds: (1) without visible mutations of the chlorophyll apparatus, for example, 8-ethoxycaffein, (2) probably with such mutations, for example, ethylene oxide and mustards. Some agents, for example, nebularine, do not cause chromosome breakage, rearrangements, or X_1 sterility, but may increase mutation-rates considerably and cause fundamental changes in the mutation spectrum.

Chromosome breaks induced by strongly ionizing neutrons do not differ from those induced by X-rays. Random breaks, re-attached to form translocations, rarely produce noticeable changes in morphology, anatomy or ecology, but such translocations are highly instrumental in the genetical isolation of plant populations.

Plant-breeding in its genetical aspects rests on a profound knowledge of genes and chromosomes, the importance of heterochromatin and euchromatin, chromosome number, heterozygosity, gene recombination and mutation control. Mutations, whether spontaneous or induced, are generally regarded as arising at random. Gustafsson feels that this is not so. The mutation spectrum varies with the type of species and mutagenic agent used. The time does not seem far off when we shall be able to induce chromosome rearrangements and gene changes independently from one another, and control or direct the mutation process so that mutations of distinct loci, including those of high-productivity effects, are intentionally produced.

Prof. A. Müntzing (Lund) discussed chromosomes in relation to species differentiation and plant breeding.

Some species, although morphologically indistinguishable from one another, are isolated reproductively. Lewis's work on *Clarkia* has shown how a study of the differentiation of populations within a species can lead to an understanding of the mechanism of speciation in that group, and the part played by chromosome re-arrangements at the intra- and inter-specific levels. The salivary gland chromosomes of *Drosophila* have provided a means by which the nature of this chromosome differentiation can be studied in detail. In only a few cases has it been adequately demonstrated that the difference between two species is genic only and that chromosomal rearrangements have not occurred. Change in chromosome number to give an aneuploid series may result from fusion or breakage of chromosomes with diffuse centromeres.

Prof. Müntzing also spoke of the part played by polyploids in plant breeding and the value such plants had. Cytological analysis had shown the origin of many polyploid cultivated species and how they could be resynthesized, so that fresh genetic material could be incorporated into existing varieties. New polyploids have also been made and found to be of value in plants such as rye, clover, turnips and fruit trees. By the use of wheat plants lacking a pair of homologous chromosomes (nullisomics) it has been possible to determine on which chromosome various genetic factors are situated and also to transfer whole chromosomes, bearing genes for disease resistance, to other varieties.

Prof. C. D. Darlington (Oxford) discussed the means of communication in the cell. These are to be inferred from chemical, genetical and radiation experiments and from comparative developmental studies. The co-operation and competition of nuclei had been revealed by classical experiments the meaning of which was now becoming clear in genetic and chemical terms.

The co-operation of gene activities and the co-ordination of chromosome movements both required communication along the chromosomes themselves. Evidence in relation to nucleoli, heterochromatin, and especially centromeres, showed that this communication was sometimes canalized along the chromosomes, a property which was variable and physiologically controlled. The inference of position effects from breeding experiments could thus be greatly extended. Further gene activity and integration could be seen as conditional not only on the local character of the cytoplasm but also on its cyclical changes. These cyclical changes in turn were co-ordinated in two normal systems (mitosis and meiosis) in every species. The relations of these normal systems were made clear by the abnormal systems which have now been described in many species and could be provisionally interpreted in terms of deoxyribonucleic acid and protein relations. With these cytological inferences the main concepts of genetics and embryology were consistent but they appeared in a new and larger perspective.

The author is indebted to Prof. C. D. Darlington (Oxford) and to Mr. K. M. Goodway (University College of North Staffordshire) for assistance in the preparation of this account. H. D. SPRINGALL

BRITISH WELDING RESEARCH ASSOCIATION

OPEN DAY AT THE ABINGTON LABORATORY

IN our present society, which is committed to the pursuit of technology in support of a material standard of life, research associations and similar bodies form an essential communication between fundamental science and industry. This theme was developed by the Minister of Supply, Mr. R. Maudling, when proposing the toast of the British Welding Research Association at the annual luncheon and open day held at the Association's laboratory at Abington, Cambridge, on July 24. The Minister went on to encourage the production of memoranda containing the essence of sound practice supported by scientific investigation, the commencement of which in the case of the Association in fields such as brazing and the construction of arc-welded machinery has been made possible by application of Foreign Operations Administration funds from the United States. In the ensuing replies the work of Sir William Larke, spanning from the inception in 1936 of the Welding Research Council on through the formative years of the Association, was warmly acknowledged on the occasion of his retirement as president.

As in former years, an exhibition of work in progress was arranged. Illustrative examples of current metallurgical work were housed in the partly completed new laboratory, since the metallurgical staff is being transferred from Park Crescent, London, to Abington this autumn.

Success in the production of strong and ductile fusion welds in high-strength aluminium alloys by means of the tungsten-arc process depends strongly upon the provision of filler material of correct composition when diluted with parent material. Performance with different compositions may be shown by means of a cracking test, in which shrinkage restraint is varied along a butt weld by means of symmetrical slots of graded length transversely cut into the parent plate at intervals along the weld. The test plate thus has the appearance of a fishbone, and with unsatisfactory conditions longitudinal weld-cracking occurs in the region of greatest restraint. The fusion welding of cylindrical fatigue specimens with the use of filler rods developed in this way was demonstrated.

In the case of the self-adjusting arc process, the arc is struck between the end of the filler rod and the plate, and the rod is advanced at a fixed speed to neutralize its own fusion. This process, although markedly successful by virtue of the results achieved and the simplicity of the control equipment, leads to some limitation in the ranges of voltage and current which may be successfully used, irrespective of the diameter of the filler wire through which the current is passed. Investigations undertaken co-operatively by the Electrical Research Association and the British Welding Research Association have shown experimentally that there are three different characteristics of arc operation and metal transfer, depending upon arc voltage. Thus, at low voltages discrete droplet transfer leads to irregular metal deposits unsuitable for welding. Above this voltage, in the practical working range, a spray transfer operates. At even higher voltages the spray transfer is accompanied by such high metal velocities that a strongly scouring action occurs in the molten pool, and unwanted complete penetration of the plate may take place. Nevertheless, in the working range, the somewhat lower spray-transfer velocity may be put to good use when welding in positions other than the horizontal. From the point of view of arc characteristics, the change from droplet to spray transfer is interesting because of the sudden change of current accompanying it.

The use of carbon dioxide as a shielding gas for arc welding of ferrous materials is of much topical interest, and typical welds made with this process were on view. In the case of other welds made with a mixture of argon and oxygen as shielding gas, unwanted porosity has been found and is thought to be associated with a reaction between carbon in the steel and gas which is either trapped or dissolved. Such porosity ought to be avoidable with sufficient added silicon in relation to carbon present in the fused metal. The manner of estimation of the requisite silicon content of the filler material was demonstrated.

Successful welding of metals such as titanium and zirconium is dependent upon the exclusion of reacting gases such as oxygen and nitrogen, for which these metals have great affinity. Welds of high quality for standardization purposes may be made in a completely closed argon chamber. In the apparatus which was shown, a sufficient degree of purity of the arc atmosphere is ensured by the production of high vacuum before flooding with argon.

Although it would be undesirable to claim that metallic titanium had not previously been cut successfully with an oxygen jet, predictions of feasibility were made by a member of staff of the Association as a result of earlier fundamental work on combustion in gas cutting. This was strikingly confirmed by experiment, and expectations of a high optimum cutting-speed, five times that for steel, were realized. Surface embrittlement, which was expected to arise from gas contamination, was not found to be as serious as anticipated, probably because of the high speeds. A practical demonstration of such cutting on moderately heavy sections was witnessed by visitors.

With regard to engineering activities, a further building frame was on view, after test to the point of plastic collapse by investigators under Prof. J. F. Baker, from the Department of Engineering in the University of Cambridge. This particular frame contained two stories, and illustrates the progress which has been made in bringing more complex constructions within the scope of load calculations for plastic collapse. The Association has gained much benefit from its financial support of this work.

Experimental stress analysis of elements of welded pressure vessels continues to fulfil an industrial requirement. The very thick pressure vessel containing circular nozzle openings, a model of which was shown last year, is shortly to be installed. The addition of reinforcement to reduce stress concentrations at its openings has been demonstrated theoretically to be unnecessary, and economy would ensue if this could be proved experimentally. At the opposite extreme, accumulated theory suggests that reinforcement may have to be substantial for large circular openings which are likely to be in use in thermal reactor vessels, because of the low ratio of shell thickness to diameter in such cases.

Stress analysis of vessels with openings has also been supplemented by pulsating pressure fatigue tests, from which the former work has been well vindicated. Fracture in some of the cases shown was directly associated with the calculable stress concentrations due to the openings themselves, rather than to unpredictable local stress concentrations induced through sharp changes of section at weld profiles.

In the fatigue laboratory, further results were presented from tests of high-quality butt welds in mild steel made by various welding processes. Recent work has also been addressed to a definition of the influence on fatigue strengths of various weld faults. Although, in the case of pipe butt welds, reductions of strength from all faults may be observed, the overriding effects of cracking and lack of penetration have been readily demonstrated. In comparison, the influence of moderate amounts of totally enclosed porosity appears to be reasonably small.

Determination of the fatigue resistance of all but the smallest welded shafts may be extremely slow if it is necessary to use a rotating-bending testing machine. In this respect, a resonance machine with a single unbalanced rotating mass, co-axial with the fixed shaft, enables an increased speed of testing to be used, with the same stress cycle and a reasonably small power-input. It is later hoped to build an apparatus of greater load capacity than that which was on view.

In the pulsating pressure fatigue testing of welded joints in thick steel tubes, fluid pressures of many tons per square inch must be applied. A machine for this purpose, developed at the University of Bristol, was shown in use. A characteristic of the machine is the reduction of fluid volume to the greatest possible extent, whereby the energy stored at each pulsation may be reduced to low values.

Although the use of ultrasonic inspection for weld flaws may increase markedly in future thick welded constructions, it has first been necessary to achieve reliable calibration with regard to the strength of echoes. In this respect, the use of standard reference blocks was demonstrated, by means of which an apparatus may be quickly calibrated. Equal attention is now being given to attenuation of pulses by virtue of different surface contours in contact with the ultrasonic probes, in conjunction with various fluid coupling agents.

During the past year, experimental work on the brittle-fracture strengths of welded mild-steel plates has been continued with the 700-ton tension test rig, which was on view together with the fractured specimens. It is now believed that the role of residual stress in promoting fracture is better understood. While these stresses have no embrittling influence of themselves, it has been shown in the presence of a notched weld parallel to the direction of tension, and notch brittle parent material, that the static strengths of wide plates may be reduced to low values, such as are normally present in structures. When the residual stresses are removed, yield point stresses may be consistently sustained before fracture takes place. Thus, it is now believed that the beneficial effect of stress-relieving of welded structures may be more readily assessed.

UNIVERSITY AFFAIRS IN GREAT BRITAIN, 1954–55

CONTRARY to the past few years, the "Returns from Universities and University Colleges in receipt of Treasury Grant for the Academic Year 1954–55", issued by the University Grants Committee*, show an increase of 1,103 in the number of full-time students; the latest figure is 81,705, compared with 80,602 in 1953–54, 81,474 in 1952–53 and 83,458 in 1951–52, and it is expected that the numbers in 1955–56 will show a further and greater increase, as it is known that there were 3,378 more full-time students in the autumn term of 1955 than in that of 1954. In the English universities, full-time men students increased by 395 and women by 500; for Wales, the corresponding figures were 46 and 17; and for Scotland, 61 and 84. There were 4,987 full-time and 2,010 part-time students from overseas within the British Commonwealth and 3,617 full-time and 1,594 part-time students from foreign countries; for 1953–54 the corresponding figures were 4,607 and 1,819 for the Commonwealth and 3,373 and 1,379 for foreign countries. There was no significant change in the distribution of full-time students among the faculties; but there were small increases both for science and technology: from 21·1 to 21·2 per cent for the former, an increase from 16,971 to 17,327, and from 12·4 to 12·9 per cent for the latter, an increase from 10,036 to 10,586. Full-time advanced students of pure science increased by 45 to 3,335, those of technology by 74 to 1,455, of agriculture by 17 to 307, and of veterinary science by 6 to 18, while those of medicine decreased by 49 to 813. Of the full-time advanced students, 2,835 (or 23·2 per cent) were working for the teacher's diploma. Of the full-time students, 64,778 were reading for a first degree, 4,099 for a first diploma and 12,212 were engaged in research or other advanced work, the corresponding figures for 1953–54 being 63,560, 4,350 and 12,166.

The proportion of assisted students was 72·9 per cent compared with 71·9 per cent in 1953–54; for England as a whole it increased from 74·2 to 74·9 per cent, but for Scotland it increased from 56·8 to 59·5 per cent, and for Wales decreased from 88·5 to 86·6 per cent. The dependence on parliamentary grants was practically unchanged, the £25,059,434 received from this source representing 70·4 per cent of the total income compared with 70·5 per cent in 1953–54. Of the recurrent income, 10·7 per cent came from fees, 4·1 per cent from endowments, 3·2 per cent from local authority grants and 1·1 per cent from donations and subscriptions, the corresponding figures for 1953–54 being 12·0, 4·3, 3·6 and 1·6 per cent, respectively. Universities were asked to show separately for the first time in 1954–55 income from grants for research and income receivable under research contracts: for England the former amounted to £1,079,307 and the latter to £685,615; for Wales the corresponding figures are £17,787 and £8,213, and for Scotland £115,308 and £45,683. The ratio of staff to students again improved, the full-time teaching staff being now 9,810, compared with 9,514 in 1953–54. The distribution of this increase among staff is: professors, 43; readers, assistant professors and independent lecturers, 36; senior lecturers, 41; and lecturers, 176.

Of the full-time students, 63,068 were in England (15,121 at Oxford and Cambridge, 18,201 at London and 29,746 at other universities and university colleges), 4,494 in Wales and 14,143 in Scotland. Except at Liverpool and at Reading, where there were decreases of 1 and 10, respectively, the increase in students was distributed over all the universities and colleges, but only at Oxford (150), Southampton (137), Durham (139), Leeds (128), St. Andrews (114) and Cambridge (104) did the increase exceed a hundred, though the increase by 95 to 719 at the Manchester College of Technology was the highest proportionate increase. The proportion of full-time students residing in colleges and halls of residence increased to 28·4 per cent; and, of these 23,243 students, 8,262 were at Oxford and Cambridge, 11,838 at other English institutions and only 1,261 in Wales and 1,882 in Scotland. The proportion of men in residence was 24·2 per cent, and of women 41·3 per cent, while 34,548 students (42·3 per cent) were in lodgings and 23,914 (29·3 per cent) at home, compared with 40·9 per cent and 31·0 per cent, respectively, during the previous year. Of the 22,463 students admitted for the first time during 1954–55 (an increase of 1,310 on 1953–54), 20,946 were reading for a first degree and 1,517 for a first diploma; of those reading for a first degree, 1,233 were under eighteen years of age and 11,843 were nineteen or more. Of the full-time students, 35,723 out of 47,793 men and 11,528 out of 15,275 women in England were receiving assistance by way of scholarships, exhibitions or other awards from public or private funds; for Wales the corresponding figures are 2,726 out of 3,187 men and 1,166 out of 1,307 women; and for Scotland, 6,331 out of 10,315 men and 2,089 out of 3,828 women. Of the 61,295 full-time men students, 36·1 per cent were in arts, 22·3 per cent in pure science, 16·6 per cent in medicine and 17·0 per cent in technology; for the 20,410 women students the corresponding figures are 63·7, 18·0, 14·4 and 0·7 per cent, respectively. Medicine and dentistry claimed 52·2 per cent of the part-time advanced students, arts 34·9 per cent, pure science 9·2 per cent and technology 2·7 per cent, compared with 49·6, 35·6, 9·3 and 4·8 per cent, respectively, during 1953–54.

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* Universities Grants Committee. Returns from Universities and University Colleges in Receipt of Treasury Grant for the Academic Year 1954–1955. (Cmd. 9800.) Pp. 50. (London: H.M.S.O., 1956.) 2*s.* 9*d.*

The recurrent income of the universities and university colleges of Great Britain increased by £4,488,054 to £35,600,078, of which £25,059,434 was from parliamentary grants, £3,815,306 from fees, £1,448,212 from endowments, £1,140,643 from local authority grants and £401,379 from donations and subscriptions. Of the total income of £26,200,007 from public funds and £9,400,001 from other sources, the University of London received £7,803,937 and £2,748,652, respectively, while the figures for other universities were Cambridge £1,659,067 and £1,371,494; Oxford, £1,489,853 and £780,791; Manchester, £1,293,893 and £321,976; Leeds, £1,107,057 and £350,586; Birmingham, £1,069,933 and £438,788; Durham, £1,152,240 and £369,320; Liverpool, £1,057,395 and £320,826; Bristol, £825,567 and £430,386; Sheffield, £710,398 and £186,487; Nottingham, £568,488 and £148,410; and Reading, £624,686 and £93,438. No other English university or university college had an income exceeding half a million pounds; but for the four universities in Scotland the incomes from public funds and from other sources were Aberdeen, £576,117 and £138,690; Edinburgh, £1,235,533 and £415,402; Glasgow, £1,229,990 and £397,244; and St. Andrews £612,090 and £129,357. The University of Wales, including the Welsh National School of Medicine, received £1,326,200 and £336,405.

Of the recurrent expenditure of £34,791,656, an increase of 15 per cent on 1953–54, administration accounted for 7·2 per cent, departmental maintenance 69·3 per cent, maintenance of premises 12·0 per cent, and miscellaneous expenditure 10·2 per cent. Departmental maintenance, which includes salaries of teaching staff, payments for superannuation, the running costs of laboratories, lecture rooms, libraries and museums, and the supply of books, specimens, materials, apparatus, etc., increased by £2,095,004 to £24,100,985 and expenditure on maintenance of buildings increased by 8·2 per cent. Salaries and superannuation amounted to £15,958,695, compared with £13,616,426 in 1953–54, the increase being 17·2 per cent for teaching staff and 14·8 per cent for technicians and laboratory assistants.

Library expenditure, excluding general maintenance of library buildings, rates, heat, light, repairs, etc., amounted to £1,352,244, or 3·8 per cent of the total expenditure, compared with 4·0 per cent in 1953–54 and 3·9 per cent in 1952–53. Of this total, £707,236 was for salaries and wages, £154,963 on periodicals and £101,885 on bindings. Of the £310,102 expended on books, £72,939 was in the schools and colleges of the University of London, including £12,192 at the Central Library, £6,183 at the London School of Economics, £9,273 at University College, £5,153 at the School of Oriental and African Studies and £4,909 at Bedford College. The University of Oxford spent £31,585 on books; Cambridge, £22,796; Manchester, £21,559; Liverpool, £11,608; Leeds, £10,116; Durham, £12,993; Birmingham, £10,215; and Bristol, £9,553. Only the Universities of London (£44,813), Oxford (£14,948) and Cambridge (£12,233) spent more than £10,000 on periodicals, and only Birmingham (£7,200), Leeds (£5,855) and Manchester (£6,458) more than £5,000. The University of Wales spent £14,789 on books and £8,457 on periodicals. In Scotland, Edinburgh spent £15,087 on books and £6,813 on periodicals; Glasgow, £11,662 and £7,382; St. Andrews, £11,856 and £4,702; and Aberdeen, £8,333 and £3,954.

INSTITUTE OF PHYSICS

REPORT FOR 1955

The thirty-sixth annual report of the Board of the Institute of Physics*, which was presented to the annual meeting of the Institute in London on July 16, indicates the growing importance of the work of the Institute and the increasing number of physicists now being employed in industry, teaching and research. The total membership rose during the year under review by 397 to 5,146, reaching the five thousand mark for the first time. There were increases in all the grades of membership, with substantial increases in the associateship and graduateship grades. 726 applications for election or transfer to the various grades were received during the year, compared with 579 during 1954. Eleven of the fifty-four candidates who took the examination for graduateship of the Institute were successful. The numbers of candidates for the final examinations for the National Certificate in Applied Physics were 309 for the ordinary level and 82 for the higher, compared with 206 and 75, respectively, in 1954.

The report mentions that representatives of the membership committee visited seven technical colleges which had applied for official recognition, or extension of recognition, by the Board as institutions suitable for training of physicists in accordance with the Institute's membership regulations. The degrees of the University of Malaya were also recognized by the Board. The report of an inquiry by the Board into the availability of places for students of physics in the universities and larger technical colleges of Great Britain was published by the Institute in its September *Bulletin*, and reprints have since been widely circulated. Many requests continue to be received from those leaving school and others concerning careers in physics, and the deputy secretary of the Institute, Mr. N. Clarke, has addressed meetings on this subject in Aberdeen, Bristol, Edinburgh, Ewell, Glasgow and Swansea. The Institute has kept in close and constant touch with the permanent officers of the American Institute of Physics and has made a joint inquiry with the Physical Society, London, about the likely demand for English translations of Russian papers on pure and applied physics.

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* Thirty-sixth Annual Report of the Board of the Institute of Physics, 1955. Pp. 18. (London: Institute of Physics, 1956.)

The need for a recognized permanent body in Great Britain before which papers on the application of nuclear energy and ancillary subjects could be read and discussed was the subject of negotiations initiated by the major engineering institutions, and as a result a body known as the British Nuclear Energy Conference was formally inaugurated at a meeting in London on November 30. The Institute of Physics and the Institutions of Civil, Mechanical, Electrical and Chemical Engineers are the founding constituent bodies, and each has three representatives on the governing board.

Details of the various activities of the nine branches and seven specialist subject groups of the Institute are briefly referred to in the report. There are eight local branches in Great Britain, and also an autonomous Australian Branch, under the presidency of Prof. L. G. H. Huxley, with divisions in the different States. During November 22–24 an exhibition of scientific instruments and apparatus was held by the Australian Branch and was well attended. The Liverpool and North Wales Branch held its inaugural meeting on May 19, 1955, in the Department of Electrical Engineering of the University of Liverpool, and the inaugural lecture was delivered by Prof. Z. Kopal, professor of astronomy in the University of Manchester, who took as his subject "The Physics of the Sun" (published in *Brit. J. App. Phys.*, **7**, 119; April 1956). The Scottish Branch, in addition to holding meetings in Glasgow, Edinburgh, Aberdeen and Dundee, arranged a course of five lectures on computers, and a conference on the training of physicists for industry was held by the Yorkshire Branch at the Rotherham Technical College on April 21. The two main subjects for discussion at the annual conference of the Education Group during April 14–15 were the teaching of thermodynamics and the place of physics in a liberal education; the Electronics Group held a symposium on recent developments in magnetic materials, and the X-ray Analysis Group has continued its work, under the direction of Prof. A. J. C. Wilson (University College, Cardiff), on the provision of data for the index of diffraction patterns which is published by the American Society for Testing Materials.

Both the circulation and the advertisement revenue of the Institute's two monthly periodicals, the *Journal of Scientific Instruments* and the *British Journal of Applied Physics*, increased satisfactorily during the year; unfortunately, costs of production continued to rise. The amount of material submitted and published in 1955 was similar to that in 1954; but as more papers were published than accepted, the average delay between submission and publication of acceptable manuscripts was reduced slightly. The fourth supplement to the *British Journal of Applied Physics*, containing the proceedings of the Electronics Group's symposium held in Cambridge, 1954, on luminescence with particular reference to inorganic phosphors, was published as part of the 1955 volume. The twelve monthly issues of the Institute's *Bulletin* (issued to members only) contained fourteen articles, some of them invited contributions and others based on lectures given to the Education Group. The *Bulletin* is appearing in a new and improved form this year. In the "Physics in Industry" series, two new volumes—"X-ray Diffraction by Polycrystalline Materials" containing contributions by thirty-one members of the X-ray Analysis Group, and "Physics of Fibres" by H. J. Woods—were published during the year, and three booklets in the "Student Monograph" series were issued.

At the general meeting of the Institute the following were elected to take office on October 1: *President*, Mr. O. W. Humphreys; *Vice-President*, Dr. B. P. Dudding; *Honorary Treasurer*, Dr. J. Taylor; *Honorary Secretary*, Prof. F. A. Vick; *New Ordinary Members of the Board*, Dr. L. R. G. Treloar and Mr. G. W. Warren. Sir George Thomson, master of Corpus Christi College, Cambridge, was elected to honorary fellowship in recognition of his outstanding contributions to physics and his services to physicists.

HIGH CLOUD OVER SOUTHERN ENGLAND

A SUBSIDIARY task of the Air Ministry Meteorological Research Flight is the making of observations of cirrus clouds, the white ice-crystal clouds, called popularly 'mare's tails' in one form, which are the highest clouds ordinarily visible. The rarely seen mother-of-pearl and noctilucent clouds are much higher. R. J. Murgatroyd, chief meteorological officer of the Flight, discusses these observations in Professional Note 119 of the Meteorological Office*.

Cirrus clouds are not easily studied in flying through them, because often they are so tenuous that the observer finds it hard to tell when he has reached a cirrus cloud clearly seen from far below. The tops, however, are more sharply defined than the bases. It was found that cirrus cloud is almost always entirely within the troposphere, though the tops are often only just below the tropopause. On a few occasions reported in the note, 'cloud' was seen in the stratosphere; but it is known that the observations in July and August 1953, which constitute the majority, were actually of volcanic dust produced by an eruption in Alaska on July 7. The heights of the tops were usually within 2,000 ft. of the tropopause, and the lower the tropopause the closer the cirrus tops were to it. Cirrus, which looks so thin from the ground, is usually between 3,000 and 5,000 ft. thick, and may be as much as 12,000 ft. thick.

An important feature when cirrus clouds were visible was a moist layer extending downwind from them at the same level, which became more pronounced (depression of frost point below dry bulb decreasing) as the clouds were approached. The humidity in the clouds seems to be surprisingly low. The depression of the frost point ranged from 12 to −2 deg. F., with a mean depression of about 3 deg. F. This average value corresponds to about 80 per cent relative humidity with respect to ice and, since the saturation vapour pressure is higher over water than ice, a markedly lower one (50 per cent) with respect to water, which is remarkable if it is correct that saturation with respect to water is necessary for the formation of cirrus cloud. The presence or absence of cirrus is a useful guide to the fighter pilot as to whether his aircraft is likely to produce a marked condensation trail, as it was found that, when cirrus was present, the probability of making a very persistent condensation trail was roughly about twelve times (60 per cent of flights) the probability (only 5 per cent of flights) when it was not.

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* Air Ministry: Meteorological Office. Professional Note No. 119: High Cloud over Southern England. By R. J. Murgatroyd and P. Goldsmith. Pp. 20. (M.O. 524 *S*.) (London: H.M.S.O., 1956.) 9*d*. net.

CRETACEOUS AMMONITES OF WEST AFRICA

CRETACEOUS ammonites have long been known from many parts of West Africa, and some of the faunas, notably those of Angola, have been the subject of substantial works. Apart, however, from descriptions of Turonian and Coniacian faunas from the Mungo River, comparatively little has been published about the Cretaceous ammonites of Nigeria. With the publication, however, of Dr. R. A. Reyment's "Cretaceous Ammonoidea of Southern Nigeria and the Southern Cameroons"*, we have for the first time a comprehensive monograph of the material from considerable areas of the country. Dr. Reyment figures about 135 species and sub-species, many of them new, ranging in age from Middle Albian to Maestrichtian. He supplies a great deal of new information of both palæontological and stratigraphical importance.

The Albian faunas consist mainly of keeled ammonites of the Mortoniceratidae, most of them species already described from Europe, Angola, Zululand or Madagascar. The puzzling genus *Neokentroceras*, characterized by exceptional tuberculation in the small specimens which alone had been figured, is now shown to have outer whorls like those of many typical members of Mortoniceratinae, in which subfamily it must now be placed. One most surprising discovery was that of a new species of *Gyaloceras*, an inflated genus of Aconeceratinae, which was previously reported only from Queensland. Like most of the other genera of this subfamily of Oppeliidae, it will probably turn out to have a wide range.

The Nigerian Cenomanian has yielded few ammonites, but the Lower Turonian has produced abundant ammonites of great interest. These include, in particular, a wide range of genera and species representing the burst of radiation from the Acanthoceratidae which characterized the early Turonian. Much light is thrown on the relationships of some genera that have been long but ill known. In addition, there are full descriptions of a number of new genera and sub-genera which fill in gaps in the story of this burst of radiation.

Most of the known forms of the families Tissotiidae and Vascoceratidae (two of the groups derived from Acanthoceratidae) characterize the deposits of the Tethys, the Cretaceous 'Mediterranean' and tropical sea, and it has been impossible to work out any accurate correlation with more northerly Turonian, characterized by other families of ammonites. Special interest therefore lies in Dr. Reyment's discovery, in association with *Hoplitoides* and *Neoptychites*, of a few specimens of *Watinoceras*, a genus which occurs in North America, England, Turkestan and perhaps Japan, and is a valuable stratigraphic indicator.

The later ammonites include an interesting group of Coniacian species, some already described by Solger, and some small and unremarkable Santonian and Maestrichtian faunas.

The author makes a sensible use of subgenera and subspecies. Thus, while he describes all the distinct forms, he avoids that inflation of taxonomic scale which is a common and dangerous tendency on the part, particularly, of those who have to deal with abundant collections of well-preserved fossils of rapidly evolving groups. No doubt among the reasons for this welcome restraint is the fact that the author is a member of the Geological Survey of Nigeria, in close touch with the field staff, and also has himself collected a large part of the material he describes.

The monograph is very well produced, admirably illustrated both with plates and line-drawings and written with a refreshing clarity and absence of 'ammonite jargon'. It will be of particular value to all who work on the African Cretaceous; but, as already indicated, its interest and importance extend far more widely.

C. W. WRIGHT

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* Reyment, R. A., "The Cretaceous Ammonoidea of Southern Nigeria and the Southern Cameroons", Geological Survey of Nigeria, Bulletin No. 25, pp. 112+25 pl., 46 figs. (Lagos). 20*s*.

PROTEIN METABOLISM, RESPIRATION AND GROWTH*

A SYNTHESIS OF RESULTS FROM THE USE OF ¹⁴C-LABELLED SUBSTRATES AND TISSUE CULTURES

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Impact of Growth on Fresh Weight, Protein Metabolism and Respiration of Carrot Tissue Explants

The characteristics of the rapidly dividing cell might reside either in substances that are peculiar to the tissue treated with coconut milk or, alternatively, they may reside more in the *intensity* of certain processes than in their *nature*.

Therefore, one may ask whether the amino-acid composition of the protein in the rapidly dividing cells is different from that of the more resting cells. The amino-acid composition of the entire protein complement in the tissue was determined from the analytical data and the changes that occur with time may also be seen. To reveal the relative molar composition of the protein, the value of 10 was arbitrarily assigned to alanine. The composition of the protein under the different treatments and at

(* *Continued from p. 734*)

Table 4. MOLAR AMINO-ACID COMPOSITION OF PROTEIN IN FAST- AND SLOW-GROWING CARROT TISSUE EXPLANTS

(Rel. composition based on alanine = 10)

Amino-acid	Slow-growing tissue (no coconut milk)	Fast-growing tissue (+ coconut milk)
Aspartic acid	10·3	10·2
Glutamic acid	11·1	11·2
Serine	8·3	7·2
Glycine	11·2	12·8
Threonine	8·3	7·4
Alanine	10	10
Valine	8·3	7·2
Leucines	12·2	11·2
Lysine	3·6	5·6
Arginine	1·8	3·1
Proline	15·6	12·7
Hydroxyproline	9·8	4·5

the different times of sampling was strikingly similar, so much so that these were all pooled, and mean values calculated for all the tissues treated with coconut milk, irrespective of the radioactive substrates, and for all the tissues not treated with coconut milk. These data are summarized in Table 4. Thus, although the treatment with coconut milk had a very great effect on the *quantity* of protein in the tissues, this seems to occur without great effect upon its *amino-acid composition*.

Some differences are to be seen in these analytical data. Cultured carrot tissue, like cultured potato tissue, differs from the resting tissue in the intact organ in that it contains hydroxyproline in unexpectedly large amounts in the protein[15]. The significance of this is not yet known. Also, the protein of the fast-growing tissue probably contained relatively more glycine, lysine and arginine, while the protein of the slow-growing tissue contained somewhat more serine, threonine, valine and leucine in addition to proline. However, recognizing the great difference in biological activity of these two systems, the differences in protein composition seems small, and work on purified proteins would be required to establish that the fast-growing cells had a protein of characteristic amino-acid composition.

The total protein of the dividing cells seems to be richer in the basic amino-acids than that of the non-growing cells and in this resembles the bulk protein of certain plant growing points[16]. However, according to Easty and Ambrose[17], the amino-acid composition of the protein of kidney cells and of neoplastic tissue derived from them differ but little, and these authors ascribe the difference in their proteins to other features than the overall amino-acid composition.

What then does the coconut milk stimulus do? By measuring the effect of the coconut milk on various properties of the tissue one may see where it exerts its effect. To do this the value of the property in question as for the fast-growing tissue is expressed as a ratio to the similar quantity for the slow-growing tissue. This has been done for the following properties: (1) the incorporation of fresh weight by water absorption as the tissue grows; (2) the overall synthesis of total protein; (3) the total respiration per explant as measured by carbon dioxide production; (4) the rate of incorporation of carbon-14 activity into a variety of amino-acids both free and combined.

Some of the results are shown in Table 5. These lead to the following comments:

(1) There is a remarkable similarity in the acquisition of fresh weight and of total protein by the tissue stimulated to growth by coconut milk. This means that the acquisition of water by the growing cells is not merely osmotic in nature but is closely linked to the metabolism with which protein synthesis is concerned. In these tissue cultures stimulated to rapid growth, the increment of fresh weight should not, therefore, be considered merely as passive osmotic water absorption but rather that the water is actually being built into the structure of the cells and is as integral a part of its growth as the increment of total protein. This aspect of water absorption is, indeed, not new. Many recent papers since that of Bennet-Clark *et al.*[18] have stressed the fact of non-osmotic and metabolically activated water absorption by cells, and one of us earlier stressed that water uptake, salt accumulation, protein synthesis and a particular part of the aerobic respiration all were determined by similar variables in potato tissue slices which retained the ability to grow (ref. 13, cf. p. 415).

(2) The stimulus to the growing cells accentuated their total respiration much more than it accentuated their growth as measured by fresh weight or total protein. This disparity is shown by the ratios 3·7 and 5·1. Thus, the protein of the growing cell does not merely support respiration in accordance with its total mass; but, under the coconut milk stimulus, a given weight of protein is *much more effective in maintaining respiration*.

(3) In the incorporation of radioactive carbon into specific amino-acids of the protein there are evident effects of two kinds. These are illustrated, on one hand, by the amino-acids glutamic acid, aspartic acid and threonine and, on the other, by proline and hydroxyproline. In all these cases substantial amounts of radioactivity were incorporated in the amino-acids of the protein from the substrates supplied. In one type of situation, illustrated by proline and hydroxyproline, the increased incorporation of radioactivity into these amino-acids caused by coconut milk is approximately measured by the increased *total* synthesis of protein which occurred. (Whereas fresh weight and total protein were stimulated 3·7 times by the coconut milk treatment, the incorporation of proline and hydroxyproline was also stimulated about three times. The incorporation of carbon-14 in the proline and hydroxyproline of the protein was also stimulated about three times.) The other amino-acids, however, behaved quite differently because the incorporation of radioactivity from their substrates into these amino-acids in the protein was stimulated by the coconut milk treatment *far in excess* of the stimulus to total protein synthesized. However, the effect of coconut milk in stimulating incorporation of carbon-14 into the amino-acids glutamic, aspartic and threonine of the protein is the

Table 5. IMPACT OF GROWTH ON FRESH WEIGHT, RESPIRATION AND PROTEIN METABOLISM

Relative increase due to growth = ratio of (*a*) fresh weight, (*b*) total protein, (*c*) respiration, (*d*) ^{14}C-activity in protein amino-acids of the fast- to the slow-growing tissue

(All data refer to Period 5 (85–109 hr.))

				^{14}C-activity in protein amino-acids				
Property	Fresh weight	Total protein	Total respiration	Glutamic acid	Aspartic acid	Threonine	Proline	Hydroxyproline
Ratio $\frac{\text{fast growing}}{\text{slow growing}}$	3·7	3·7	5·1	5·6	4·6	5·2	3·9	2·0
					5·2		3·0	

same as the degree of stimulus conveyed by the coconut milk to the total respiration.

This close relation between respiration and the latter amino-acids is derived from their origin from carbon skeletons, formed by glycolysis or the tri-carboxylic acid cycle, and the incorporation of their carbon into protein—this incorporation proceeding more readily from glucose than from free amino-acids. The connexion between respiration and the endergonic processes of assimilation and synthesis is now well established from work with higher plants and micro-organisms. Ways in which respiration may be regulated, through its coupling with phosphorylation and oxidation-reduction, have been considered with particular regard to the synthesis of protein[19,20]. For the system now under consideration, another connexion between respiration and protein metabolism may be visualized, as shown in Fig. 1.

Part of the respiration varies with the rate of protein turnover. Part of the carbon dioxide of respiration originates from protein which is broken down, and thus the pace of alternating protein synthesis and breakdown will determine the extent of carbon dioxide that emerges by this route (phase 2 of Fig. 1). It is this component of the respiration which may be greatly stimulated in the fast-growing tissue, so that the apparent efficiency of the protein contained in the tissue to produce carbon dioxide, as shown by the ratios in Table 5, is much greater than the slow-growing tissue.

Thus, one may visualize the total bulk of protein as consisting essentially of two moieties. One element of the protein remains relatively steady; the other actively undergoes alternating synthesis and breakdown, and, in this latter sequence, it is linked with part of the respiration as measured by carbon dioxide production. This means that a part of the carbon which emerges as carbon dioxide may do so after it has been built into the protein molecule. Moreover, from the other data referred to, it is apparent that *the incorporation of carbon in the protein molecule proceeds much more readily from glucose than from the free amino-acids of the tissue.*

On the other hand, some free amino-acids do incorporate their carbon directly into at least certain of the proteins (for example, proline and hydroxyproline); but it appears that the particular protein moieties which are synthesized in this way represent proteins which are not in a metabolically active state of synthesis and breakdown but which, once formed, seem to constitute metabolically a 'point of no return'. Whereas the specific activity data clearly show that the proline of the protein could be embodied directly from the free proline in the cell, it is quite apparent that this could not occur with aspartic acid, glutamic acid, etc., for the specific activities of these substances in the protein bear no relationship to the specific activities of the substances as they occur free in the cell.

Respiration, Protein Synthesis and Breakdown: Some Parallel Situations

Older views of Warburg, recently revised[21,22], would have it that the rapidly dividing, or cancerous, cell has its fermentation stimulated to the point where it can obtain enough usable energy in the form of adenosine triphosphate to suffice for growth by cell division, whereas the normal cell can only achieve these ends through oxidative respiratory mechanisms. If this is so, though it is not accepted without question[23], it would not appear in the present work.

The present investigations lead to a different concept of the randomly proliferating plant cell. In the growing cells there are apparently several routes by which carbon dioxide can emerge. The familiar glycolytic–Krebs cycle pathway and its alternative, the gluconic acid shunt, may all apply to some extent. In the rapidly growing cells, however, it is necessary to recognize the interaction of protein metabolism and respiration because the carbon which enters into metabolically active protein now appears to emerge through protein breakdown, the release of amino-acids, the formation of amides, the deamidation and deamination of these substances to produce carbon skeletons which may be oxidized away to form carbon dioxide. Such carbon skeletons may enter the Krebs cycle as alternatives to the products of glycolysis[13]. Overall, this can result in the incorporation of carbon from sugar into protein and its eventual emergence as carbon dioxide; but the pace of this process may be conditioned by the pace of alternating synthesis and breakdown of the metabolically active moiety of the protein.

The peculiarity of the stimulus to rapid cell division, caused by the coconut milk growth factors, is that it not only enriches the protein content of the cells as a whole but it may also increase, in a disproportionate way, the importance of the protein turnover and of the associated respiration.

In this connexion it is of interest that Vrba[24] has re-emphasized the role of protein breakdown and re-synthesis in brain during muscular exercise. Not only is there seen to be an accentuated turnover of protein in a "cyclical process of degradation and resynthesis of the protein fraction of brain nervous tissue" but "during this process free glutamine is formed from the free glutamic acid, which is simultaneously an initial link for the phase of resynthesis". The parallel is clear.

By contrast the less-active moiety of the tissue protein, which once formed does not break down again, is only affected by the growth stimulus in the proportion that the total protein is increased and to the same extent that cell number and fresh weight are also increased.

Thus the rapidly dividing, proliferating, tumorous-like cells of these rapidly growing tissue cultures stimulated by coconut milk stand in sharp contrast to many viruses. These, and particularly tobacco mosaic virus, divert the protein metabolism of the host cell into the synthesis of virus protein which, once formed, is not reincorporated into metabolism. It constitutes, therefore, a "point of no return" (see ref. 15, p. 553, for references there cited). The coconut milk, however, stimulates that moiety of the protein which is metabolically active and which, through alternating synthesis and breakdown, can contribute to the total respiration and energy exchanges for the physiological use of the growing cell.

The stable, metabolically inactive protein moiety which does not 'turn over' may have more than merely structural properties. This fraction could possess and exert enzyme activity, and indeed there are many other indications that enzyme activity is unequally divided between different kinds of protein fraction to be found in cells.

Final Conclusions

The value of plant tissue cultures used under conditions which contrast in the rapidly growing and the slow growing states will now be evident. By recognizing and making use of the complications of growth and metabolism, conclusions can be derived that are unattainable if biochemical study is only upon systems which attempt to eliminate these complexities.

Much modern biochemistry is pre-occupied with cellular particles and particulate preparations. However, the study of metabolism in relation to growth, as here described, requires work on the whole cell to reveal the integrated operation of the whole system. Smuts's principle of "Holism"[25] applies here, for "The whole is not something additional to the parts: it is the parts in a definite structural arrangement and with mutual activities that constitute the whole" (loc. cit., p. 104).

In the use of radioactive substrates to reveal metabolic sequences it is therefore necessary to recognize the existence of separate phases or compartments in the cell and to recognize that in each of these, quite different reactions may involve simultaneously the same substrate; but it is also encouraging that these complications can be surmounted. The means to do this is to determine, for all available tissue constituents, not merely the existence of radioactivity in a given compound, not merely the specific activity of the tissue metabolite at a given time, but, by the investigation of time sequences, to make an estimate of the average specific activity of the carbon which must have been involved in the metabolic change that occurred. From the relations which these calculated results bear to the known specific activity of the source supplied, it is possible to appreciate the kind of complications that occur within the cell. Since this enables the investigator to recognize clearly that reactions occur in different compartments of the cell and to recognize that the total complement of a given constituent is made up of at least two different metabolic pools which do not mingle, this adds a valuable technique to the carbon-14 tracer method.

Even a relatively simple experiment, when planned to deal with all these complications, becomes a formidable task. To solve these problems, teamwork becomes essential, and this was happily achieved in the present case by pooling resources of personnel, equipment, technique and even substances synthesized from three different laboratories in three different countries.

It is too soon and perhaps too optimistic to suggest that the results here described could be applied directly to the investigations of cancerous growth in animal organs. The possibility, however, remains that the characteristic properties of the cancerous cell, like those of carrot cells stimulated by coconut milk, may lie not so much in distinctive substances and reactions as in accentuated rate of 'turnover' of their metabolically active, labile constituents owing to enhanced synthesis and breakdown. Investigations of nitrogen metabolism[26] in relation to cancer seem not to have considered this possibility. In plants this cyclical process may in part control the release of usable energy via a phase of respiration which is peculiarly linked with the ability of the cell to grow by cell division and to utilize metabolic energy for assimilation in such processes as water intake and salt accumulation. If these results have wider application, this pioneer experiment will indeed have been justified, and this general account will have achieved its purpose.

The full details of the work will be published elsewhere in due course.

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A SPECIFIC CHEMICAL DIFFERENCE BETWEEN THE GLOBINS OF NORMAL HUMAN AND SICKLE-CELL ANÆMIA HÆMOGLOBIN

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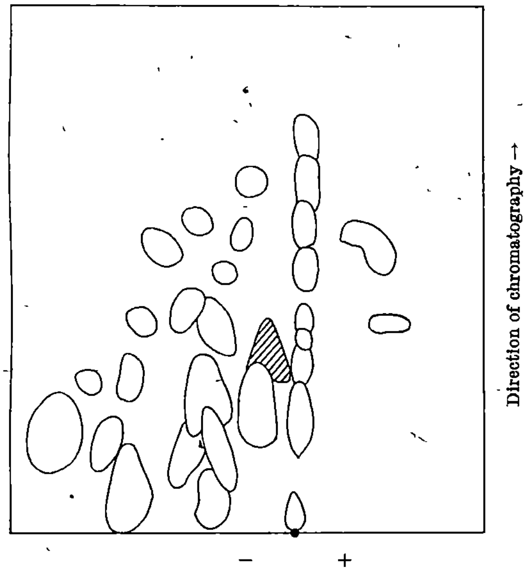
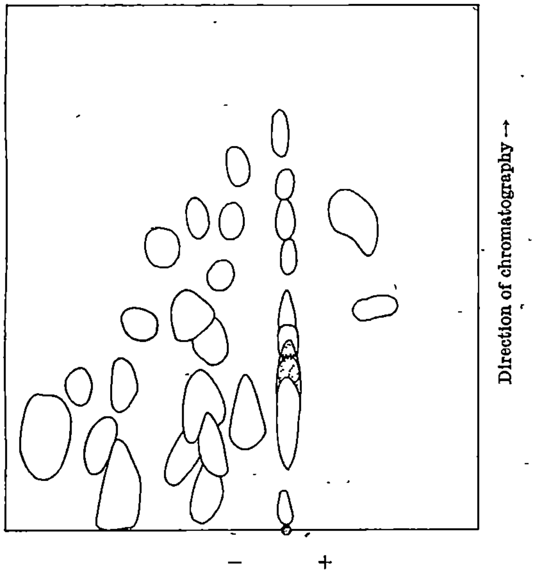
A NEW and rapid technique of characterizing the chemical properties of a protein in considerable detail has been devised; by its application a specific difference is found in the sequence of amino-acid residues of normal and sickle-cell hæmoglobin. This difference appears to be confined to one small section of one of the polypeptide chains.

Of all the abnormal human hæmoglobins, the one that has been most intensively studied is hæmoglobin *S* from patients with sickle-cell anæmia. In 1949 Pauling and his collaborators[1] demonstrated by electrophoretic experiments that at neutral *p*H the hæmoglobin *S* molecule has a net charge which is more positive by three units compared with the normal molecule, hæmoglobin *A*. It has since been suggested[2] that this difference is really due to hæmoglobin *S* having fewer free carboxyl groups than does hæmoglobin *A*. It is also known that in the reduced state the abnormal protein has a much lower solubility[3]. However, careful determinations of the amino-acid composition of the two proteins[4,5] did not show any significant differences between them within the accuracy of the methods employed. Comparison of the N-terminal[6] and C-terminal[7] amino-acids and of the sulphydryl groups[8] was equally disappointing. On this evidence alone, it is not possible to decide whether the difference between the proteins, which is in any event small, lies in the amino-acid



Sickle cell hæmoglobin



Normal hæmoglobin

Fig. 1. 'Finger prints' of human normal and sickle-cell hæmoglobins. Electrophoresis at pH 6·4, chromatography with n-butyl alcohol/acetic acid/water (3 : 1 : 1). The shaded and the stippled spots are those belonging to the peptide showing the difference

sequences of the polypeptide chains or whether it lies in the folding of these chains leading to a masking of some amino-acid side-chains.

Hæmoglobin is still too large a molecule for detailed analysis of amino-acid sequence. However, it was thought that if a rapid method could be found of characterizing the chemical properties of the peptides in a tryptic digest, then perhaps a replacement of even a single residue for another might be detected without elaborate analysis.

The action of trypsin on proteins is at present the most reliable way of splitting a peptide chain at specific peptide bonds. The enzyme attacks only those bonds which are derived from the carboxyl group of the amino-acids lysine and arginine. There are about sixty of these in the hæmoglobin A and S molecules[5], but since it is expected[9] that each molecule is composed of two identical half-molecules, the number of peptides obtained by the action of trypsin should be about thirty, with an average chain-length of ten amino-acids. Small differences in the two proteins will result in small changes in one or more of these peptides. These should be detectable when the mixture is examined by a two-dimensional combination of paper electrophoresis and paper chromatography. It was decided to call the resulting chromatogram the 'finger print' of the protein.

To prepare such a 'finger print', samples of purified[10] hæmoglobins A and S were denatured by heat at 90° C. for 4 min. and digested with trypsin (2 per cent by weight) at pH 8 and 37° C. for 43 hr. Aliquots of these digests (equivalent to 3 mgm. of protein) were placed on large sheets of Whatman No. 3 MM paper between glass plates and subjected to electrophoresis[11] in pyridine/acetic acid at pH 6·4 for 150 min. at 16 V./cm. The paper was then dried. Ascending chromatography with n-butyl alcohol/acetic acid/water (3 : 1 : 1) and development of the peptide spots with ninhydrin produced the chromatograms shown in the tracings of Fig. 1. When the papers were run strictly in parallel, reproducibility was often good enough to superimpose the spots belonging to similar peptides in the two chromatograms.

The 'finger prints' show approximately thirty peptide spots, as was expected from the amino-acid composition. This confirms the view that the human hæmoglobin molecule consists of two identical half-molecules and not of four identical sub-units each carrying one of the four hæme groups. The same number of peptides was found for both hæmoglobins, as was to be expected from their containing the same number of lysine and arginine residues. Most of the peptides are well resolved, and appear to be similar in the two proteins. However, there is one peptide spot clearly visible in the digest of hæmoglobin S which is not obvious in the hæmoglobin A 'finger print'. In the tracing it has been marked by shading. Apart from its position, this peptide is characterized by its orange-colour reaction with

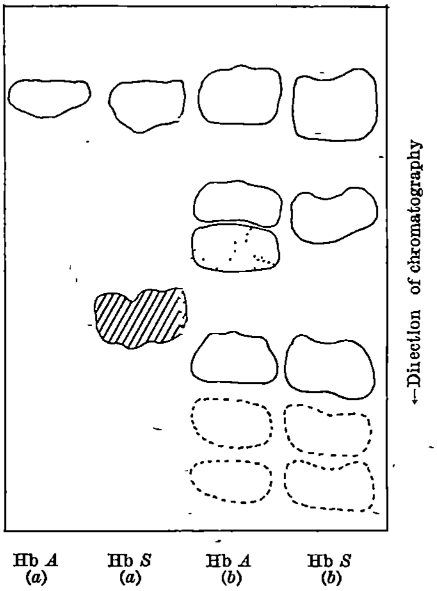


Fig. 2. Chromatogram of fractions of hæmoglobin A and S digests obtained by large-scale paper electrophoresis. (a) Slowest moving positively charged fractions; (b) neutral fractions

ninhydrin. Close inspection of the 'finger print' of hæmoglobin *A* shows the outline of an orange peptide spot in the 'back-bone' of neutral peptides which are not separated by electrophoresis. This spot, which has been stippled in the tracing, is not present in the neutral fraction of the digested hæmoglobin *S*. However, the neutral peptides are not really well separated by this two-dimensional technique.

Accordingly, larger amounts of the digests from both hæmoglobins were run in one direction only, using the electrophoretic conditions described earlier. Many bands were obtained. Both the band of neutral peptides and the slowest of the positively charged bands were eluted in each case, but separately. The eluted peptide mixtures were subjected to descending chromatography with *n*-butyl alcohol/acetic acid/water (4 : 1 : 5). Fig. 2 is a tracing of the chromatogram obtained showing the behaviour of the 'extra' or 'sickle cell' peptide in the two digests. This confirms that there is a particular peptide in the neutral fraction of the hæmoglobin *A* digest, which in the hæmoglobin *S* digest is shifted to the slowest positively charged zone. In addition, the R_F value of the hæmoglobin *A* peptide in the chromatographic solvent is lower than that of the analogous peptide derived from hæmoglobin *S*.

Summarizing the results of the electrophoretic and chromatographic examination, it can be seen that there is one peptide among the thirty or so which in hæmoglobin *S* is positively charged, but which is uncharged at the same pH in digests of hæmoglobin *A*. This agrees with the higher net positive charge[1] of the parent protein, hæmoglobin *S*. There is also a small change in the chromatographic behaviour of the peptide. On the other hand, corresponding pairs of all the other peptides show similar behaviour in these separating systems and therefore probably have similar constitutions.

One can now answer at least partly the question put earlier, and say that there is a difference in the amino-acid sequence in one small part of one of the polypeptide chains. This is particularly interesting in view of the genetic evidence[12] that the formation of hæmoglobin *S* is due to a mutation in a single gene. It remains to be seen exactly how large a portion of the chains is affected and how the sequences differ.

Full details of these experiments will be reported elsewhere. I am indebted to Dr. A. C. Allison (Oxford) and Dr. G. Seaman (Cambridge) for supplying samples of hæmoglobin *S* and blood from patients with homozygous sickle-cell anæmia ; and I acknowledge the encouragement and interest shown by Dr. M. F. Perutz, and the expert assistance of Mrs. Leslie Barnett and Miss Rita Prior.

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IDENTIFICATION OF A NEW NORMAL EMBRYONIC HÆMOGLOBIN

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DURING a current study of the process of formation and appearance of the two hitherto known types of normal hæmoglobin, and of the different serum protein fractions of the fœtal blood throughout the various stages of embryonic life, we were able to examine the blood of a ten-week old embryo, recovered from an intact extra-uterine pregnancy. To the best of our knowledge this is the smallest human embryo of which blood chemistry data have been reported in the literature.

Using the method described by Singer[1] we found that the hæmoglobin of the ten-week old embryo consisted of 83 per cent of the alkali-resistant type.

The electrophoretic examination of this hæmoglobin was carried out in a Thomas paper electrophoresis apparatus on Whatman No. 1 filter paper using a veronal buffer solution of 0·04 ionic strength at 8·6 pH. In a 20-hr. run at 150 volts and 1·5 m.amp. per in. of filter paper a 3 per cent hæmolysate of this embryonic hæmoglobin, prepared by Drabkin's[2] method, showed a definitely slower mobility compared with the electrophoretic mobility of adult hæmoglobin used as control as shown in Fig. 1.

Later on we discovered an embryonic hæmoglobin with an identically slow electrophoretic mobility in the blood of a 20-week old fœtus weighing 450 gm. The concentration of the alkali-resistant type of hæmoglobin in this blood was 52 per cent. The electrophoretic mobility of the embryonic hæmoglobin was compared both with that of hæmoglobin recovered from cordal blood of a full-term newly born with approximately the same concentration of alkali-resistant fraction and with adult hæmoglobin. The hæmoglobin of the 20-week old fœtus showed a distinctly slower mobility as compared with both the newly born's cordal blood and the adult hæmoglobin. A mixture of the embryonic and the newly born's cordal blood hæmoglobins showed an electrophoretic mobility between both, as shown in Figs. 2 and 3.

The fact that, on one hand, the hæmoglobin of the embryonic and of the newly born's cordal blood, containing the same percentage of the alkali-resistant type of hæmoglobin, moved with different mobilities, and on the other hand, the hæmoglobins of the two embryos (Fig. 3, *a* and *c*), although differing substantially in their concentration of the alkali-resistant fraction, had the same mobility, is of special significance. It indicates that the difference in the electrophoretic mobility of these two embryonic hæmoglobins on one hand, and the cordal blood hæmoglobin of the newly born on the other hand, is not due to different concentrations of the alkali-resistant hæmoglobin fraction. It is due to the presence of a different hæmoglobin in the red blood corpuscles of early embryonic life.

This third hæmoglobin may be identical with a new embryonic hæmoglobin for which Allison[3] has recently proposed the name of "primitive type P" of normal hæmoglobin. According to this author, the synthesis of this hæmoglobin seems to be under a different genetic control from that of the hæmoglobins of later fœtal life. This appears to have been definitely established for the early embryonic hæmoglobin of the mouse.

Further investigations are being undertaken in our laboratory to elucidate the characteristics of this new type of normal hæmoglobin. We are especially attempting to determine the process of its disappearance from the fœtal blood and the eventual pathogenic role of abnormal persistence of this hæmoglobin beyond embryonic life.

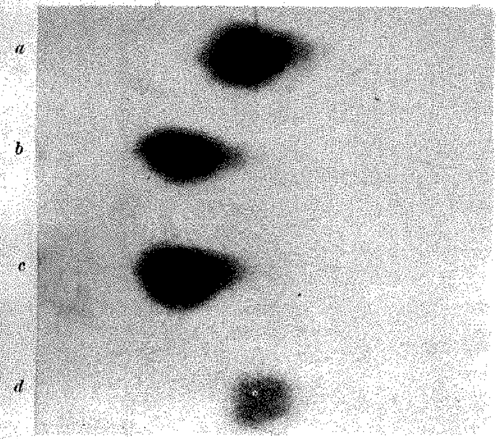

Fig. 1. Comparison of the electrophoretic mobilities of the new embryonic and adult hæmoglobins
a and *d*, normal adult hæmoglobins; *b* and *c*, embryonic hæmoglobin from a ten week old embryo (duplicate run)

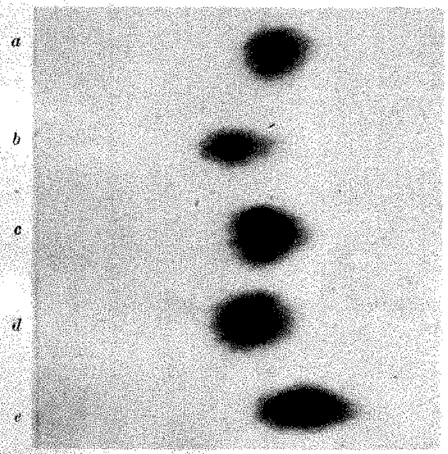

Fig. 2. Comparison of the electrophoretic mobilities of the new embryonic, new-born cordal blood and adult hæmoglobins
a and *e*, normal adult hæmoglobins; *b*, embryonic hæmoglobin from a 20-weeks old fœtus; *c*, hæmoglobin from the cordal blood of a full-term newly born; *d*, mixture of the embryonic and the newly born's cordal blood hæmoglobins

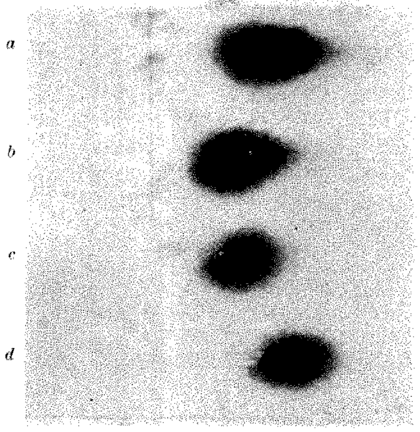

Fig. 3. Comparison of the electrophoretic mobilities of the new embryonic hæmoglobin with those of hæmoglobins from thalassæmic and normal adult blood
a, hæmoglobin from the blood of a nine-months old child with thalassæmia and 32 per cent of alkali-resistant hæmoglobin fraction; *b* and *c*, embryonic hæmoglobins from the ten- and twenty-week-old embryos, respectively; *d*, normal adult hæmoglobin

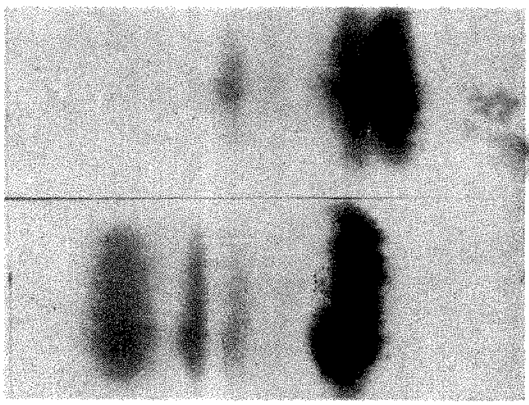

Fig. 4. Electrophoretic pattern of the serum protein of a ten-week-old embryo as compared with that of a normal adult serum (below)

An unusual electrophoretic pattern was found in the serum of the 10-week old embryo, with a total protein content of 2·8 gm. per cent (Fig. 4). In this serum five protein fractions were found, a small one corresponding to α_1 globulin and two others to α_2 and β globulin fractions of a normal adult blood serum, used as control in the same run. Of the two remaining protein fractions with electrophoretic mobilities close to that of the albumin fraction of the adult serum, one of them was not superposable on any fraction of the normal adult or of any new-born cordal blood serum. This fraction may be specific for the blood serum of early embryonic life.

No γ globulin fraction could be found in the serum of the ten-week-old embryo, indicating perhaps that the gamma globulin is formed during the embryonic life much later than the other serum protein fractions.

This study was in part supported by a grant from Dr. William Levine, Brooklyn, New York.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Effect of the Local Chromosomal Environment upon the Genotype

Critical data bearing on the question of gene-conversion were obtained by analysis of a yeast hybrid heterozygous for nine different genes. Thirty-four tetrads from a single family heterozygous for the genes controlling cadmium-sensitivity vs. resistance (*CD*/*cd*)[1] and fermentation of methyl-α-D-glucopyranoside (*MG*/*mg*) were obtained from a single hybrid in which most of the nine loci segregated regularly. In addition to *CD* and *cd* a third phenotype (cd^M) was characterized by capacity eventually to achieve cadmium-resistance, presumably by mutation—a potential lacking in the *cd* genotype. The three types are indicated by a three-membered ratio *CD* : cd^M : *cd* (Table 1).

Tetrad analysis makes it possible to establish a presumptive difference between recombinations produced by gene-conversion and recombinations produced by crossing-over.

Table 1

(*a*)	*CD MG*	*CD MG*	*cd mg*	*cd mg*	24	
(*b*)	*CD MG*	*CD mg*	*cd MG*	*cd mg*	2	(18,177 and 18,181)
(*c*)	*CD MG*	*CD mg*	*cd mg*	*cd mg*	1	(18,285)
(*d*)	$cd^M MG$	$cd^M MG$	*cd mg*	*cd mg*	1	(18,257)
(*e*)	*CD MG*	$cd^M MG$	*cd mg*	*cd mg*	1	(18,289)
(*f*)	*CD MG*	$cd^M MG$	$cd^M mg$	*cd mg*	1	(18,341)
(*g*)	*CD MG*	*cd MG*	$cd^M mg$	*CD mg*	1	(18,253)
(*h*)	*CD MG*	*cd MG*	$cd^M mg$	$cd^M mg$	1	(18,281)
(*i*)	$cd^M MG$	*CD mg*	$cd^M mg$	*cd mg*	1	(18,297)
(*j*)	$cd^M MG$	$cd^M mg$	*cd mg*	*cd mg*	1	(18,193)

No recombinants between *CD* and *MG* were found in the first twenty-four tetrads. Tetrads (*b*) contained recombinants (underlined) produced by crossing-over. Tetrad (*c*) contained one recombinant (*CD mg*) resulting from gene-conversion (*MG mg mg mg*).

In tetrads (*d*) and (*e*) both *mg* segregants are *cd*, suggesting that the cd^M genes arose by conversion of *CD* to cd^M. In (*f*) one *CD* gene converted to cd^M and one *cd* gene to cd^M. In (*g*) and (*h*) recombinant segregants occur. In (*g*) it appears that a *cd* gene had converted to cd^M and (if this is correct) that a cross-over between *CD* and *MG* had occurred simultaneously. In (*h*) a similar event may have occurred with one *CD* converted to cd^M.

Conversion of *MG* to *mg* occurred in (*i*) and (*j*); in (*i*) conversion of *CD* to cd^M and *cd* to cd^M may have occurred, while in (*j*) conversion of both *CD* genes to cd^M is indicated.

Table 2 shows the genotypes of two parents and the types of segregation in thirty-four hybrid tetrads. In twenty-two tetrads every gene-pair segregated regularly; in five tetrads individual gene pairs segregated irregularly. The remaining seven tetrads showed respectively 2, 2, 2, 3, 3, 3, and 5 irregularities each. The only tetrad irregular for *MA*/*ma* was also irregular for *MG*/*mg*; previous data gave no evidence of dependence[2].

The genes controlling the synthesis of anthranilic acid and histidine are linked[3], and both underwent conversion together in two tetrads, while each was converted once in two other tetrads.

The genes *AN* and *PR* are on different chromosomes, but their conversion is apparently interdependent. The chromosomes carrying these genes segregate in a non-random manner, presumably by synapsis of non-homologous centromeres[4].

In the last tetrad the five gene-pairs undergo conversion concurrently. The *AN* and *PR* genes were converted to the dominant state whereas *MG*, *CD* and *HI* were converted to the recessive state.

Both parents required adenine for growth and neither parent was pink, indicating a further lack of some undefined synthetic capacity. The ability to synthesize methionine is essential for the production of pink pigment in adenine-dependent cultures[5]. Eight asci produced one pink culture; three produced two pinks, while twenty-three produced none. All cultures were tested for their ability to grow in medium lacking adenine. None of the pink cultures could grow in its absence, but thirteen tetrads contained single clones which grew in the absence of adenine after a longer delay than usual for a clone carrying the standard dominant gene. One tetrad contained two such 'slow' clones. Local deficiencies (or excesses) of the materials required for the synthesis of nucleic acids might be expected in cells unable to synthesize adenine. When adequate (or excessive) material is present in a specific position,

Table 2. Types of Segregations of 9 Gene-pairs in 34 Tetrads of One Family

The 2-membered ratios are dominant : recessive; the 3-membered ratios are dominant : intermediate : recessive. The numbers in parenthesis indicate the tetrad serial number. Non-Mendelian ratios are underlined.

12994	*a*	*SU*	*me*	*MA*	*mg*	*cd*	*hi*	*an*	*PR*
17915	*a*	*su*	*ME*	*ma*	*MG*	*CD*	*HI*	*AN*	*pr*

	Gene pairs								
Number of tetrads	*a*/*a*	*SU*/*su*	*ME*/*me*	*MA*/*ma*	*MG*/*mg*	*CD*/*cd*	*HI*/*hi*	*AN*/*an*	*PR*/*pr*
22	2 : 2	2 : 2	2 : 2	2 : 2	2 : 2	2 : 2	2 : 2	2 : 2	2 : 2
1 (18,261)	2 : 2	2 : 2	3 : 1	2 : 2	2 : 2	2 : 2	2 : 2	2 : 2	2 : 2
1 (18,341)	2 : 2	2 : 2	2 : 2	2 : 2	2 : 2	1 : 2 : 1	2 : 2	2 : 2	2 : 2
1 (18,257)	2 : 2	2 : 2	2 : 2	2 : 2	2 : 2	0 : 2 : 2	2 : 2	2 : 2	2 : 2
1 (18,229)	2 : 2	2 : 2	2 : 2	2 : 2	2 : 2	2 : 2	1 : 3	2 : 2	2 : 2
1 (18,325)	2 : 2	2 : 2	2 : 2	2 : 2	2 : 2	2 : 2	2 : 2	2 : 2	1 : 3
1 (18,289)	2 : 2	2 : 2 : 0	2 : 2	2 : 2	2 : 2	1 : 1 : 2	2 : 2	2 : 2	2 : 2
1 (18,281)	2 : 2	0 : 2 : 2	2 : 2	2 : 2	2 : 2	1 : 2 : 1	2 : 2	2 : 2	3 : 1
1 (18,297)	2 : 2	2 : 2	2 : 2	2 : 2	1 : 3	1 : 2 : 1	2 : 2	2 : 2	2 : 2
1 (18,285)	2 : 2	2 : 2	2 : 2	1 : 3	1 : 3	2 : 2	2 : 2	2 : 2	2 : 2
1 (18,253)	2 : 2	2 : 2	2 : 2	2 : 2	2 : 2	2 : 1 : 1	3 : 1	3 : 1	2 : 2
1 (18,189)	2 : 2	2 : 1 : 1	2 : 2	2 : 2	2 : 2	2 : 2	2 : 2	3 : 1	3 : 1
1 (18,193)	2 : 2	2 : 2	2 : 2	2 : 2	1 : 3	0 : 2 : 2	1 : 3	3 : 1	3 : 1

Symbols *a*/*a*, mating-type; *SU*/*su*, sucrose fermentation; *ME*/*me*, melibiose fermentation; *MA*/*ma*, maltose fermentation; *MG*/*mg*, methyl α-D-glucopyranoside fermentation; *CD*/*cd*, cadmium resistance; *HI*/*hi*, histidine synthesis; *AN*/*an*, anthranilic acid synthesis; *PR*/*pr*, proline synthesis.

both dominant genes might be reconstituted and some of the excess used for converting at least one of the defective recessive alleles into a functional dominant, producing a 3 : 1 ratio. When a region suffers a deficiency of constructional materials, it might not always be possible to build a second dominant allele to match the one already present, and a 1 : 3 ratio occurs. Since linked genes (or genes juxtaposed by non-homologous synapsis) behave similarly, it may be inferred that the deficiencies (or excesses) are non-specific. The fact that both excesses and deficiencies of dominants (3 : 1 and 1 : 3) occur in the same cell suggests that nutritional irregularities may be highly localized and that problems of transport are involved.

Emerson's[6] attack on the demonstrability of gene conversion in *Saccharomyces* considers only phenotypic ratios, whereas in the demonstration of gene conversion involving 1 : 3 phenotypic ratios of one gene linked to four others[7], the regular behaviour of the other four genes remains to be explained. His proposal yields contradictory interpretations when applied to a 'conversion' pedigree involving twenty-five families and twelve generations[8]. He does not mention the crucial papers[9] on conversion of the multiple alleles of *MZ* and he cannot explain the present results.

Our work has been supported by grants from the National Cancer Institute of the National Institutes of Health, Public Health Service, *C*-2140, and from the Illinois Division of the American Cancer Society.

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Sex Chromatin as an Aid to the Identification of Sex in Forensic Medicine

THE existence of a sex difference in the morphology of intermitotic nuclei may be of importance, not only anatomically and clinically, but also for its value as an additional method of sex determination in forensic medicine. We have already shown[1,2] that the presence of sex chromatin in the female nucleus can be utilized to determine the sex of unfixed human tissues which have been immersed in water or exposed to atmospheres of varying humidity and temperature. This nuclear feature persists for a period of 2–3 weeks, depending on the nature of the environment in which the tissues decompose.

Further investigations in this Department on the persistence of sex chromatin after death have since been made and emphasize the importance of our previous findings. Portions of full-term human female fœtal tissue were buried in direct contact with the soil, some two feet from the surface. At regular intervals small fragments of skin, muscle and cartilage were removed, prepared by routine histological techniques and the nuclei examined for the presence of sex chromatin. The sex of the tissue could be determined in this way with certainty for four weeks after burial, which was considerably longer than had been the case with tissues degenerating in other environments.

Previously, we compared the persistence of sex chromatin in cartilage cells of fixed and unfixed material and noted that while this mass of chromatin is particularly well seen in fixed cartilage cells from female subjects, in unfixed cartilage its period of survival is no greater than in other tissues. This fact has been confirmed in cartilage cells of young fœtal material by Gleaister[3]. We have also found that articular cartilage removed from joints with hitherto intact capsular tissues possesses no advantage in post-mortem sex determination. The cells of the dental pulp in extracted teeth were examined in anticipation that, being virtually sealed from their surroundings, nuclear detail might be preserved for an extended period. However, sex chromatin persists for only 24 hr. in isolated teeth and for a maximum of one week in teeth immersed in physiological saline, the latter being considered to simulate the environment of teeth *in situ* after death. We conclude, therefore, that sex chromatin persists for a similar length of time in the majority of tissues.

A method has been described for the determination of sex from blood films[4]. We have attempted to determine sex in this way from an examination of blood on scalpel blades used in the dissection of fresh post-mortem tissues, but find it of no value, due to hæmolysis with complete destruction of white blood cells. However it is often possible to determine sex from accompanying epithelial cells transferred from the skin, even on blades afterwards kept in room air for a number of weeks. A preliminary investigation into the possibility of sexing human hairs in a similar way, from epithelial cells adhering to the roots of hairs removed from the scalp, indicates that, as with material adhering to instruments, diagnosis can be made.

Reference to the most recent text-books of forensic medicine reveals that the original work on sex chromatin by Murray Barr and his colleagues only receives mention by Polson[5], and no suggestion has yet been made as to the possible medico-legal significance of this aspect of cell morphology. The results of our investigations, which will be published more fully, show that the sex of small fragments of mutilated tissue, of material adhering to instruments and of human hair can be determined, in certain circumstances, from the appearance of nuclear chromatin.

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The Fine Structure of Bone

X-RAY crystallographic studies by Engström and his collaborators[1,2] have shown that the apatite crystallites of bone have linear dimensions of about 220 A. × 65 A. The crystals were aligned with their long axis parallel to the collagen fibre axis, and it was suggested that there may be three such inorganic crystals for each 640 A. period of the collagen fibril. In a recent communication, Fernández-Morán and Engström[3] observed a "predominance of rod- or needle-shaped apatite particles 30–40 A. wide and about 200 A. long" in thin sections of bone by means of electron microscopy. This result is in reasonable agreement with those obtained by X-ray diffraction; but no evidence is offered that the regions of higher density present in the micrographs (which appear to have reproduced badly) were in fact due to apatite. Nor is it clear whether electron microscopy has provided any further evidence as to the manner of alignment of the particles, for Robinson and Watson[4] have identified apatite in thin sections of bone by means of electron diffraction, and have indicated that the particles were deposited on the 'doublet' band region of the period of the fibril.

Electron microscopy and X-ray diffraction, however, have not given unequivocal results regarding the site of the apatite particles; but work in this Laboratory has clarified the position to some extent[5]. In this work transverse and longitudinal sections of undecalcified embryonic avian bone were cut with a glass knife, and viewed in a modified Metropolitan-Vickers (*E.M.*III) electron microscope. Densitometer traces of electron micrographs of newly formed osteogenic fibrils demonstrated at least five bands and five interbands within a main period of the collagen fibril. At an early stage of calcification, very dense particles, of less than 100 A. in size, became localized in a ring between the *d* and *ab* bands of the main period, that is, in the major region of indentation of the period (Fig. 1). In transverse sections of the appropriate part of the fibrils, the particles were seen to be irregular in outline, were about 100 A. apart, and numbered up to ten per ring.

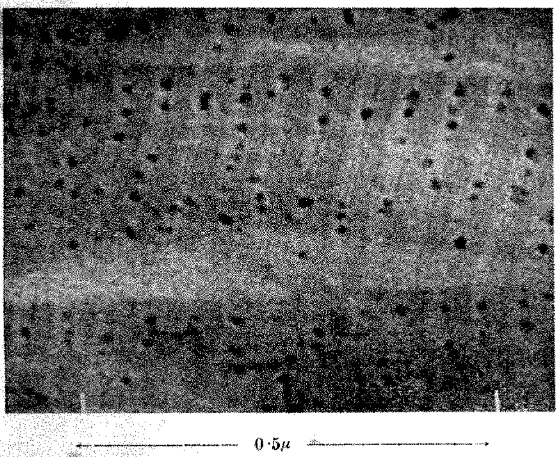

Fig. 1. A section of periosteal bone from a 16-day embryo, showing the periodic structure of the collagen fibrils; apatite particles are localized in one interband of each period, namely, between the *d* and *ab* bands. × 110,000

Measurements of the Bragg spacings of powder diffraction patterns, obtained by electron diffraction of such sections, were in close agreement with those obtained from a control specimen of hydroxyapatite. It is therefore considered that these particles are to be identified with the apatite component of bone. There was no clear evidence, however, from either electron microscopy or electron diffraction, of any preferred orientation of the particles with respect to the fibre axis. The observation on embryonic bone of the localization of dense apatite particles between the *d* and *ab* bands is precise, and it is believed that such clarity of deposition has not been recorded in previous work. This finding may also have a bearing on the mechanism by means of which the apatite crystals become preferentially orientated with their *c*-axis parallel to the collagen fibre axis already demonstrated by means of X-ray diffraction[1].

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The Lateral Rectus Muscle and Sixth Cranial Nerve in the Pig

THE lateral rectus muscle and sixth nerve have been studied in four young pigs ranging in age from three to six weeks. Fixation of the orbital contents and brain stem was ensured by ante-mortem perfusions. The muscle was examined in frozen sections taken through longitudinal and transverse planes, and stained by the diammine silver ion technique[1]. A block of the brain stem extending from the upper medulla to mid-brain was treated by the Bielschowsky pyridine–silver process, and sections, namely, dorso-ventral, longitudinal and transverse, were examined. The trunk of the sixth nerve was studied in preparations stained by hæmatoxylin and eosin and by methylene blue.

The volume of nerve in the lateral rectus was calculated to be approximately 9 per cent. Four main types of ending were observed in the muscle: (1) motor end-plates, found most abundantly in the posterior and middle thirds; (2) muscle spindles of standard type, anteriorly placed and deep to the peripheral zone of small muscle fibres; (3) large numbers of longitudinal fibres connected by collaterals and ending freely in fine filaments on the muscle fibres; (4) tendon endings at the attachments of the muscle.

Nerve cells on the sixth nerve in man have been reported by Nicholson[2]. In two of our animals, a few small ganglia were observed adjacent to the fibres of the sixth nerve in the region of the cavernous sinus.

Each ganglion consisted of 8–12 small multipolar cells intermingled with groups of non-myelinated nerve fibres. These structures, being morphologically similar to autonomic ganglia, were regarded as fragments from the plexus on the wall of the internal carotid artery.

A small-celled component near the rostral limit of the abducens nucleus was studied with particular care. The cells here are not representative of first-order neurones, and their function is not known.

In the cat[3] and the pig[4,5] a contribution has been reported from the mesencephalic root of the fifth nerve to the trochlear nerve at its decussation. In the case of the sixth nerve, no similar direct connexion was evident. Investigations are now being carried out concerning a possible connexion between the first division of the trigeminal and the oculomotor nerves in the pig; such a connexion has been observed in man and certain mammals by other workers.

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Milk Production and Interval between Milking

In a recent communication[1] results were presented challenging the generally accepted theory that secretion-rate in the dairy cow declines with time in the interval between successive milkings. These Ruakura experiments showed that secretion-rate was constant up to 20–24 hr. It was suggested that, under a twice-a-day milking regime, unequal intervals of considerable magnitude might be employed without any significant difference in milk yield due to direct pressure effects.

An experiment to test this has recently been completed at Ruakura. The work extended over two years. In the first year seven sets of monozygotic twins and in the second year eleven sets were milked such that one member of each pair was milked at equal 12-hr. intervals and the other member at intervals of 8 and 16 hr.

Mean productions for the complete lactations were:

	Year	No. of sets	Milk	Fat	Days
12—12	1954–55	7	5628·3	252·4	232
16—8			5461·4	246·1	232
12—12	1955–56	11	6438	316	264
16—8			6555	321	264

These results are not only of obvious theoretical interest but also have important implications for the dairy industry.

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Preferential Uptake of Sulphone by Affected Skin Tissue of Leprosy Patients as detected by a Tracer Method

Diamino-diphenyl-sulphone and a number of its derivatives have been found to be very effective in the treatment of leprosy; but the exact mode of their action on the affected tissue and invading *Mycobacterium* has not yet been definitely established[1–3]. In the present work, diamino-diphenyl-sulphone labelled with sulphur-35 was used for studying the time variation of concentration of the drug in blood and healthy and diseased skin tissues of the leprosy patients. An interesting observation was that the drug was found to be localized to a greater extent in the affected tissues compared to healthy ones. Such studies were not possible with the help of earlier colorimetric techniques[4], as these required tissues in bulk. The method used here was found to be ten times more sensitive than the colorimetric techniques.

Diamino-diphenyl-sulphone labelled with sulphur-35 (procured from the Atomic Energy Research Establishment, England) was administered to nine patients as a single oral dose of 4 µc./kgm. body-weight. The specific activity of the drug was about 0·75 µc./mgm. After administration of diamino-diphenyl-sulphone, samples of skin tissues were removed by biopsy from affected sites as well as from adjacent healthy sites, at different intervals. These were finely minced and homogenized with distilled water. The suspension was then uniformly spread over previously weighed copper planchets and dried under an infra-red lamp. Simultaneously with skin samples, blood was also collected from each patient. 0·1 c.c. of blood was similarly dried on the pre-weighed copper planchets. The planchets were reweighed to get the thickness of the sample in mgm./cm.². The thickness of the deposits varied from 4–6 mgm./cm.². They were placed under a previously calibrated end-window Geiger–Müller counter (window thickness 2·8 mgm./cm.²) and the activity of the sample was deduced from the recorded number of counts per minute and the sample thickness[5].

The concentration of diamino-diphenyl-sulphone (sulphur-35) in the blood, healthy and affected skin tissues of the leprosy patient is shown in Table 1. It is apparent from the table that the concentration in the healthy skin runs almost parallel to the concentration in blood. Within an initial period of 6 hr. after administration, concentration in blood seems to be 2–3 times that in the healthy skin. If, however, a comparison be made of the concentration of the

Table 1. Variation of the Concentration of Diamino-Diphenyl-Sulphone in Blood, Healthy and Affected Tissues

Patient	Hours after administration	Concentration of diamino-diphenyl-sulphone (in µc./gm.) in		
		Blood	Healthy skin	Affected skin
Nature of lesion: single				
M. H.	6 hr.	0·035±0·002	0·013±0·003	0·143±0·007
P. M.	18 ,,	0·013±0·002	0·014±0·003	0·140±0·006
G. H.	24 ,,	0·008±0·003	0·009±0·003	0·084±0·006
M. S.	144 ,,	0±0·001	0±0·001	0·010±0·003
Nature of lesion: multiple				
B. M.	6 hr.	0·033±0·002	0·016±0·003	0·067±0·005
M. Y.	18 ,,	0·008±0·003	0·005±0·002	0·064±0·005
B. D.	24 ,,	0·010±0·003	0·005±0·002	0·083±0·006
J. S.	72 ,,	0±0·001	0±0·001	0·004±0·001
M. R.	144 ,,	0±0·001	0±0·001	0·005±0·002

N.B. The errors indicated in this table are the standard errors of beta-counting only.

drug in the diseased skin with that in the healthy, the relative concentration of sulphone is about ten times greater in the diseased site. No significant difference could be observed in the concentration of diamino-diphenyl-sulphone in the case of multiple lesions compared with those with single lesions. 72 hr. after the administration of the drug, the concentration in the blood or healthy skin was too feeble to be detected by our method.

We wish to thank the Indian Council of Medical Research and Ministry of Education, Government of India, for financial help. We are also indebted to Prof. N. N. Das Gupta for guidance and discussions.

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Effect of Antibiotics on the Growth and Alkaloid Production of Tobacco Plants

Antibiotics are being used increasingly for the chemotherapy of plant diseases. In tobacco it has been proved effective to use streptomycin to control blue mould[1] and wildfire[2]. In *Datura stramonium*, Steinegger[3] showed that penicillin increased both the growth and alkaloid production. Nickell[4] stated that a change in the alkaloid content of tobacco plants by using antibiotics could be utilized to good advantage.

Several tests were made with Robinson Medium Broadleaf Maryland tobacco, using bacitracin, sodium penicillin, streptomycin sulphate, dihydrostreptomycin sulphate, terramycin hydrochloride and agrimycin 200 *C* (streptomycin 660 μgm./mgm.) supplied by Chas. Pfizer and Co. (The constant interest and help of Dr. R. A. Benedict, Mr. V. J. Carroll and Dr. L. G. Nickell, of Chas. Pfizer and Co., are acknowledged.)

Greenhouse solution cultures containing four concentrations of agrimycin 200 *C*. Agrimycin 200 *C* was added to the nutrient solution[5] at concentrations of 0, 10, 50, 100 and 200 p.p.m. of streptomycin. The fresh weights of the entire plants produced after two months in 2-litre crocks of this solution were 287, 336, 194, 110 and 59 gm., respectively. The percentages of total alkaloid on fresh-weight basis were 0·025, 0·024, 0·039, 0·047 and 0·019, respectively. The amounts of alkaloid per plant were 70·5, 80·3, 75·9, 51·7 and 11·1 mgm., respectively. Thus a small concentration of streptomycin appears to have been slightly beneficial; but larger concentrations were definitely unfavourable, causing more pronounced stunting and browning of the roots than of the tops; but at the highest concentration dead spots appeared on the leaves. Since growth was inhibited to a greater degree than alkaloid synthesis, a maximum alkaloid percentage, on a weight basis, was produced at 50–100 p.p.m. However, no evidence of specific increase in alkaloid synthesis was observed.

Greenhouse solution culture containing other antibiotics. The experimental conditions were similar to the preceding one except that larger nutrient solution containers were used. Since the structure of bacitracin is incompletely known, it was used at 5 and 20 units per litre. The other antibiotics were tested at concentrations of 50 and 200 p.p.m. The fresh weights of all other plants were less than the control (780 gm.), except the lower concentration of penicillin (782 gm.). In all cases the plants grown at the higher concentration of the antibiotic were smaller than at the lower. In the cases of the lower concentration of streptomycin sulphate, dihydrostreptomycin sulphate and sodium penicillin the quantity of alkaloid synthesized per plant was 317·1 mgm., 275·7 mgm. and 216·5 mgm., respectively, and was greater than the control (190·9 mgm.), tending to confirm the indications obtained at the lowest concentrations in the first experiment. Thus there may be an optimum concentration of each antibiotic in the nutrient solution at which the fresh weight and alkaloid synthesis are maximum; but if such optimum exists it is very low. This may be due to the influence of the antibiotic in depressing competitive development of micro-organisms in the nutrient solution. However, at higher concentrations all the antibiotics had an unfavourable effect on alkaloid synthesis as well as on fresh weight.

On examination of the antibiotic activity in the root, stem and leaves of these plants it was found that all parts of the plants which had received streptomycin and dihydrostreptomycin showed significant antimicrobial activity compared to the control. In the terramycin samples only the root gave significant activity, and significant activity was not found in any part of the bacitracin or penicillin samples.

Antibiotic sprays on the tops of plants grown in soil. The five antibiotics as used in the previous experiment were tested in this experiment, also. Bacitracin was used at 200 units per litre and the other four at 200 p.p.m. Tobacco plants were grown in 7-in. pots in the greenhouse. They were divided into three groups and each was sprayed with a given antibiotic twice, four times, or six times at intervals of 30, 15 or 10 days, respectively, during their growth period. No significant differences were found either in plant size or in alkaloid content per plant due to the antibiotic used or the frequency of spraying.

Field test on spraying with different concentrations of penicillin. Since penicillin showed an increase of both plant growth and alkaloid production of *Datura stramonium*[5] and also indicated how little it affected plant size in the solution culture, it was tried in the field by spraying ten times at intervals of 10 days throughout the growth period with several concentrations of penicillin; namely, 0, 50, 100 and 200 p.p.m. These four treatments, in four replications, were laid out in the field in a Latin square design. Statistical analysis of the results did not show any significant difference either in fresh weight of plant, in alkaloid concentration, or in total alkaloid produced per plant due to different treatments.

The experiments described above failed to show any effects on the plants produced by antibiotics sprayed on the leaves. They did demonstrate marked unfavourable effects of any considerable concentration of antibiotics in the nutrient solution. They showed some evidence of stimulatory effects of small concentrations in the nutrient solutions;

but these may be secondary effects. It appears improbable that such small concentrations could be provided reproducibly to the roots of plants growing in soil. Thus, commercially grown tobacco leaf of 'predesigned' alkaloid content does not appear to be feasible by any of the antibiotic applications described in this paper.

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A Chemotactic Response in Wheat Bulb Fly Larvæ

The eggs of wheat bulb fly (*Leptohylemyia coarctata* Fall.) are laid in the soil during the summer and are usually found on fallow land or where there is a light cover of vegetation such as potatoes. The larvæ develop and remain in the egg in diapause until the following January or February. Meanwhile, such fields may have been autumn-sown with wheat which the larvæ infest upon hatching[1]. The mechanism by which the larvæ locate the wheat plants is the subject of this investigation.

Laboratory observations indicated that cut wheat shoots could be detected in Petri dishes by the larvæ when both larvæ and shoot were on damp filter paper; but when the shoots were separated from the damp paper by a cover glass laid under them the results were less positive. The use of growing plants was more desirable in tests and the following method was evolved. Wheat seeds were germinated on damp filter paper in Petri dishes and transplanted into a sodium alginate jelly when the first leaf emerged from the coleoptile. Identical dishes of jelly without wheat were made up simultaneously. In preliminary tests, cubes of jelly taken three or four days later from the wheat dish without including or damaging the roots or plants and similar cubes from the non-wheat jelly were placed on damp filter paper around the edge of a Petri dish, and newly hatched, unfed wheat bulb fly larvæ were introduced centrally. A large number of larvæ was later seen in the wheat jelly cubes.

To test this observation, ten Petri dishes were then arranged. The dishes were set up as follows, after minor adjustments in the first five: the jelly was made up to the formula of 1 gm. sodium alginate 'Manucol' *SS/LM* and 0·2 gm. calcium citrate to 100 ml. of water. In each dish one ¼-in. cube of wheat jelly and a similar one of non-wheat jelly were placed opposite and equidistant, ¼ in. away from the central ¼-in. square in which ten newly hatched larvæ were introduced. The dishes were orientated differently. The lids were marked out in ¼-in. squares and the positions of the larvæ which immediately began to move were recorded on correspondingly squared graph paper every ten minutes.

The larvæ began to aggregate quickly in the wheat jelly, the total number in the various sites after approximately 1 hr. being shown in Table 1.

Table 1. Larvæ found in Various Sites in Petri Dishes containing Cubes of Wheat and Non-wheat Jelly

Test	No. in wheat jelly	No. in non-wheat jelly	No. still wandering	Missing
1	7	2	1	0
2	1	0	9	0
3	6	1	3	0
4	4	1	5	0
5	1	1	8	0
6	5	0	5	0
7	4	1	4	1
8	7	0	3	0
9	5	0	5	0
10	4	1	5	0
Totals	44	7	48	1

The total area on which the larvæ could wander (including the sides and top of the cubes) per dish was 12·1 sq. in. The area of 1 cube (minus base) was 1·25 sq. in. while the proportion of the total area occupied by one cube was 0·104. The number of larvæ which could be expected in an area of cube size per dish would be 1·04 ± 0·43 should the wandering be of a random nature; but this is considerably exceeded by the larvæ in the wheat jelly. It is probable that an exudation from the wheat plants into the jelly and thence into the damp filter paper was detected by the larvæ.

The nature of the larval response is still being investigated, as is the constitution of the substance in the wheat jelly. The speed with which a substantial proportion of the larvæ find the jelly (in some experiments 60 per cent reached it within ten minutes) suggests that the response is a directional one (taxis); but the nature and speed of the movement may also be influenced (kinesis)[2]. The larvæ are able to leave the jelly after entering it and when exposed for 24 hr. they become dispersed over the dish. It is possible that by this time the substance in the wheat jelly has diffused more or less evenly throughout the dish.

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Inhibitory Effect of Glucose on Enzyme Formation

The induced biosynthesis of many microbial enzymes is susceptible to the inhibitory effect of glucose[1]. The physiological significance of this phenomenon has been indicated by the study of an L-histidine-requiring mutant strain of *Aerobacter aerogenes* in which glucose inhibits the formation of histidase, thereby conserving the L-histidine for its specific role as growth factor[2]. Under conditions that permit a gratuitous, linear production of *myo*-inositol dehydrogenase (another inducible enzyme in *A. aerogenes*) in the absence of the inducing agent, the glucose effect is still operative, indicating that glucose interferes with the production of enzyme rather than with the process of induction[3].

Recently, it has been possible to demonstrate in two instances the reversal of the glucose inhibition of induced enzyme biosynthesis. In a wild strain of *A. aerogenes* L-histidine was substituted for ammonium sulphate, the customary nitrogen source of the glucose-containing minimal medium. In a mutant

Table 1. THE PRODUCTION OF HISTIDASE AND UROCANASE BY TWO STRAINS OF *A. aerogenes*

Strain	Growth Medium*				Histidase† (units/10 mgm. cells)	Urocanase† (units/10 mgm. cells)
	L-Histidine	Glucose	$(NH_4)_2SO_4$	L-Glutamate		
Wild	+	−	+	−	170	403
	+	−	−	−	182	420
	+	+	+	−	< 5	< 5
	+	+	−	−	70	220
L-Glutamate-requiring mutant	+	−	+	+	203	398
	+	−	+	−	197	366
	+	+	+	+	< 5	< 5
	+	+	+	±	65	130

* These substances were added, where indicated, to the basal salt medium in sufficient amounts to give a final concentration of 0·2 per cent.

† Histidase and urocanase are the first two enzymes in the series degrading L-histidine to L-glutamic acid, formamide and ammonia (ref. 4). They were assayed by determining the ability of dried-cell preparations to degrade L-histidine and urocanic acid, respectively (ref. 3). One unit of enzyme is defined as that activity which results in the degradation of 0·1 micromole of substrate in 1 hr. under the conditions of the assay.

strain of this organism (kindly supplied by Dr. B. D. Davis, of New York University) which required L-glutamic acid for growth, L-histidine was substituted for L-glutamic acid in a glucose–ammonium sulphate medium. In both cases the production of histidase in the presence of glucose was a prerequisite for growth, and both conditions resulted in growth of the cells and the formation of the histidase series of enzymes (Table 1).

These observations demonstrate that glucose permits histidase biosynthesis in *A. aerogenes* when the action of this enzyme system furnishes products necessary for growth and not obtainable from the degradation of glucose. Conversely, glucose inhibits histidase biosynthesis when the products of the reactions catalysed by this enzyme system merely augment the supply of metabolites resulting from glucose degradation.

Compared with that of other substances, the degradation of glucose by *A. aerogenes* has one unusual feature. Glucose is metabolized under aerobic conditions at a rate which is at least double that commensurate with the growth-rate and total crop of cells; the extremely large amount of glucose metabolized during growth is reflected in the amount of labile ('high energy') phosphate present in the cells (Table 2). Additional information obtained in this laboratory indicates that the metabolism of glucose in the presence of inorganic nitrogen (NH_4^+) results in a plentiful supply of nitrogenous organic compounds. These results are in good agreement with the observation that vitamin, amino-acid and purine and pyrimidine supplementation fails to increase the growth-rate of this organism on glucose, while such supplementation does accelerate growth on other substances[3]. Cells growing on glucose, far from being deficient in the substances necessary for protein synthesis, actually possess these substances in excess. The uniformly negative results of past attempts to effect a reversal of the glucose inhibition by enriching the growth medium are thus understandable.

Table 2. SOME CHARACTERISTICS OF THE GROWTH OF *A. aerogenes* ON DIFFERENT SUBSTANCES

Substrate	Carbon uptake in μatoms/mgm. growth	Labile PO_4 in μmoles/mgm. cells*	(*k*)†	Rate of carbon uptake‡ μatoms/mgm./hr.
Glucose	110	12·2	1·26	139
L-Histidine	89§	7·7	0·59	53
Glycerol	58	2·1	1·00	58

* These experiments were done in collaboration with Mr. Fred Valentine.

† The growth-rate constant, *k*, is defined by the expression, $dC/dt = kC$, in which *C* is the turbidity of the culture in optical density units, and *t* is time expressed in hours.

‡ This was calculated by multiplying the carbon uptake (μatoms/mgm. growth) by the growth-rate constant (hr.$^{-1}$) of the cells on that particular substance.

§ L-Histidine is assumed to have five utilizable carbons. One of its carbon atoms is not metabolized, but excreted as formamide.

If we now consider the class of enzymes the formation of which is inhibited by glucose metabolism, an interesting generalization can be made: the 'glucose-sensitive' enzymes the biological functions of which are known furnish the cell with carbon-building blocks and energy (for example, enzymes degrading carbohydrates) or nitrogen (for example, amino-acid deaminases), that is, products also readily obtainable from the metabolism of glucose.

This generalization permits a clearer conception of the inhibition. It would appear that the levels of the metabolites resulting from intermediary metabolism control the synthesis of enzymes which form these metabolites, presumably by a system of feedback mechanisms. The existence of analogous feedback mechanisms controlling biosynthetic reactions has already been indicated[5], and in some cases it can be shown that the actual formation of a biosynthetic enzyme is inhibited by the presence of the final product of the reaction sequence[6]. Thus, certain biosynthetic enzymes, too, seem to be formed only when their products supplement the composition of the growth medium, not when they augment it. Glucose is metabolized so rapidly by an enzyme system always present in the cells that its intermediary products (carbon, nitrogen and energy in forms available for synthetic purposes) are formed faster than they can be removed by anabolic reactions. This accumulation seems to prevent the synthesis of enzymes the products of which would only augment the already large metabolic pools.

This work was supported in part by a research grant (*G*-3554) from the U.S. Public Health Service, by an institutional grant to Harvard University from the American Cancer Society, and by funds received from the Eugene Higgins Trust.

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A New Embedding Medium for Electron Microscopy

THE introduction of *n*-butyl and methyl methacrylates as embedding media[1] constituted an important development in the preparation of ultra-thin sections of biological material; but their use is attended by various major difficulties. Shrinkage occurs on polymerization, hard objects are not penetrated by the monomer so that the plastic shrinks away and does not provide sufficient support, and sometimes there is an unaccountable appearance of bubbles around the specimen. Moreover, the polymerization process is not uniform and sometimes causes severe damage. This is perhaps most strikingly seen in bacteria where often only empty remnants of cell walls remain.

Attempts have been made to minimize these distorting effects by modifying the methacrylate procedure[2], but only with partial success. The substitution of a different embedding medium seems desirable. The possible usefulness of the epoxy resins for the preparation of ultra-thin sections of bacteria has already been indicated[3].

We have examined a series of epoxy resins, supplied under the name of 'Araldite'*, for their suitability as embedding media. On the addition of a hardener, which is a liquid anhydride, the resin sets slowly without shrinkage to form a light-gold block. The viscosity of the mixture and the hardness of the final block can be controlled with a plasticizer, dibutyl phthalate, and the rate of hardening can be varied with an amine accelerator. By a suitable variation of these components it is possible to produce an embedding medium with the properties required for electron microscopy. Slightly different combinations will be found convenient for different types of specimen; one such combination is described here.

The components were measured into a graduated cylinder warmed to 48° C. to facilitate drainage and were mixed in the following order:

'Araldite' *M*	100 ml.
Hardener 964 *B*	100 ml.
Plasticizer	10 ml.
Accelerator 964 *C*	3 ml.

Although the mixture can be stored at 4° C. for several days we found it convenient to prepare it in quantities one-tenth of those indicated. After stirring, a clear, golden liquid resulted which was more viscous than methacrylate monomers; but the viscosity could be reduced by holding the solution at 48° C. and infiltrating the specimens at this temperature.

In the preliminary trials the 'Araldite' mixture has been used for embedding bacteria, fragments of lung and mature hair fibres. After fixation and dehydration the specimens were soaked for 1–2 hr. in a 50/50 mixture of alcohol and 'Araldite'. They were then transferred to pure 'Araldite' for 2–3 hr. at 48° C., and finally placed in No. 00 gelatin capsules with fresh 'Araldite'. Curing for 48 hr. yielded a light-gold block with a hardness comparable with methacrylate.

The 'Araldite' had excellent cutting characteristics; sections were floated on to 20 per cent acetone–water, mounted on carbon films and examined in the electron microscope. Their electron density was similar to methacrylate. As had been hoped, bacteria were intact, and hair fibres were sufficiently well supported to allow thin sections to be cut and details of internal structure to be revealed.

It is considered that such an alternative embedding medium will be valuable for studies of tissue fine structure; but the resin must be tested on many different types of specimen before its potentialities can be fully assessed.

We are indebted to Dr. V. E. Cosslett and Mr. R. W. Horne, of the Cavendish Laboratory, Cambridge, for providing electron microscope facilities. One of us (G. E. R.) would like to thank the Commonwealth Scientific and Industrial Research Organization, Australia, for a studentship.

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* Trade name for epoxy resins developed by Messrs. Ciba, Ltd., Basle, and made in Great Britain by Aero Research, Ltd., Duxford, Cambridge, from whom all the components described are available.

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Re-appraisal of the Evidence for the Metabolic Conversion of Vasopressin into a Less Active Derivative

THE intermediary metabolism of peptide hormones is unknown, and it is therefore of great interest that Dicker and Greenbaum[1] have recently suggested "that both kidney and liver slices transform vasopressin into substances of lower antidiuretic activity". They reached this conclusion because they found that the activity of 'Pitressin', when incubated with rat kidney slices, decreased until 20 per cent of the initial antidiuretic potency remained; thereafter, there was no further inactivation. When the resultant supernatant from such an incubation mixture was added to fresh kidney slices its activity remained constant although it could be completely abolished by liver slices. Thus, the property by which Dicker and Greenbaum distinguish between vasopressin and the product of its metabolism is that the latter resists inactivation by kidney slices while vasopressin does not.

The results of *in vitro* experiments do not necessarily apply to the fate of vasopressin *in vivo*, but Dicker and Greenbaum attempted to show that, following intravenous infusion of vasopressin into rats anæsthetized with ethanol, the metabolic derivative of vasopressin is excreted in urine. After infusing large amounts of vasopressin they found that the antidiuretic activity excreted in urine was within the range found in previous investigations (3·1–22·0 per cent of the dose infused[2]). However, when urine containing this excreted activity was infused into another rat, they claim that 48–59 per cent of the dose now appeared in the urine. The explanation offered is that liver and kidneys *in vivo* treat vasopressin and the antidiuretic activity in urine as do slices of these organs.

Table 1. EXCRETION OF ANTIDIURETIC ACTIVITY IN URINE

	Per cent of dose recovered from urine	
	'Pitressin' infusion (200–400 mU./rat)	Infusion of urine secreted during and following 'Pitressin' infusion*
	4·8	13·8
	20 0†	10·4†
	5·1†	6·0†
	5·4	11·0
Mean	8·8 ± 3 7 (S.E.)	10·3 ± 1 6 (S.E.)

* The urine was adjusted to plasma osmoticity.
† Results obtained in rats anæsthetized with ethanol.

Accordingly, half the infused urinary antidiuretic substance would be destroyed in the liver while the remainder would pass through the kidneys unchanged.

We have been engaged in the study of the fate of vasopressin for some years[3-6], and in continuing this work it was necessary to follow up Dicker and Greenbaum's interesting hypothesis. We have therefore repeated their *in vivo* experiments. We found that in rats infused with 'Pitressin' the urine secreted during the period of infusion (1 hr.) and during the subsequent hour had antidiuretic activity equivalent to between 4·8 and 20·0 per cent of the dose. In rats into which this urinary antidiuretic activity was infused, the urine contained between 6·0 and 13·8 per cent of the antidiuretic activity infused (Table 1). That is, the urinary antidiuretic activity was excreted in the same proportion as was 'Pitressin'. These experiments were performed on both conscious rats and on rats anæsthetized with ethanol.

The transformation of vasopressin *in vivo* into a less-active metabolic product remains a possibility; but the experimental evidence upon which this hypothesis was based cannot be confirmed.

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Protective Action of Vitamin B_{12} in the Hyperthyroid Rat

THE protection afforded by vitamin B_{12} against thyrotoxicosis in the rat was explained as due to a restoration in part of the uncoupling of oxidative phosphorylation caused by thyroxine[1]. Since it is known that osmotic damage to mitochondria could cause a diminution in oxidative phosphorylation[2], the possibility was considered that in hyperthyroidism there may be an altered distribution of vitamin B_{12} in the cell fractions.

The basal diet employed was a purified casein ration[3] with vitamin additions including folic acid (3 mgm./kgm. of diet). Groups of six to eight male rats (Wistar strain), 50 gm. in weight, were fed this vitamin B_{12}-free ration with modifications as shown in Table 1. Iodinated casein ('Protomone': Cerophyl Laboratories, Kansas City, Mo.) was added to the diet at 0·3 per cent level. Vitamin B_{12} was given intraperitoneally at 10 gamma/rat on alternate days. All animals were killed at the end of five weeks when those of group 3 showed distinct symptoms of hyperthyroidism. Blood was withdrawn by venipuncture after phenobarbitone anæsthesia, immediately citrated and an aliquot centrifuged for plasma. Livers were excised, chilled in cracked ice and a 20 per cent homogenate prepared in ice-cold isotonic (0·25 *M*) sucrose; an aliquot was used for centrifugal fractionation[4], particulate fractions being carefully washed with sucrose solution.

Vitamin B_{12} in all samples was liberated by overnight incubation under toluene with papain (B.D.H.) using 25 mgm./gm. of liver or per c.c. of blood or plasma, in acetate buffer of *p*H 4·6 [5]. The samples were then autoclaved, homogenized, neutralized and made to volume. Assays were made with *Lactobacillus leichmannii* (ATCC 7830) by a turbidimetric adaptation of the U.S.P. method[5]. All results are averages for at least four animals in each of the groups.

It may be seen (Table 1) that in the hyperthyroid rat there is a marked fall in the concentration of vitamin B_{12} in the circulating blood and in the percentage retained in the blood cells; this is prevented by vitamin B_{12} administration. A similar fall in liver and mitochondrial vitamin B_{12} of thyrotoxic animals is also corrected by feeding the vitamin. However, in the latter case, there is a rapid uptake of the vitamin which resides largely in the nuclear and supernatant fractions. It has been observed that the values for vitamin B_{12} in these two fractions return to normal levels when iodinated casein is withdrawn from the diet.

The pronounced lowering of liver and its mitochondrial vitamin B_{12} in hyperthyroidism parallels the known decrease of liver pyridinonucleotides and of their percentage linked to mitochondria[6]. It is also consistent with other observations (unpublished data) on the more rapid *in vitro* release into the surrounding medium of the intramitochondrial nucleotide components[7] from livers of thyrotoxic rats. Since the synthesis of adenosine triphosphate is rendered inoperative as a result of structural damage to mitochondria[2], the observations on the protective action of vitamin B_{12} against thyrotoxicosis[1] seem explicable on the basis that vitamin

Table 1

Group	Vitamin B_{12} in blood		Vitamin B_{12} in liver			
	Whole blood	Plasma	Whole homogenate	Nuclei	Mitochondria	Supernatant
	mμgm./c.c.		mμgm./gm. of liver on wet basis			
1. Basal diet	1·53 ± 0·43*	0·65 ± 0·15*	45·5 ± 5 2*	14 2 ± 1·0*	12·9 ± 0 7*	16·8 ± 2·7*
2. Basal diet + vitamin B_{12}	1·80 ± 0 30	0·81 ± 0 19	49 2 ± 3 7	20·8 ± 1 8	13·2 ± 1 2	12 9 ± 0 9
3. Basal diet + iodinated casein	0 90 ± 0·30	0·55 ± 0·25	37 9 ± 2 5	13 7 ± 0·7	8 1 ± 0 3	14·7 ± 1·3
4. Basal diet + iodinated casein + vitamin B_{12}	2 01 ± 0·25	1·10 ± 0·25	96·3 ± 4 5	41 3 ± 3·0	18 4 ± 0 4	31·9 ± 3·1

* Standard error.

B_{12} aids in the maintenance of mitochondrial integrity.

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Effect of Orotic Acid on Vitamin B_{12}-deficient Rats

Studies in this laboratory[1,2] have recently shown that orotic acid is a factor for growth and survival in rats depleted of the animal protein factor of casein. Also, vitamin B_{12} has a protective effect on the deficiency in animal protein factor[3]. This indicates a relationship, from a nutritional point of view, between vitamin B_{12} and orotic acid. In the present communication the direct influence of orotic acid upon the deficiency of vitamin B_{12} is reported.

To this end, thirty-six weanling rats, male and female in equal number, of the Sprague–Dawley strain weighing 40–45 gm. were employed. The animals were divided into three groups, all of which were fed the basal vitamin B_{12}-deficient corn–soybean meal ration proposed by Register *et al.*[4], namely, whole ground yellow corn 46·35 gm., commercial soybean meal 46·35 gm., corn oil 5 gm., cystine 0·3 gm., calcium hydrogen phosphate 0·92 gm., calcium carbonate 0·6 gm., sodium chloride 0·44 gm., crystalline manganese sulphate 0·04 gm., thiamine 0·3 mgm., riboflavin 0·3 mgm., niacin 2 mgm., pyridoxine 0·2 mgm., pantothenic acid 2 mgm., folic acid 0·025 mgm., biotin 0·01 mgm., inositol 10 mgm., choline 100 mgm., *p*-aminobenzoic acid 25 mgm.; vitamins A and D were administered weekly. Iodinated casein or desiccated thyroid were omitted.

Group 1 served as control and received only the basal ration. Group 2 were fed the basal ration supplemented with vitamin B_{12} (2γ/100 gm. of diet). Group 3 received the basal ration supplemented with orotic acid (1,000γ/100 gm. of diet).

The animals were maintained on their respective ration for 4 weeks; at the end of this period weights were recorded and the liver betaine–homocysteine transmethylase activity was determined, on 6 animals for each group, by the method of Williams *et al.*[5]. It is known, in fact, that in vitamin B_{12}-deficiency growth is retarded, and the liver betaine–homocysteine transmethylase activity is decreased[5].

Table 1

Group No.	Supplement to 100 gm. basal ration	Body-weight after 4 weeks (gm.)	Transmethylase activity, γ methionine formed per hr. per gm. liver
1	None	95 (77–113)*	300 (288–322)*
2	2γ vitamin B_{12}	120 (104–155)	510 (425–580)
3	1,000γ orotic acid†	117 (107–133)	440 (383–517)

* Range of individual values.

† Orotic acid manufactured by Biochemical Inc., Co., Cleveland, Ohio.

The results are shown in Table 1.

From these results it appears that orotic acid has a growth-promoting action on the B_{12}-deficient rats; moreover, orotic acid is a factor stimulating liver betaine–homocysteine transmethylase activity.

These data suggest a metabolic relationship between orotic acid and vitamin B_{12}.

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Glass Surface and Blood Coagulation

Platelet-free, citrated plasma, collected and handled in silicone-treated apparatus, has a very long clotting time on recalcification. The exposure to glass surface greatly shortens the clotting time, and various hypotheses have been advanced to explain this phenomenon[1–4]. The present study is an attempt to examine certain aspects of this reaction by the exposure of various normal and pathological plasma specimens and plasma fractions to a standard glass surface in the form of glass 'ballotini' spheres of 0·12 mm. average diameter. The activity may be assessed either by recalcifying the activated specimen directly or by adding a sample to a standard volume of silicone-collected plasma and recording the recalcified clotting time of the mixture. The use of this silicone plasma as a diluent is essential for testing samples which are devoid of one or more clotting factors (cf. Table 1). (For reasons to be discussed elsewhere, in some experiments 'silicone plasma' containing 2,000–10,000 platelets/c.mm. was used as the diluent for the activated, platelet-free samples.)

The results of such experiments are shown in Table 1, and it will be seen that the ability to respond to glass contact is not lost after heating at 56° C. or after absorption with aluminium hydroxide and is retained in the 30–50 per cent saturated ammonium sulphate fraction. These properties suggest that the substance concerned is not identical with any known plasma-clotting factor. The activation by glass contact could also be demonstrated in hæmophilic and christmas disease plasma and in the plasma of patients treated with dindivan, which indicates that the factors deficient in these samples cannot be directly concerned with contact activation. By adding small samples of glass-contacted plasma or fractions to platelet-rich plasma in siliconed containers, the prothrombin consumption of the latter was found to be markedly increased and thrombin generation greatly accelerated. These findings are consistent with past observations, based on different methods of approach[4–6]. Control samples of the

Table 1

Substance tested	Recalcified clotting times (sec.) in silicone*			
	Glass-activated sample undiluted	Activated sample : dilution in silicone plasma		
		1 : 3	1 : 9	0
1. Normal plasma				
a, untreated	165	245	310	2,000
b, heated at 56° C †	∞	285	325	2,000
c, adsorbed with $Al(OH)_3$	∞	240	340	3,000
d, heated and adsorbed with $Al(OH)_3$	∞	290	360	1,100‡
2. 30–50 per cent saturated $(NH_4)_2SO_4$ fractions of:				
a, adsorbed plasma	∞	230	305	2,200
b, heated and adsorbed plasma	∞	260	330	3,000
3. Euglobin from 2*b*	∞	320	420	1,320‡
4. Hæmophilic plasma	3,600+	225	260	915‡
5. Christmas disease plasma (mild case)	500	210	380	4,400
6. Dindivan plasma (see text)	355	240	305	1,200‡

0·2 ml. of glass-activated samples or of their mixtures with silicone plasma were recalcified with 0·05 ml. of 0 1 *M* calcium chloride at 37° C.

* The clotting times are strictly comparable only within each individual experiment, that is, horizontally.

† Denatured fibrinogen precipitate was removed by high-speed centrifugation.

‡ Platelets (2,000–10,000/cm.) were deliberately added to the silicone plasma in these experiments.

substances, listed in Table 1, were not exposed to glass contact and had no effects comparable with the contacted specimens, showing that their activity was specific to glass contact and not incidental to the methods of preparation of the plasma fractions. The euglobulin fractions formed an exception to this rule and were apparently activated by the dilution procedure in the course of their preparation.

When plasma which has been exposed to a large glass surface is removed from contact with glass, its clotting time rapidly lengthens, showing that the activity is unstable. This sequence of activation – decay can be repeated; but the response is lessened with each repetition until the plasma is 'exhausted' and will not clot in glass. On the other hand, heated plasma or the fractions in Table 1 are much more stable in this respect, when incubated alone, but will still rapidly lose activity when mixed with untreated plasma. A heat-labile inhibitor system in plasma would account for these findings. If such an inhibitor is related to that described by Fiala[3] it would make it difficult to accept his hypothesis, according to which the shortened clotting time of plasma exposed to glass and other surfaces is due to the absorption of an inhibitor by these substances.

The most plausible explanation of the present findings is that an active substance is liberated from a precursor at the glass-plasma interface and is afterwards rapidly destroyed by an antagonist. The actual level of activity under any given contact conditions would then represent a dynamic equilibrium between these two opposite effects, the precursor being continuously exhausted at a rate which depends on the contact area, temperature, etc. A better understanding of the kinetics of this phenomenon will help to control an important variable in coagulation tests and thus increase their sensitivity and accuracy. For example, platelet-free plasma from dindivan-treated patients has been found to have a consistently prolonged coagulation time when recalcified under standard contact conditions (for example, with glass powder, or as in Table 1). Quantitative aspects and methods of measurement of the reactions described will be discussed in a further communication.

In a wider sense the 'contact' phenomenon may be of physiological significance as an initial stage of a general reaction to 'injury' (cf. the "pain producing substance"[7]) of which blood clotting is only one, rather late, evolutionary offshoot. The final formation of fibrin clot may, nevertheless, provide a very convenient indicator for the study of such early injury reactions the effects of which are by no means limited to coagulation.

I wish to thank Dr. R. G. Macfarlane and Dr. Rosemary Biggs for their generous advice and valuable criticism in the course of this investigation. The work was supported by a grant from the Royal Australasian College of Physicians and by the Sister Sanders Scholarship, University of Sydney.

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Pharmacological Effects of Certain Diaminodiphenoxy Alkanes

A SERIES of diaminodiphenoxy alkanes was found independently by Raison and Standen[1] and Collins, Davies and Hill[2] to possess high schistosomicidal activity. Hill[3] has described in detail the therapeutic effects of one of these compounds in comparison with lucanthone (Miracil *D*), which is used in the treatment of bilharzia, and found that in mice the compound 1 : 5-di (*p*-aminophenoxy) pentane dihydrochloride (M. and B. 968*A*) was more active than lucanthone. The relative therapeutic indices were 3·3 (*LD*50 = 0·62 mgm./gm., *CD*50 = 0·19 mgm./gm.) and 0·9, respectively, and it had a more rapid action in clearing the mice of the schistosomes.

While the pharmacology of this compound and other active compounds was being studied, we encountered a toxic effect on the eye. This precluded the clinical use of this particular compound, though other compounds which retained therapeutic activity, yet were sufficiently devoid of this toxic action, will be described elsewhere.

On the oral treatment of monkeys, infected with *S. mansoni*, with daily doses of 100 and 200 mgm./kgm. of M. and B. 968*A* for four days, temporary impairment of vision occurred. This was obvious from their abnormal feeding behaviour—they could not readily see or focus on the food presented to them—and a marked dilatation of the pupils, which did not constrict to strong illumination either so readily or to the same extent as a normal eye.

Investigation showed that vision was impaired in some species, but not in others. The mouse, rat, guinea pig, rabbit and ferret were insensitive to single oral doses up to 400 mgm./kgm. (about two-thirds of the mean lethal dose in the mouse). On the other hand, the monkey, dog and cat were highly susceptible. In the cat, the species chiefly studied, single doses of 100–400 mgm./kgm. by mouth or by subcutaneous injection, or 25–50 mgm./kgm. given intravenously, caused loss of the blink reflex and marked dilatation of the pupils with almost complete loss of the pupillary, light and near reflexes. Visual perception, as judged by the animals' behaviour, was also impaired within twenty-four hours. If the compound was acting centrally, all the optic centres would be affected, but this seemed improbable in the absence of other central nervous symptoms.

The instillation of eserine into an affected eye within a few days of treatment, or peripheral stimulation of the oculomotor nerve in decerebrate preparations, caused pupillary constriction, indicating that paralysis of the nerves and muscles responsible for constricting the pupil had not occurred. The mydriasis was not due to an atropine-like or ganglion-blocking type of action. It was therefore inferred that the compound was probably acting directly on the retina or optic nerve.

Ophthalmoscopical changes were first observed after about seven days and consisted in marked constriction of the retinal vessels with pallor of the optic disk; in two weeks there was some pigmentary disturbance which after eight weeks became the predominant feature, producing a fundus picture resembling retinitis pigmentosa. Though this effect on the eye was by far the most characteristic and important toxic aspect of the compound, it also caused vomiting in cats and dogs, when given orally, but no other serious toxic effects were observed.

The significant histological changes in the eye, described in detail elsewhere[4], were almost entirely confined to the retina, there being widespread injury to the outer layers of the retina with total or patchy destruction of the visual cells, and localized displacement of the outer nuclear layer of the retina with arcade and rosette formation. There was marked degeneration and proliferation of the pigment epithelium. Bipolar cells and ganglion cells were preserved. Histologically these changes most closely simulate those which follow the administration of sodium iodate[5-7], rather than those resulting from iodoacetate[7,8].

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Test for Cross-linking of Linear Polymers

CERTAIN linear polymers which have been used as picture varnishes are known to become cross-linked by the action of light. It is important to us to find out whether this is likely to happen for any particular case, since the insolubility resulting from cross-linkage makes it impossible to remove the varnish by solvent action alone.

The method which has been developed requires only a small rectangle of the varnish film (4–9 mm.^2, 20μ thick), and can be completed within an hour. The fragment of film is attached near the bottom of a filter-paper strip with one or two drops of a suitable solvent from a micrometer syringe. The fragment is then leached by developing the strip as in paper chromatography, although in this case there is only one solvent phase, and lengthy equilibration is unnecessary. This solvent should be chosen from among the best for the polymer. A dye, absorbed preferentially by either polymer or paper, may be dissolved in it.

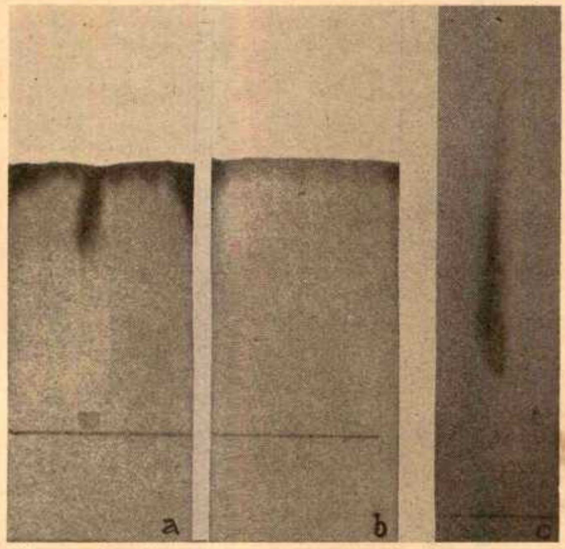

Fig. 1. Cross-linkage tests on 1-in. chromatography paper (Whatman No. 1). Origins are marked by horizontal pencil lines: the varnish fragments were placed just above these lines in (*a*) and (*c*). Solvent flowed upwards.
(*a*) A methacrylate polymer after being heated for 4 hr. at 155° C. Solvent and stain: benzene with 0·015 per cent sudan IV. (*b*) Blank strip for comparison. (*c*) Polyvinyl acetate after the same treatment as (*a*). Solvent: methanol. Light green was used as a paper stain so that leaching could be followed, but the resin was positively indicated by spraying with equal volumes of 5 per cent cerium nitrate and 0·1 *N* iodine

A long streak of soluble polymer moves along the paper so long as leaching continues, and ends fairly abruptly, to form a rounded tail, when all soluble polymer has been removed from the varnish fragment. The process is stopped as soon as the tail is clearly separated from the origin. Any polymer rendered insoluble by cross-linkage remains unmoved at the origin, so that the outline of the original fragment is sharply visible. This can be seen in Fig. 1(*a*), where a proportion of the polymethacrylate is cross-linked. The soluble portion forms a tail just behind the solvent front. Measurements by an interference method of the contraction in thickness suggest that about a third of the film has been rendered insoluble. Absence of resin at the origin in Fig. 1(*c*) indicates that none of the polyvinyl acetate has become cross-linked.

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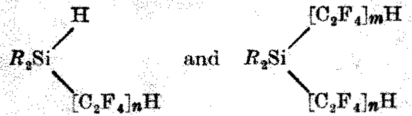
Free Radical Reactions with Inorganic Covalent Hydrides: a Route to Polyfluoroalkyl Silicon Compounds

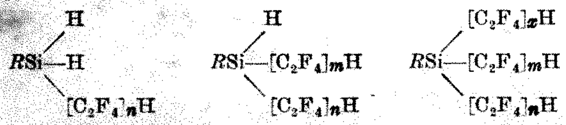
THE reactions of hydrocarbon free radicals are reasonably well established, but much less is known about the reactions of inorganic free radicals based on elements such as bismuth, silicon, germanium, lead, zinc, phosphorus, arsenic, tin or aluminium. The relative stabilities of some of these radicals can be predicted with reasonable certainty. The $SiCl_3$ radical, for example, should be similar in type to the CF_3 or CCl_3 radical, and it is not surprising that trichlorosilane reacts with olefins[1,2] to give $SiCl_3.[\text{olefin}]_n.H$; thus tetrafluoroethylene[2] yields $SiCl_3.[CF_2.CF_2]_m.H$, where $m = 1$–4.

Alkylsilyl radicals should be more reactive than trihalogenosilyl radicals, and a general study of their chemistry has been initiated. In particular, their reactions with olefins provide a useful new route for the synthesis of silicon compounds, and especially of polyfluoroalkyl silicon compounds.

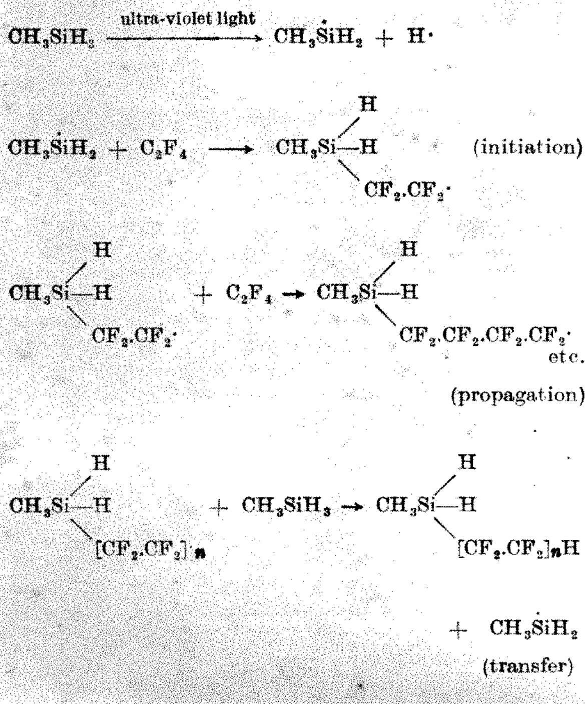
The free radical addition of a compound containing more than one Si—H bond to an olefin occurs with great ease. Thus with tetrafluoroethylene, dialkylsilanes, R_2SiH_2, yield the compounds



and alkylsilanes, $RSiH_3$, yield the compounds

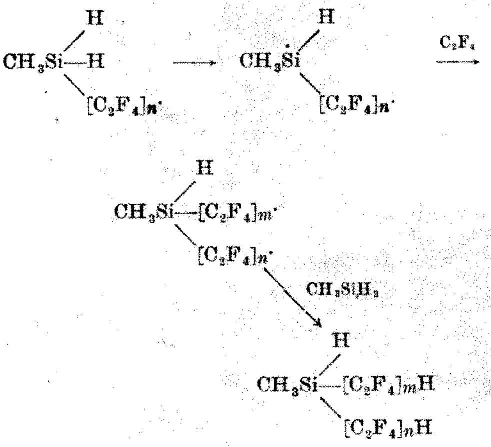


by very rapid quantitative chain reactions; for example:



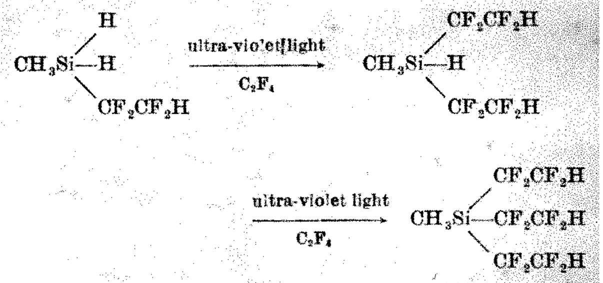
$CH_3SiH_3 \xrightarrow{\text{ultra-violet light}} CH_3\dot{Si}H_2 + H\cdot$
$CH_3\dot{Si}H_2 + C_2F_4 \longrightarrow$
CH_3Si—H
$CF_2.CF_2\cdot$
(initiation)
$+ C_2F_4 \rightarrow$
$CF_2.CF_2.CF_2.CF_2\cdot$
etc.
(propagation)
$+ CH_3SiH_3 \rightarrow$
$[CF_2.CF_2]_n\cdot$
$[CF_2.CF_2]_nH$
$+ CH_3\dot{Si}H_2$
(transfer)

The value of n can be controlled by the ratio of reactants used, and the compound where $n = 1$, for example, has been obtained in 63 per cent yield. It is noteworthy that under normal conditions the above propagation step proceeds in preference to initiation of new chains involving the second or third Si—H bonds:



Compounds containing more than one polyfluoroalkyl group attached to silicon are produced by the further reaction of the initial product $CH_3SiH_2[C_2F_4]_nH$ with tetrafluoroethylene; that is, mixed carbon–silicon di-radicals are not involved in the reaction.

The compound in which $n = 1$ can be made to react further with the same or a different olefin, so that a wide variety of silicon compounds can be obtained by this method; for example:



It is evident that such facile free-radical reactions are not restricted to silicon, and many other inorganic free radicals derived from covalent inorganic hydrides can be predicted to react with olefins such as tetrafluoroethylene. Compounds such as $P(CF_2.CF_2H)_3$, $Me_2BCF_2.CF_2H$, $MeAl(CF_2.CF_2H)_2$, $Me_3PbCF_2.CF_2H$, and $Zn(CF_2.CF_2H)_2$ should be capable of synthesis by this general method, although it is equally clear that certain of these will be stable only at relatively low temperatures.

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'Acceleration' of Chemical Reactions

In a recent monograph on the thermodynamics of irreversible processes, Prigogine[1] has investigated in some detail the time variation of the entropy production (d_i^2S/dt^2). An examination of the implications of the general theory for the case of a chemical reaction leads to some interesting new concepts.

The entropy production at any particular time is given by

$$\frac{\mathrm{d}_iS}{\mathrm{d}t} = \frac{1}{T}Av \qquad (1)$$

where T is the absolute temperature, v the reaction velocity at that moment and A the instantaneous affinity defined as $-\sum\limits_i \nu_i\mu_i$ (ν_i is here the stoichiometric coefficient and μ_i the instantaneous chemical potential of the i^{th} component involved in the reaction). The coefficients ν_i are positive for products and negative for reactants.

On differentiation of equation (1)

$$\frac{\mathrm{d}_i^2S}{\mathrm{d}t^2} = \frac{1}{T}(A\dot{v} + \dot{A}v) \qquad (2)$$

where, in general, $\dot{v}$ and $\dot{A}$ represent differential coefficients with respect to time. We now propose to term the quantity $\dot{v}$ the 'acceleration' of a chemical reaction. This conception is valid only when the reaction velocity is not constant; otherwise, of course, $\dot{v} = 0$.

Utilizing Prigogine's theorem that the contribution to the rate of change of the entropy production per unit time by the rate of change of the generalized force' is equal to the contribution due to the 'acceleration', we obtain from equation (2)

$$A\dot{v} = \dot{A}v \qquad (3)$$

The reaction velocity v may be expressed as the rate of change of the 'degree of advancement' of the chemical reaction, ξ. Thus,

$$v = \frac{\mathrm{d}\xi}{\mathrm{d}t} \text{ and } \dot{v} = \frac{\mathrm{d}^2\xi}{\mathrm{d}t^2}$$

$\mathrm{d}\xi = \mathrm{d}n_i/\nu_i$, where n_i is the mole number of the i^{th} component.

The affinity A is a function of the variables of state p (pressure), T (temperature) and ξ. At constant pressure and temperature,

$$\dot{A} = \left(\frac{\partial A}{\partial \xi}\right)_{p,T}\frac{\mathrm{d}\xi}{\mathrm{d}t}$$

and equation (3) becomes

$$A\dot{v} = \left(\frac{\partial A}{\partial \xi}\right)_{p,T}v^2$$

Hence,

$$\dot{v} = \left(\frac{\partial \ln A}{\partial \xi}\right)_{p,T}v^2 \qquad (4)$$

It is this equation (4) that provides us with an explicit relation for the 'acceleration' of a chemical reaction.

In addition, Prigogine has established a general theorem which, for our purposes, may be expressed as

$$\dot{A} \leqslant 0 \qquad (5)$$

or by

$$v^2\left(\frac{\partial A}{\partial \xi}\right) \leqslant 0$$

However, since v^2 is always a positive quantity, the above relation implies that

$$\left(\frac{\partial A}{\partial \xi}\right)_{p,T} \leqslant 0$$

that is, the affinity decreases during the course of a chemical reaction and, at equilibrium, $A = 0$,—a result well known to workers in chemical thermodynamics.

Moreover, extending the foregoing theory, we find, from equations (3) and (5),

$$A\dot{v} \leqslant 0 \qquad (6)$$

and the 'acceleration' of a chemical reaction has, in general, the opposite sign to the affinity.

These results may easily be generalized to several simultaneous, accelerated reactions by following the usual methods as outlined by Prigogine.

To sum up: some of the basic properties of the newly defined 'acceleration' of a chemical reaction—equation (4)—have here been developed for those cases where Prigogine's theorems are applicable, that is, under certain restrictive conditions indicated in his work.

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'Macrocrystalline' Carbon

From a mathematical analysis of the X-ray diffraction patterns of products obtained at various stages during the graphitization of carbon, Franklin[1], and later Houska and Warren[2], have shown that only two carbon interlayer spacings are possible: 3·35 A. for the orientated stacking in graphite, and 3·44 A. for the random orientation of the planes in carbon. Precise measurement of the interlayer spacing of cokes and carbons is not possible because of the very diffuse nature of the diffraction maxima, and it is therefore of interest to report that 'macrocrystalline' carbon with an interlayer spacing of 3·45 A. has been prepared by sublimation of artificial graphite under high vacuum. The material, as deposited, has a nodular surface with a grey metallic sheen. It has a low porosity, a hardness of between 1 and 2 on the Moh scale (compared with a value of less than 1 for graphite) and a true density of 2·22. The carbon content is greater than 99 per cent and the ash less than 0·4 per cent. The carbon planes of the individual crystallites are found to lie very approximately parallel to the surface on which deposition occurs, and the crystallite size, as shown by the sharpness of the lines in the diffraction pattern, is similar to that of artificial graphite. A diffraction pattern of this material together with patterns of graphite and a sample found to be a mixture of the two phases is shown in Fig. 1.

Contrary to expectation, this material did not graphitize readily. Prolonged treatment with strong sulphuric acid containing a little nitric acid had no effect, and temperatures in the range 2,800–3,000° C. were needed to convert a sample into graphite.

The hardness and stability of this compound suggest cross-linkage between the carbon-layer planes. Whatever form this linkage takes, the graphite layers must still be largely retained, and it must exist without introducing sufficient 3-dimensional order to give any general (*hkl*) reflexions. The method of preparation and purity of the compound make it necessary for the cross-linkage to be through carbon atoms, and some system similar to that suggested by Gibson, Holohan and Riley[3] may exist.

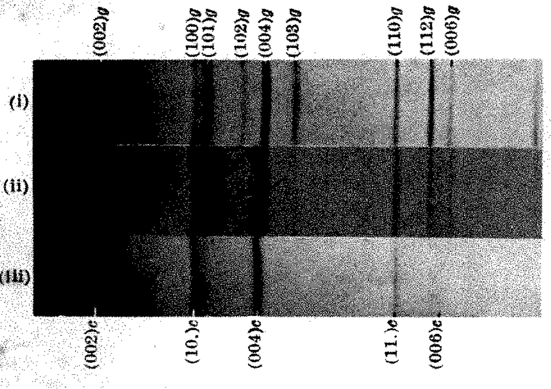

Fig. 1. (i) Natural graphite; (ii) mixture of graphite and macrocrystalline carbon; (iii) macrocrystalline carbon

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Effect of Fatigue Stresses on the Recovery Properties of Metals

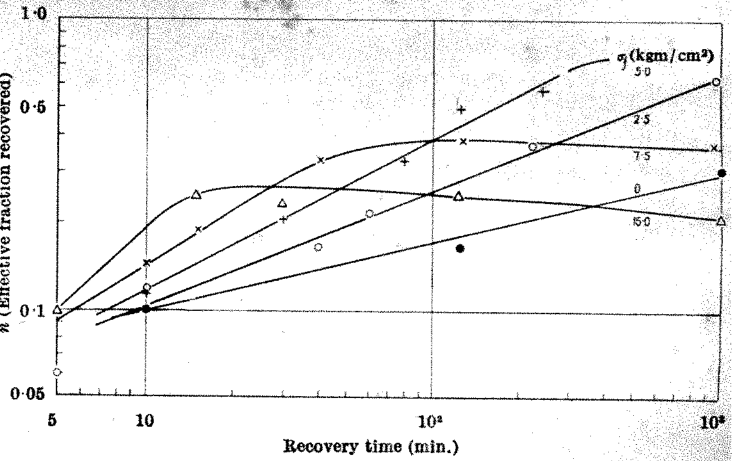

Fig. 1. Degree of recovery, represented by *n*, plotted against the recovery time for various levels of fatigue stress

In order to examine the nature of the interaction between the processes of creep, fatigue and recovery, some preliminary experiments have been conducted at room temperature on metals of low melting point. The tensile creep stress in these experiments was imposed by means of a mechanical spring system. The fatigue stress (also tensile) was applied by an electromagnetic vibrator and was detected and measured using a barium titanate crystal incorporated in the specimen grips.

A low-level sinusoidal fatigue stress (of about 300 c./s.) superimposed on the static creep stress increases the creep-rate of lead markedly. This phenomenon has already been observed by Greenwood[1]. In the present case, the measurements show that this increase is considerably greater than that resulting from applying the peak stress (static stress plus fatigue stress amplitude) statically. The most interesting results, however, are those which relate to the recovery processes. The investigation has been confined, to date, to the recovery of the transient creep properties during the unstressed period of an interrupted creep test. The degree of recovery that occurs may, of course, be deduced from the subsequent creep behaviour on reloading. All the specimens were subjected to a fixed amount of creep, under fixed conditions of stress and temperature, prior to the recovery period (ρ). The stress conditions applied during this period were varied, for the different tests, and an index of recovery, *n*, was deduced from the subsequent creep curve. The use of this index has been demonstrated elsewhere[2]; it is sufficient to say here that it represents the magnitude of the transient creep component on reloading by expressing this as a fraction of the original component for the fully annealed metal. Thus if the original transient creep is expressed in the usual power-law form by $\varepsilon = \beta_1 t^m$, where ε is strain and t the time, β_1 and m being constants, and if the 'recovered' component, exhibited on reloading, is given by $\beta_2 t^m$, then $\beta_2/\beta_1 = n$.

The results of a series of experiments on lead are given in Fig. 1. If no fatigue stress is imposed during the recovery period, we obtain a linear relationship between log *n* and log ρ, with a slope of about 1/3. This is in accord with previous work[2]. As the fatigue stress is increased, the rate of recovery at first increases; but eventually a second process, which has the characteristics of hardening, occurs. This slows up, or reduces, the total recovery observed. At higher fatigue stresses, the metal either fails by fatigue during the recovery period or fails shortly after reloading. The acceleration of recovery by the fatigue stress is similar to that observed in copper and other metals, using hardness as an index[3]. No previous observations appear to have been made on the transient creep recovery. This also appears to be the first observation of a 'mechanical re-hardening' under fatigue stresses.

Any adequate theory for these observations must take account of these two broad effects, acting in opposition. The present state of dislocation theory offers a reasonable basis for their interpretation. This may be very briefly summarized as follows. Dislocation jogs are formed by the intersection of dislocations during the creep process. These jogs, in motion, can generate vacancies (or interstitials). Such generation occurs, therefore, under the alternating stresses during the recovery period. The increased number of vacancies generated increases the probability of their diffusion to dislocations, and hence the probability of dislocations climbing. The rate of polygonization, which is controlled in part by the climb process, is therefore accelerated. This, then, is a possible mechanism for increased recovery. On the other hand, these same vacancies contribute to work-hardening by impeding dislocation motion, particularly when they form clusters, and over prolonged times this second process reduces the effects of the first. Ultimately the metal fails in fatigue by the growth of a crack initiated from a vacancy cluster, probably aggregated by dislocations acting as carriers.

It is interesting to compare results obtained in a very different field[4]. An initial softening of sodium chloride single crystals irradiated by 50-kV. X-rays was followed by a hardening over very prolonged times. This appears to be similarly explicable in terms of the vacancies created by the irradiation.

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Flow-Birefringence and Stress

IN a recent communication[1], Dr. A. S. Lodge proposed: (*a*) to equate the extinction angle χ in flow-birefringence with the direction of the principal tensile stress, and (*b*) that the degree of birefringence Δn is proportional to the magnitude of the difference of the principal tensile and compressive stresses ΔP. For *plane* simple shear, $\Delta P \times \sin 2\chi = 2\tau$ or $\tan 2\chi = 2\tau/(\sigma_x - \sigma_y)$, where τ is the measured shear stress, $\sigma_x - \sigma_y$ the difference in 'normal stresses', both of which can be derived by various methods, for example, using Mohr's circle[2].

Lodge mentioned the possibility of the experimental proof of this assumption by simultaneous measurements of both the flow-birefringence and the normal stress $\sigma_x - \sigma_y$ $(= P_{11} - P_{22})$ using the Weissenberg rheogoniometer[3].

We investigated this possibility on a 15 per cent solution of *P*-100 poly*iso*butylene in decalin (maximum viscosity approximately 10,000 poises or a relative viscosity of $\sim 10^6$) at 30° and 50° C. in a range of rates of shear, D, from 0·007 to 4·5 sec.$^{-1}$. Three sets of experiments with separate instruments were run: (1) flow-birefringence tests, giving Δn and χ as functions of D; (2) 'flow curves' giving the shear stress τ as a function of D; and (3) 'normal stress' experiments giving $\sigma_x - \sigma_y$ as a function of D from measurements of the total thrust F, divided by the area (πR^2) of the plate in the cone-and-plate arrangement[4], $\sigma_x - \sigma_y = \dfrac{2F}{\pi R^2}$. We then made the following checks:

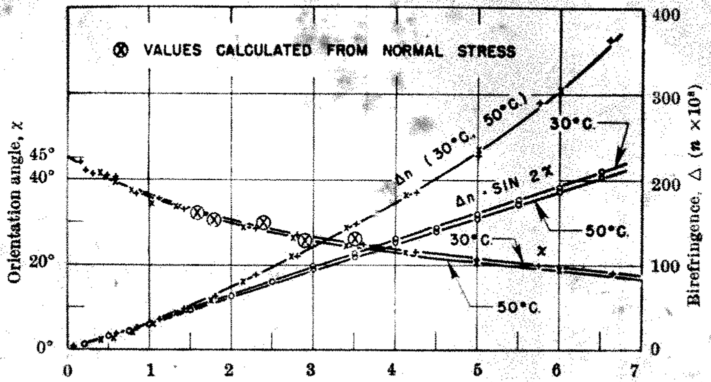

Fig. 1

(*a*) According to Lodge's assumption, Δn should be proportional to Δp for any solution, a relationship that was derived by Kuhn and Grün[5] and generalized by Treloar[6] for the stress-birefringence of highly elastic materials, such as rubber. As Lodge states, the identical relationship has been derived by Kuhn and Kuhn[7] for the flow-birefringence of an infinitely dilute solution of free-draining coiled molecules. As seen in Fig. 1, this proportionality is valid in the whole range of rates of shear investigated at both temperatures. The plot of Δn vs. τ proposed by Peterlin and Signer[8] is definitely curved upwards.

(*b*) The calculated values of χ from the normal stress measurements are plotted in Fig. 1 as circles: they check within 1° with the χ-values determined from the flow-birefringence experiments.

These checks show that the basic assumption of stress-birefringence of solids, that is, the proportionality of Δn and the difference of the principal stresses, is equally valid for the flow-birefringence of polymer solutions. The angle χ, giving the direction of the principal tensile stress, can be used to calculate the normal stress from the shear-stress and vice versa.

These checks probably will allow the well-developed results for the rheology of rubber (incompressible materials characterized by one shear modulus)—a 'continuum-mechanical theory' that has been summarized in Treloar's book—to be applied to the problem of the elasticity of flowing solutions of polymers, which have been treated hitherto by 'molecular theories'.

The proportionality constant, C, between Δn and ΔP:

$$C = \frac{\Delta n}{\Delta p} = \frac{2\pi}{45} \frac{(n^2 + 2)^2}{n} \frac{\alpha_1 - \alpha_2}{\kappa T}$$

depends essentially on the polarizabilities α_1 and α_2 of the monomer unit, which are calculable to some degree from the structural formula[9]. This would lead one to expect Lodge's result, namely, its independence of concentration of polymer and distribution of chain-length. Our values for $(\Delta p/\Delta n)T$ were $2{\cdot}14 \times 0{\cdot}10^7$ and $2{\cdot}04 \times 0{\cdot}10^7$ for 30° and 50° C. respectively, as compared with $2{\cdot}1 \times 10^7$ at 30° C. or $2{\cdot}3 \times 10^7$ at $-35°$ C. measured for solid poly*iso*butylene by Stein, Holmes and Tobolsky[10]; n for the solid polymer is approximately equal to that of the solution.

A comparison of the viscosity, η, at a given rate of shear, to the maximum value at low rates of shear, η_0, showed that the relationship proposed by Buchheim and Philippoff[11], namely, $\eta/\eta_0, = \sin 2\chi$, was not valid, η decreasing faster than $\sin 2\chi$ with D.

A check of the numerical evaluation of the theory of prolate ellipsoids published by Scheraga[12] showed that a proportionality between Δn and τ exists until

$$\alpha = \frac{\text{rate of shear}}{\text{rotational diffusion constant}} \approx 5, \text{ or until}$$

$\chi \approx 25°$, not the one between Δn and Δp. $\eta/\eta_0 = \sin 2\chi$ is valid in the whole range with deviation of only a few per cent. Whether this is a result of the assumptions in the mathematical theory or is due to a basically different mechanism of flow cannot yet be decided.

Further tests on the dynamic properties of the same solution (dynamic shear modulus and dynamic viscosity) over a wide range of frequency gave values not directly comparable with that calculated from the flow experiments, pointing to an obvious gap in the theory of such comparisons.

A more extensive publication will follow in the *Journal of Applied Physics*, following a paper presented at the meeting of the American Physical Society, High Polymer Physics Division, in Pittsburgh, Pa., on March 16, 1956.

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April 6.

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Differential Sputtering of Grain Boundaries in Polycrystalline Tin

IT has been reported[1] that in a polycrystalline aggregate the properties of grain boundaries such as precipitation and chemical etching depend upon the difference in orientation of the adjoining grains. During our studies of cathodic sputtering of polycrystalline tin, we have observed differential etching from boundaries forming tricrystals[2]. Further work has shown that this differential etching can be correlated with the varying density of dislocation along the boundaries.

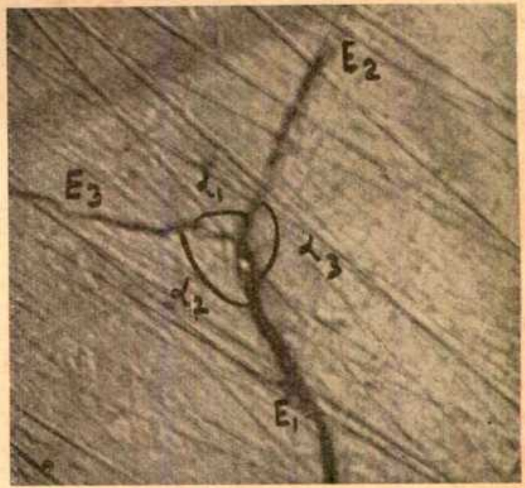

Fig. 1

A specimen of high-purity well-annealed polycrystalline (white) tin was polished mechanically. It was subjected to slow sputtering in a flushing atmosphere of argon (pressure about 0·1 mm.) employing the usual technique. The cathode–anode gap was 1·2 cm. and the applied rectified potential was 500 volts. Fig. 1 (× 100), showing a typical micrograph of the sputtered surface, is representative of a large number of results.

The dihedral angles, α, between the tricrystal boundaries were measured close to the junction within an accuracy of 1°. The relative grain-boundary free energies E were calculated by the expression

$$\frac{E_1}{\sin \alpha_1} = \frac{E_2}{\sin \alpha_2} = \frac{E_3}{\sin \alpha_3}$$

We have assumed the energy E_1 of the most etched boundary arbitrarily to be unity. The difference of orientation, θ, between the adjoining grains was obtained from Aust and Chalmers's data[3] for the grain-boundary energy vs. small angle of misfit for white tin. The Burgers vector b is taken as 5·831 A. Using the dislocation model of a simple grain boundary, the relative dislocation densities ($= \theta^2$ rad$/b^2$) along the tricrystal boundaries have been evaluated (see Table 1).

It is easy to see that the sputtering of the grain boundaries depends upon the density of dislocations, those with higher densities of dislocation having sputtered to a greater extent. The results support the 'transition lattice' theory of the grain boundary.

Thanks are due to the Council for Scientific and Industrial Research, Ministry of Education, Government of India, and the Scientific Committee, Uttar Pradesh, for support of the research schemes,

Table 1

Grain boundary	Opposite dihedral angles ($\alpha°$)	Relative boundary energies (E)	Relative difference in orientation ($\theta°$)	Relative densities of dislocation
Most etched	$\alpha_1 = 101$	$E_1 = 1{\cdot}000$	9·0	$7{\cdot}26 \times 10^{12}$/cm.^{2}
Moderately etched	$\alpha_2 = 117$	$E_2 = 0{\cdot}908$	6·6	3·90
Least etched	$\alpha_3 = 142$	$E_3 = 0{\cdot}626$	3·1	0·86

and to the Physics Department, University of Lucknow, for facilities for this work. One of us (B. D. S.) wishes to thank the Scientific Research Committee, Uttar Pradesh, for the award of a research assistantship.

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Influence of Trace Electrolytes on Interfacial Tensions at the Oil/Detergent Solution Interface

Recently, there has been some discussion between Brady, Pethica, Cockbain and others regarding the form in which the Gibbs adsorption isotherm should be applied to surface-active electrolytes in the absence of any added electrolyte. Under such conditions, and assuming complete dissociation of the surface-active electrolytes, it has been shown, for example[1], that the Gibbs equation (neglecting the correction for activities) may be written in the form

$$\frac{2kT}{A} = -c\frac{d\gamma}{dc} \qquad (1)$$

where γ is the interfacial tension; c the concentration of surface-active electrolyte; A the area occupied per film ion at the interface; k the Boltzmann constant, and T the absolute temperature. This has been verified by Cockbain[2] for sodium dodecyl sulphate at the oil–water interface. Other investigators, however, have found[3,4] that the form theoretically applicable in the case of excess added electrolyte, namely,

$$\frac{kT}{A} = -c\frac{d\gamma}{dc} \qquad (2)$$

appears also to apply in practice to the case of no added electrolyte.

While studying the interfacial tension behaviour of ionic detergents adsorbed at an oil (petroleum ether, b.pt. ~ 120° C.)–water interface a curious effect was observed, which may well reconcile these discordant results both with each other and with theory. Four systems have been investigated, namely, sodium dodecyl sulphate and dodecyltrimethylammonium bromide each in aqueous solution and in 0·1 *M* sodium chloride. Interfacial tensions were determined by a drop volume method.

The results for each detergent in 0·1 *M* sodium chloride appeared normal. Ageing was appreciable only at very dilute concentrations ($\sim 10^{-5}$ *M*). In aqueous solution, however, the results depended on the purity of the water used.

In the first series of experiments the aqueous solutions were made up with water from a standard Manesty still (specific conductance $\sim 4 \times 10^{-6}$ ohm^{-1} cm.$^{-1}$). Ageing effects extending over hours were observed with sodium dodecyl sulphate at all concentrations studied ($\sim 10^{-2} - 10^{-4}$ *M*) and with dodecyltrimethylammonium bromide at concentrations $\sim 10^{-3}$ *M*. This work was repeated using the same water redistilled from a glass still and freshly boiled to remove carbon dioxide (specific conductance $\sim 2 \times 10^{-6}$), but little improvement was noted.

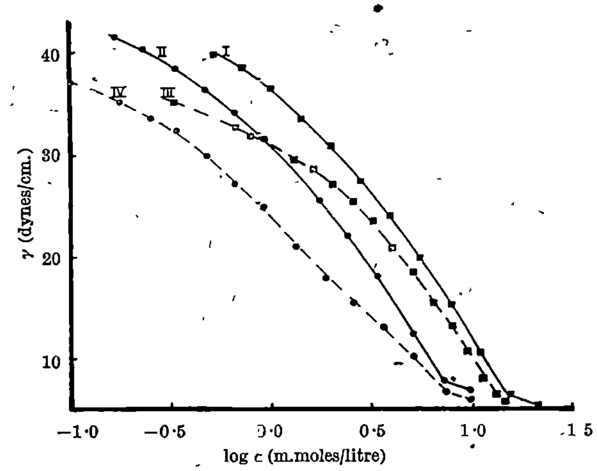

Fig. 1. Interfacial tensions of sodium dodecyl sulphate and dodecyltrimethylammonium bromide at the petroleum ether–water interface.
I, Dodecyltrimethylammonium bromide in water passed twice through a column of 'Biodeminrolit'; II, sodium dodecyl sulphate in water passed twice through a column of 'Biodeminrolit'; III, dodecyltrimethylammonium bromide in glass-distilled water; IV, sodium dodecyl sulphate in glass-distilled water

Finally, the Manesty-distilled water was passed twice through a column of ion exchange resin ('Biodeminrolit') and collected in polythene vessels (specific conductance $\sim 0{\cdot}9 \times 10^{-6}$ ohm^{-1} cm.$^{-1}$), no special precautions being taken to exclude carbon dioxide or ammonia present in the atmosphere. In this instance little ageing was observed except in very dilute solution, and the γ-$\log_{10}c$ curves obtained (Fig. 1) were found to be displaced from the original curves towards higher interfacial tensions at comparable concentrations.

Surface potential studies with dodecyltrimethylammonium bromide by us (which will be described elsewhere) permitted the surface area (A) occupied per film ion to be determined independently of the Gibbs equation, thus enabling the correct form of the Gibbs equation to be found. It was found that with glass-distilled water the 1.kT form (equation (2)) applied, while with ion-free water the 2.kT form (equation (1)) was appropriate. This suggests that glass-distilled water contains a swamping excess of electrolyte, but the conductivity values indicate this is not so. We must conclude, therefore, that this anomalous behaviour in normal distilled water is due to a specific adsorption at the interface of one or more trace counter ions present in the bulk, although no attempt has been made to determine the nature of these ions. Likewise, the long ageing effects can be attributed to the slow adsorption of the trace counter ions from the bulk of the solution.

Thus the disagreement regarding the appropriate form of the Gibbs equation to be applied to surface-active electrolytes in the absence of added electrolyte may be due merely to the purity of the water employed by the different investigators. In conclusion, it may be added that the results reported here for ionic detergents add to the extensive literature already available, for example, on the sensitivity of monolayers in general[5-9], and carboxylic soap films in particular, to trace electrolytes.

We wish to express our thanks to Sir Eric Rideal for many interesting discussions, and for the valuable suggestions arising therefrom.

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'Continuous' Intensities in the Soft X-Ray Region

The generally accepted empirical law relating the intensity of the 'continuous' X-radiation with energy and atomic number, $I = kZV^2$ (for constant current), is known to apply to the 'hard' X-ray region; but its validity has never been established in the 'soft' X-ray region. The classical experiments which established it were done with deep ionization chambers; the integrated intensity over the whole band of emitted wave-lengths as well as the intensity at any arbitrary wave-length over the range were found to fulfil the above law approximately.

We have attempted to see how far this law was obeyed in the soft X-ray region using a 15-stage beryllium–copper photomultiplier in vacuum as detector, together with a d.c. amplifier as recorder of the total radiation emitted from the target. Our experiments were confined to two types of thick target—copper and carbon—over a range of energies from 200 V. to 8,000 V., that is, from thresholds of 62 A. to 1·5 A. respectively. Previous experiments with photographic plates had shown that 'background' radiation was emitted over a wide range of wave-lengths from the 'threshold' to well over 500 A.; this was superimposed on the characteristic soft X-radiation from the target. The latter occurs for copper at about 13 A. and 170 A. for the *L* and *M* bands respectively, while the *K* radiation of carbon was excited at about 45 A.

In order to avoid spurious results, the targets were bombarded at a red heat in vacuum for several periods of 15 min. each, before making observations; the surface, conditioned in this way, gave repeatable results over the time taken by the observations, which was generally a few minutes. The choice of working conditions was facilitated by having the target rotatable on a ground joint so that the angle of optimum intensity through the main and subsidiary slits (0·1 mm. and 5·0 mm. respectively) could be accurately set, to give a maximum of intensity for all the wave-lengths emitted into the photomultiplier. This is usually close to grazing incidence.

The procedure adopted was to apply a constant voltage to the target and vary the current, noting the d.c. output response. This was repeated over the whole range explored. All the results both from 'contaminated' and clean targets showed that for any fixed voltage the X-ray output is directly proportional to the current. However, for any fixed current, the output is approximately proportional to the *first* power of the voltage. This is illustrated in Fig. 1, where log intensity is plotted against log voltage for two different current values in the case of clean targets of copper and carbon. Except for the lowest energy points for carbon at 200 volts, the slope is about 1·15, so that in this region of soft X-rays, the 'square' law does not appear to be valid.

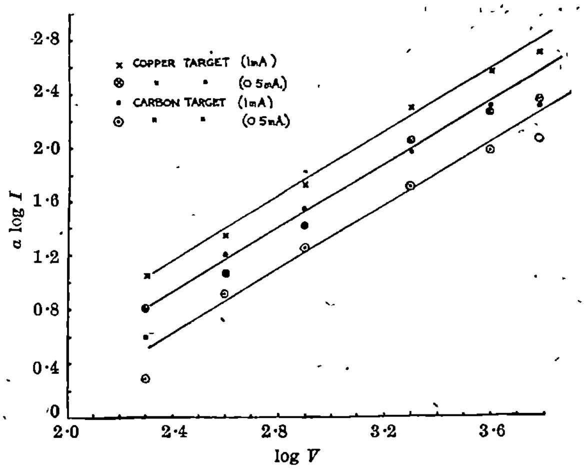

Fig. 1

It will also be seen that the dependence on atomic number is no longer given by the empirical relation, for the ratio decreases from about 3 at the lowest energy to about 2 for medium and high energies in the range chosen. It is hoped to publish fuller details at a later date.

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Importance of Gas Spaces in the Propagation of Detonation of Granular Explosives

It has been suggested that in low- and medium-velocity detonation in condensed explosives, propagation may be due to heating in the shock front of gas entrapped in the explosive[1]. The temperature in these gas pockets has been shown to be very high[2], and the hypothesis is confirmed by the known effect of increase in gas pressure in stopping detonation in certain granular explosives[1]. The temperature attained in the gas depends on the compression ratio and the ratio of the specific heats of the gas, γ. If the hypothesis is correct, increase of γ should cause an increased temperature, and hence an increased rate of reaction, which should be manifested as an increase in the velocity of detonation of the explosive fired at cartridge diameters below that required for maximum velocity. We have now demonstrated this effect experimentally.

We have examined the effect of replacing air ($\gamma = 1{\cdot}40$) by argon ($\gamma = 1{\cdot}67$) as the surrounding medium on the velocity of detonation of two granular explosives. These were granular T.N.T. (Grade 1, 22–30 B.S.S.) of density 1·00 gm./cm.^{3} and cartridge diameter 1¼ in., and an 82/18 mixture of ammonium nitrate (specific surface 1,200 cm.^{2}/gm.) and aluminium (specific surface 1,600 cm.^{2}/gm.) of density 0·75 gm./cm.^{3} and cartridge diameter $\frac{7}{8}$ in. The velocity of detonation was measured photographically.

For the T.N.T. the velocity of detonation in air was 1,380 ± 20 m./s., and in argon 1,580 ± 15 m./s. For the ammonium nitrate composition, the velocities were 2,850 ± 30 m./s., and 3,100 ± 30 m./s., respectively, the limits quoted being standard deviations. There is clearly a significant increase in velocity, which further confirms the view that the mechanism of propagation of detonation involves heating of the gas spaces by the shock front.

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Effect of Lightning Discharges on Magnetographs

Chaubal, Deshmukh and Malurkar[1] recently reported an instance of "minor oscillations" recorded particularly by the La Cour *H* and *D* magnetographs of the Alibag Observatory during a thunderstorm which passed over Alibag on June 2, 1955. They were interested to know if similar observations were available from other observatories.

Since 1952, two complete sets of photographically recording magnetographs, one Watson and the other La Cour, have been functioning regularly in the Magnetic Section of the Kodaikanal Observatory. During the past four years or more, in the thunderstorm seasons, I have often noticed in the traces of these magnetographs oscillations of precisely the same character as reported by Mr. S. L. Malurkar and his co-workers. I have always thought them to be caused by lightning discharges. However, I have now examined all our La Cour and Watson records from 1952 to date in order to check the correctness of the impression that these characteristic oscillations are of rather common occurrence and are indeed associated with thunderstorms. In our records there are some dozens of instances of such oscillations which correspond with thunder and lightning reported by our weather observer. There are also some instances in which similar, though usually less-marked, oscillations are noticeable, but no corresponding thunderstorms are recorded in the weather observer's diary. The cause of these latter oscillations is obscure; perhaps, during the normal watch hours the weather observer has not noticed the somewhat distant or minor lightning discharges, and presumably has not reported all the thunderstorms that may have occurred late in the night. It is also not impossible that some of the very feeble oscillations are due to the momentary, but heavy, direct current which the battery supplies to the self-starter of a motor-car engine starting up rather close to the magnetic observatory. However, in all cases in which there is correspondence between the magnetic oscillations recorded and the lightning reported there can be little doubt but that it is the short-duration electric currents accompanying lightning strokes which are responsible for the perturbations recorded by the magnetographs.

The variometer room at Kodaikanal is a very substantially built, thermally well-insulated chamber with a thick roof and heavy double walls of stone masonry. Both the Watson and La Cour variometers are installed on piers supported by the masonry floor in exactly the same manner. The sensitivity (taken to mean the ability to respond fully to a variation of duration comparable or greater than the period of the instrument) of the Watson *HF* instrument is considerably higher than that of the corresponding La Cour instrument. It does not seem that the method of mounting of a magnetograph has much to do with its capacity for recording the oscillations caused by impulsive lightning discharges.

From Kodaikanal records it is clear that often the magnetic oscillations due to lightning strokes occur simultaneously in all the three traces (*H*, *D* and *V*) of the La Cour variometers, although the amplitudes are different in the three components, evidently because the corresponding intensities are also different. We have many instances in which the Watson instruments (especially *H* and *D*, the performance of the *VF* instrument being often unsatisfactory) have also recorded such oscillations during thunderstorms; but these oscillations have smaller amplitudes than those recorded by the La Cour variometers, and are very much damped. These differences are evidently attributable to the fact that compared to the La Cour variometers the Watson magnetographs have considerably greater inertia and higher damping.

I am indebted to Mr. R. V. Subramanian for assistance in examining the magnetic records.

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Vowel Sounds and Perceptual Constancy

IT has been known for some time that vowels are distinguished from one another mainly by the frequencies of the formants or regions of the auditory spectrum in which there is a comparatively large amount of energy. Recently, the hypothesis has been put forward by Joos[1] that when a listener identifies the vowel in a particular word he does so not by considering the absolute value of the lowest two formant frequencies, as was previously thought, but by assessing the frequencies of these formants in relation to the formant frequencies of other vowels which he has heard pronounced by that speaker. On this hypothesis, the identification of a particular sound depends on the acoustic structure of the neighbouring sounds.

A similar process is known to occur in the perception of other kinds of sensory data. Thus in visual experiments the same response, 'white', may be given to a piece of paper in sunlight and in an artificially lighted room, despite the wide differences in the spectra of the light reflected from the paper: the other neighbouring stimuli compensate for the differences[2].

It has recently become possible to demonstrate the auditory phenomenon with the aid of synthetic speech, which can now be precisely controlled and yet sound so natural that it is invariably confused with ordinary recorded speech. The instrument accomplishing this is the Parametric Artificial Talking Device of the Ministry of Supply Signals Research and Development Establishment. The sounds of most utterances can be specified in terms of six variables. Three of these are the formant frequencies: the other three are the intensity of the voicing; the intensity of the fricative noise which is present in some sounds such as *s*; and the fundamental frequency, which determines the pitch of the utterance. In the Parametric Artificial Talking Device, complex sounds are synthesized in accordance with the variations of these six parameters as functions of time.

In the current experiment, two versions of the phrase *Please say what this word is* were synthesized. The two versions were the same except in the range of their first formants, which were as shown in Table 1. Each version was followed by an identical test sound, which was a word of the form *b*-(vowel)-*t*. Recordings of these sentences followed by the test word were played to fifteen subjects, the playings being separated by at least five minutes. The subjects were asked to indicate whether the last word was *bit, bet, bat* or *but*. Fourteen of them reported hearing different words in the two cases, despite the identical physical stimulus. The experiment was repeated on fifteen different subjects, but with a ten-second silent interval between the introductory sentence and the test word. In this case only seven subjects described the words as different; the difference between the two groups is significant, $p < 0{\cdot}01$ by the exact treatment of a 2×2 table.

Table 1. DISTRIBUTION OF RESPONSES FROM THIRTY SUBJECTS

Preceding words with	Test word heard as *Bit*	*Bet*	*Bat*
First formant, 300–675 c.p s.	20	10	0
First formant, 150–400 c.p.s.	0	19	11

This establishes that there is an auditory parallel to the visual constancy effects cited earlier. Furthermore, the slight differences present in the auditory case may allow fresh experiments to reveal the mechanism of these constancy phenomena. Unlike the visual case, the auditory one allows interpolation of other voices, skewing of the distribution of preliminary stimuli, and similar experiments directed at comparing constancy phenomena with data on level of adaptation in psychophysics[3].

Finally, the experiment also demonstrates the value of a speech synthesizer, since comparable control of the stimulus could not be achieved using a live voice. The psychological and phonetic implications of these results are now being followed up in further experiments using synthetic speech.

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Ministry of Supply
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"Automation Economics"

In his review of my book "The Economic Consequences of Automation" (September 1, p. 444), Mr. Austen Albu, while giving me credit for the originality of my argument on the inflationary effect of the pipeline-lag between input and output during periods of increasing production, accuses me of having contradicted my own theory. He states that the argument conflicts with my view that automation reduces the extent of inflation by raising the output of goods and reducing the need for labour.

Mr. Albu should have noticed, in my chapter entitled "Deflation or Inflation?", the following sentence: "It is our contention that, provided that there is an increase in the *aggregate* cost of production, the increase in the output is likely to be preceded by an increase in prices, even if there is a decline in the cost per unit" (p. 77).

The word 'aggregate' was italicized in the book. Had he noticed it, he could not possibly have attributed to me the categorical view that automation reduces the extent of inflation. It depends on how automation affects the aggregate cost of production as distinct from cost per unit of output. My attitude is defined even more clearly in the following passage: "In so far as the grand total paid out for raw materials, transport, wages, etc., is reduced [by automation] it results in a reduction in total income and consumers purchasing power, and should therefore tend to produce a deflationary effect. If, however, the total is increased, then the effect of automation will be inflationary even if the cost of production is reduced. . . . For during the 'pipeline-lag' described above, the volume of consumer purchasing power will increase without being accompanied by a corresponding increase in the volume of goods available to consumers" (p. 80).

Throughout the book I endeavoured to avoid answering with a dogmatic 'yes' or 'no' the large number of questions raised by automation in the economic sphere. I gave a list of influences working in favour or against inflation, deflation, unemployment, capital requirements, etc. A reviewer could easily single out apparently conflicting statements and accuse me of having contradicted myself; the only way in which I could have avoided this would have been by presenting only one side of the arguments. Instead, I prefer to rely on the judgment of those who will read my book with sufficient care to form a well-balanced opinion on it.

PAUL EINZIG

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London, E.C.4.

If one accepts Dr. Einzig's view that all steps taken to increase production are inflationary, then the only distinguishable effect of automation is, as he says on p. 84, to reduce the extent of inflation. I think that the appearance of inconsistency arises out of the impression given by the title and some of the chapters that the book is about this mysterious concept 'automation'; whereas it is, in fact, a consideration of more general economic problems.

AUSTEN ALBU

6 Hampstead Hill Mansions,
Downshire Hill,
London, N.W.3.

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, October 15

Society of Chemical Industry, Pesticides Group (at 14 Belgrave quare, London, S.W.1), at 5.30 p.m.—Dr. J. A. Freeman: "Grain torage Problems".

University of London (at the Institute of Education, Malet treet, London, W.C.1), at 5.30 p.m.—Mrs. E. C. Mee: "Junior chool Education Today"*. (Second of eight lectures on "Problems f the Junior School". Further lectures on October 22, 29, November 5, 2, 19 and 26.)

Royal Institute of Chemistry, London Section (at the North-West Kent College of Technology, Miskin Road, Dartford), at 7.30 p.m. –Prof. A. R. Ubbelohde, F.R.S.: "Melting and Crystal Structure".

Tuesday, October 16

University of London (in the Anatomy Theatre, University ollege, Gower Street, London, W.C.1), at 1.15 p.m.—Mr. A. J. Taylor: Machines and Men: The Nineteenth Century Background to utomation"*.

Institute of Navigation (at the Royal Geographical Society, Kensington Gore, London, S.W.7), at 3 p.m.—Annual General eeting. Captain A. M. A. Majendie: "The Place of Navigation in odern Air Transport". (Presidential Address.)

Institution of British Agricultural Engineers (at the Royal ociety of Arts, 6 John Adam Street, London, W.C.2), at 4 p.m.—r. D. R. Bomford—John Fowler Memorial Lecture.

Institution of Chemical Engineers (at the Geological Society, urlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. R. ayler and Mr. H. R. C. Pratt: "Liquid–Liquid Extraction", Parts and 10; Mr. H. R. C. Pratt, Mr. L. E. Smith and Mr. J. D. Thornton: Liquid–Liquid Extraction", Part 11.

Royal Institute of Chemistry (at University College, Gower treet, London, W.C.1), at 5.30 p.m.—Dr. P. Gray: "The Chemistry f Dinitrogen Tetroxide". (Meldola Medal Lecture.)

University of London (at the London School of Hygiene and ropical Medicine, Keppel Street, Gower Street, London, W.C.1), t 5.30 p.m.—Dr. K. M. Smith: "The Electron Microscope in the tudy of Viruses*". (Second of fourteen lectures on "The Scientific asis of Medicine".)

Royal Institution (at 21 Albemarle Street, London, W.1), at p.m.—Dr. A. C. Menzies: "Optics in Industry". (Further lectures n October 23, 30, and November 6.)

Wednesday, October 17

University of London (at the Postgraduate Medical School of ondon, Ducane Road, London, W.12), at 2 p.m.—Prof. A. Neuberger: The Proteins of Connective Tissue"*.

Royal Meteorological Society (at 49 Cromwell Road, London, W.7), at 5 p.m.—Scientific Papers.

Royal Society of Medicine, Comparative Medicine Section t 1 Wimpole Street, London, W.1), at 5 p.m.—Dr. Douglas McClean: The Scientist as Citizen" (Presidential Address).

British Coal Utilisation Research Association (in the Lecture heatre, Institution of Civil Engineers, Great George Street, London, W.1), at 5.30 p.m.—Prof D. M. Newitt, F.R.S.: "Some Contribu-ons of Chemical Engineering to the Processing of Coal". (Fifth oal Science Lecture.)

Eugenics Society (at the Royal Society, Burlington House, iccadilly, London, W.1), at 5.30 p.m.—Symposium on "Artificial nsemination (Donor)"*.

Institution of Electrical Engineers, Radio and Telecommunication Section (at Savoy Place, London, W.C.2), at 5.30 p.m.—r. R. C. G Williams: "The Electronic Age". (Chairman's Address.)

Royal Microscopical Society (at Tavistock House South, Tavi-ock Square, London, W.C.1), at 5.30 p m.—Dr. R. Barer: "Further evelopments in Quantitative Microscopy".

Society of Chemical Industry, Corrosion Group (at 14 Belgrave quare, London, S.W 1), at 6.30 p.m.—Mr. M. A. Pearson: "Hydrazine a Corrosion Inhibitor".

Society of Chemical Industry (joint meeting with the London ection of the Royal Institute of Chemistry at the Institute of Metals, Grosvenor Gardens, London, S.W.1), at 6.30 p.m.—Mr. R. Llewelyn avies: "Design of Research Laboratories".

Thursday, October 18

University of London (in the Anatomy Theatre, University ollege, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. R. S yholm: "Magnetism and its Importance in Everyday Life"*.

Institution of Mining and Metallurgy (at the Geological ociety, Burlington House, Piccadilly, London, W.1), at 5 p.m.—r. E. J. Pryor and Mr G. M. Lowe: "Changes in Copper Solubility uring Flotation of Malachite": Dr. J. M. Fletcher, Dr. D. F. C. orris and Mr. A. G. Wain: "Outline of a Solvent Extraction Process r the Purification of Niobium from Ores or from Ferroniobium".

Linnean Society of London (at Burlington House, Piccadilly, ondon, W.1), at 5 p.m.—Mr. Harry V. Thompson: "Myxomatosis nd the Rabbit in Britain"; Prof. H. R. Hewer: "The Method of ispersal of Animals".

University of London (at Goldsmiths' College, New Cross, London, S.E.14), at 5 p.m.—Prof. H. J. Eysenck: "Measuring Human Personality"*. (Second of six lectures on "Recent Pioneer Work in Education". Further lectures on October 25, November 1, 8 and 15.)

Institution of Civil Engineers (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. G. M. Binnie: "The Control, Storage and Use of Water". (Second of a series of six lectures on "The Conservation of Natural Resources".)

University of London (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 5.30 p.m.—Dr F. H. C. Crick: "The Structure and Function of Small Viruses"*. (Third of fourteen lectures on "The Scientific Basis of Medicine".)

Society of Chemical Industry, Road and Building Materials Group (at 14 Belgrave Square, London, S.W.1), at 6 p.m —Dr. P. J. Rigden: "Roads and Road Problems in South Africa".

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

Friday, October 19

Institution of Electrical Engineers, Education Discussion Circle (at Savoy Place, London, W.C.2), at 6 p.m.—Discussion on "Experiments for the Electronics Laboratory", opened by Mr. V. Attree.

Institution of Mechanical Engineers (at 1 Birdcage Walk, Westminster, London, S.W.1) at 6 p.m.—Mr. T. A. Crowe: "Motive Power on Sea and Land". (Presidential Address.)

Institution of Chemical Engineers, Graduates and Students Section (at Caxton Hall, Westminster, London, S.W.1), at 6.30 p.m.—"Impressions of the German Chemical Industry". (Conversazione on the Overseas Industrial Tour, 1956.)

Saturday, October 20

British Psychological Society (in the Psychology Department, Birkbeck College, Malet Street, London, W.C.1), at 2.30 p.m.—Dr. David Hamlyn: "Is a Theory of Perception Possible?"

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S.E 23), at 3.30 p.m.—Mr. Colin M. Turnbull: "Life in a Congo Village"*.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Lecturer, Grade B (honours graduate) in Physics at Brighton Technical College—The Director of Education, 54 Old Steine, Brighton (October 18).

Assistant Lecturer or Lecturer (with special interests in mineralogy and petrology) in the Department of Geology—The Registrar, University College, Singleton Park, Swansea (October 20).

Lecturer in Papermaking Technology—The Registrar, Manchester College of Science and Technology, Manchester 1 (October 20).

Biochemist, Senior grade—The Medical Superintendent, Stobhill General Hospital, Glasgow, N.1 (October 27).

Director of the Computing Unit—The Secretary of Faculties, University Registry, Oxford (October 30).

Assistant Experimental Officer (preferably with a degree in biology or at least H.S.C. or G C.E. to advanced level with biology or equivalent) at Merlewood Research Station, Grange-over-Sands, Lancashire, for work on soil invertebrates, including some field work—The Establishment Officer, The Nature Conservancy, 19 Belgrave Square, London, S W.1 (October 31).

Assistants in Mathematics—The Secretary of University Court, The University, Glasgow (October 31).

Chair of Psychology in Canterbury University College, Christchurch, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (October 31).

Lecturer in Psychology—The Registrar (Room 9, O.R.B.), The University, Reading (October 31).

Post-Doctoral Research Fellow in Organic Chemistry—The Secretary, The Queen's University, Belfast (October 31).

Principal (with high academic qualifications and appropriate educational and administrative experience in a University College or Technical College)—The Clerk to the Governors, Woolwich Polytechnic, London, S E 18 (October 31)

Ernest Canning Research Scholar (with a good honours degree in metallurgy, chemistry or physics, and industrial or research experience) for fundamental research in metal finishing—The Registrar, The University, Nottingham (November 3).

Soil Physicist (with a university honours degree in science (with physics as a major subject), together with evidence of research experience, preferably in the field of soil physics) in the Division of Soils, Commonwealth Scientific and Industrial Research Organization, Adelaide, for research on the movement and measurement of water in soils—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting Appointment No. 270/143 (November 3).

Chair of Chemistry in the University College of the West Indies—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (November 8).

Lecturer or Assistant Lecturer in Chemical Engineering—The Registrar, The University, Leeds 2 (November 12)

Imperial Chemical Industries Research Fellow in Physics, Chemistry, Metallurgy, Engineering, or Geology, or in a subject allied to these—The Registrar of the University of Wales, University Registry, Cathays Park, Cardiff (November 15).

Lecturer (preferably with qualifications in one of the following: (*a*) first year teaching in botany; (*b*) algology, especially marine algology; or (*c*) cytology or cytogenetics) in the Department of Botany, University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Cape Town, November 15).

Lecturer in Metallurgy—The Reader in Metallurgy, Department of Metallurgy, University Museum, Parks Road, Oxford (December 1).

Lecturers (3) and a Senior Lecturer in Physics at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C 1 (Australia, December 15)

Analyst to assist with analysis of materials from animal feeding experiments—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire.

Animal Husbandry Officer (with a university degree in agriculture and practical experience of livestock improvement programmes, especially cattle and pasture work, and preferably with tropical experience) in British Honduras, to be responsible to the Director of Agriculture for the Agricultural Department's livestock policy—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.63/31/06.

Assistant, Grade B (preferably honours graduate, with teaching, research or industrial experience) in Physics—The Clerk to the Governors, Mid-Essex Technical College and School of Art, Market Road, Chelmsford.

Assistant Pathologist in the Department of Cancer Research—The Secretary, The London Hospital Medical College, Turner Street, London, E.1.

Chair of Physics in the University of Khartoum—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1.

Departmental Assistant (with a degree in agriculture and considerable practical farming experience) in Agriculture at the School of Agriculture, Sutton Bonington—The Registrar, The University, Nottingham.

Head (with a good honours degree and experience in the direction and administration of metallurgical research, either academic or industrial) of the Metallurgy Division, the work of which is carried on in London and Sheffield and includes both fundamental and applied research in the general and physical metallurgy of iron and steel—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting "H.M.D.".

Laboratory Technician to assist with research and class routine—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W 2.

Lecturer in Pharmaceutical Chemistry at the Technical College, Bradford—The Director of Education, Town Hall, Bradford.

Physicist to assist in physical and clinical work associated with X- and gamma-ray treatment and investigation—The Secretary, Physics Department, Institute of Cancer Research, Royal Cancer Hospital, Fulham Road, London, S.W.3.

Physicists (2) or Applied Mathematicians (2) (with an aptitude for experimental work) for fundamental research and development work on the physics and mechanics of certain textile machines and processes; a Physicist or Mechanical Engineer for fundamental research and development work on the flow of fluids through textiles; and a Chemist for analytical work on the investigation of defects in textiles and on the development of new research methods—Dr. D. W. Hill, Director of Research, British Cotton Industry Research Association, Shirley Institute, Didsbury, Manchester 20.

Principal/Senior Scientific Officer (with a first- or second-class honours degree in chemical engineering or chemistry, and/or A.M.I.Chem.E.), to lead a team concerned with chemical process development and plant design studies—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting A.1169/34

Research Student (graduate in chemistry or physics) for the study of flames by infra-red spectroscopy—Dr. G. J. Minkoff, Chemical Engineering Department, Imperial College of Science and Technology, London, S.W.7.

Scientific Officer (Chemist), Scientific Officer (Biologist), and an Assistant Scientific Officer in the Metropolitan Police Laboratory—The Secretary, Room 165 (S), New Scotland Yard, London, S.W.1.

Senior Lecturer in Market Garden and Glasshouse Crops—The Clerk to the Governors, Essex Institute of Agriculture, Writtle, Chelmsford, Essex.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

University of Reading. National Institute for Research in Dairying, Report 1955. Pp. 148. (Shinfield: National Institute for Research in Dairying (University of Reading), 1956). 4*s*. [88

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Atom 1956: An Illustrated Summary of the Second Annual Repor of the United Kingdom Atomic Energy Authority. Pp. 24. (London H.M. Stationery Office, 1956.) 1*s*. 6*d*. net. [8

Local Government—Areas and Status of Local Authorities i England and Wales. Pp. 18. (Cmd. 9831.) (London: H.M. Stationer Office, 1956.) 1*s*. net. [8

Ministry of Health. Report of a Working Party on Anaestheti Explosions including Safety Code for Equipment and Installation Pp. iv+39. (London: H.M. Stationery Office, 1956.) 2*s*. 6*d*. net. [8

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United States Department of Commerce: National Bureau o Standards. Miscellaneous Publication No. 218: Hydraulic Researc in the United States, 1956 (including Contributions from Canadia Laboratories). Edited by Helen K. Middleton. Pp. xii+216. (Washington, D.C.: Government Printing Office, 1956). 1.50 dollars. [8

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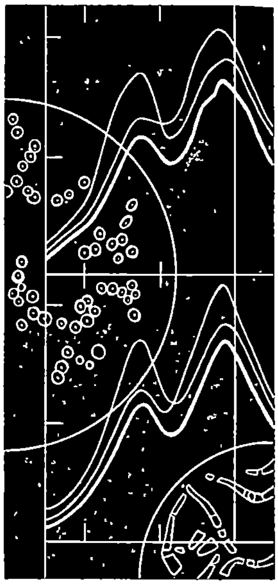
BOOKS ON SPECIALIZED SUBJECTS

Books on science, research, electronics, industrial work, electrical and mechanical engineering can be quickly supplied through your local Smith's shop or bookstall. College and works librarians and students, particularly, are invited to ask for lists of books on any subject. Any books not stocked locally will be quickly obtained from Head Office.



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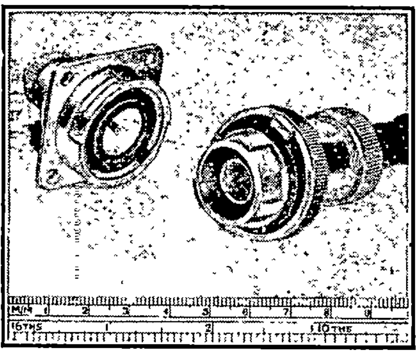

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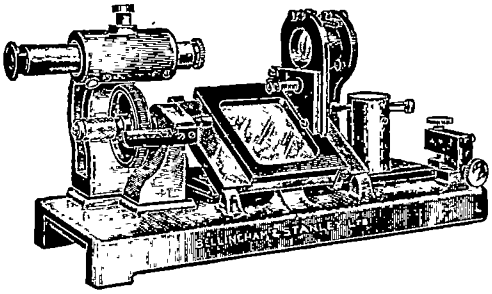

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THE FINANCING OF UNIVERSITY RESEARCH

AT the second session of the Home Universities Conference a discussion on the financing of research in universities by outside bodies started from the data provided by a report on the relations between scientific research in the universities and ndustrial research in Great Britain which Dr. V. E. Cosslett had edited for the Association of University Teachers. It was several months, however, before the report was actually published* by the International Association of University Professors and Lecturers, with the assistance of the United Nations Educational, Scientific and Cultural Organization. n the meantime, in the debates on the Department of Scientific and Industrial Research Bill, both the control and adequacy of government research in Britain have come under fresh review, and in particular the adequacy of Government support of research in the universities was raised by Lord Cherwell. Prof. S. H. Beer's book on "Treasury Control", while concerned with the co-ordination of inancial and economic policy generally in Great Britain, raises some fresh issues in regard to the inancial control of research and of such activities as those of the universities, where accounting on a year-to-year basis may well lead to inefficiency and where he quinquennial principle has big advantages.

Since that book was published, a further report from the Public Accounts Committee has argued that mprovements in university procedure and methods affecting administration and contract practice are desirable in order to avoid waste and extravagance; and the preliminary estimates resulting from a survey of British investment in research and technical development made by the Department of Scientific and Industrial Research have been presented by Mr. Ernest Rudd in a paper to the British Association read at Sheffield on September 4. The figures were given in comparison with similar estimates for the United States and following the estimates made in the spring of last year by Sir Harold Hartley, and they raise once more the question of the adequacy of expenditure in Britain on research. Its distribution has also been challenged in connexion with the Department of Scientific and Industrial Research as well as, on occasion, in connexion with the development of nuclear energy and automation.

These three aspects of the national research spectrum cannot be sharply separated. If research—at the universities, in industry or in the government services—is not wisely directed, the effort is not likely to be distributed wisely, or if well distributed to yield the maximum return. If control is too rigid and exercised without regard to the nature of the work or the conditions in which scientific work s most fruitful, we are unlikely to attract the creative minds that are needed or to gain full advantage from the expenditure sanctioned. To devise the controls which provide the maximum freedom and stimulus for those engaged in research, and ensure that adequate resources are at their disposal, while at the same time seeing that the nation's available resources for research are deployed to the best advantage, so far as can reasonably be judged, and that there is no unjustifiable overlapping or waste, is a difficult task demanding judgment of a high order as well as insight and imagination and wide knowledge and experience.

The report of scientific research in universities and industry which was discussed at the Home Universities Conference shows how delicate is the balance, and it was obvious at that discussion that the universities themselves took a very wide public view of the problem. The report helps to supply the knowledge of the detailed ways in which university laboratories maintain direct contact with those of industrial laboratories which, apart from evidence obtained from industry in an inquiry made by the Manchester Joint Research Council, is largely lacking. After briefly outlining the organization of research in Great Britain, it describes the detailed relations of university and industrial research before considering the difficult problems which any great increase in the industrial research undertaken in university departments or by individual members of their staffs raises for the universities.

The inquiry was limited to research in the natural sciences, including engineering and technology, but excluding medical research. In these fields the inquiry showed that only 6 per cent of research projects in the universities undertaken by members of their academic staffs are financed wholly, and 32 per cent partly, from outside sources, and about half these projects appear to be initiated from outside sources. In all, about 20 per cent of the resources of scientific and technological departments in British universities are engaged on work of direct interest to industry, and this figure is equivalent roughly to 10 per cent of their total budgets and to 5 per cent of the university budget as a whole. This figure includes the support received from research associations, but not that received from other Government agencies, which may total another 7 per cent of the university income with a further 2 per cent coming from the charitable foundations, such as the Nuffield Foundation, and learned societies. Moreover, general opinion was overwhelmingly in favour of this contact with industry: 82 per cent of those replying thought it was of value to their own studies and only 23 per cent thought that it conflicted with their research interests; 86 per cent agreed that it was in the interests of the department as a whole.

This total of some 14 per cent of university income, however, represents about 25 per cent of the total income of the scientific and technological departments, and may amount to as much as 50 per cent of their funds for research. It should be noted that, in contrast to the position in the United States, most of these projects have been put forward on the initiative of the university worker. Apart from the present large pre-occupation with nuclear research, government grants to British universities have been primarily for fundamental investigations and are not related to immediate industrial needs, though this is not to say that in making a grant a research council may not have some longer-term national need in mind. The system, however, appears to be working well. But apart from these annual grants, the capital requirements of a university are likely to continue to be great, and even if private and industrial benefactions increase their support, the State will probably in future provide the major proportion of the capital as well as the current finance for university research.

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* The Relations Between Scientific Research in the Universities nd Industrial Research: a Report on Conditions in Great Britain Edited by Dr. V. E. Cosslett. Pp. vii+187. (London: International Association of University Professors and Lecturers, 1956.) 15s.

Before considering the particular issue which caused most concern at the Home Universities Conference, the great variety of part-time, occasional and informal exchange of staff between industry and the universities should be noted. The usual method of getting specialist help from industrial scientists by university departments has been to appoint them as part-time lecturers. Direct interchange as yet is only on a small scale; but there has been a growing tendency since 1945 to increase the intercourse between industrial and university scientists, and the interchange of staff at all levels is a factor of the greatest importance in breaking down the tendency to look down upon industrial research. There are also many other varied ways in which intercourse between the universities and industry occurs in scientific and technological matters, and in general the report suggests that the universities should not be called upon to devote more of their resources to industrial problems. Some room for improvement may well remain, and in particular the relations of the universities to the research associations appear to merit closer examination.

While there are strong forces working against the establishment of closer relations between research associations and university departments, in preference to direct connexions between the latter and private firms, it has been argued that connexions between industry and the universities should be increasingly channelled through the research associations. This is quite apart from the educational functions of the latter, though those functions might be encouraged by such a development, which could well have the effect of ensuring that eminent university scientists are only called upon as consultants to industry for very specialized problems. On the other hand, the effectiveness of particular research associations as research organizations requires critical consideration before such a step is taken for any particular industry. On the basis of the general measure of support which industry gives to research, as indicated by Mr. Rudd's survey, little confidence can be felt that industry will simultaneously increase still further its benefactions to the universities.

The main problem at the present time arises from the increasing tendency during and since the War for government departments and industrial concerns to call on the universities for help in solving scientific and technological problems. This can result in the larger part of the research work of a particular university department being in the form of short-term contracts, and unless there is some degree of central control in a university, individual departments can in this way expand so as to throw out both the normal balance of research and teaching and that between fundamental and applied research. Even to devise appropriate methods of control within the university involves a number of delicate problems if the conditions for fruitful creative work are to be preserved. These are considered in the report, which seeks, however, rather to elucidate the principles that should guide policy and practice rather than to elaborate a precise system.

The report takes as the basis for a sound policy that a rough balance should be preserved between teaching and research in the university as a whole and in each department, and a similar balance between internally and externally financed research. As a first principle, adequate resources should be available within each university to finance the main lines of research in each department, so that appeals to outside bodies are for extension only and are never allowed to become a dominant and controlling factor. Universities best serve the community which supports them by undertaking fundamental investigation of natural phenomena rather than by working on problems of more or less immediate interest to industry. Accordingly, industrial and other private bodies can best support the universities by making unrestricted grants to their general funds, instead of earmarked grants for particular investigations or actual research contracts. The best place for applied research is usually the research association or the individual firm, and the report suggests that it would be well to accept as a limit for scientific departments that not more than one quarter of the total budget should be derived from outside sources.

The report does not consider whether or not applied research is appropriately carried on at the colleges of technology, though clearly the same considerations apply there as with the university departments of technology. Agreement, moreover, is desirable among universities as to the broad criteria to be used in assessing research contracts and the terms under which contracts would be accepted; and the proposals put forward in the report on the sponsored research policy of colleges and universities, prepared by a committee of the American Council on Education, are regarded as providing a reasonable basis for discussion. For those very large projects demanding installations so costly that they would seriously disturb the balance between a department and the rest of a university, the best solution is regarded as the establishment of a special research station with State funds which would be staffed and operated either by the State or by several universities in co-operation.

The difference in outlook between private industrial interests, with the natural desire to reap a quick advantage from priority in use, and the community of scholarship of the university is at the root of one of the chief arguments for strictly limiting the volume of research undertaken by universities and the conditions for acceptance. In time of peace, work carried out in academic laboratories should be free of restrictions on publication, and work involving ndustrial secrets should be carried out in industry itself, while secret work under government contract has only a place in a university under conditions of emergency and should be transferred to a State establishment as soon as facilities can be made available.

The report does not discuss exhaustively these and other problems which are causing increasing concern in the universities. But it stresses the need for wider recognition of the problems with which the universities and their scientific and technological departments are confronted in their relations with industry and with Government. It argues that more detailed official investigation is required if we are to work out solutions appropriate to the structure of research in Britain, and in particular suggests that we should develop still further the role of the research associations as a buffer, or filter between industry and the universities.

PAST ZOOLOGISTS AND PRESENT GENETICS

Portraits from Memory

Recollections of a Zoologist. By Prof. Richard B. Goldschmidt. Pp. x+181+4 plates. (Seattle: University of Washington Press, 1956.) 3.50 dollars.

Theoretical Genetics

By Prof. Richard B. Goldschmidt. Pp. x+563. (Berkeley and Los Angeles: University of California Press; London: Cambridge University Press, 1955.) 64*s.* net.

PROF. RICHARD B. GOLDSCHMIDT, doyen of the genetical world and president of the most recent International Congress of Genetics, began his scientific life in Germany before genetics, as we know it, came to birth with this century. He can look back to a different era in zoology when the foundations were being laid for what have now grown into virtually new sciences; and he can recount personal reminiscences of men—the Hertwigs, Boveri, Roux and Spemann, to list but a few—who can be little more than names in books to most of us nowadays. In "Portraits from Memory" he looks back over the years and, with a wealth of delightfully told anecdote, brings to life for us this vanished world. We can sit in at a doctoral examination at Heidelberg, where the candidate attends resplendent, if uncomfortable, in tails and silk hat while professorial jealousies work themselves out; we can see the Kaiser fidgeting his way through a lecture by Richard Hertwig on sex determination; and we can share the triumph of the discovery of syphilis spirochætes and the heartache of its reception. At the end, names are mere names to us no longer. They are living men, brought to life by a portrayal of their foibles and jealousies as well as their talents and their greatness. We may feel that at times their pictures emerge in perhaps over-stark contrast of black and white, for one of the charms of the book is the way in which it relives Prof. Goldschmidt's own youthful enthusiasms; but our only regret can be that the portraits are not even more numerous. One reader at least would very much have liked to see Correns and Bauer, for example, through Prof. Goldschmidt's eyes, for portraits of the early geneticists are all too rare.

In "Theoretical Genetics" Prof. Goldschmidt turns to a totally different subject—the basic theoretical problems of genetics as he sees the science. It should be made clear at the outset that his coverage is by no means complete. Population genetics, genetic systems, chromosome mechanics, variability and selection, for example, are not dealt with. Rather, he concentrates on a discussion of the genetic materials and the way they do their work: on entities and processes at the cell-level. His approach is essentially physiological and developmental, and his treatment is, as we have come to expect of him, forthright and provocative. Nothing is left unchallenged, although one feels that the challenge is not always either effective or justified. It is generally accepted, for example, as the first principle of genetics that the phenotype is the product of reaction of the genotype and the environment. First, restating this to read ". . . that orderly development is the result of an interplay between genic activity and environment", Goldschmidt goes on to give his opinion that it "is a completely misleading statement in spite of its apparent truth", adding ". . . if we consider the organism within the environment to which it is adapted, development is completely controlled by the genic material". But surely, in the absence of any definition and criterion of adaptation, which is not supplied, this begs the question; and in any event, the statement cannot be true in any final sense, for it has been repeatedly shown that similar structures on the same individual may differ in ways attributable only to chance upsets themselves scarcely referable to differences in the genotype.

Now, evidence can be obtained about materials of genetical importance from three sources: by their direct observation, microscopically, chemically, and so on; by their behaviour in hereditary transmission; and by their action in producing their effects. Each kind of evidence has its own value and its limitations. Our task is not to set one against the other, but to combine them towards a fuller understanding of organization and action. It is, in a sense, the familiar and often complicated biological problem of elucidating and relating structure and function, appearing in a new setting. This emerges clearly from Goldschmidt's section on the nature of the genetic material where he analyses the concept of the gene—a term which he does not like and wishes to abandon. He was, in fact, the first to point out that the classical notion of the gene was too simple, and his latest discussion will be read with interest. He also discusses whether the deoxyribonucleic acid or the protein fraction of the chromosomes is the true genetic material, and finally favours the protein. His reasons for doing so are not clear, and indeed one wonders whether basically it is not simply because, as emerges much later in the book, he assumes that the genic material must act by producing replicas of itself, the agents of gene action being in fact proteins. This assumption itself is challengable, and indeed the very question he starts with is not obviously the right one. Both fractions would appear to be essential, so that one is led rather to ask what each does and how they complement one another in the joint function of reproduction and action.

Moving to the less-understood cytoplasm, the water becomes even deeper. Goldschmidt clearly has an intense dislike of the notion of the plasmagene—the "wobbly concept" as he calls it—and he is anxious to do away with it. His attempts will certainly not carry universal conviction. He rules out kappa particles, even as a model, on the grounds that kappa is a virus—deadly not to those carrying it but to those which do not—without ever discussing the criteria which distinguish virus and plasmagene, or analysing the deeper significance of these criteria. Plastids are likened to organisms and their evidence faded out; and the existence of information about cytoplasmic segregation in plants is mentioned, only to be dismissed on the grounds that, thinking of cytoplasmic differentiation and its obvious difference from genetic segregation, the zoologist will be "skeptical". The notion of the plasmagene may well have been abused; but it was introduced to meet a need, and it is not to be so lightly rubbed out. The inference of "self-propelling processes" and "steady states" on physiological grounds is no alternative to the postulation of self-producing particles in the cytoplasm from the evidence of transmission. One does not prove the other, but it equally does not replace it. Indeed, we are led to ask what basis the controlled self-impelling process has. Is it structural? Is it, in fact, some kind of plasmagene?

The cytoplasm has a structure and organization different from that of the nucleus. It does a different job. It appears more heterogeneous, and its parts may well have come together in a different way. We must expect these parts to be differently related one to another and to the nucleus. In short, they pose the problem of structure and function in a new and perhaps even more difficult way. We shall need all the evidence we can gain, whatever its source, and we shall need to clarify our concepts if we are to arrive at the answer. The history of the gene concept has surely shown us that the physiological does not replace the mechanical and that deeper understanding comes when we try, not to oppose, but to relate particle and process, structure and action, form and function.

One could go on through the full five hundred pages of the book objecting and arguing almost endlessly, and by so doing attesting, I believe, to Prof. Goldschmidt's success in at least one of his chief aims. "Theoretical Genetics" is avowedly for the specialist. It presents a point of view on controversial subjects, and a point of view to stir fruitful discussion rather than to secure facile agreement. It collects together an imposing amount of fact and opinion, though unfortunately not every author's views are correctly reported or their references correctly cited. It might have benefited by condensation, for there are lengthy digressions; and in any event the treatment is so exhaustive as at times to be exhausting. Cross-references, too, would have helped where evidence is touched on before being given in detail, and where a subject is taken up again on later occasions. It remains, however, a book which should be widely read among geneticists. Its arguments and conclusions will arouse disagreement, often deep disagreement; but in disagreeing we can scarcely fail to be challenged into critical examination of much that we too frequently take for granted.

Kenneth Mather

THE JEWS IN ANCIENT AND MODERN TIMES

This is Israel

Palestine—Yesterday, Today and Tomorrow. By Dr. Theodore Huebener and Dr. Carl Hermann Voss. Pp. x+166+8 plates. (New York: Philosophical Library, 1956.) 3.75 dollars.

THE first half of this little volume is devoted to a historical sketch. "Every effort has been made to treat the various religious and political issues fairly and objectively", states the wrapper, and the reader will endorse the claim. Remarkably succinct and lucid is the survey covering the Biblical period (with due use of modern scholarship), subjugation by Rome, the ministry of Jesus and rise of Christianity, the rise of Islam and the comparatively peaceful rule of successive Islam empires, the Crusades with massacres alike of Jews and Moslems, the successive Turkish invasions, the First World War, the Balfour Declaration (1917), the British Mandate, the war between Arabs and Jews, and the establishment of the State of Israel in 1948. This portion of the work would be usefully supplemented by more maps.

The remainder of the volume deals not with the political but with the cultural record. The authors touch on the preparation of the two Talmuds, building on Old Testament commentary a rule of life. Two dissenting Jewish bodies are mentioned: the Samaritans (a tiny group now fallen under Arab rule), and the Karaites, a scattered Jewish brotherhood who endeavour to follow literally the Old Testament rather than Talmudic and subsequent commentators. The linking is noted in Jewish consciousness throughout the centuries of the land of Israel with the sense of an Israelite religious mission. The authors mention also the friendly understanding reached in 1918 between the Jewish leader Weizmann and King Hussein of the Hedjaz and confirmed the following year by his son and heir, the Emir Feisul—an understanding not encouraged by British authority, who unfortunately deprecated also the beginnings of Israeli–Transjordan co-operation prior to the British transformation of Transjordan into the State of Jordan.

The story of Zionist aspiration and achievement is told through accounts of a few of the great protagonists of the drama. Very interesting is the account of the movement "Back to the Land" initiated by Aaron David Gordon—"this refined, sensitive, vegetarian non-resistant" from Russia, whose settlement, started in 1909 with twelve young pioneers at Dagania near the Sea of Galilee, still persists, transformed to fertility. "Today", state the authors, "over one fifth of the people of Israel live on the land and till the soil". Theodore Herzl, of course, bulks large in the story of Israel, as does Eliezer ben Yehuda, who established and enlarged the modern Hebrew language, though unfortunately too early to emulate Kemal Atatürk by conforming the language to Western Latin script. The moving and inspiring story is told of the American Henrietta Szold, founder of the hospital organization throughout Israel and supporter of the educational work. Space has not been found for mention of Aude Wingate, the great British officer who brought comfort to many in Israel, nor of Martin Buber, the noble contemporary Israeli philosopher of individual responsibility. The great Hadassah hospital, the Hebrew University of Jerusalem, the scientific research Institute at

Rehovot and the constantly extending Techneion at Haifa are, of course, mentioned. The work of all continues and grows, though the splendid buildings and equipment of the two first-named are to-day held sterile and unused by the State of Jordan. The amazing transformation of the desert Negev is also described.

Undoubtedly those who so devotedly and cheerfully labour to create the new Israel are sustained by the sense that they are path-finders for future generations not only in Israel but even over the whole world. Recalling how almost each one has, personally or through others beloved, suffered from the mistakes of the world behind us, who will call their aspiration priggish or even unreasonable ?

DOROTHEA WALEY SINGER

CONTROL OF HUMAN CONDUCT

Social Control

By Dr. Joseph S. Roucek and Associates. Second edition. Pp. viii+603. (Princeton, N.J.: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd., 1956.) 50s. net.

THIS is yet another of the immense array of introductory texts produced in the United States which deal with various aspects of the study of sociology. It opens by restating the familiar theme of increases of crime and chaos in the post-war world which leads to the conclusion that, "if mankind is ever to be free from fear of aggression . . ., the wise control of human conduct is far more significant than any degree of mastery of the world of nature". This is quite unexceptionable, if somewhat trite. But, unfortunately, we may be misled too readily by the suggestion that the book attempts to deal with the intimidating problem as to how "wise control" is to be exercised. Social control is quickly redefined in the opening paragraphs as the "processes, planned or unplanned, by which individuals are taught, persuaded or compelled to conform to the usages or life-values of groups", which begs the whole question as to whether these usages, etc., can be continued further into the twentieth century without undue loss, or even peril. Furthermore, the most important issue latent in this formulation, as to the extent to which social control can be effectively planned and executed—even within this narrow context—is given only the briefest and most superficial treatment.

For the most part, the book provides a very general and at times somewhat dogmatic account of the social and psychological influences which shape our personalities and our societies in ways we tend to take for granted. The social 'conditioning' of personality, the leadership process, propaganda and similar topics are all passed in review without any general conclusion being reached. The final chapter on "Social Control and the Atom Bomb" is characterized by a deep pessimism: the last sentence in the book is that "the doom of mankind may already have been decreed". Whether this is intended as a judgment based on mature reflexion on the problems of social control, or whether it is a merely irresponsible or somewhat unconsidered remark, is not clear. But it can only be regretted that the brief and somewhat naïve section on economic and social planning could not have been greatly expanded, so as to deal with the basic problem of "wise control" which is posed but not discussed, let alone resolved.

It is recognized that some kinds of public planning and administration are successful, and have provided the foundations on which the modern urbanized way of life has been based. But it has proved exceedingly difficult to widen and strengthen these foundations, and the fact has not been recognized that the time has come when precise questions as to how and why must be put, with all the intellectual and moral courage that we can command.

T. S. SIMEY

MODERN ASTRONOMICAL OPTICS

Proceedings of a Symposium on Astronomical Optics and Related Subjects

Held in the University of Manchester, April 19th–22nd, 1955. Ed. by Prof. Zdenek Kopal. Pp. xv+428. (Amsterdam: North-Holland Publishing Co.; New York: Interscience Publishers, Inc., 1956.) 45 guilders; 90s.

THE contents of this impressive volume cover a very wide field of problems ranging from abstract considerations on information theory to questions of a very practical nature concerning dye filters, interferometers, etc. But they all have one common denominator: they refer to problems characteristic of modern astronomy which, extending its observations to invisible objects—that is, to very faint and distant stars and star-systems—has to develop new methods of registering and analysing the observable data. These again give rise to quite novel difficulties.

Modern electronic devices make it possible, for example, to measure with photomultipliers, attached to the 200-in. telescope at Palomar, the light intensity of a star of not much less than magnitude 24, which would correspond to observing Sirius as far away from us as one million parsecs; it should be possible to measure even fainter stars. However, how will the observer locate such a star in the photometer if this star is invisible—that is, it cannot even be located on a photographic plate ? Similarly, when formerly the observer wished to make a spectral investigation of a star, he produced an image of this star on the slit of a spectrograph, keeping during the exposure the star image steady on the slit. For faint objects this is no longer possible. So different devices have to be developed to enable monochromatic analysis of very faint invisible light sources. The last chapter, on filter photography of thin films, is thus devoted to problems of this kind.

Since a great refinement is a common necessary feature of all observations, all disturbing effects, like the scintillation of star images, have to be carefully analysed to eliminate their influence; Chapter 5 deals with resolution problems and scintillation. It becomes thus also clear why the information theory plays an important part. The actually observed effects frequently appear to be scarcely related to what the observers actually wish to find out; thus a minute analysis of the content of information in the observed data is needed.

This book is a rich source of information for every modern astronomer. An astronomer brought up in the tradition of spherical astronomy and celestial mechanics may feel a bit bewildered, like a connoisseur of classical music or painting listening to music by Hindemith or looking at pictures by Braque.

E. FINLAY-FREUNDLICH

Flow of Gases Through Porous Media

By Dr. P. C. Carman. Pp. ix+182. (London: Butterworths Scientific Publications; New York: Academic Press, Inc., 1956.) 30*s*.

IT is some twenty years since Dr. P. C. Carman suggested the permeability method for the measurement of the surface area of fine particles such as cement. During these years the range of interest in the flow of fluids through porous media has increased considerably, and in this book he has presented a concise account of the subject, including the recent work on gas diffusion and separation.

The primary aim of the book is to present a quantitative account of the flow process when a gas enters or passes through porous media. The theme of the book is a discussion of the Kozeny–Carman equation for the flow in such systems, and one of the great merits of the text is that the writer has explained in detail the limitations of this approach and the consequent reasons for its failure in some instances.

Chapter 1 contains a formal presentation of the Carman equation as developed for unconsolidated media, and in Chapter 4 the application of this equation for measurement of particle surface is given. Of greater interest is the discussion in Chapter 2 of the influence of abnormal pore texture, the distribution of pore size and the problem of flow through consolidated media.

Chapter 3 covers slip flow and Knudsen flow and a short account of diffusion in porous media. Chapters 5 and 6 contain an account of more recent work on the flow of sorbable gases, leading to a discussion on surface diffusion and gas separation processes. Finally, Chapter 7 covers the transition zone to turbulent flow and an introduction to the conditions of fluidization.

This is a scholarly text written by an acknowledged authority in this field, and it will be welcomed by all whose activities so much as touch on this subject. The book as written has rather a terse style, and a general introduction, particularly to Chapter 1, would have been of value to the more general reader.

Reduction with Complex Metal Hydrides

By Norman G. Gaylord. Pp. xvi+1046. (New York: Interscience Publishers, Inc.; London: Interscience Publishers, Ltd., 1956.) 15 dollars.

THIS book, which started in 1951 as a review article on reductions with lithium aluminium hydride, is a comprehensive survey of the preparation, properties and uses of all the complex metal hydrides known up to the end of 1953. The reactions of these hydrides with inorganic as well as organic compounds are described. Then there is a useful general discussion of reduction of organic compounds with complex metal hydrides: stereochemical features and analogies with Grignard reactions are reviewed. Each functional group has a chapter to itself, with full references and tables giving substance reduced, product and yield. In addition, the more interesting cases are described in fair detail with supporting formulæ and reaction schemes.

A very considerable number of the compounds mentioned are from the chemistry of natural products. The collecting together of so many examples will be of particular value to those investigating steroids. The information is set out in a very acceptable form, easy to follow. There are very few mistakes, either chemical or typographical. It is a pity that throughout the book aluminium is spelt aluminum.

The book of this size and scope, which could so easily have been little more than a catalogue, is interesting and informative. It gives a balanced view of this extraordinarily fertile field and will doubtless stimulate further research in both inorganic and organic chemistry. E. E. TURNER

Theory of Combustion Instability in Liquid Propellant Rocket Motors

By Luigi Crocco and Sin-i Cheng. (Agardograph, No. 8.) Pp. viii+200. (London: Butterworths Scientific Publications; New York: Interscience Publishers, Inc., 1956. Published for and on behalf of the Advisory Group for Aeronautical Research and Development, North Atlantic Treaty Organization.) 37*s*. 6*d*.; 5.25 dollars.

A LIQUID-PROPELLANT rocket motor is a complicated system in which fuel and oxidizer are pumped through a perforated injector plate, combined in a combustion chamber and accelerated to supersonic exit-speeds in a Laval nozzle. This book is a compendium of theoretical considerations (related only perfunctorily to experiment) on the problem of understanding and learning to avoid such instabilities of the system as lead to oscillations of an organized character in the pressure and temperature in the combustion chamber; these can be responsible for mechanical or thermal failure of components. 'Chugging', or low-frequency instability, is ascribed to an interaction between the time-lag for change in injection-rate to produce changes in combustion-rate, the time-lag for these changes to evacuate the chamber to a different pressure, and the time-lag for this to affect the injection-rate through the equations of the pumping system. The equations are treated, in addition, for the case of a servo-mechanical control, which feeds back signals from the combustion chamber into the fuel flow-line, and for the case when the combustion time-lag itself varies with chamber pressure, which can lead to additional instability.

'Screaming', or high-frequency instability, is ascribed to the interaction of factors such as these with the normal modes of oscillation of the gas in the combustion chamber. Only 'longitudinal' modes (with motion along the axis) are here treated, although the authors admit that transverse and rotary 'sloshing' modes should also be considered important, as more recent work has, in fact, emphasized. M. J. LIGHTHILL

Atomic Physics

An Atomic Description of Physical Phenomena. By Prof. Gaylord P. Harnwell and Prof. William E. Stephens. (International Series in Pure and Applied Physics.) Pp. x+401. (London: McGraw-Hill Publishing Company, Ltd., 1955.) 60*s*.

THIS book exhibits the difference between the methods of teaching in American and British universities. It is based on a course of lectures given by the authors to first-year postgraduate students at the University of Pennsylvania. The standard is suitable for British undergraduates in their final year; but the book would be expensive for students here at 60*s*. The nearest equivalent published in Britain is Max Born's "Atomic Physics".

D. F. JOHNSTON

THE CALDER REACTORS: RESEARCH AND DEVELOPMENT PROBLEMS

By L. ROTHERHAM

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THE design of the reactors at the Calder Hall Atomic Power Station, opened by H.M. The Queen on October 17, sprang directly from a proposal made at the Atomic Energy Research Establishment in 1953 for a small power reactor called PIPPA to supply the electricity needs of the Establishment. This reactor was never constructed; but many of its main features have been retained in the Calder Hall reactors designed and built by the Industrial Group. No fuel other than natural uranium being available, a thermal neutron reactor with graphite or heavy-water moderation was essential. Heavy water was very expensive and not readily available in the United Kingdom. Its use would have required the core to be carried inside an exceedingly massive pressure shell in order that the necessary working temperature could be reached, and there were fears, which later experience has shown to be well founded, that there might be difficult problems in preparing fuel elements sufficiently resistant to corrosion by water at high temperature. The use of natural water-cooling for a graphite-moderated reactor is not physically impossible, but the same corrosion problems exist and it is doubtful if coolant tubes strong enough to stand the pressure can be made which will not absorb neutrons so avidly that a natural uranium pile becomes impracticable. The choice, therefore, fell on a gas-cooled graphite-moderated design. Many gases were considered from the aspects of coolant efficiency, neutron absorption, chemical stability and inertness at the working temperature and ease and cheapness of acquisition. Carbon dioxide was chosen, as it combines to a remarkable degree the desired qualities. Its nearest rival is helium, which can only be obtained from dollar sources and incurs high transport costs.

The choice of a graphite-moderated reactor cooled with carbon dioxide was supported by the belief that such a reactor could be built with a simple development programme in which all important problems could be foreseen at the start, and attacked simultaneously. Many types of reactor which have great potential advantages can only be constructed after a two-stage experimental programme has been carried through. For example, the nuclear-hydraulic mechanism which determines the manner and rate of boiling in a boiling-water reactor cannot safely be elucidated by theoretical studies alone, and the design of such a reactor for economic power must be preceded by the building and operation of an experimental reactor. This would delay the main programme by three to five years. For Calder Hall much useful information was available already from experience with BEPO and the Windscale piles, relating particularly to uranium fabrication and the manufacture and behaviour under irradiation of graphite. Unlike the water-cooled piles, the pressure of operation was determined by the economics of the circulating blowers and not by temperature, and a pressure of 7 atmospheres was chosen which led to a design for a pressure vessel only just outside previous experience. There was a further feature of great importance in the design. The use of natural uranium and the relative absence of neutron-absorbing material from the core allowed a good 'neutron economy'—that is, led to the maximum number of spare neutrons being captured in uranium-238 rather than in structural material or coolant. As a result, the 'conversion ratio' (number of plutonium atoms produced per uranium-235 atom fissioned or converted to uranium-236) is very satisfactory. Higher values can be obtained with cold heavy-water moderated piles of large size because of the very low capture cross-section of heavy water; but they are less likely to be realized with heavy-water power piles because of the presence of more extraneous material in the core and increased neutron leakage. As the Calder Hall reactors produce plutonium with by-product power, this high conversion ratio was desired; but it is just as valuable for a pure power pile because it allows better utilization of the fuel in each irradiation cycle.

The development programme comprised numerous individual jobs carried out at the Atomic Energy Research Establishment and in the laboratories of the Research and Development Branch of the Industrial Group. Some were started at Harwell before the design had been accepted for construction by Risley; but Harwell and the Industrial Group worked side by side thereafter. Only a selection from the experimental and theoretical work is described here.

Even if neutron cross-sections at all relevant neutron energies for all materials in the core were known, it would not be possible to calculate sufficiently accurately the reactivity of the fully loaded core. 'Exponential experiments' were therefore carried out at Harwell, in which the distribution of neutron flux was measured in sub-critical piles supplied with neutrons from an external source. These piles had lattice structures similar to that proposed for the main one, and from these measurements it is possible to deduce the reproduction constant of the infinite lattice, and the migration areas which determine the rate of escape of neutrons from a finite core. These quantities are needed to allow the effective reproduction constant of the actual reactor to be calculated. In principle, this type of experiment should give all the information needed. In practice, it is usually not possible to represent the actual reactor lattice arrangement exactly, because it is not known in time, nor can the effects of high temperature easily be simulated. Considerable theoretical ingenuity has to be employed in making use of these measurements. The original Harwell core design was chosen on the basis of existing knowledge to combine large power output and small core diameter while employing natural uranium. A re-evaluation was made in the Research and Development Branch at Risley, starting from a given core size fixed by the engineers, and aiming at optimum plutonium production without necessarily insisting on the use of natural uranium (by that time enriched uranium had become available from the Capenhurst Diffusion Plant). This led to changes which appear slight, such as an increase in the uranium rod diameter from 1 to 1·15 in., but which have quite significant effects on conversion ratio and other properties. When the structure was settled in detail, the expected reactivity was re-calculated, making the fullest allowance possible for the existence of zones of different properties within the core. These exist because of the different fuel channel sizes and varied expansion gaps between graphite bricks that are provided in different parts of the reactor. An ideal theoretical treatment of this problem, in which the neutron flux distribution in each zone is properly 'matched' to that in its neighbours by suitable boundary conditions, is not possible at present. We hope that by the use of automatic computers particular cases will be solved in future. For the present, judicious averaging and adjustments have given results in tolerable agreement with measurements, and by sound judgment and some luck the pile has turned out to be capable of operating on natural uranium. There are other theoretical problems which have to be solved in designing a reactor of this sort. The effectiveness of control rods, and the flux of radiation outside the core vessel must be calculated. The latter is needed in designing the shield and instrumentation.

Apart from these studies on 'neutron engineering', a considerable amount of development work to improve the heat transfer of the fuel was carried out both at the Atomic Energy Research Establishment and in the Industrial Group laboratories. Heat transfer generally imposes a limit on the maximum operating power of a gas-cooled reactor, in that it is impossible to remove more than a certain amount of heat from fuel elements at a given temperature without the expenditure of excessive power in circulating the coolant through the reactor. It is always possible to remove this limitation by increasing the coolant pressure, although structural considerations then impose a limit. Anything which can be done to increase the heat-transfer properties of the fuel elements themselves is therefore greatly to be desired.

The first line of development, used in the Windscale reactors, was to increase the heat-transfer surface by the addition of longitudinal fins to the fuel container. It was possible, by this means, to achieve ratings (MW./tonne) some five times greater than those which would have been possible with plain cylindrical fuel elements. Further development of this type of extended surface proved difficult because of poor mixing of the gas between the fins with that towards the outer diameter of the channel. This is a difficulty inherent in the gas-cooled natural uranium reactor, since the channels must be of large diameter (that is, about 4 in.) to accommodate the flow of coolant, and the fuel must be in the form of a cylindrical rod, for reasons of neutron economy.

Experimental work at Harwell led to the development of turbulence promoters, and a significant improvement was obtained by the use of these in the Windscale reactors. More important, however, this work led to the development of the transverse finned Calder fuel element. This type of fuel element achieved a given heat transfer-rate with a smaller mass flow and a higher outlet temperature than the longitudinally finned type, and the power required to pump the coolant is also rather less; it is therefore well suited for use in a power reactor where a high outlet temperature of coolant is desirable. Experiments have shown that there is a well-defined circulation in the form of two vortices 'geared together' in the space between the fins and maintained by the flow at the fin tips. It is this systematic circulation rather than the production of random turbulence which accounts for the good heat-transfer properties of the transverse finned element.

The instrumentation of the reactor presented a number of novel problems. For example, it is essential in a high-power reactor to be able to detect fuel elements with damaged sheaths. This is done by monitoring samples of the coolant gas for fission-product activity. Each of about two thousand fuel channels has a sampling pipe which runs through the pressure vessel to a selector valve and thence to a detector, the samples being returned to the circuit by a special blower after monitoring. The samples are filtered to remove solid matter and are then exposed in a precipitation chamber where solid decay products from gaseous fission-product elements that may be present are deposited on a wire. The wire is drawn into another chamber, where it is observed by scintillation particle detectors which report its state of contamination. The counter assembly, which has to work in high-pressure carbon dioxide, was developed in the laboratory at Windscale.

The principal metallurgical problems of the Calder reactors were concerned with the fuel elements and the pressure vessel. These are always likely to be key problems in reactors of this type, since there will always be technical and economic advantages in designing as close as possible to the limit on these points. At the same time, an extremely high degree of reliability is required in both fields. It will be obvious that a major failure of the pressure vessel could be a very serious matter, especially if it occurred in a brittle fashion. Although failure of a single fuel element would not be disastrous, only an extremely low incidence of failure can be tolerated if the reactor is to operate consistently; furthermore, this degree of reliability will be required for increasing lives in the future.

Pressure Vessels

The general problems of building steel pressure vessels for reactors of the Calder type are extremely interesting scientifically. The size of the Calder vessels, the thickness of steel plate involved and the continuity of the welded construction are all features which increase the tendency of the structure to fail in a brittle manner. In addition to the problem of brittle fracture, however, the temperature-range in which creep becomes important may be entered, and this is a combination of circumstances which is quite unusual. In addition to these factors, site fabrication, the oxidation resistance of the steel, the stress relief and inspection of the completed vessel and the effects of irradiation on the steel must be taken into account.

Certain general features of the brittle fracture phenomenon have now been elucidated, and it is recognized that steels vary in their tendency to propagate or to arrest cracks. Methods of reducing the tendency to brittle failure by means of composition and/or heat treatments are available, although the difficulty of doing so increases with thickness of plate. Unfortunately, however, there is no way of applying the available data quantitatively in a design, so that design engineers must exercise their judgment in a qualitative fashion, based on previous experience. At the same time, metallurgical features which provide a higher measure of notch ductility may reduce creep resistance; the grain size is particularly important, a fine grain being desirable for a low temperature (for the transition from brittle to ductile fracture) but disadvantageous from the creep point of view.

Up to about 375° C., creep effects can largely be neglected in the design of steel structures. However, if the pressure vessel is exposed to the hottest gases as well as irradiation, which causes internal heating, the creep range may readily be entered. In this case, the provision of adequate long-term creep data becomes a very difficult problem, since very long lives are involved and allowable strains are very small: 0·1 per cent strain in twenty years is typical. In addition, relatively little is known of the ductility that may be expected under these conditions and for such long times. In the case of the Calder reactors, only modest cooling was required to avoid creep problems, and this solution was accepted. It was then possible to select a steel with excellent notch ductility so that the maximum factor of safety from brittle fracture was provided. In future designs, however, which may be required to operate with higher gas temperatures but where at the same time cooling would be more unattractive on economic grounds, it may be necessary to deal with both creep and notch ductility simultaneously. There is scope for the development of special steels to withstand this combination of conditions, and this is being pursued with encouraging results.

The effect of irradiation on the properties of steels is not fully understood, especially when the irradiation is carried out below about 300° C. Samples have been loaded into the Calder piles both to provide a continuous check on the condition of the steel in these reactors and to provide more quantitative data for future designs.

Oxidation studies in carbon dioxide carried out on steel samples indicated that no important problem need arise in reactors of this type. Site fabrication and inspection problems, however, required considerable thought, and this is likely to be the case in subsequent reactors also.

Fuel Elements

For the fuel elements, a very considerable research and development programme was required. This programme may be divided arbitrarily into the following three phases, although it will be realized that there was actually considerable overlap in time: (*a*) feasibility studies; (*b*) specification of fuel element and of manufacturing processes; (*c*) studies of probable behaviour in the reactor.

During the feasibility period, it was necessary to show that the general style of fuel element proposed was broadly satisfactory, both from the point of view of manufacture and pile behaviour; in particular, the feasibility of the general size and shape of the element and the choice of a magnesium alloy for the finned sheath had to be demonstrated. Following the decision to proceed with the reactor, one of the most urgent problems was to develop methods for the production of the cans, which involved the bulk manufacture of a completely new magnesium alloy to more rigorous standards of cleanliness than for any previous requirement and the final fixing of the alloy after many experiments on oxidation and corrosion, weldability and deformation behaviour. For the uranium bar, processes had to be developed for casting longer bars than previously used and heat-treating them to a newly defined metallurgical condition. The fuel element manufacturing processes were, of course, completely new, and included many stages; those of greatest importance are probably welding of the end seals, decontamination of the external surface from traces of uranium and the final inspection processes needed to guarantee the high standards of reliability required.

The last category of work, however, that of studying probable behaviour in the reactor, is of greatest interest scientifically and, of course, is devoted not only to proving the first fuel elements but also to the development of better fuel elements, both for the Calder and more advanced reactors. The aim has been to try to predict the various changes that may occur in service which may influence the behaviour or life of fuel elements and to determine, with progressive accuracy, their magnitude. This work permits an estimate of the life of the first fuel elements to be made and, by indicating the probable limiting features, is expected to lead to rapid improvements in the elements for these reactors and valuable information for the design of future reactors.

Unfortunately for the analytical studies, very little information was available on irradiation damage at the outset and, up to the present time, experiments on prototype fuel elements have necessarily been limited in such respects as size, burn-up and thermal and neutron gradients; this is inevitable in the current phase of reactor development. However, theories existed concerning the mechanisms of irradiation damage in uranium, both as regards overall dimensional changes and local surface effects ('wrinkling'). These theories predicted that improved stability would be obtained from a fine and random grain structure. Evidence that this was likely to be true under Calder conditions was obtained, and suitable heat-treatment processes were defined just as the cartridge production line was being constructed. It is believed that this particular problem has been solved, and that the Calder cartridges will be adequately stable to the burn-up required. New phenomena are, of course, expected to become increasingly important as future reactors of the Calder type require higher burn-ups and temperatures; ideas on these matters are developing.

For various reasons it was desirable in the Calder reactors to make the fuel elements as long as possible and to stack them vertically, one above the other. It was appreciated that this would probably lead to progressive bowing of the elements, especially in view of the high density of uranium, and this has led to an extensive creep programme. Relatively little was known of the creep behaviour of uranium, and the present work has been complicated by a number of factors, including the complex longitudinal and radial thermal gradients in the uranium column, which had to be based on calculation rather than experiment. The calculation of bowing from basic creep data, therefore, proved difficult, particularly as the strain-rates of interest were very much lower even than those determined in high-sensitivity creep tests. Furthermore, the creep properties of different uranium specimens varied greatly, and were affected to an unusual extent, compared with other metals, by trace impurities and grain size. Although the uranium as produced at Springfields is an exceptionally pure metal, it had not previously been necessary to relate impurities to mechanical properties, and this new requirement coincided both with development work to produce purer uranium and with the heat-treatment studies mentioned above. In addition to the tensile creep work, it was desirable to carry out rig tests, both in and out of pile. Finally, A. H. Cottrell, of Harwell, has considered the possible effects of irradiation on creep behaviour; this work, which is to be published shortly, indicated a possibly important effect which had to be taken into account. Despite these difficulties, it has been possible to give a reasonable forecast of bowing behaviour in the Calder reactors. Although this is unlikely to be an embarrassment in these reactors, the information obtained will probably lead designers away from the use of uranium as a load-carrying member in future power reactors.

Although it was necessary to study the magnesium canning alloy from many points of view, the work on mechanical properties is probably of greatest importance. In the pile, the magnesium must have adequate strength, both as a link in the load-carrying structure and also in order to retain the correct shape of the heat transfer surfaces. At the same time, there must be sufficient ductility, in the presence of welds and other stress-raising features, to withstand, without the formation of the slightest crack, the inevitable strains resulting from the temperature and irradiation effects on the cartridge, some of which have been mentioned above. This combination of properties is required under irradiation over the whole range of temperature encountered in the pile.

Magnesium, a hexagonal metal, has relatively low ductility at room temperature, whereas at the higher temperatures in the Calder reactors its strength is falling off rather rapidly. However, in view of the advantages from using magnesium, careful work was undertaken to assess these factors and to modify the properties of the material, as necessary. Many creep tests were carried out, including some under predetermined strain schedules rather than with a fixed load, since this gives more information on the unusual strain conditions in the reactor. In these tests particular attention has been given to ductility, both general and local, and to the phenomena related to the onset of crack formation. Two interesting features have been noted. One is that under appropriate conditions, small voids are formed; these have a characteristic size and concentration determined both by the material and the strain conditions, which may include irradiation. The other feature is that grain size, frequently a disadvantage with magnesium alloys, has a large effect on deformation mechanisms. The grain size of interest, of course, is that which is stable at reactor temperatures, and this increases the difficulty of control. For the first cartridges for Calder, major changes in composition were not possible; but modest adjustments to the composition of the alloy were found to be useful as a result of critical strain/grain growth experiments. Although for the future a complete theoretical survey of magnesium alloys has been carried out and several systems selected for experimental work, there is a growing feeling that the present material has a combination of properties fairly well suited to the wide and somewhat conflicting requirements of reactors of this type.

The work of the development teams, of course, was not ended with the completion of the reactor. During the start-up the physicists of the team worked on control problems and made the nuclear measurements which have confirmed the work of the past years.

The effect of varying the operating parameters was studied, the effect of fission-product poisoning determined, the control rods calibrated and their optimum disposition investigated; in general, a very clear picture of the characteristics of the reactor was obtained.

Work will continue in future years, and facilities are provided in the reactor to permit the study of the effect of irradiation under the appropriate conditions on fuel, graphite and pressure-vessel steel. Teams of the Research and Development Branch of the Industrial Group, together with their colleagues in the four industrial nuclear power companies, are working on the advancement of the technology of gas-cooled reactors. Calder presents the first step in the carefully planned development of gas-cooled nuclear power stations. The experience on the first reactor, and the improvements we now know can be made, lead us to believe that the decisions taken several years ago were the right ones.

GEOLOGY OF KILIMANJARO*

By DR. C. DOWNIE, DR. D. W. HUMPHRIES, W. H. WILCOCKSON and P. WILKINSON

KILIMANJARO, situated on the border between Kenya and Tanganyika, presents special claims for geological attention. In the first place, it is one of the largest volcanic mountains in the world and the highest mountain in Africa, the summit reaching 19,340 ft. above sea-level. The mountain mass is 50 miles long and 30 miles wide and contains more than 1,000 cubic miles of volcanic rock. Though only 200 miles south of the equator, because of its great height it has a permanent ice cap and exerts important local meteorological effects which are a major factor in the provision of water for the surrounding important agricultural region. In the second place, Kilimanjaro belongs to the East African Rift Valley petrographic province, the rocks of which belong to the alkaline suite which plays so prominent a part in petrogenetic theory. The association of rocks is so characteristic that apart from certain localities in East Africa, of which Mount Kenya is one, it can only be closely matched, petrographically and chemically, in the widely separated areas of the Oslo District in Norway and the Ross Archipelago in Antarctica. Detailed analysis of the geological and tectonic features of these areas, already known to be similar in certain respects, may be expected to throw new light on the origin of the rocks and on theories of petrogenesis generally.

Such considerations, together with the question as to whether Kibo, the highest summit, is likely to erupt again, and doubt concerning the effects on

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* Substance of a series of papers read before Section C (Geology) on August 31 at the British Association meeting in Sheffield.

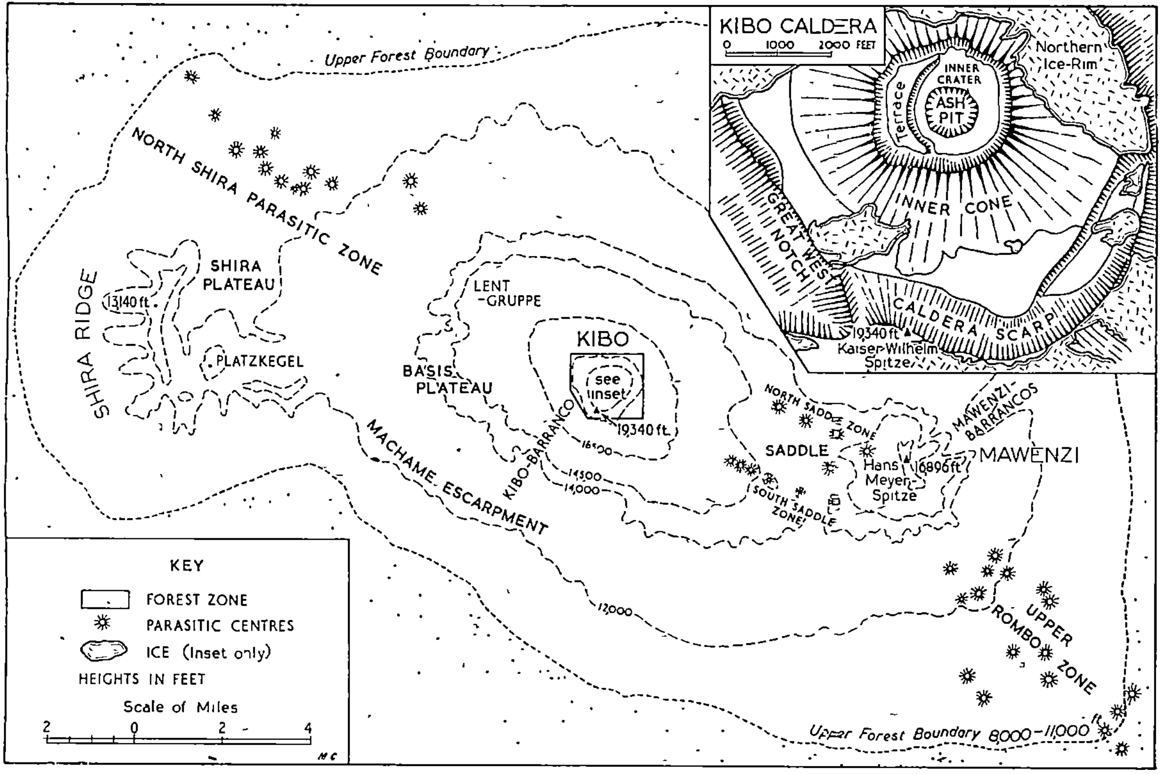

Fig. 1. Map of the Kilimanjaro area (reproduced, by permission, from the *Geological Magazine*, 1956)

water-supply of the shrinking glaciers, prompted the Geological Survey of Tanganyika to invite four members of the staff of the Geological Department of the University of Sheffield to join with three of its own geologists in making a reconnaissance survey of the mountain in 1953. The results so far obtained[1] are briefly set out here.

Composition and Structure of Kilimanjaro

The volcanic mountain rises more than 15,000 ft. from a platform of basement rocks varying from 2,500 to 4,000 ft. above sea level. Since the geological age of the mountain is not great, its innermost portions have not yet been laid bare by erosion, so that, generally, knowledge of its superficial rocks only can be obtained; the one really deep section to be seen is at the east end where two great gorges, the Mawenzi Barrancos, have been cut and expose between 4,000 and 5,000 ft. of volcanic rock. Nevertheless, it is clear that, from an early stage, activity was concentrated at three main centres corresponding to the main topographical heights, Shira, Kibo and Mawenzi, and the early activity at these centres may well have been contemporaneous. So far as can be seen, the early lavas were trachybasalts, which later gave place to phonolitic rocks.

The most degraded of the three peaks is Shira, a trachybasaltic cone which attained a height of 18,000 ft., but underwent cauldron subsidence. The resulting caldera is now represented only by the south and west walls, which form a long ridge rising to little more than 13,000 ft. After the cauldron subsidence was complete, an inner cone, the Platzkegel, was built and the volcano was invaded by a suite of radial dykes. At one point on the ring-fracture a parasitic vent erupted phonolitic lavas. After activity at this centre ceased, the eastern and northern walls were eroded and the caldera floor was flooded by lavas from Kibo.

Mawenzi, the eastern peak, has also suffered much from erosion and is now a craggy mountain, nearly 17,000 ft. high, with little resemblance to a volcano. It also is composed almost entirely of trachybasaltic rocks; but locally, in the later stages, flows of olivine basalt occurred. The rocks of the upper parts of the mountain were described by the German workers as "Brockentuffen", but, though true agglomerates do occur, a large proportion of the apparent pyroclastic rocks have proved to be flow breccias which are unusually thick in comparison with the amount of solid lava. This indicates that these lavas must have moved with a flow mechanism which may be related to the formation of 'aa' as reported from the volcanoes of Hawaii. Mawenzi was essentially a volcanic cone of which the structure has been complicated by multiple vents. The plug of dioritic rock filling the main vent is exposed in the East Barranco at 14,000 ft. The last phase of the vulcanicity of Mawenzi was the intrusion of an extensive suite of trachybasaltic and basaltic dykes, more than a thousand in number, most of which are grouped in a parallel swarm, though some of them have a radial arrangement.

At the end of the period of effusion of trachybasaltic lavas Kibo formed a cone probably about 18,000 ft. high; but activity continued here after the eruptions had ceased at the other centres. These later eruptions began with the outpouring of rhomb-porphyries followed by other phonolitic lavas by which the present complex puy-shaped cone was

Table 1

VOLCANIC ACTIVITY	SEDIMENTS
Solfatari	Inner Moraines
Inner Crater Series	
Erosion	? = Outer Moraines
Calder Rim Series and Parasitic Cones	
	Boulder Beds
Small-Rhomb-Porphyry	
	Boulder Beds
Phonolite	
	Boulder Beds
Rhomb-Porphyry* Lavaturm-type Phonolite	
	Boulder Beds
Kibo Trachybasalt Mawenzi Trachybasalt Shira Trachybasalt	
10,000 ft. of lavas unexposed	
Erosion of Pliocene surface (Dixey)	

* Lavas characterized by stout, tabular plagioclase phenocrysts, called rectangle-porphyries, occur near the base of the rhomb-porphyry series and also near the top of the Kibo trachybasalts.

built up (Table 1). The mountain gives evidence of three distinct episodes of cauldron subsidence. The first affected the main rhomb-porphyry cone, but is much obscured by later flows. The second formed the present topographic caldera, and the third the crater of the Inner Cone. In the Inner Crater, solfataric activity with extensive deposition of sulphur is still continuing[2].

A late stage in the volcanic history was the development of a large number of parasitic cones, some forty of which have been mapped above the forest belt alone. They are distributed along west-north-west to east-south-east and north–south lines across the mountain and are composed of pyroclastic rocks and basic and ultrabasic lavas.

Petrogenesis

The trachybasalts are striking rocks containing abundant thin tabular phenocrysts of plagioclase in a matrix of plagioclase with some potash felspar, augite and iron ore. They are present in great volume and, so far as can be seen, make up the greater part of the mountain. On the other hand, the phonolitic lavas have a much smaller bulk and do not exceed 1 per cent of the total extrusives. The rhomb-porphyries, the most abundant of the phonolitic types, contain large phenocrysts of anorthoclase, usually with olivine in a fine-grained matrix generally of alkali felspar, augite and iron ore. They have much in common with similar rocks from Oslo, Mount Kenya and the Ross Archipelago. In the more alkaline lavas poured out late in the history of Kibo there is abundant nepheline, often as large phenocrysts. The basic and ultrabasic rocks, found principally interstratified with the trachybasalts of Shira and in the parasitic cones, are olivine basalts and ankaramites rich in augite and olivine. These lavas are of distinctly alkaline character, and, in some cases, develop abundant large nepheline phenocrysts and so may be called ankaratrites.

Consideration of the succession, petrographic characters and the chemical variations of this rock series indicates that we are here dealing with a consanguineous suite, with a parental magma near to the trachybasalts. The ultrabasic rocks appear to have formed by the accumulation of early augite and hornblende. The later phonolitic lavas show an enrichment of alkalis, suggesting a course of differentiation similar to the line of descent described from other alkaline volcanic provinces. The general trend of change in the Kilimanjaro rocks is fairly closely paralleled in the region in and around the Gregory Rift Valley, where trachybasalts are widespread among the earlier eruptions and are followed by more alkaline types.

Glacial History of Kilimanjaro and its Bearing on the Date of the Vulcanicity

During intervals in the effusion of lava it is clear that glaciers extended far down the mountain slopes. Boulder beds with striated pebbles occur at several localities associated with bedded sands and valley erosion in the pre-existing lavas. No evidence of glaciation appears to be present in the Shira and Mawenzi successions, and the last activity of these centres appears to have pre-dated the ice age. The younger lavas of Kibo, however, are separated from the trachybasalts by a period of erosion, and the succeeding activity, which is confined to this centre and the parasitic cones, was interrupted on several occasions by major glacial episodes. The glacial sediments deposited during these periods are found at definite horizons in the lava sequence on and around Kibo, and these are indicated in Table 1. Succeeding all activity, except for solfataric activity and perhaps the outpouring of the Inner Crater lavas, there was a further extension of the ice which deposited great moraines as low as 11,000 ft. on Mawenzi and Shira as well as Kibo. Nilsson[3] suggested that these belong to the Gamblian period, and it is therefore tempting to correlate the earlier extensions of glaciers with the three earlier Pluvial periods of East Africa, and the more recent moraines with the succeeding Makalian and Nakuran episodes. Thus the main activity of the mountain is pre-Pleistocene and, if Dixey[4] is correct in his interpretation of the Pangani River system, of Pliocene age. During the Pleistocene period only Kibo was intermittently active; but it is uncertain if any activity, except that of the solfatari, persisted into the post-Glacial period.

Present Glaciers of Kilimanjaro

The present glaciers of Kibo are but the ragged fringe of the ice cap which formerly covered the whole summit of the mountain, the centre having largely disintegrated and ablated. There is no ice in the Inner Crater or in the Ash Pit. Within the Caldera Wall there are isolated, stagnant ice masses which are decaying rapidly. The major glaciers occur on the southern and western flanks of Kibo, the Penck Glacier reaching to below 16,000 ft. These glaciers commence just below the crest of the Caldera Wall and are thus cut off from any potential-gathering ground (or 'névé-field') on the summit of the mountain. The glaciers of the northern slopes are more limited in extent, and although commencing within the outer crater wall are also without névé-fields. Thus the glaciers of Kilimanjaro are almost stagnant, and their recession is rapid. It seems likely, therefore, that within a few decades the ice will have entirely disappeared.

From such a reconnaissance survey our knowledge of the mountain must still be incomplete. It is hoped to fill in some of the gaps during a second expedition in 1957.

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[1] *Geol. Mag*, 93, 218 (1956).

[2] Unpublished reports of the Geological Survey of Tanganyika.

[3] *Geograf. Ann*, 13, 276 (1931).

[4] *Quart J. Geol. Soc*, 102, 351 (1946).

GLASS: RECENT RESEARCH AND DEVELOPMENTS

THE systematic study of glass and the subject of glass technology is a field with which the University of Sheffield is particularly associated, Sheffield being the only University in the United Kingdom which has a Department of Glass Technology, and, in fact, this was the first such Department in the world.

The existence of this Department and its growth is largely due to the work and vision of Prof. W. E. S. Turner, who first organized the Department in 1915 and became the first professor of glass technology in 1920. It was very fitting, therefore, that Prof. Turner should have been present to give an introductory talk to the meeting of Section B (Chemistry) of the British Association on September 4 at Sheffield which was devoted to glass. In his talk, Prof. Turner dealt with the history and development of the subject since 1910, the year in which the British Association last met in Sheffield. He referred to the parts which chemistry, physics and engineering have played, and continue to play, in the extension of understanding and practice in the industry, themes which were developed by the subsequent speakers.

Prof. R. W. Douglas, the present occupant of the chair of glass technology in the University of Sheffield, spoke on the nature of glass. After stressing the importance of the viscosity of glass and the manner in which it varies with temperature in glass manufacturing processes, he said that this relation of viscosity with temperature is of fundamental importance in any discussion of the chemistry and physics of glass. The high viscosity is associated with the nature of the forces between the atoms; the directed bonds between silicon and oxygen being particularly important.

Silica melts at 1,713° C.; but the liquid so formed flows with great difficulty because of these strong directed forces, and it is easy to cool the liquid through its freezing point without its solidifying. It is this mechanism which makes the formation of glass possible, and in this sense glasses are supercooled liquids.

On cooling further, a second stage of thermodynamic instability is reached. The distribution function of a liquid has a particular value for each temperature; but the difficulty of the atoms moving in respect to one another increases rapidly as the temperature falls, until the time taken for the distribution function to reach the value appropriate to the lower temperature becomes long compared with the time taken to make an experimental measurement. The properties of glass then appear to vary with time towards equilibrium values corresponding to the temperature of the experiment. This behaviour is observed when the temperature falls below that at which glass has a viscosity of about 10^{13} poises.

Eventually, after cooling roughly another hundred degrees, the rate of approach to equilibrium configuration becomes so slow that the distribution function is fixed. At room temperature glass is therefore a very special type of solid which has the macroscopic mechanical properties of a solid but in which the atoms are arranged with the disorder of those of a liquid and in which thermal motion of translation has ceased.

The function of other oxides, added to silica to produce glasses which have properties required for ease of fabrication, were mentioned briefly.

This theme was taken up by Mr. W. J. R. Merren, of Pilkington Brothers, Ltd., who dealt with new glasses. This title included many special kinds of glass which had been prepared to meet the demands of scientific development, the needs of research, and of new developments in various industries.

New optical glasses which have very high refractive indices were mentioned; these contain considerable amounts of the rare-earth element, lanthanum. Another development in optical glasses has been the production of glass of extremely high transparency. This involves the use of very pure materials and the melting of the glass batch in platinum vessels on a commercial scale.

Other glasses have been developed which absorb infra-red radiation, and are very useful, for example, in projectors to prevent overheating of the slides. Glasses are also required which transmit infra-red radiation. In preparing these glasses it is important to reduce, so far as possible, the very small amount of water which ordinary glasses can contain, for this small amount is enough to cause very marked absorption. It seems that for work beyond 5μ, glasses based on silica will not be useful; in this region selenium and sulphide glasses can be used, arsenic sulphide glass transmitting out to 15μ.

The developments in atomic energy have also made demands on the glass technologist. Radiation-absorbing glasses have been sought for one type of protective window, and a lead glass which contains as much as 80 per cent lead oxide has been made for this window. A window 3 ft. × 2 ft. × 2 ft. (the great thickness is necessary to get sufficient absorbing power) will weigh about 4,000 lb. A similar glass, when especially pure and transparent, has found application as a γ-ray detector by using the Čerenkov radiation.

Certain glasses have the property of changing under the action of harmful radiation, either developing a colour or an ability to fluoresce which they did not possess before, and so can be used to measure the 'dose' of radiation to which they have been exposed. Glasses such as these are quite different from the normal soda-lime-silica glass. Glasses for absorbing X-rays, for example, may contain large quantities of elements such as tantalum, boron, phosphorus and germanium, while the dosimeter glasses are potassium, barium, aluminium phosphates with as much as 7 per cent silver in them.

Dr. J. H. Partridge, of the General Electric Co., Ltd., continued Mr. Merren's theme, dealing with the demands which the lamp and electronic industry has made for new glasses. Here again, constituents which had not been thought of as useful in glassmaking thirty years ago are being used, or constituents such as soda and other alkaline oxides which were considered essential in earlier times are omitted. For example, the inner tube of the mercury lamp which is familiar in street lighting installations is made of a glass which contains no alkali. At 700° C. an evacuated tube of this glass about 30 mm. in diameter and 1 mm. wall thickness will become distorted only very slowly.

Another glass, used for making the sodium discharge lamp, is remarkable in that it contains no silica. This is in order that it shall withstand the attack of the sodium vapour. Other special glasses have had to be developed in order that suitable wires can be sealed through glass to secure and make contact with the electrodes in thermionic devices; such glasses must have a very high electric resistance. Dr. Partridge's paper was illustrated by an excellent colour film of glass-making operations; this film emphasized the changes in normal procedure entailed in making articles from some of these special glasses.

A paper different from the others, in that it dealt with a new industry which has grown out of the glass industry itself, was presented by Dr. A. De Dani, of Fibre Glass, Ltd. Glass fibres may be drawn as single continuous fibres or by the glass wool process. This process consists in subjecting a stream of glass issuing from a platinum orifice to an intense blast of superheated steam. The stream of glass is thus shattered, resulting in a multitude of very fine fibres of glass. It was thought at one time that the steam shattered the glass into droplets which were then drawn into fibres, but calculations showed that this explanation was not very probable. The process has therefore been investigated using high-speed ciné photography.

Some of the films taken in the experiments were shown to the meeting. The audience was thus able to see an example of industrial research in a new development of the glass industry; thereby completing the review of the many-sided aspects of glass technology—a subject in which physics and chemistry must be applied for a fundamental understanding of the material, in which physics, chemistry, engineering and mathematics are applied in the industrial development, and an industry which, although several thousand years old, is now, with few exceptions, such as high-quality table-ware and decorative pieces and the production in small quantities of special glasses, a fully mechanized industry.

SEVENTH INTERNATIONAL ASTRONAUTICAL CONGRESS

THE Seventh International Astronautical Congress was held in Rome this year during September 17–22, and was attended by more than four hundred delegates from many various countries and of equally varied interests. There is, of course, practically no scientific subject which is not involved in astronautics one way or another, and which does not stand to profit from its findings. The proceedings took place in the magnificent Congress Hall of the Espozisione Universale di Roma, and during the two and a half days of technical sessions more than forty papers were presented. An unusual feature—at least for a scientific meeting—was the use of a simultaneous translation service in Italian, French, German and English. Despite the valiant efforts of the Italian linguists providing this service, it would no doubt have been improved had the translators been natives of the country into whose language they translated, and had they had a knowledge of scientific terminology. These stern requirements would seem necessary to ensure the complete success of such a service.

With so many papers to be presented, only a quarter of an hour was allotted to each speaker, and there was practically no time for formal discussion. This made the task of digesting the contents of many of the lectures difficult, particularly as many of them were not available in printed form. Special interest was aroused by the contributions of the delegation from the United States, who, numbering among them the first professional 'astronautical engineers', introduced an atmosphere of reality unusual in conferences on this subject. With regard to the speculations concerning the relative progress of the American and Soviet attempts to set up an artificial Earth satellite, it is not inappropriate to remark that the only Soviet delegate, Prof. L. I. Sedov, of the U.S.S.R. Academy of Sciences, disclaimed any knowledge of his countrymen's progress in this venture and declined to make any statement on the subject.

The American artificial satellite, or to give it its code name, 'Project Vanguard', formed the subject of many papers. It is to be a three-stage rocket, appearing, however, to be composed of only two stages, because the last stage is carried inside the second. The initial stage is 44 ft. long and 45 in. in diameter, and is powered by a liquid oxygen rocket with kerosene as a fuel, and pressurized by helium; it is intended to carry the projectile to a height of 36 miles, and to achieve an all-burnt velocity of 5,500 ft./sec. The casing of the initial stage, after being jettisoned, is expected to land at a distance of 75 miles from the launching station. The second stage is 32 ft. long, and employs a bifuel rocket unit with nitric acid and hydrazine hydrate as propellants, and also pressurized by helium. It is expected to increase its speed to 13,400 ft./sec. at all-burnt, when its height would be 140 miles. Besides enclosing the final stage, it contains the control and guidance equipment, which is to be brought into action during a period of coasting flight after the operation of the second-stage rocket, to effect the critical final adjustments to the course of the projectile. The final stage of the rocket is then spin-stabilized, and launched from within the nose of the second. It consists of a solid-fuel rocket mounted on a magnesium alloy sphere, 20 in. in diameter, which is the Earth satellite itself. The final velocity would have to be about 26,000 ft./sec. and it is anticipated that the perigee of the satellite's orbit would be about three hundred miles from the surface of the Earth. When the casing of the solid rocket is at last jettisoned, about ten minutes will have elapsed since take-off, and the satellite will have travelled some fifteen hundred miles from the launching point.

The projectile is finless, and control on the first two stages is to be obtained by deflecting the rocket venturi on gimbals. A considerable degree of accuracy in both final speed and direction of motion is required if the orbit is to be successfully established. As an example, if there is no error in speed and if the perigee is not to be less than two hundred miles above the Earth, nor the apogee more distant than eight hundred miles, an angular error of about 3° in the direction of motion is all that can be tolerated. On the other hand, if there is no angular error, and the orbit is to be within the same limits, the velocity error must be no more than ± 450 ft./sec. No official commitment on expected accuracy is forthcoming, though it was suggested in discussion that as many as fifty satellites might have to be launched to give a reasonable likelihood that one might be placed in a satisfactory orbit. Precisely what would form a 'satisfactory' orbit is, in any event, difficult to define. The magnitude of the air density—and so of the drag—at such extreme altitudes is the chief factor governing the useful life-time of the vehicle, but is also one of the unknown properties which it is hoped that observation of the satellite may enable to be evaluated. Tentative estimates put the mean loss in apogee and perigee at (initially) about 250 ft. and 200 ft. per day, respectively. Because of the Earth's oblateness, the variation in the radius of the apogee and perigee is in fact oscillatory, with a period of forty days and an amplitude of about two miles.

It is hoped that observation of the track of the satellite vehicles may also supply data leading to determinations of the variation of gravitational acceleration, and of the shape of the Earth. In addition, it is hoped to be able to interlock the geodetic networks of the continents more closely than has been possible before. During the initial circuits in the orbit, the satellite can be located by the radio signals it sends out; but as the batteries have only a limited life, later observation will depend on visual and photographic records, when the satellite is visible before dawn or after sunset. In this 'Operation Moonwatch', the help of amateur astronomers all over the world is being enlisted, through the International Astronautical Federation. The track of the satellites takes them eastwards as far south as 45° latitude on the Greenwich meridian, and north to the same latitude at a longitude of 180° (so that they will not be visible in Britain). Some other data are to be telemetered from the satellites, though it seems that there is little room for the installation of many instruments. The weight of the satellite is only 21½ lb. (The complete take-off weight of the three stages is 22,600 lb., implying a mass ratio of more than a thousand.) The nature of the observations to be made was not announced, though the possibilities are without limit. High on the list of priorities is the counting of impacts by meteors. This and many other experimental techniques which might be involved are being practised already, and several of the papers presented at the Congress dealt with them.

One of the greatest of the potential hazards to man in space flight is the effect of heavy primary cosmic radiation. More than twenty-five stratosphere balloon flights conducted by the United States Air Force have carried biological specimens to altitudes above 30 km. in geomagnetic latitudes above 55°. Although no somatic health hazard has been observed over periods of about twenty-four hours—the longest period of exposure obtained—the repeated observation of streaks of grey hair on black mice, 200μ in width, has suggested that a so far unidentified mechanism causes wider radial spread of radiation effects (by some 20 times) than has been predicted before. In another paper, details were reported of personal experiences during half-minute periods in a zero-gravity condition. (These were experiments conducted in an aircraft.) The majority of the subjects tested reported as feeling "very comfortable".

Looking still further ahead, another paper discussed the time dilation effect of relativity theory, and its effect on humans travelling in a vehicle moving at speeds near that of light. The general conclusion seemed to be that man's life-time would be effectively increased to such an extent that he can survive outward journeys which in terms of light-years of distance far exceed his normal life-time.

T. NONWEILER

OBITUARIES

Prof. J. B. Leathes, F.R.S.

WITH the death, at Montreux on September 14 at the age of ninety-two, of Prof. John Beresford Leathes, physiology lost another of its dwindling links with the past century. Born on November 5, 1864, the son of a clergyman, and educated at Winchester and New College, Oxford, he also was intended for the Church; but a natural bent for science drew him to the study of medicine, and he qualified M.B. in 1893, and F.R.C.S. a year later, from Guy's Hospital, London.

A talent for chemistry, the teaching of which was a strong feature at Guy's, decided Leathes to follow the applications of chemical knowledge to the elucidation of physiological problems, in pursuit of which plan he went to work for two years with Drechsel at Berne, and then under Schmiedeberg in Strasbourg. On his return, like Sherrington before him, he was appointed to the lectureship in physiology at St. Thomas's Hospital, where he stayed for some ten years, during the last eight of which he also held a part-time appointment at the Lister Institute, which was one of the main foci of development for the rapidly evolving subject of biochemistry. He thus became one of that small and devoted band which included C. J. Martin, Harden and Young, Cathcart, Dakin and Raper, who did so much to forward the interests of that subject in its formative years. It was in that stimulating environment that his interest in metabolic problems was aroused, and where his book, "Problems in Animal Metabolism", was produced. His first published papers dealt with body fluids, proteolytic enzymes, protein metabolism, and the fat content of various muscles. Most of his subsequent work had to do with fat metabolism, and in much of this he had the collaboration of H. S. Raper; their joint monograph on "The Fats" (1910 and 1925) is still a standard work.

In 1909 he became professor of pathological chemistry at Toronto, where he was shortly joined by Raper. During these years he was elected to the fellowship of the Royal Society (1911). In 1915 he went as professor of physiology to Sheffield, in succession to J. S. Macdonald, who had moved to Liverpool, and he remained there until his retirement in 1933.

Leathes took a keen and practical interest in medical and dental education, and by reason of his work on the General Medical Council, and as dean for nine years of the Sheffield Medical School, he not only influenced his own University, but also played an important part in shaping the medical curriculum of his time. It is no more than fair to say that he, and the late Sir Arthur Hall, together were largely responsible for making the Sheffield Medical School the outstanding success it became. Their aim was to unify the medical curriculum; and they did this by weakening the barriers between the pre-clinical and clinical courses of study by extending physiology and biochemistry, with appropriate laboratories, into the ward teaching of clinical medicine—a development which has since been applied in other schools. The results of the experiment were encouraging, as also were those of an innovation which Leathes introduced into the B.Sc. course, and which consisted in making the candidates spend a further year after the final examination working up some special field, on which they produced a thesis, which had to be approved before the degree was granted. The average standard of these theses was surprisingly good, and the subject, in some instances, provided the new graduate with a field into which he could enter with some confidence for further study.

Leathes was elected to the Physiological Society in 1895, and in 1952 was accorded the distinction of honorary membership. He served for three periods on its committee, and for ten years as an editor of the *Journal of Physiology*. This latter service, often now forgotten, was perhaps his best contribution to British physiology, for he took infinite and unsparing pains in helping authors, young and old, who lacked the ability to express themselves clearly. As he was in Toronto when the Biochemical Society was formed in 1911, he happened not to have been an original member, but he joined it in 1913.

In 1921 he was elected a fellow of the Royal College of Physicians, and gave the Croonian Lecture in 1923; it dealt with fat metabolism in various aspects, and in its relation to cellular structure and functions. He also gave the Harveian Oration in 1930, on "The Birth of Chemical Biology". Other honours included the D.Sc. Sheffield in 1933, and Manchester 1936, and the honorary fellowship of New College, Oxford.

Leathes was essentially a modest and scholarly man, of kindly and phlegmatic disposition, one of the few physiologists with a classical education, and a good linguist; he began the study of Russian at the age of eighty. Tall and wiry, he was, even at that age, good for a brisk walk of ten miles or more. Among other accomplishments, he was a pastellist of discernment, despite his high degree of myopia, or perhaps even on account of it, as he was unaware of much landscape detail which tends to distract the amateur. After his retirement he moved to Wantage, and worked in the Physiological Laboratory at Oxford, with John Mellanby. Their published work, which was interrupted by the Second World War, dealt with thrombokinase, and with the action of lecithin upon it. He then moved successively to Lyme Regis, London, Southbourne, and finally to Switzerland, near the scene of some of his happier early years.

Leathes spent his life largely in helping others by patient and unselfish acceptance of responsibilities which brought no ponderable reward—service on the Council of the Royal Society, 1924–26, on the Medical Research Council, 1928–31, the General Medical Council, 1919–38, and on its Education Committee, of which he was chairman in 1931. But he will long be remembered with affection by many friends and pupils.

C. Lovatt Evans

Dr. A. E. J. Vickers

Dr. A. E. J. Vickers, who died suddenly on September 8 at the age of fifty-eight, was director of research at the Thermal Syndicate, Ltd., Wallsend, Northumberland, a position he had held since November 1947; he was elected to the Board of Directors in April 1953. His early academic education began with training in 1915 in Sheffield for the teaching profession; but, probably influenced by war work in a munitions factory, he decided to make chemistry his future profession and, following study in Stoke and London, took an external London B.Sc. in chemistry in 1922.

He then joined the late Dr. J. W. Mellor, of the British Refractories Research Association (now the British Ceramic Research Association), Stoke-on-Trent, where he developed an interest in mineralogy, and in 1927 he took the post of chief chemist to Buxton Lime Firms Co., Ltd. (now the Lime Division of Imperial Chemical Industries, Ltd.). Two years later Dr. Vickers moved to the Billingham works of Imperial Chemical Industries, Ltd., and continued investigations in the problems of refractories and in mineralogy, gaining his Ph.D. in 1935 with a thesis on the colloidal properties of clay. During the latter part of his stay at Billingham he was in charge of research on ceramics, mineralogy and physical methods, including a variety of applications of spectroscopy and microscopy, and when he moved in 1947 to the Thermal Syndicate, Ltd., his work continued to be largely in the field of ceramics, but at higher temperatures than heretofore.

Dr. Vickers was keenly interested in the work of scientific and technical societies, including the Royal Institute of Chemistry, the Society of Glass Technology and the Society of Chemical Industry, and he was a founder member of the Institute of Ceramics. He was also very much concerned with higher education, being a member of the council of St. John's College in the University of Durham. Apart from his professional work, Dr. Vickers was a keen photographer, gardener and musician, and he was an active member of the Anglican Church. He is survived by his wife and by a son and a daughter, training respectively for the medical and dental professions.

Prof. B. M. Duggar

Benjamin Minge Duggar, botanist, mycologist, plant physiologist, plant pathologist and microbiologist, who died at New Haven, Connecticut, in mid-September, a fortnight after his eighty-fourth birthday, had a long and varied career. After holding posts in his native state of Alabama and elsewhere, Duggar became professor of botany in the University of Missouri in 1902. Afterwards he was professor of plant physiology first at Cornell (1907–12) and then in the University of Washington (1912–27), from where he moved to the University of Wisconsin as professor of plant physiology, plant pathology and economic botany (1927–43). Finally, in 1944, he became consultant on mycological research and production to the Lederle Laboratories Division of the American Cyanamid Co.

Although during recent years Duggar became widely known for the part he played in the discovery and development of the antibiotic aureomycin, his name is not associated with any one particular topic. Duggar's distinction lies rather in the breadth and vigour of his interests and his lively appreciation of the novel. Throughout his working life he was always to be found actively engaged in the front line of botanical advance and he made notable contributions in many fields.

After an undergraduate period in Alabama and Missouri, Duggar visited universities in Germany (where he was presumably influenced by the 'new botany'), France and Italy, and some of his early publications related to cytological and anatomical studies on pollen development in *Bignonia* and members of the Araceae. Then he turned to plant physiology, on which he wrote later a text-book ("Plant Physiology, with Special Reference to Plant Production", 1911). During the nineteen-twenties, virus diseases of plants claimed his attention (when the results of his very pertinent studies led him to inspired speculation on the nature of the infective agent) and in 1936 he edited for McGraw-Hill the two-volume "Biological Effects of Radiation".

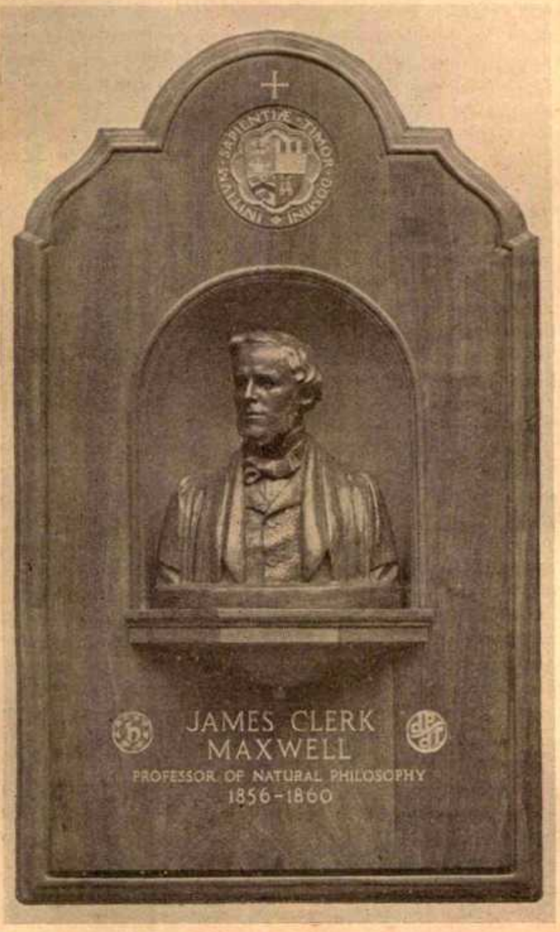
Duggar's first publication (1892) was on teleutospore germination of a rust and he maintained an interest in fungi throughout his life. Possibly, it is by his contributions to mycology and mycological plant pathology that he will be best remembered. While on the staff at Cornell he worked on diseases of fruit and vegetables and in 1909 published "Fungous Diseases of Plants", an important work which was a standard text-book for the succeeding decade and which is still remarkable for its blend of the scientific and the practical and for its modern approach. On the academic side, Duggar made contributions to an understanding of spore germination, and his physiological studies on fungi may be considered to have culminated in a well-known series of papers published in the *Annals of the Missouri Botanical Garden* (1916–19).

G. C. Ainsworth

NEWS and VIEWS

James Clerk Maxwell : Memorial at Aberdeen

A memorial panel to James Clerk Maxwell, by C. d'O. Pilkington Jackson, was unveiled in the Mitchell Hall, Marischal College, Aberdeen, by Sir George Thomson, master of Corpus Christi College, Cambridge, on October 15. The central feature is the bronze portrait bust showing Clerk Maxwell as a young man, under thirty, when he was professor of natural philosophy in the University of Aberdeen during 1856–60. The two devices flanking the inscription are the sign for Saturn, enclosed by a laurel wreath, which refers to the paper on the "Stability of Saturn's Rings" for which Clerk Maxwell was awarded the Adams Prize at Cambridge in 1857, and the thermodynamics formula $\mathrm{d}p/\mathrm{d}t = JCM$, which he used as a pun on his name.


INITIUM SAPIENTIÆ TIMOR DOMINI
JAMES CLERK MAXWELL
PROFESSOR OF NATURAL PHILOSOPHY
1856-1860

Clerk Maxwell was appointed professor of natural philosophy at Marischal College, Aberdeen, at the age of twenty-five. When the fusion of Marischal College and King's College took place in 1860, under the Universities (Scotland) Act, 1858, the two chairs of natural philosophy in Marischal and in King's were combined, like other duplicated chairs, and Prof. David Thomson of King's, being the senior, occupied the single chair, and Clerk Maxwell, not yet thirty, was retired on a pension for life. In the summer of 1860 he was appointed professor of natural philosophy in King's College, London, where he remained until 1865, when he retired to an estate which he had inherited from his father at Glenlair, in Galloway, to prepare his "Treatise on Heat" (1870) and "Electricity and Magnetism" (1873). In 1871 he was appointed to the new chair of experimental physics at Cambridge, where he designed and superintended the erection of the Cavendish Laboratory.

Agricultural Botany in Reading : Prof. A. H. Bunting

Dr. A. H. Bunting has been appointed professor of agricultural botany in the University of Reading, as from October 15, in succession to Prof. D. W. Goodall (*Nature*, 173, 894 ; 1954), who has been appointed director of the new Tobacco Research Institute of the Australian Commonwealth Scientific and Industrial Research Organization established in North Queensland. Prof. Bunting, who is thirty-nine, was born in South Africa, and graduated at the University of the Witwatersrand in 1937. He then proceeded as a Rhodes Scholar to Oxford, where work on the respiratory enzyme systems of barley led to the degree of D.Phil. The war years were spent at Rothamsted Experimental Station, where his principal concern was with sewage sludge as a soil amendment. After a short period of work for the Medical Research Council, he proceeded to Tanganyika, where he organized scientific research in connexion with the ill-fated groundnut scheme of the Overseas Food Corporation. When the scheme was wound up, Prof. Bunting moved to the Sudan, where he took responsibility for setting up a new research station at Tozi, with the view of developing field crops in that area. Prof. Bunting's wide experience in large-scale field experimentation, and in applied plant physiology and ecology, should stand him in good stead in his new post at Reading. It should also ensure the continued broadening of his Department's interests which has been apparent in recent years. There is little doubt that tropical crops and conditions will occupy a prominent place in the teaching programme under his leadership, and one may expect the Department to continue as a valuable nursery for workers in agricultural research overseas.

The Kalinga Prize: Prof. George Gamow

The Kalinga Prize for the popularization of science, offered annually by the United Nations Educational, Scientific and Cultural Organization, has been awarded for 1956 to Prof. George Gamow, of the University of Colorado at Boulder. The Kalinga Prize, presented by Mr. B. Patnaik, a director of a foundation for the economic, social and cultural progress of the Indian State of Orissa, is valued at £1,000. Prof. George Gamow was born on March 4, 1904, at Odessa, and became an American citizen in 1939. He studied physics at the University of Leningrad and later was associated with the Institute of Theoretical Physics of the University of Copenhagen, the University of Cambridge and the Institut Pierre Curie in Paris. He also served as a professor at the University of Leningrad. After having taught physics during 1934–56 at the George Washington University at Washington, D.C., Prof. Gamow has just been appointed professor of physics at the University of Colorado at Boulder. Prof. Gamow is serving or has served as scientific adviser to a number of major organizations, including the Bureau of Ordnance, Department of the Navy; the Applied Physics Laboratory and the Operational Research Office of Johns Hopkins University; the Los Alamos Scientific Laboratory and the Radiation Laboratory of the University of California; the Air Force Scientific Advisory Board; and Convair, San Diego, Cal. He is well known for his scientific research, which has led to more than a hundred publications in such fields as the theory of radioactive decay and a model of an atomic nucleus, relativistic cosmology and the origin of chemical elements, and the theory of protein synthesis. Prof. Gamow, however, has not devoted his scientific career solely to research and teaching. He has also become well known as the author of some ten books and a large number of articles in the field of science popularization. Although they often treat such subjects as the theory of relativity or the quantum theory, his works combine an accurate presentation of scientific facts with an easy, good-humoured style.

Mellon Institute of Industrial Research, Pittsburgh: Dr. P. J. Flory

Since the retirement earlier this year of Dr. E. R. Weidlein as president of the Mellon Institute of Industrial Research, Pittsburgh (see *Nature*, April 21, p. 733), a new post has been established, that of executive director of research, and Dr. Paul J. Flory, professor of chemistry and acting chairman of the Department of Chemistry, Cornell University, has been appointed the first holder. The post carries the responsibility of guiding the whole field of investigation in the Institute, and for this Dr. Flory is very well suited, his career to date being divided almost exactly between academic and industrial research. After graduating from Manchester (Ind.) College, followed by postgraduate work in physical chemistry at the Ohio State University, Dr. Flory spent four years (1934–38) in research on synthetic fibres, synthetic rubbers and other polymeric substances at the duPont Experimental Station, Wilmington, Del. For the next two years he was engaged in teaching and research in the Basic Science Laboratory of the University of Cincinnati, and then, during 1940–43, was a research chemist with the Standard Oil Development Co., Elizabeth, N.J. Following this, he was head of fundamental research for the Goodyear Tire and Rubber Co., Akron, Ohio, and then in 1948 he went to Cornell University to direct graduate research in polymer chemistry. Dr. Flory's book, "Principles of Polymer Chemistry" (1953), is an authoritative work in this field. Besides his work on high polymers, however, he has carried out investigations in photochemistry, chemical reaction kinetics, thermodynamics and statistical mechanics. Dr. Flory is a member of the National Academy of Sciences and holder of the Joseph Sullivant Medal (1954) of the Ohio State University, the Leo Hendrik Baekeland Award (1947) of the American Chemical Society, and the Colwyn Medal (1954) of the Institution of the Rubber Industry (Great Britain).

Perkin Centenary Celebrations in Bradford and Leeds

The West Riding Section of the Society of Dyers and Colourists will be celebrating during October 31–November 3 the centenary this year of W. H. Perkin's discovery of the dyestuff mauveine. The celebrations will commence with two lectures: the first will be given on October 31 at 7.30 p.m. by Prof. John Read in the Hotel Metropole, Leeds, his subject being "The Life and Work of Perkin"; and on the following day, also at 7.30 p.m., Dr. C. M. Whittaker will give a lecture in the Victoria Hotel, Bradford, on "Early Stages in the Renaissance of the British Dyemaking Industry: Tales from Turnbridge, Huddersfield, 1899–1920". During November 1–3 an exhibition will be held in the Technical College, Great Horton Road, Bradford, which will illustrate the developments in dyestuffs and closely related products from the time of Perkin's discovery of mauveine to the present day and also the modern uses of dyestuffs. On November 2 the West Riding Section will hold a dinner and dance in the Victoria Hotel, Bradford. Further information on all these events can be obtained from the Society of Dyers and Colourists, 19 Piccadilly, Bradford 1.

Royal Society Antarctic Expedition

The Royal Society announces that the War Office has agreed to the appointment of Colonel Robin Smart as leader of the main party of the Royal Society International Geophysical Year Antarctic Expedition until January 1958. The main party of about twenty will leave London Docks on

November 15 in the *Magga Dan*, which is being shared with the Trans-Antarctic Expedition, and will arrive at Royal Society Base, Halley Bay, at the end of December 1936. They will relieve the advance party of ten men who sailed in the M.V. *Tottan* from Southampton on November 22, 1955, under the leadership of Surgeon Lieutenant-Commander David Dalgliesh. The main party will install the scientific equipment and erect huts so that the station is fully operating at the commencement of the International Geophysical Year on July 1, 1957. Colonel Smart will return to the United Kingdom at the beginning of January 1958; but the main party will remain at Halley Bay until the end of the International Geophysical Year on December 31, 1958. Colonel Smart, who is at present deputy director of Army health, Western Command, Chester, is forty-two years old. He graduated in medicine in the University of Aberdeen in 1936 and was commissioned into the Royal Army Medical Corps in the same year During 1948–49 Colonel Smart was a member of a War Office team working in the Arctic region of Canada and he returned to Northern Canada and Alaska in 1950.

An Optical Astronomy Observatory for the University of Michigan

A grant of 545,000 dollars has been made to the University of Michigan by the National Science Foundation, Washington, D.C., for the support of studies leading to the establishment of an optical astronomy observatory. The studies are under the direction of Dr. Robert R. McMath, director of the McMath–Hulbert Observatory, and are a continuation of work undertaken last year by the University with the aid of previous grants totalling 300,000 dollars from the Foundation. The most recent grant to the University includes 30,000 dollars for a study leading to the erection of a solar telescope. The establishment of an optical astronomy observatory will include initially a 36-in. and an 80-in. telescope, and work so far has consisted of a search for a suitable site, the design and erection of equipment to test the sites, and work on the 36-in. telescope. The optics for this telescope are nearing completion at Yerkes Observatory. The test equipment consists of a 'seeing' tower which is erected on potential sites for the purpose of gathering data that will help guide the astronomers in selecting a spot where an observatory can operate with maximum efficiency. The tower is a triple-shelled steel structure, 60 ft. in height, equipped with a telescope that continually measures the turbulence in the atmosphere by gauging the size of the image of the star Polaris. This information, along with wind and temperature data, is transmitted to recording instruments situated at the base of the tower. The tower will make these automatic recordings over a period of more than eighteen months. The search for a site has now been reduced to approximately five sites, all of which are situated in the south-western United States because climatic and atmospheric conditions there are favourable and because it is one of the few remaining areas in the United States where an observatory can be erected a sufficient distance from the light and dust generated by cities. Four sites at present under study are Kitt Peak (6,800 ft.) in southern Arizona, the Sierra Ancha region (7,500 ft.) in central Arizona, Chevelon Butte (6,900 ft.) in northern Arizona, and the Hualpai region (7,400 ft.) in north-western Arizona. The Kitt Peak site is of special interest because it is on the Papago Indian Reservation. The mountain is sacred to the Papagos and the Papago Tribal Council granted special permission for the erection of a 'seeing' tower. Similar towers will be erected on other sites, including the Junipero Serra, California.

European Bison from Poland

Through the Forestry Commission, Poland has generously presented to the United Kingdom a breeding pair of European bison. They arrived on October 9 and are in the London Zoo for a period of quarantine; afterwards they will be on show to the public and may later be transferred to Whipsnade. European bison are rare forest animals and, until the arrival of the pair from Poland, the Zoological Society had none in its care. Poland has between eighty and ninety European bison, representing, it is understood, a substantial proportion of world stocks; the pair now in Britain are from a reserve near Cracow.

Bristol Museum

That the Bristol Museum plays an energizing part in the cultural life of the city and surrounding county is shown in the report of the city's Museum Committee for 1955. Although the main activities of the Museum are linked to the permanent exhibits, fifteen major temporary exhibitions were also arranged; these ranged from geology as illustrated by railway posters to a collection of postage stamps issued in the nineteenth century. A special feature is arranged each month to show either objects on loan or recently given. The city archivist has provided material each quarter for a special case while the city librarian exhibits local documents of topical interest. The Bristol Society of Architects has devised illustrations which enable visitors to understand and appreciate the principles of architecture, examples being drawn from the locality. As in previous years, six lectures have been provided during the winter months to audiences of more than three hundred at each session. Conducted summer walks have again been arranged, some of the walks attracting so many visitors that they have been embarrassing to conduct. The staff of the Museum was again invited to give many lectures to various organizations, while an interesting development was the loan of small assemblages of zoological and botanical material to H.M. Prison at Falfield. Classes from all types of schools have visited the Children's Room. The demands in history and natural history are now approximately equal; but although the room is in constant use during term-time, requests exceed the number which it is possible to accommodate. The Saturday Nature Club, now more than a year old, has been enthusiastically attended by 50–60 members each week, chiefly older primary school children. This is a record of which Bristol Museum might well be proud and should serve as a model for other areas.

Trinidad and Tobago Forest Department: Report for 1954

The annual report for 1954 of the Trinidad and Tobago Forest Department (pp. 44+1 map. Trinidad: Government Printing Office, 1955; 36 cents) gives a statement of the present areas of forestry in the Islands. Their total area amounts to 1,863 and 116 square miles, respectively, practically all of which is below a thousand feet. In Trinidad and

Tobago forest reserves now cover 279,996 acres, or 22 per cent of the country. To this about 65,000 acres of hill forest will be added when the surveys have been completed, bringing the total to 27 per cent. Adjustments are probable later, and it is assumed that the forest estate will eventually be about 300,000 acres—a very satisfactory area for the Islands. Of this area, 64,000 acres have been allocated to the plantation programme, mainly teak (an exotic, of course), and about 100,000 acres, parts of which have not yet been declared forest reserves, may be found to be inaccessible for a long period. Swamps cover a certain amount of area. Thus there are 128,000 acres of accessible forest to be regenerated under systems other than teak and mixed hardwood plantations. In the north a natural regeneration programme is in force over 31,800 acres, which will be treated under the shelter-wood system. In general, the forest management in the Islands may be considered to be in a satisfactory state.

André Mayer Fellowships of the Food and Agriculture Organization

The United Nations Food and Agriculture Organization has established a number of fellowships for advanced training in preparation for research work in topics of particular interest to member countries and to the Organization as a whole. Five or six fellowships are being offered this year, spread over the whole field covered by the Organization, namely, agriculture, agricultural economics and statistics, fisheries, forestry and nutrition. They will be called André Mayer fellowships in memory of the late André Mayer, who was closely associated with scientific research in France as well as international work, particularly in relation to the Organization. The awards will be for periods up to two years, with the possibility of an extension to a maximum of thirty months, and payment will be about 250 dollars a month. Further information can be obtained from the Secretariat of the F.A.O. National Committee for the United Kingdom, c/o Ministry of Agriculture, Fisheries and Food, 10 Whitehall Place, London, S.W.1.

Scottish Postgraduate Scholarships in Agriculture

The Department of Agriculture for Scotland has awarded the following postgraduate scholarships in agricultural subjects, tenable for periods up to three years at the institution shown: *Husbandry*, R. C. Kirkwood (University College of Wales, Aberystwyth), A. McKechnie (University of Reading), and J. L. Beveridge, S. S. Fluss and C. G. M. Duncan (University of Cambridge); *Engineering*, D. A. Jack (King's College, Newcastle upon Tyne). The awards held by the following, all of which are in husbandry, are being continued for a further period: A. D. Drysdale (University of Minnesota), D. M. S. Livingston (University of Aberdeen), C. Smith (Iowa State College), R. A. N. Napier (University of Edinburgh), J. Frame, I. C. Beattie and W. C. Smith (Massey Agricultural College, New Zealand), and N. C. Lawson (Macdonald College, McGill University).

Announcements

Major C. W. Hume, director of the Universities Federation for Animal Welfare, which he founded originally in 1926 as the University of London Animal Welfare Society, has been awarded the Albert Schweitzer Medal of the American Animal Welfare Institute.

Dr. R. Lessing has been elected president of the National Smoke Abatement Society in succession to Sir Ernest Smith.

The following appointments in the University of London have been announced: Mr. P. V. Danckwerts, deputy director of research and development of the Industrial Group, Atomic Energy Authority, to the University chair of chemical engineering science tenable at the Imperial College of Science and Technology; Dr. H. Tropper, senior lecturer at Queen Mary College, to the University readership in electrical engineering tenable at that College.

Dr. D. Starkie, director of research at the Hosiery and Allied Trades Research Association, is relinquishing his appointment in order to join the Board of English Rose, Ltd., as director of research in charge of the newly created Department of Research. Dr. Starkie will head a team of experienced scientists and technologists and will be concerned with research on hose materials, machines and products.

The sixth George Scott Robertson Memorial Lecture, given under the auspices of the Ministry of Agriculture, Northern Ireland, will be delivered in the Sir William Whitla Hall of The Queen's University, Belfast, at 3 p.m. on October 26, by Dr. D. P. Cuthbertson, director of the Rowett Research Institute, Aberdeen. The subject will be "Animal Nutrition in relation to Production and Disease". The Lecture will be open to the public.

The programme of lectures for 1956–57 of the Bedson Club, King's College, Newcastle upon Tyne, is as follows: October 26, modern inorganic stereochemistry, by Prof. R. S. Nyholm; November 16, the chemistry of some naturally occurring polyacetylenes, by Prof. B. Lythgoe; and January 25, polymerization in heterogeneous systems, by Prof. C. E. H. Bawn.

The first meeting of the British Society for Immunology will be held at the Wellcome Foundation, 183 Euston Road, London, N.W.1, during November 9–10. Following introductory remarks by Sir Henry Dale, the meeting will consist of the reading of scientific papers, the afternoon of the first day being devoted to a symposium on "Complement". Further information can be obtained from Prof. G. Payling Wright, Department of Pathology, Guy's Hospital Medical School, London, S.E.1.

The Morcom Green, Edwards Prize, which is offered yearly through the New Zealand Institute of Chemistry for the encouragement of original research by younger chemists, has been awarded this year to I. R. C. McDonald, of the Dominion Laboratory, Department of Scientific and Industrial Research, New Zealand, for his work on methods for the analysis of insecticides used in agriculture. Mr. McDonald has been engaged in the analysis of complex organic mixtures, with particular emphasis upon wool fat, insecticidal mixtures and wood chemistry, and has developed original techniques, using a double-beam infra-red spectrophotometer, for determining accurately the proportions of the toxic substances present in insecticide formulations.

Erratum. In *Nature* of August 4, p. 240, it was stated that Dr. F. Körösy had been appointed professor of physical chemistry in the Technion–Israel Institute of Technology, Haifa; he has, in fact, been appointed research fellow in physics at the Technion.

PHYSIOLOGICAL AND CELLULAR ASPECTS OF AGEING

A VARIETY of interesting papers were read at a joint meeting of the Dutch Society of Gerontology and the British Society for Research on Ageing, held at the Antoni van Leeuwenhoek-Huis (Netherlands Cancer Institute), Amsterdam, on July 27 and 28. Included in the programme were papers by guest speakers from the United States, Canada and South Africa.

One of the difficulties in studying morphological or physiological changes with old age has been that of distinguishing between fundamental alterations due to senescence and changes due to the operation of secondary factors, for example, nutrition. Dr. J. J. Groen, of Amsterdam, described a condition, 'senile' paradentosis, which might have been thought at first to have been in either category. This condition is characterized by resorption of the alveolar bone of the tooth sockets, usually accompanied by retraction of the gingiva; it is progressive and leads eventually to loss of teeth and to extensive atrophy of the jaw. The condition may begin in the young or middle-aged. Another condition well known in old people is senile osteoporosis, particularly in the spine and pelvis. This condition is clinically recognizable by X-rays; but it produces remarkably few metabolic changes. The phosphorus, calcium and phosphatase of serum of such patients seem to be unchanged, and the cause of the condition has been the subject of much speculation. Until recently, osteoporosis has been recorded by physicians and paradentosis by dentists—but Dr. Groen believes that they are one and the same disease. His investigations showed that all those suffering from one of them were found upon investigation to be suffering also from the other.

The etiology of this complaint was investigated at some length; but only one constant factor could be found—in all cases the patients were people who had stopped taking milk at an early stage in their lives. Investigation of their diets, which seemed adequate in most nutrients, showed a calcium intake between 250 and 450 mgm. per day. A few patients on whom balance studies were done while they were on their 'home diet' had negative calcium balances of 50 to about 200 mgm. a day. Control individuals who drank a pint to a quart of milk a day showed scarcely any sign of paradentosis or of osteoporosis at an advanced age.

Dr. Groen pointed out that Allbright had thought that osteoporosis in old persons was due to a decrease in sex hormones; but his own investigations had shown that the disease can occur before the menopause, and is invariably associated with a long-protracted low intake of calcium. He believes, in fact, that the condition 'paradentosis–osteoporosis' is mainly a result of a chronic, low-grade calcium deficiency.

Dr. T. Gillman, of South Africa, also recorded the syndromes of many nutritional conditions met with in South Africa among native populations. These included kwashiorkor, pellagra and an accumulation of iron in the liver which was sometimes followed or accompanied by fibrosis; he stressed the significance of his results in the study of gerontology.

Clinical studies on blood pressure by Dr. M. Landowne, of Bethesda, using intra-arterial recording, showed that the systolic pressure increases by an average of 4·8 mm. of mercury or 4 per cent per decade. This is the momentary peak pressure; but the average increase of the entire systolic period is 2·8 mm. mercury or 2 per cent per decade. There is also a decreased cardiac output of 1 per cent per year due partly to decrease in the blood pumped by each beat. Portion of this decrease is effected by a slowing of the heart. Just as in training for athletic activities the heart-rate slows, so in old age it slows as an adaptive change, for by so doing there is a large diastolic filling period, thus providing a better stroke/volume than if the diastolic pressure was shortened.

Dr. R. Van Zonneveld, of Gröningen, described a survey of old persons in the Netherlands which began with an inquiry among the old people themselves as to how they felt and what infirmities they complained of. This is to be followed by an announcement of the details of a survey which will be carried out in collaboration with twenty-four regional teams of doctors.

The question of whether sex hormones are invariably decreased in old age was discussed by Dr. O. Mühlbock, of the Netherlands Cancer Institute, on the basis of his work on highly inbred mice. Frequently in old female mice an enormous hypertrophy of the uteri is observed. It was found that the œstrogenic hormones maintaining this uterine development are produced by the ovaries. These old ovaries show few follicles; but cells can be seen in the periphery, obviously coming from the germinal epithelium, which look very like granulosa cells. They penetrate into the ovarian stroma forming small anovular follicles which are probably the source of at least some of the female sex hormone. In some cases the adrenals too may contribute œstrogens in old mice. In old adrenals so-called 'A' cells develop just under the cortex. These cell groups may show adenomatous development, and in this case probably also produce œstrogens.

In some animals there is also an enormous development of the mammary glands. This may be in part due to female sex hormones, but also to the high production of prolactin by the old pituitary. It was found that these mice often had pituitary tumours of a similar nature to those which can be produced in younger animals by prolonged œstrogen treatment. These pituitary tumours contain no gonadotrophin, growth hormone or corticotropin, and only a little thyrotrophic hormone. A high prolactin activity is, however, regularly found.

These studies emphasized that hormone imbalance may occur in old age, leading to endocrine hyperactivity rather than inactivity in some cases, and that this appears to be genetically determined.

Kidney studies of old rats by Dr. and Mrs. Friedman, of Vancouver, also demonstrated endocrine changes in old animals. In this case it is apparently decreased neurohypophysial function which is responsible for their results. They found that both young and old animals appear to excrete sodium identically, but that the older animals excrete a much more watery urine which suggests a decrease of the tubular water-absorption mechanism. If 'Pitressin' is given to the old animals with the saline solutions used in producing a salt load on the kidneys, re-absorption of water becomes the same as in the young animals, although sodium re-absorption was a little less. The neurohypophysis was shown to be unresponsive to direct osmotic stimulus in the old rat.

Cellular and tissue studies in old age were described by Dr. P. J. Thung, of the Netherlands Cancer Institute, Dr. G. H. Bourne, of London, and Dr. H. Saxl, of the Department of Medicine, Leeds.

Dr. Thung's paper dealt with amyloidosis in senile mice. He pointed out that mice easily develop amyloid, which may be produced experimentally in response to injection of a wide variety of substances and even by a milk and cheese diet. In old age, however, untreated mice similarly often develop amyloid. Genetical factors appear to be of prime importance in this tendency to amyloid degeneration, both experimentally and spontaneously, as some strains are rarely affected whereas others may show a 100 per cent incidence. Many of the substances which in mice cause amyloid, in the rat produce only necrosis and fibrosis. Similarly, it was found that chronic alcoholism, which in man would be expected to lead to liver cirrhosis, in mice caused heavy degrees of amyloidosis of the liver.

In human pathology it is increasingly recognized that amyloid degeneration is far more frequent than the classical condition found secondary to chronic suppurative disease. Its various forms range from this secondary amyloidosis to the amyloid found in cases of rheumatoid arthritis and the amyloid infiltrations frequently observed in the cardiac muscle in old age. These forms apparently represent different varieties of a common derangement of protein metabolism, on the causes of which as yet little is known. In mice, however, this derangement occurs much more easily than in man, and the causative agents consequently are less specific. Among these, old age plays an important part.

Dr. G. H. Bourne described the principal changes that take place in cells as they age, and directed attention to the fact that in many organs in old animals there is a histochemical increase in the activity of phosphatases and esterases and that biochemical studies have recorded an increase in activity of other hydrolytic enzymes. It may be that this increase in hydrolytic enzyme activity, which is destructive of many esters essential in metabolic activities, is one of the fundamental changes taking place in ageing cells.

The question of a possible link between protein and polysaccharide involvement in arteriosclerosis and lipid metabolism was discussed by Dr. H. Saxl, of the Department of Medicine, Leeds. She suggested the following mechanism by which the tissue polysaccharides *in situ* and certain components of the serum form an anti-lipæmic system: (*a*) in the presence of elastase, and especially the fraction which appears to have elasto-mucase activity, the mucopolysaccharides are made soluble and unstable; (*b*) the action of the serum inhibitor is to inhibit the removal of the soluble polysaccharides and by a direct action on these to make them stable and orthochromatic, and either secondarily or as a result of this interaction to activate a lipase.

An examination of the mode of the lipolytic action on atheromatous arterial walls has shown that there appear to be a degradation of neutral lipids of the atheromatous plaques and liberation of the soluble acid fats, which diffuse in the tissues.

G. H. BOURNE

CHEMISORPTION

SYMPOSIUM AT KEELE

A SYMPOSIUM on chemisorption was held by the Chemical Society during July 16–19 in the University College of North Staffordshire, Keele. The symposium, which was organized by Prof. W. E. Garner, was divided into five sections, the first of which dealt with the theory of chemisorption, with Prof. Garner as chairman. D. A. Dowden (Billingham) gave a general review of the covalent aspects of adsorption, extending the usual classification of *sp* and *d* bonds from metals to semiconductors. He considered that adsorbed gases could either be held strongly on the intermetallic type of *dsp* orbitals, or more weakly on atomic *d* orbitals. Using the ideas of crystal field theory, he indicated how the d^3sp^2 orbitals of a surface metal atom might split to give a d^2p set for the underlying metal and a *dsp* orbital in the surface. He did not consider that the surface metal atoms exhibit *dsp* free valencies, but emphasized the role of *dz* orbitals in weak adsorption. T. B. Grimley (Liverpool) used the *L.C.A.O.* or tight-binding approximation to discuss the interaction of a hydrogen atom with an electron in a surface state of the metal. Where a singly occupied surface state or partly occupied *d*-band is available, a bond is to be expected, the hydrogen atom being located over the metal atom. J. H. de Boer (Geleen) gave a critical account of theories relating heat of adsorption to surface coverage, and contact potential. He considered particularly the cases of cæsium on tungsten and hydrogen on nickel. The deficiencies of the simple double-layer theory were described and then improvements, allowing for discrete layers and mutual depolarization of dipoles, were tried. The conclusion reached was that some heterogeneity was present even with cæsium on tungsten. G. C. A. Schuit, L. L. van Reijen and N. H. de Boer (Amsterdam) described thermodynamic data for the adsorption of hydrogen on nickel supported on silica, and other supported transition metals. Definite evidence for heterogeneity was deduced, and experiments on the hydrogen–deuterium exchange showed the existence of a few sites specially active at 77° K. In the discussion, the thought was expressed that the silica support might in some way be contributing to the heterogeneity observed.

The next section dealt with chemisorption on insulators, and the chair was taken by D. A. Dowden. J. J. Kipling and D. B. Peakall (Hull) described results on the adsorption of liquids on silica gel and alumina. Four tests were made to distinguish chemisorption from physisorption: irreversibility; time effects; evidence for reaction at specific sites; and the relation of extent of chemisorption to the number and nature of active groups in the surface. S. J. Gregg (Exeter) described how some water was retained by active oxides even at the highest temperatures, probably hydroxyl groups. A second variety of adsorption, probably involving molecular water that was hydrogen-bonded to the surface, was indicated by the failure of desorption isotherms to close with the adsorption isotherms even at the lowest pressures. The presence of some hydroxyl groups appears essential for this type of adsorption. If silica is heated to 600° C. it becomes hydrophobic, showing a type V isotherm, but becomes hydrophilic when exposed until half saturated with water vapour. A. Kloosterziel (Amsterdam) described results on the interchange of deuterium atoms between alumina containing deuterium and ethylene. His kinetic analysis was developed in great detail for a number of possible models, to give the distribution of deuterium over the ethylene molecules as a function of time of contact. His conclusion was that, in the exchange process, two ethylene molecules require to be adsorbed at one site, probably an Al^{3+} ion. Subsequent discussion on these papers brought out the fact that physical and chemical adsorption frequently overlap in energy and that it is undesirable to try to draw too firm a dividing line.

The third section dealt with chemisorption on metals, and the chair was taken by Prof. D. D. Eley. B. M. W. Trapnell (Liverpool) reviewed his recent work on evaporated metal films and showed how heats of adsorption of oxygen and hydrogen on a range of metals may be related by a single numerical factor. A correlation of adsorption heats with atomic number for a series of metals appears to be more satisfactory than a correlation with *d*-character. This he related to the properties of the free atom, the states of which, he suggested, resemble the surface states of a bulk metal. The reactivity of gold and mercury in oxygen chemisorption so far stands outside all such schemes. He outlined new data on velocities of chemisorption on ten metals, and related them to exchange velocities of hydrocarbons (W, Rh > Pd > Ni > Fe). R. Suhrmann (Hanover) reviewed his results on changes in electrical resistance brought about by adsorption of gases on thin films of nickel and bismuth, the latter metal being chosen since its films show semiconducting properties. As an example of his work, he found that hydrogen on adsorption increases the resistance of nickel films at 90° K. On bismuth hydrogen effects only a very small decrease of resistance, attributed to a polarization $H_2^+ \,..\, Bi^-$. The paper by J. C. P. Mignolet (Liège) dealt with the problem of charge transfer in physical adsorption, as revealed by the author's extensive results on contact potential changes brought about by adsorbed gases. Thus in a case like nickel–xenon (0·85 V.) he concluded that the *d*-orbitals of the nickel are the acceptor orbitals. Where these are not present, smaller effects are observed, for example, zinc–xenon (0·21 V.). The method may be used as a diagnostic test for empty surface *d*-orbitals and reveals their presence in copper, since copper–xenon is 0·67 V. G. C. Bond and J. Addy (Hull) described results on the addition of deuterium to cyclopropane. The distribution function for deuterium in the products is considered to give a measure of the catalytic activity, the metals in descending order being rhodium, iridium, platinum, palladium, nickel. The paper by D. D. Eley and D. R. Rossington (Nottingham) gave a kinetic analysis of the parahydrogen conversion on a copper film which led to a value of 8 kcal. for the heat of chemisorption. Apparent frequency factors and activation energies were determined for copper, silver and gold catalysts in the form of foil, film and wire. The apparent activation energies were constant for a given metal, but the frequency factors increased in the order: foil, film, wire. The results for the three metals fell on a logarithm (frequency factor)—*E* relation that is characteristic of the catalyst type. The paper by P. M. Gundry and F. C. Tompkins (London) dealt with the slow adsorption of hydrogen and carbon monoxide on nickel. They found the Elovich equation applicable, and proposed a model of a homogeneous surface, with sites of strong adsorption reached via precursor sites of weak adsorption, linking up with Dowden's *d*-orbital model. J. H. Leck (Liverpool) described the effects of positive ion bombardment on metal surfaces. The positive ions were found to penetrate the surface to a depth of several atoms. In the discussion, D. J. C. Yates (Cambridge) outlined infra-red evidence for the loss of rotations by methane on adsorption on silica.

Prof. W. F. K. Wynne-Jones took the chair for the fourth section, which considered chemisorption on carbon. D. J. E. Ingram (Southampton) described the application of the electron resonance technique to the problem of carbonization. There is clear evidence for high concentrations of trapped electrons, apparently sited around the edges of condensed rings. On absorption of oxygen, the concentration of electrons and their delocalization are both decreased, the effect being reversible. A. Harker, A. Marsh and W. F. K. Wynne-Jones (Newcastle) described results on the physical and chemical structure of carbons. Oxygen chemisorption was shown to be markedly affected by hydrogen atoms and metal atoms in the main carbon structure. J. F. Goodman (Cambridge) outlined investigations on the effect of adsorption of oxygen on carbon carried out in Dr. F. P. Bowden's laboratory. They lead to the view that oxygen, by adsorbing between the carbon sheets, lowers the electron density and hence the cohesion between the sheets.

The final section, under the chairmanship of Dr. F. S. Stone, dealt with semiconductors. Dr. Stone's introduction defined *n*- and *p*-type semiconductors, and outlined the results of electron transfer and barrier-layer theory. The saturation coverage of gas is very low (less than 5 per cent) where barrier layers are operative, but in other cases—for example, carbon monoxide and hydrogen on zinc oxide—saturation occurs at high coverages and covalent bonds are probably formed. He described the work of Kubokawa, which has shown how hydrogen may be absorbed on zinc oxide below 110° with no effect on semiconductivity. According to R. Morrison, this may be explained by reaction of hydrogen with chemisorbed O^- species. Ionic processes may also be of importance—for example, in cases such as oxygen on cuprous oxide, calcium oxide and uranium oxide —where surface coverages less than 1 are found.

The next speaker, P. T. Landsberg (Aberdeen), emphasized the experimental criteria necessary for a decision on barrier-layer theory in a specific case. E. R. S. Winter (Birmingham) described the results of oxygen-18 exchange between oxides and various oxygen-containing gases, reviewing earlier work and presenting new data. In many cases the activation energy fell to a lower value at higher temperatures, corresponding to a change-over of the rate-determining step from dissociative adsorption to lattice exchange. Evidence was brought forward to show that the decomposition of nitrous oxide on nickel oxide proceeds on a small fraction of sites and involves the participation of lattice oxygen. Similar results hold for the carbon monoxide–oxygen reaction; but a different set of sites is involved. R. Rudham and F. S. Stone (Bristol) described the chemisorption of oxygen, carbon monoxide and carbon dioxide on cuprous, nickel and cobalt oxides, correlating observed heats with reversibility and surface coverage. Oxygen chemisorption was activated and extensive, exceeding the monolayer in cuprous and cobalt oxides, and this is probably a general effect for oxygen on *p*-type semiconductors. J. D. M. McConnell and L. E. J. Roberts (Harwell) considered adsorption of gases on uranium dioxide and thoria. Oxygen is considered to adsorb on the uranium ion, accepting electrons from the solid, while a carbon monoxide molecule donates electrons to a uranium or thorium ion. There is evidence for an autocatalytic adsorption of oxygen on uranium oxide, analogous to that observed by Dowden and Beebe in 1938 with chromia, and this point raised some discussion. The final paper, by R. J. Davis (Fulham), showed how antiferromagnetic interactions in the cation lattice of α-Cr_2O_3, V_2O_3 and other oxides affect the unit-cell dimensions. He considered that these cation–cation interactions might be involved in the chemisorption of hydrogen, and in ring-closing reactions of hydrocarbons.

The meeting was exceptionally well attended, the discussions were lively on most topics, and the arrangements made by Prof. H. D. Springall and the University College all helped to make the symposium a considerable success. The proceedings of the symposium are to be published in the near future by Butterworths and Co. (Publishers), Ltd.

D. D. Eley

PROGRESS IN RADIOBIOLOGY

CONFERENCE IN STOCKHOLM

The Fifth International Conference on Radiobiology met in Stockholm during August 15–19, under the chairmanship of Prof. George de Hevesy. About 180 scientists from nineteen countries were present, and eighty contributions read and discussed. In comparison with previous meetings, emphasis was placed more on the hæmopoietic and genetic effects of radiation, and less on its primary physical or chemical action.

During the past year, it was shown that hæmopoietic cells injected into heavily irradiated animals of the same, or even of a different, species can colonize the blood-forming tissues of the hosts. This explains how animals can survive lethal doses of radiation if part of their blood-forming tissue is shielded, or if they receive after irradiation an injection of hæmopoietic cells of another animal. The hypothesis that recovery is promoted by some humoral or subcellular factor is now unnecessary, and at this meeting it was reported that the 30-day survival of *CBA* mice after 950 r. depends on the number of intact spleen cells inoculated, and is independent of the number of nuclei of damaged cells (D. W. H. Barnes, M. P. Esnouf and L. A. Stocken). The effectiveness of a given inoculum is greatest when the graft is least different genetically from the host (J. Soska, V. Drasil and Z. Karpfel; J. A. Cohen, O. Vos and D. W. van Bekkum). After 950 r. whole-body irradiation to mice and subsequent injection of spleen cells, the entire blood-forming tissue was taken over by the graft. No reversions to tissue of host origin were observed up to 157 days after grafting from another mouse. With heterologous (rat) grafts, reversion may occur (C. E. Ford, J. L. Hamerton, D. W. H. Barnes and J. F. Loutit).

Of medical interest was a more sensitive assessment of hæmopoietic damage in persons exposed to low occupational doses, by means of a new method of collecting and treating blood-count data (M. Helde). The great sensitivity of red-cell precursors was seen after 50 r. whole-body X-irradiation of rats, when the number of late and intermediate normoblasts in the bone marrow fell to less than 50 per cent in 24 hr. (E. V. Hulse). It now seems established that exposure to radiation increases the risk of leukæmia in man (W. M. Court-Brown). Study of 828 case histories of leukæmia from the Danish cancer register (M. Faber) leads to the conclusion that both chronic myeloid and acute leukæmia can be induced by radiation, and that part of the increased incidence is due to diagnostic X-ray procedures in which bone marrow is exposed. The absorption, retention and removal were described of the decay products of radium and thorium (K. Aurand, W. Jacobi and A. Schraub), of strontium-90 in bone (M. Owen and J. Vaughan) and of yttrium (R. Lewin, B. Rosoff, H. Hart, K. G. Stern and D. Laszlo).

Work done on chemical protectors has failed to reveal a common mechanism for their action. Some earlier observations on cysteamine have not been confirmed (Z. M. Bacq). It was ineffective when given to chicks or administered orally to rats. It was suggested that cysteine and cysteamine act by inducing anoxia (J. F. Duplan and H. Marcovitch; J. A. Cohen, O. Vos and D. W. van Bekkum). Cysteine protected *Glis glis* from mortality if administered twenty-one days after irradiation, provided the animals were kept meanwhile at 4° C. in their hibernating state (H. Kunkel, G. Höhne and H. Maass). It is difficult in this case to see how the protector could interfere with primary radicals or exert its influence by specific reactions involving —SH or —S—S— groups of target molecules (A. Pihl and L. Eldjarn; U. Hagen). We are reminded of the specificity of protectors by the fact that α-thiolamino-acids are protective, whereas β-thiolamino-acids enhance radiation effects in mice (R. Koch). Dose-reduction factors of cysteamine and of β-aminoethyl*iso*thiouronium change with the dose of radiation. Critical damage is thought to occur at different sites after different doses, and the efficiency of protection to vary from site to site (A. Catsch).

Among agents which increase radiosensitivity, oxygen has retained its interest. The sensitivity of *E. coli* irradiated in buffer solution increased with oxygen concentration in the bubbling gas, and reached almost full sensitivity at 3 per cent oxygen (T. Alper). The sensitivity change in Ehrlich ascites tumour cells from anoxia to full oxygenation occurs at lower concentrations of oxygen than previously reported (O. C. A. Scott), and a similar pattern of sensitivity was found in the ascites form of the Yoshida rat sarcoma (W. Dittrich). The sensitivity typical of the anoxic state was attained 3 sec. after stopping the circulation in mouse tails (P. Howard-Flanders). Cooling mice to 0–0·5° C. afforded a dose-reduction factor of 2·8, an effect largely attributed to the anoxic condition of hypothermic animals (S. Hornsey). Organic peroxides produced by X-rays seem to be implicated in mutagenesis in *Drosophila*, since it is potentiated by pretreatment with dihydroxydimethyl peroxide or formaldehyde, or with cyanide or azide (F. H. Sobels).

The question of the contributions of the direct and indirect effects to biological damage received some attention. The direct effect in polythene and dry bovine serum can be influenced by oxygen or temperature, but seems to be independent of small amounts of water (P. Alexander). In contrast, it was claimed that the radiosensitivity of enzymes in wet yeast cells is 2–50 times higher than in dry cells, suggesting a high contribution from the indirect effect (F. Hutchinson).

The respiratory system of mouse-liver slices is affected by doses higher than 10^6 r. Sensitivity is determined by cytochrome *c*, which is destroyed by indirect action (B. Rajewsky, G. Gerber and H. Pauly). Yoshida ascites cells 20 min. after 20,000 r. show a drop in respiration and in aerobic and anaerobic glycolysis, and changing relative levels of adenosine di- and tri-phosphate. These differences become less pronounced at 40 min. (G. Höhne, H. A. Künkel and H. Maass). Incorporation of *dl*-phenylalanine-^{14}C into cell components of mouse liver is higher after 500 r. whole-body exposure (J. A. V. Butler, P. Cohn and A. R. Crathorn). The rate of incorporation of phosphorus-32 into rat thymus deoxyribonucleic acid is reduced to half within 3 min. after 1,000 r. to the whole body (M. G. Ord and L. A. Stocken). Increased incorporation of tracers after irradiation may be due to reduced size of body pool (F. Sherman and A. B. Almeida).

A single sub-sterilizing dose of 1,050 r. given to rabbit ovaries is less damaging to late primordial follicles than if given in fractions of 210 r. every 48 hr. (P. Desaive). The sterilizing dose for female mice, on the other hand, does not seem to be dependent on dose-rate, whether delivered at 2·5 r. daily or in one exposure (H. and U. Langendorff).

In a session on genetic effects in *Drosophila*, H. J. Muller and I. I. Oster presented new evidence that true reversals of the original forked (*f'*) mutation can be induced by X-rays. They believe that point mutations of whatever origin are indistinguishable in principle, and are due to qualitative chemical changes in the gene locus. Alkylating agents were reported to have produced a large number of point mutations in loci that have not been observed to mutate under X-irradiation, and the distribution of chemically and X-ray induced mutations on the *X*-chromosome has been found to vary with the mutagen used (O. G. and M. J. Fahmy). Chromosomes of spermatids are at least twice as sensitive to the X-ray induction of lethals and translocations as those of mature sperm in inseminated females (I. I. Oster). Crossing-over in spermatogonia can be induced by injection of formaldehyde (F. H. Sobels). Chromosome breaks, and possibly also intragenic changes, induced by X-rays in mature sperm, are thought to undergo recovery if the sperm are retained for one day in the male (K. Nordback and C. Auerbach). At least five times as many small-effect detrimental mutations as recessive lethals are induced in male *Drosophila* by X-rays (K. G. Lüning and S. Johnsson). The reduced viability of flies receiving irradiated chromosomes is accompanied by a decreased rate of development, and it was suggested that growth-rate studies might be useful in assessing genetic damage due to radiation in mammals (G. Bonnier).

Two films were shown illustrating the effect on mitotic behaviour of irradiating parts of cells in tissue culture with α-ray microbeams. Sensitivity increased by a factor of 10 from prophase to metaphase (M. I. Davis, I Simon-Reuss and C. L. Smith), and irradiation of chromosomes was much more effective in producing anaphase and telophase abnormalities, than irradiation of cytoplasm only (R. Munro). When roots of *Vicia faba* are irradiated with very high intensities of X-rays, in the range 600–1,200 r./min., a class of chromosome breaks becomes apparent which rejoin very rapidly and which may be due to breakage of ionic bonds. These breaks are to be distinguished from those others, regarded as due to the breakage of co-valent bonds, which remain open for a relatively long time (S. Wolff).

Under the appropriate chairmanship of Prof. Å. Gustaffson, a special session met on the last day to discuss the application of the mutagenic effects of radiation to plant breeding. Facilities and techniques were described for the Brookhaven Laboratory (H. J. Curtis) and plans outlined for the improvement of the rice crop in India (A. R. Gopal-Ayengar). Of 427 radiation-induced mutations in soya beans, only 1 per cent seem to be of some economic value (M. Zacharias). In black currants, selection of mutated shoots from irradiated cuttings was reported to have given promising results (R. Bauer). A review was given of the work of the Swedish group in utilizing 'directed' mutations produced in barley by various physical and chemical agents (D. von Wettstein).

MICHAEL EBERT
ALMA HOWARD

POPULATION GENETICS

A SYMPOSIUM on population genetics, with particular reference to stability of development, was held on the afternoon of Monday, September 3, at a joint session of Sections D (Zoology) and K (Botany) of the British Association in Sheffield. It was opened with a paper by Dr. J. M. Thoday entitled "Environmental Heterogeneity and the Genetic Architecture of Populations". Dr. Thoday began by pointing out that one of the most remarkable discoveries of recent biology was the great diversity of genotypes to be found in any population of out-breeding species. Comparative uniformity of individual morphology is mediated by a wide range of genotypes, each highly heterozygous and compounded of chromosomes many of which, though successful in heterozygous combinations, are deleterious, or, even lethal, if made homozygous. This great genetic heterogeneity of populations is generally held to find its explanation as an adaptation permitting populations to survive change of their environment. Nevertheless, the heterozygosity on which this individuality depends involves a price, for it necessarily involves the production of some segregants poorly adapted to contemporary environmental conditions and, hence, involves relative infertility. The out-breeding systems by which heterozygosity is maintained are also less secure than self-fertilization. Some scientists therefore find it difficult to believe that the long-term selection for heterozygosity can be powerful enough to over-ride the short-term selection for fertility, and therefore doubt whether it is sufficient as an explanation of the ubiquity of the cross-breeding systems that maintain heterozygosity. Dr. Thoday suggested that if we consider the nature of environment heterogeneity, we find reason to believe that selection for heterozygosity on a relatively short-term basis may be strong. Environmental heterogeneity may be classified as random, directional or cyclic, the latter being the type to which he gave most attention. If the period of the cycle is longer than generation time, then the cycle will involve selection for new genotypes each generation and periodic reversal of the direction of selection. In these circumstances, a population may be expected to become heterozygous for genes appropriate to peak and trough conditions of the environmental cycle. Further, a certain degree of heterozygous advantage is to be expected as a system buffering the population against loss of peak genes in trough conditions, and vice versa. This system is precisely that known to occur in populations of *D. pseudoobscura* studied by Dobzhansky. Superimposed on the system, and hence in a heterozygous context, selection will proceed further to produce *individuals* capable of withstanding a longer and larger proportion of the range of environmental conditions imposed by the cycle. Only the success of this form of evolution can permit the evolution of longer generation times, and the end will be heterozygous individuals that can withstand the whole cycle and hence perhaps live for several cycles.

Dr. Thoday suggested that our finding that the ability of individuals to control their development despite environmental variation very often depends on heterozygosity may well be explicable in terms of such a history of adaptation to cyclic conditions which he attempted to show are ubiquitous, especially since spatial differentiation of the environment must produce cyclic conditions in time, as dispersal of seed, etc., works in both directions.

The remaining papers were all concerned with this ability of individuals to maintain organized 'normal' development despite internally or externally caused disturbances. Mr. J. A. Beardmore reported on the effects of a diurnal temperature cycle on stability as measured by bilateral asymmetry of sternopleural chæta number in *Drosophila melanogaster*. Two long inbred lines the inbreeding history of which had occurred at constant 25° give more stable F_1 hybrids at 25°, the F_2 flies being, if anything, more stable than the F_1. In the fluctuating temperature conditions (mean 25°, midnight 20°, midday 30°), the reverse result is found, the F_1 being less stable than the inbreds and the F_2, if anything, less stable than F_1. He also reported evidence that though laboratory flies from constant-25° rooms are usually less stable in the fluctuating than in the constant-temperature incubator, newly captured wild flies give offspring superior in the fluctuating condition, indicating this to be the nearer to a wild environment. Six months in constant laboratory conditions may be sufficient for populations to lose their relative adaptation to the fluctuating condition. Experiments on natural populations involving comparisons in constant temperatures have therefore to be interpreted with caution.

Mr. J. Maynard Smith followed with a paper entitled "Developmental Flexibility in *Drosophila*". He began by stressing the point that the degree to which the development of organisms is under control or stabilized is not always to be measured by the degree of uniformity of the end product. Sometimes fitness may require different phenotypes in different environments. The superior capacity of outbreds, as compared with inbreds, is usually deemed demonstrated when it is shown that the outbreds are more uniform than corresponding inbreds ; but when the situation is such that optimum phenotype varies with environment, then the best-regulated development should lead to variation of phenotype corresponding to variation of environment, and in these conditions, if outbred individuals are superior to inbreds, they should vary more than inbreds.

Mr. Maynard Smith described his attempt to test this hypothesis in *Drosophila subobscura*. The character measured was the length of time for which adult flies could survive at 33·5° C. in dry air. Three inbred lines and the three hybrid populations between them have been tested. In all three hybrid populations, individuals which were kept at 25° C. as larvæ and pupæ, and then at 15° C. as adults for a week before testing, lived approximately 2·5 times as long as did individuals of the same genotype kept at 15° C. throughout. Thus outbred individuals are capable of long-lasting acclimatization to high temperatures if they are kept at 25° C. during the pre-adult stages. Of the three inbred lines, one showed no capacity for acclimatization, and the other two acclimatized significantly less than did the hybrids. Thus the capacity to withstand exposure to high temperatures is a phenotypic character which can be modified adaptively in response to changed conditions during development, to a greater extent in outbred than in inbred individuals. In this particular case, therefore, the hypothesis outlined above has been confirmed.

The final paper was given by Dr. H. Rees on "The Stability of Meiosis in Inbred and Crossbred Rye". He said that when inbreeding is forced upon a species such as rye, which normally outbreeds, the progeny show inbreeding depression in relation to the chromosome mechanism much as they do for more familiar aspects of the phenotype. At meiosis one general consequence is a reduction in chiasma frequency. In some extreme cases when chromosomes are frequently unpaired and hence lost during cell division, this causes considerable pollen and egg infertility. Another result of inbreeding concerns the stability of plants in relation to chiasma frequencies. Thus *between plants* of identical genotype *within* inbred lines there is more variation in chiasma frequency than between plants of the same genotype within heterozygous families ; under comparable experimental conditions the chiasma frequencies of homozygotes are less stable. Similarly, variation is greater between pollen mother cells within anthers of homozygotes than it is *within anthers* of heterozygotes. It has been found, however, that although homozygotes are generally less stable than heterozygotes, the instability cannot be explained in terms of the degree of homozygosis alone. Inbred lines equally homozygous may show different degrees of instability. Stability evidently must be related to the particular genotype.

Chiasma frequency, of course, to a large extent determines the degree of gene recombination and hence the variability in outbreeding populations. The average chiasma frequency is known to be genotypically controlled. The above results make it clear also that the range of chiasma frequencies within an anther (that is, the degree of 'instability') is also subject to the control of the genotype. From the population point of view this means, therefore, that the average amount of recombination through chiasma formation per plant may be adjusted by natural selection, and that the variety of the gametes, in respect of recombination, can also be adjusted adaptively. J. M. THODAY

THE NATIONAL INSTITUTE FOR RESEARCH IN DAIRYING, SHINFIELD

REPORT FOR 1955

SOME years ago Dr. E. V. McCollum, an eminent American authority on nutrition, stated that "The people who achieved, who have become large, strong, vigorous people, who have reduced their infant mortality, who have the best trades in the world, who have an appreciation for art, literature and music, who are progressive in science and in every activity of the human intellect, are the people who have used liberal amounts of milk and its products" ! Even though this may well be regarded by many as something of an over-statement, it is undoubtedly true that milk contains a greater number of the individual nutrients essential for health in man than any other single food. Calculations made a few years ago showed that home-produced milk, consumed in Great Britain as liquid milk, supplied some 17 per cent of the total protein and some 12 per cent of the total fat in the people's food, as well as important proportions of its minerals, vitamins and energy content. The gross value of the milk and milk products produced annually in Britain amounts at present to some £400 million. Apart from economic considerations, it is worth recalling that the milk secretion process itself is one of the chief physiological functions on which the very existence of mammalian life depends.

With facts like these in mind, it is most encouraging to read of the work that is being done and the progress that is being made at the National Institute for Research in Dairying, Shinfield, under the direction of Prof. H. D. Kay, whose most informative annual report for 1955 has been recently published*. Lists of staff, patrons, fellows and members of the Institute are given, from which it can be seen that the number on the staff of the Institute now exceeds three hundred and that about a hundred of them are graduates in some branch of science.

The report can be regarded as consisting in the main of three principal parts. The first of these is the foreword, which contains a short but valuable outline of some of the recent findings that have been made at the Institute. More than thirty individual items are referred to. This part of the report should be of special interest to those who want to know as briefly as possible, and in an immediately practical way, what advances were made in 1955 without having to read in detail about the work of the Institute as a whole.

The second, and by far the largest, part of the report gives an account of each of the eight principal departments of the Institute, and also discusses the work of the four smaller sections that deal with such a wide variety of subjects as isotopes, statistics, psychology, and liaison with the dairy industry. Some of the problems under investigation are of a very practical nature, such as the prevention of infestation of cheese by mites, and the effect of 'vacuum' level on the rate of milking by machine. Others are scientifically more fundamental and require for their elucidation the expert knowledge and training of research workers in bacteriology, chemistry, physics, physiology, nutrition and engineering. Examples that might be cited of these fundamental researches are the work that is being done on the biochemistry and physiology of milk secretion with particular reference to the formation of fat and protein in the mammary gland, and the detailed study that is being made of the chemistry of the β-lactoglobulins in milk.

A third section of the report, which will prove of special value to many readers, comes under the heading of library. It gives a list, with full titles and references, of the 151 papers that were published by members of the staff between October 1954 and September 1955. A mere glance at this formidable list will impress the reader with the great scope and importance of the researches that are being done by what is clearly a very capable and enthusiastic band of workers.

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* University of Reading. National Institute for Research in Dairying: Report 1955. Pp. 148. (Shinfield: National Institute for Research in Dairying, 1956.) 4*s*.

THE BRITISH STEEL CASTINGS RESEARCH ASSOCIATION

ANNUAL REPORT

THE British Steel Castings Research Association is one of the newest of the research associations operating under the aegis of the Department of Scientific and Industrial Research; although now having produced its third annual report*, this co-operative research organization, before it became attached to the Department, had been operating for some years under the wing of the British Steel Founders' Association. These were formative years, but from the present report it is apparent that this young and virile research body has reached a promising stage of development; and a new research station is in course of erection at a suitable site in Sheffield, the home of so many famous developments in the steel world.

The steel-founding industry in Britain would appear from this report to be a compact and co-operative industry, well able to uphold the best traditions of British engineering industry. Much of the work of the Association in its brief existence has been confined to work carried out in member foundries. This liaison would appear to be particularly good, advisory work being also done by the Association's staff. Further, extramural research has been supported at several universities, and work of considerable value has emerged from these activities.

In the early days of its existence, the parent body of the Association, known as the Research and Development Division of the British Steel Founders' Association, took over from the British Iron and Steel Research Association the work of the old Steel Castings Committee, which had been responsible for notable activities in the field of steel founding, in particular in regard to steel casting, moulding sand and furnace refractory practice. From the days of Boswell in the First World War, when the first scientific studies of British moulding sands were undertaken in a number of foundries, the steel-founding industry has applied progressively scientific methods to its moulding practice; the developments outlined represent, on the part of the steel-founding industry, the realization of the value of co-operative scientific research. The work in the past has been closely associated with the Refractories Department of the University of Sheffield. From my own experience of the industry, this aspect of the work has already gained world-wide recognition, both in regard to the properties of the moulding materials available in Britain, and the bearing which founding techniques may have on the quality of the casting. The aim of the founder is to make a sound casting with the minimum of sand adherence, not only for the purpose of economical production in the foundry, but also with the object of reducing the health hazard in the foundry and the fettling shop.

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* British Steel Castings Research Association. Third Annual Report, 1956. Pp. ii+25. (The Association, Broomgrove Lodge, Sheffield 10.)

The work of the Association is under the direction of Dr. A. H. Sully, and is divided into five main sections: (i) metallurgy, comprising in itself a field of wide scope, for man's mastery of the properties of metals is a never-ending pursuit; (ii) foundry practice and moulding materials; (iii) steelmaking; (iv) plant engineering; and (v) industrial health.

In the metallurgical field the immediate problems have been to study the practical techniques that produce sound castings and thereby the optimum mechanical properties, which the ever-increasing demands of engineering practice may require. This has involved the study of the interdendritic microporosity in steel castings, which may be of more widespread occurrence than is generally appreciated. An increasing need in engineering practice has been for materials that remain tough at very low temperatures. An investigation into such properties referred to in the present report has shown that for low- and medium-alloy steels the highest resistance at low temperatures is developed in fully hardened and tempered steels. The importance has also been demonstrated of avoiding temper brittleness in steels known to be susceptible to it by water quenching from the tempering temperature.

Considerable light has been thrown on the problem of sand adherence to steel castings by investigations carried out under Dr. T. P. Hoar at the University of Cambridge under the sponsorship of the Association. Equally interesting in these respects has been the research carried out under the supervision of Prof. J. White at the University of Sheffield on the hot-strength properties of moulding sands. Reaching the scale of extended and promising trials on the foundry floor is the use of sands bonded with bentonite–kaolinite clay mixtures that have been shown in the laboratory to have better foundry 'life' properties than mixes bonded solely with bentonites, the latter being generally an imported raw material.

In the steelmaking investigations, particular attention is being devoted to the use of oxygen injection, a relatively modern practice which promises to give enhanced control to the steelmaking process. Efforts are also being made to bring the conclusions of the many erudite studies of the physical chemistry of steelmaking on to the stage of the steel-melting furnace.

Plant engineering must ever be important in the growing mechanization and instrumentation in all types of industrial practice. In an industry in which the art of founding is applied, a complexity of process is inevitable, and therefore the engineering aspects introduce a wealth of needs. Improvements in fettling tools and moulding machines accordingly introduce problems that are to be found in the research programme.

Notable advances have been made in the field of industrial health. The Association has succeeded in introducing new methods of dust control in stand and swing-frame grinders, that have received the approval of H.M. Factory Inspectorate. One of the outstandingly successful events of the Association's year was the conference on "Steel Foundry Dust Control and Ventilation" held at York in October. The report of this conference has been adjudged by the practical observers of developments in the industry to have constituted a milestone of progress against the health hazards of the steel foundry, an achievement that must have valuable economic and social results.

The Association has a Technical Advisory Committee structure that is not too unwieldy, and yet brings to the Committee table the best brains in the industry, a commendable situation in these days when the efforts of too many executives and technical men tend to become strained in an almost committee-ridden age. In regard to the Library and Information Services, the policy has been continued of building up as complete a collection as possible of current literature on steel-foundry subjects, while relying on borrowing and interchange to fulfil marginal needs and other requirements. In these respects, Sheffield is building up an enviable reputation for the efficiency of its library and interchange services, so important a need in a great technological centre. The *Abstract Journal* of this Association can be regarded as one of the best of its kind. The new Research Station is expected to be completed before the end of the year.

R. J. Sarjant

COMPARISON OF SOME DIRECT AND INDIRECT EFFECTS OF IONIZING RADIATIONS IN PROTEIN

By Dr. P. ALEXANDER, Dr. M. FOX*, Dr. K. A. STACEY and D. ROSEN

Chester Beatty Research Institute and Physics Department, Institute of Cancer Research, London, S.W.3

A NUMBER of investigations[1] have shown that changes in chemical and physical properties of proteins occur after irradiation both in dilute aqueous solution, when the action is produced by the free radicals formed in the water, and in the solid state, when the energy is absorbed directly by the protein. We have studied with the same proteins both types of process to illustrate their similarities and differences. The relative efficiency of the two processes may provide a guide to their relative importance in initiating the series of processes which lead to cellular damage. The principal criteria used for determining alterations in the protein have been changes in solubility, ultra-violet absorption, chromatographic behaviour and alterations in molecular weight as revealed by light-scattering and the ultracentrifuge.

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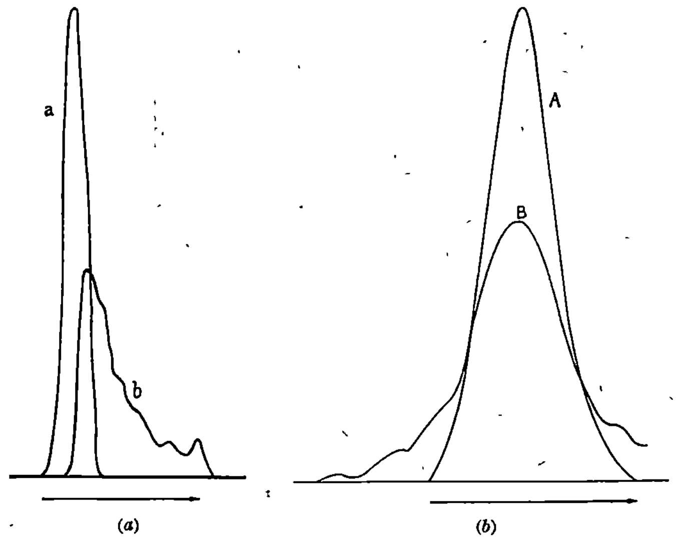

Fig. 1. The Lamm scale ultracentrifuge diagrams of irradiated bovine serum albumin.

(a) Indirect effect. The control solution (a), and the irradiated solution (b) which has received 100,000 r., are 1 per cent.

(b) Direct effect. The solid has received 8 × 10^6 r. and is measured as a 1 per cent solution (B) compared with a control solution (A)

Indirect Effect

Dilute solutions of proteins are precipitated by irradiation with a sufficiently high dose ; but little is known about the changes which precede this effect. Several workers[2,3] have reported on the apparent increase in the ultra-violet absorption and the formation of dimers upon the X-irradiation of serum albumin and fibrinogen, whereas hæmocyanin was shown by Svedberg and Brohult[4] to split into well-defined sub-units by α-irradiation.

We have found a marked rise in the weight average molecular weight of serum albumin (both human and bovine) as determined by light scattering upon exposure of dilute solutions to X-irradiation. This rise is due to the formation of a very polydisperse range of aggregates which have been shown by examination in the ultracentrifuge[5] (Fig. 1a) and the electron microscope to range from dimers up to units of many hundred molecules. Since the apparent molecular weight as measured by light scattering depended on the ionic strength of the solution in which the measurement was made, and furthermore could be reduced by the addition of urea (final strength 4 M) the larger aggregates behave as associations of partially denatured molecules held together by secondary forces. The proportion of protein in the main ultracentrifuge peak was unaltered by the addition of urea, so that it is probable that the smaller aggregates are covalently cross-linked.

We have confirmed the observation that the ultra-violet absorption of serum albumin at 280 mμ apparently increases after irradiation, but cannot accept the contention that this is the result of a preferential attack on the tyrosine residues which are responsible for this band[3]. The apparent increase is due to loss of light by the greatly increased scattering by the large aggregates formed on irradiation. The light scattering was measured directly at 436 and 546 mμ with an instrument used for molecular weight determinations, and the scattering at other wave-lengths was calculated by the Rayleigh–Debye equation. These values were used for correcting the spectrum determined in a spectrophotometer, when it is seen (Fig. 2) that the true absorption of the protein is only slightly, if at all, changed on irradiation. The correction applied for scattering may be somewhat too small, since the scattering was only determined for the angles between 40° to 135°, which will give a low value of the total loss of light due to the largest aggregates. For the experiment shown in Fig. 2, the weight-average molecular weight increased from 7 × 10^4 to 1·5 × 10^6, while the number-average, estimated from the decrease in the amount of material with the sedimentation constant of the starting material, cannot have exceeded 1·5 × 10^5. The great difference between these two averages proves that some very large aggregates must be present. If the serum albumin was irradiated in the presence of salt or titrated to a pH away from its isoelectric point, the change in the ultra-violet spectrum was less. This effect is not the result of protection by competition for the radicals formed by the salt, but is due to the fact that the aggregates formed are smaller and therefore scatter less light.

While the absorption of serum albumin at 280 mμ is almost wholly due to tyrosine, that of lysozyme at the same wave-length is due to tryptophan. On irradiation of dilute solutions of this enzyme with X-rays (see Fig. 3) the ultra-violet maximum first decreases, but increases again with larger doses. The initial effect probably represents a preferential attack on the tryptophan by the free radicals formed by irradiating water. This behaviour may be correlated with the ability of tryptophan and its derivatives to compete very effectively with other substances for free radicals produced in solution[9]. The increase at higher doses is again due to aggregation, and on correcting for this by measuring the scattered light, it appeared that the true absorption maximum continues to decrease.

The object of further research will be to determine the primary chemical changes, produced by the radiation, which result in the observed aggregation. This aggregation reflects a most significant physico-

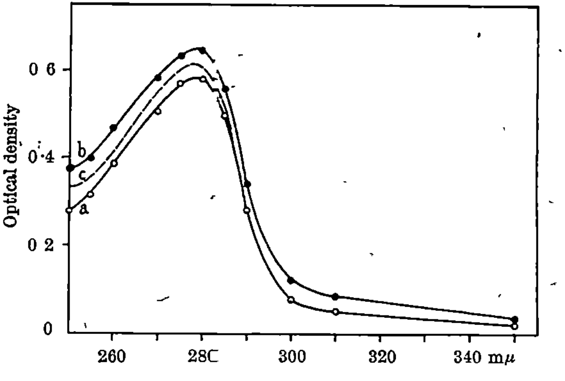

Fig. 2. Effect of irradiation on the ultra-violet spectrum of bovine serum albumin ; 30,000 r. was delivered to a 0·1 per cent solution. The light scattering at 437 mμ and ultra-violet absorption was determined at 0·044 per cent in 0·1 M sodium chloride. The correction due solely to light scattering was calculated from the molecular weight, 1 5 × 10^6 and the dissymmetry [∼ 2]. (a) Control ; (b) irradiated protein ; (c) corrected curve

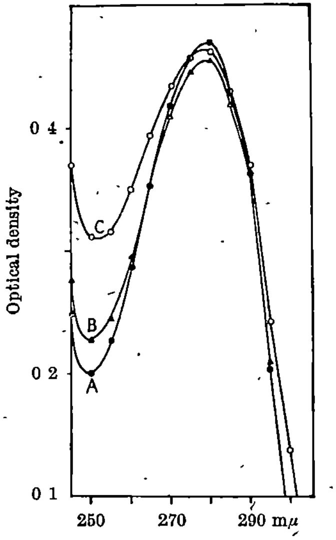

Fig. 3. Ultra-violet absorption spectrum of 0·025 per cent solutions of lysozyme (*B*) after 10,000 r., and (*C*) after 30,000 r., compared with an unirradiated control (*A*)

chemical change following an indirect action, and may also give rise to the other changes reported, such as more facile heat denaturation.

Direct Action

The irradiation of solid serum albumin produces effects which are quite different from those following indirect action. The protein was not dried completely, since it was felt that the presence of approximately 5 per cent of water, which is essential to retain the protein in its native form, would not introduce any significant 'indirect' contribution.

The radiation effect is influenced by the presence of oxygen; irradiation with γ-rays in air begins to render part of the sample insoluble in water at 4 × 10^6 r., and at 8 × 10^6 r. 90 per cent failed to pass through a filter of pore size less than 0·3μ after suspending in water. The fraction dissolving contains large aggregates, and these appear to behave in a similar way to those produced by indirect action; for example, a sample of bovine serum albumin given a dose of 2 × 10^6 r. has a weight-average molecular weight of 1·5 × 10^6. The ultracentrifuge pattern (Fig. 1*b*) again shows that the irradiated protein is polydisperse and contains material of very high molecular weight. But unlike the protein irradiated in solution, some of this material sediments more slowly than the starting product, indicating that some degradation has taken place. The aggregate can, in part, be dispersed by concentrated urea. This will also dissolve some of the protein which had become insoluble in water with doses greater than 6 × 10^6 r. This behaviour suggests that secondary forces contribute to aggregation; but that new covalent inter-molecular cross-links are formed.

Irradiation of the dry material brings about a true change in ultra-violet absorption, as can be seen from Fig. 4, where the absorption measured has been corrected for scattering by the aggregates. This indicates that the tyrosine is attacked; the extent of the change is much greater than could be accounted for by energy taken up directly in the tyrosine residues themselves. The ultra-violet spectrum of polytyrosine (a sample kindly given by Dr. E. Katchalsky) is not detectably altered by the dose which produces a 20 per cent change in serum albumin. Since the initial uptake of energy is independent of the molecular structure, the same *fraction* of the tyrosine should be affected in a protein as in a polypeptide entirely composed of tyrosine residues. The observation that a greater proportion of the tyrosine is affected in the protein suggests that energy taken up in other amino-acid residues contributes to the attack on the tyrosine. This appears to be another example of a process found in other systems[7] also which we have referred to as energy transfer without implying any particular physical or chemical mechanism.

When a 1 per cent aqueous solution of serum albumin was irradiated with α-particles from polonium, the changes produced resembled those from the direct action of γ-rays, in that the ultra-violet absorption was generally increased and both aggregation and degradation were found. Since the biological effectiveness of α-rays is considerably greater than that of X-rays, we believe that the similarity of the effect of α-rays to direct action by sparsely ionizing radiation may be biologically significant.

Oxygen Effect

Barron and his colleagues[3] showed that the physico-chemical change produced by irradiation of serum albumin in solution was influenced by oxygen; but we were surprised when substantial differences were found between irradiations of the solid carried out in oxygen and in vacuum, since it was generally believed that oxygen effects occurred only when the action of the radiation was indirect. The first effect of irradiation is to produce aggregates, and with bigger doses true insolubility in water sets in. Both effects occur much more readily following irradiation in the presence of oxygen, and, for example, 8 × 10^6 r. in air renders 50 per cent insoluble while the same dose

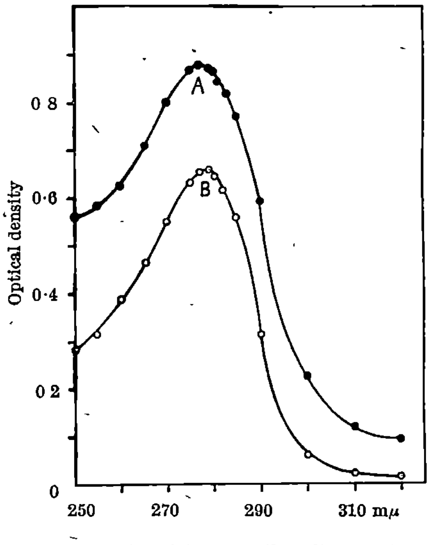

Fig. 4. Effect of irradiation on the ultra-violet absorption spectrum of solid serum albumin. The spectrum of a 0·1 per cent solution of material which has received 8 × 10^6 r. (in air) (*A*) is compared with that of an unirradiated control (*B*). The insoluble fraction (about 50 per cent) has been removed by a porous porcelain filter candle (max. pore diameter 0·5μ). Light-scattering measurements show that none of this increase is due to aggregation, since the weight-average molecular weight is less than 200,000

given *in vacuo* only produces aggregation which can be detected by light scattering and ultrafiltration.

Preliminary experiments showed that irradiation in oxygen introduces into serum albumin new groups (possibly unstable peroxides) which are capable of initiating the polymerization of vinyl compounds. For example, the addition of 20 mgm. of protein given 2×10^6 r. to 10 ml. of a 10 per cent aqueous solution of methacrylic acid, followed by removal of air from the solution, initiated immediate polymerization and the product appeared to be a 'graft' macromolecule containing protein and polymethacrylic acid. Unirradiated or vacuum-irradiated protein was ineffective for this purpose.

From ultracentrifuge measurements the amount of serum albumin having the sedimentation constant of the original material was determined after different irradiations. For indirect irradiation the rate of disappearance decreases with dose; but from the initial slope it can be computed[5] that one protein molecule becomes incorporated in an aggregate for every 250 eV. of energy deposited in the system (hence $G = 0{\cdot}4$). When the solid protein was irradiated, one molecule disappeared from the original peak in the ultracentrifuge pattern for every 50 eV. of energy taken up. Hence $G = 2{\cdot}0$ if oxygen is present, but the value is much less *in vacuo*. For this aggregation process direct action is approximately five times as efficient as indirect processes, and this shows, as has already been pointed out for the degradation of deoxyribonucleic acid[8], that the great preponderance of water in most living systems does not necessarily imply that the contribution of indirect action predominates in initiating the chain of events leading to the final injuries.

The ultracentrifuge measurements were made in the Institute for Physical Chemistry, Upsala, Sweden, and will be published jointly with Dr. Sven Brohult.

This investigation has been supported by grants to the Chester Beatty Research Institute (Institute of Cancer Research: Royal Cancer Hospital), from the British Empire Cancer Campaign, the Jane Coffin Childs Memorial Fund for Medical Research, the Anna Fuller Fund and the National Cancer Institute of the National Institutes of Health, U.S. Public Health Service.

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GENETICS OF HÆMOGLOBIN AND BLOOD POTASSIUM DIFFERENCES IN SHEEP

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If hæmoglobin preparations from different adult sheep are subjected to electrophoresis on filter paper at *p*H 8·6, three distinct types of animal may be recognized[1]. One finds either a single component moving relatively rapidly towards the anode, or a single component moving rather more slowly, or a mixture apparently consisting of both these components. We will refer to the hæmoglobin moving more rapidly towards the anode at *p*H 8·6 as sheep hæmoglobin *A*, and to the less rapidly migrating hæmoglobin as sheep hæmoglobin *B*. The three types of animal can then be conveniently designated as *A*, *B* or *AB* with respect to their hæmoglobin constitution (Fig. 1).

Sheep may also be classified into two distinct types according to the potassium and sodium concentrations in their blood[2]. In one type the potassium concentration is relatively high (about 36 m.equiv./l.) and the sodium concentration correspondingly low, whereas in the other type the potassium concentration is relatively low (about 11 m.equiv./l.) and the sodium concentration correspondingly high. The two types of animal have been called *HK* and *LK*, respectively. The plasma potassium concentrations are the same in the two types of animal and the phenomenon is therefore entirely due to differences in the red blood cells. Preliminary evidence has indicated that these two types are genetically determined in a simple Mendelian manner, the *HK* type being recessive[3].

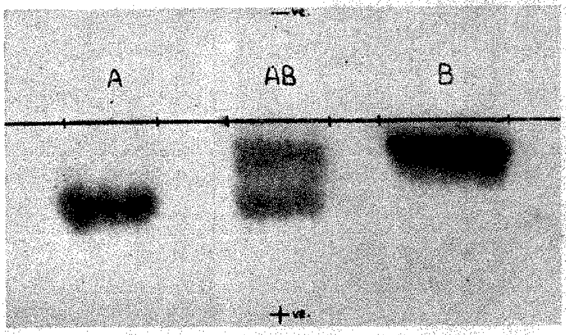

Fig. 1. Paper electrophoresis of the three types of sheep hæmoglobin
(0·15 *M* borate buffer, *p*H 8·6, 185 V., 17 hr.)

In the present investigation, the hæmoglobin and potassium types were determined on a large number of individual animals from a single flock in which detailed pedigrees were available. It was hoped to study among other things the genetics of the overall situation and to investigate any interrelationship between the two sets of red blood-cell characteristics.

A flock of Lanark-type Scottish Blackface sheep on rough hill grazing in Peebleshire was examined. The animals were bled at weaning time when the lambs were approximately six months old and the ewes varied from 2½ to 5½ years of age.

Table 1. Hæmoglobin and Potassium Types in 1,804 Scottish Blackface Sheep

	Hæmoglobin type *A*	*AB*	*B*	Totals
High-potassium	577	314	46	937
Low-potassium	521	282	64	867
Totals	1,098	596	110	1,804

Table 1 shows the frequencies of the different phenotypes in 1,804 animals in which complete data were obtained. 61 per cent of the animals were of hæmoglobin type *A*, 33 per cent *AB*, and 6 per cent *B*. 52 per cent of the animals were *HK* and 48 per cent *LK*. There was no obvious association between any of the hæmoglobin types and either of the potassium types, and the two systems of classification appear to be independent.

Table 2 summarizes the family data in the hæmoglobin types. The table is incomplete with regard to certain of the mating types, because many of the rams used for producing the lamb crop had been sold before the hæmoglobin determinations were made. Nevertheless, a typical segregation pattern may be observed. *A* offspring are not produced if one or other parent is *B*, and *B* offspring are not produced if one or other parent is *A*. *A* × *A* matings produce only *A* offspring, whereas *AB* × *AB* matings produce all three types. The findings are consistent with the hypothesis that the hæmoglobin types are genetically determined by two alleles each responsible for the formation of one kind of hæmoglobin. On this hypothesis the gene frequencies can be obtained directly by counting, and in this population the frequency for the *A* hæmoglobin would be about 0·77 and that for the *B* hæmoglobin 0·23. Assuming random mating and no differential selection, one can calculate from the Hardy–Weinberg equation the expected proportion of the three phenotypes in the total population. Fairly good agreement is in fact obtained (Table 3). However, there is a slight deficiency of heterozygotes, the explanation of which is uncertain.

Table 2. Segregation of Hæmoglobin Types

Parents		Offspring			
Ram	Ewe	*A*	*AB*	*B*	Total
A	× *A*	32	—	—	32
A	× *AB*	11	2	—	13
A	× *B*	—	1	—	1
AB	× *A*	25	23	—	48
AB	× *AB*	8	12	8	28
AB	× *B*	—	1	4	5
?	× *A*	200	64	—	264
?	× *AB*	61	66	14	141
?	× *B*	—	17	9	26
		337	186	35	558

Table 3. Hæmoglobin Types in 1,933 Animals. A Comparison of the Observed and Expected Proportions assuming a Hardy–Weinberg Equil'brium

Hæmoglobin type	Observed No.	Observed Per cent	Expected No.	Expected Per cent
A	1,173	60·7	1,155	59·8
AB	642	33·2	678	35·1
B	118	6·1	100	5·2
Totals	1,933		1,933	

Table 4. Segregation of Potassium Types

Parents		Offspring			
		Observed		Expected	
Ram	Ewe	*HK*	*LK*	*HK*	*LK*
HK	× *HK*	106	2	105	—
HK	× *LK*	35	63	42	59
LK	× *HK*	39	39	35	46
LK	× *LK*	17	64	14	64
		197	168	196	169

Table 4 summarizes the data on the inheritance of the *HK* and *LK* types. The expected numbers of segregants from the different matings have been calculated on the hypothesis that the dimorphism is due to a single gene pair, that *HK* is recessive and that mating is at random. The observed and expected numbers are in good agreement. The only notable discrepancy is the occurrence of two *LK* animals from matings of *HK* parents, and these can probably be attributed to mistaken identity or illegitimacy. The *HK* animals can therefore be regarded as homozygous for one allele whereas the *LK* animals represent the heterozygotes and also the homozygotes for the other allele. The possibility that the gene responsible for the *LK* phenotype may not be completely dominant has been examined by comparing the quantitative findings in known heterozygotes with those obtained in the remainder of the *LK* animals. A significant difference of 0·68 m.equiv./l. whole blood was observed, the heterozygote having the higher value. This would imply an average difference between heterozygous and homozygous *LK* animals of about 1·7 m.equiv./l.

The absence of association between the hæmoglobin phenotypes and the potassium phenotypes presumably means that the genes responsible for the two sets of red cell characteristics are at independent loci. Nevertheless, in both high- and low-potassium phenotypes, individuals with hæmoglobin *A* have higher average values of whole-blood potassium than those with hæmoglobin *B*, whereas the *AB* individuals are intermediate.

Table 5. Mean Concentrations of Whole-blood Potassium in each Phenotype

Hæmoglobin type	Potassium type *HK*	*LK*
A	38·8 ± 0·2	12·0 ± 0·1
AB	36·4 ± 0·2	11·3 ± 0·1
B	34·8 ± 0·6	10·6 ± 0·2

Data on the concentration of red blood-cell potassium in the different hæmoglobin types will obviously be required before the physiological significance of this correlation can be assessed.

One of us (F. L. W.) is in receipt of a grant from the Agricultural Research Council.

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NATURE OF THE TUMOUR-ENHANCING FACTOR

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INTEREST in the nature and mechanism of the enhancing factors present in tumour and normal tissues has increased latterly, though first described by Flexner and Jobling[1] so long ago as 1907. We have recently reviewed[2], *inter alia*, the literature of the enhancing factors which break down homologous and even heterologous host resistance to transplanted tumours and have worked with them for several years, realizing that they provide an important clue to the nature of certain tissue antigens concerned both in tumour immunology and in transplantation surgery.

The rat sarcoma (*Rd*/3) used was responsive to the enhancing factor in lyophilized *Rd*/3 sarcoma[3]; and from experiments using cortisone in normal and adrenalectomized rats, it was suggested that the enhancing factor effect was the indirect result of a heightened immunity, which was of a different order to immunity to living tumour cells for it occasioned no plasma cell response, nor increase in size of the lymph nodes or spleen. The work of Kaliss[4] showing that combined pre-treatment with cortisone and enhancing factor weakened or abolished the enhancing effect was confirmed in rats[5], as was that of Kaliss and Molomut[6], who showed that enhancing factor activity was present in rabbit and mice antisera to mixed mouse tissue antigens.

All results, including the appearance of rat-cell hæmolysins in the serum, pointed to the apparent paradox that enhancing factor treatment was a process of active immunization. Since tumour immunity was abolished thereby, lethal tumour antibodies were not being induced, and a working hypothesis was the formation of an incomplete or blocking antibody. This accorded with the fact that enhancing factor activity was not found in extracts of completely normal tissues, but only in those damaged by heating, freezing, mechanical disintegration, etc. (see Green[2]). A search was begun for the responsible tumour antigen(s) and by that time much serological work on tumour-bearing animals suggested that tumour lipids and lipoproteins might be incriminated, particularly as it was already known that enhancing factor activity was present both in fatty and watery tissue extracts. Work was in progress (Hakim and Green[7]) suggesting, *inter alia*, that the spontaneous tumour after transplantation might contain new phospholipids. (The work is still incomplete, but Hakim[8] has published a short account of some of it.) A phospholipid extract from *Rd*/3 sarcoma was thus available and it was injected into a strain of Wistar rats (Leeds) which at that time was resistant to growth of this tumour. In the first experiment thirty-four of thirty-six treated rats grew lethal tumours and only one of ten controls. A second experiment was nearly as decisive. The lipid was effective in doses of 4–0·4 mgm. when mixed with the tumour inoculum or given intraperitoneally. As it transpired, these were lucky results, such small doses being effective, probably because only very slight lowering of immunity was needed to break down strain resistance. In succeeding experiments the tumour was rapidly adapting itself to the host. This factor was not then realized, and failure to obtain enhancement with later lipid fractions led us to numerous modifications in extraction methods without success, for neither tumour phospholipid nor lipoprotein was regularly enhancing in pre-treated rats, but more often immunizing. Employing much higher doses, however, the last three experiments were even more decisive than the first, and it is now certain that the enhancing factor activity resides mainly, if not wholly, in the tumour lipoproteins and that the phospholipids, when artificially separated, retain much of this activity.

Table 1. ENHANCING EFFECT OF FRACTIONS FROM FROZEN *Rd*/3 SARCOMA

Average figures of groups of five rats injected during ten days prior to tumour transplant

Tumour preparation	Dose	Tumour area 13 days (sq. cm.)	Tumour wt./100 gm. carcass 16 days (gm.)	Spleen wt./100 gm. carcass 16 days (mgm.)
Saline emulsion of frozen tumour	0·5 ml.	2·1	19·9	287
50 per cent soluble protein	3 × 1 ml.	2·0	19·3	377
50 per cent soluble protein (petrol. ether extracted)	3 × 1 ml.	1·9	21·4	310
Lipoprotein*	3 × 10 mgm.	2·2	20·6	363
Crude phospholipid*	3 × 25 mgm.	1·9	20·2	413
Nil	—	1·2	8·6	721

All given intraperitoneally except Group 1 which was subcutaneous.

* Enhancement now maintained for 4 generations without further treatment.

Table 2. ENHANCING EFFECT OF FRACTIONS FROM FRESH *Rd*/3 SARCOMA

Average figures of groups of seven rats injected over ten days prior to tumour transplant

Tumour preparation	Dose	Route	Tumour wt./100 gm. carcass at 14 days (gm.)	Spleen wt./100 gm. carcass at 14 days (mgm.)
50 per cent soluble protein	5 × 1 ml.	Intraperitoneal	17·6	466
50 per cent soluble protein (petrol ether extracted)	5 × 1 ml.	,,	16·7	425
Soluble protein (lipoprotein extracted)	5 × 1 ml.	,,	9·4	590
Lipoprotein*	2 × 17 mgm.	Intravenous	19·8	401
Phospholipid*	2 × 50 mgm.	,,	16·5	408
Controls	—	—	8·1	680

* Enhancement now maintained for 4 generations without further treatment.

The results of two experiments are given in Tables 1 and 2. In one the tumour was stored at 0° C. for fourteen days, whereas in the other fresh tissue was used. The extracts were prepared as follows:

Soluble protein: Sarcoma homogenized in blender in normal saline to yield a 50 per cent (wet weight) solution. Stood 30 min. (0–5° C.), centrifuged at 4,000 rev./min. for 2 hr. Supernatant solution used.

Lipoprotein: Cold ethanol added slowly with stirring to equal volume soluble protein extract. Stood 12 hr. (0–5° C.), centrifuged and supernatant dialysed 24 hr. against 0·1 *M* saline using 'Visking' dialysis tubing. Lipoprotein freeze-dried.

Soluble protein after lipoprotein extraction: Alcohol precipitate redissolved in normal saline to yield 50 per cent (equiv.) solution.

Crude phospholipid: Sarcoma homogenized with 10 vol. cold 95 per cent ethanol–ether (3 : 1) for 15 min. Stood 30 min. Centrifuged to clarify. Supernatant concentrated to a few millilitres by vacuum distillation under nitrogen at room temperature. Residue extracted with three volumes of chloroform repeated thrice. Chloroform extract washed overnight in cold room with distilled water, and vacuum-distilled under nitrogen at room temperature.

Refined phospholipid: Crude phospholipid dissolved in petroleum ether (40–60° C.), centrifuged and any sediment discarded, precipitated with excess of acetone and a few drops of a cold saturated solution of magnesium chloride in ethanol.

The results were unequivocal and show that in both frozen or fresh tumour homogenate the enhancing factor is associated with a tumour lipoprotein fraction, little activity remaining after its removal, whereas the lipid-extracted soluble proteins retained full activity. Enhancing activity was greater in material from frozen tumours, and it should be noted that a simple unhomogenized suspension of frozen tumour was rich in enhancing factor. Tumour phospholipids were also active though not quite so much as the lipoprotein. In one experiment (Table 2) additional groups (not tabulated) were given serum and serum gamma-globulin from sarcoma-bearing and normal rats, and splenic soluble proteins from tumour-bearing rats. In all groups there was slight but definite enhancement, the greatest being with gamma-globulin from tumour-bearing rats, thus confirming the result of Kaliss and Kandutsch[9] in mice.

A striking feature was the size of the spleen, which normally progressively increases during growth of this tumour. There was an inverse relationship between splenic size and the enhancing activity of the extracts (cf. Tables 1 and 2) which has been evident in all successful experiments. Enhancement abolishes the normal immune reaction of the host to the tumour.

From these results and many others, the chemical nature of enhancing factor is now clear and its mode of action fairly clear. It is a lipoprotein, and the lipid haptene, which is also enhancing, is a phospholipid(s). The former is the water-soluble enhancing factor and the latter the fat-solvent-soluble enhancing factor. The chemical nature of the active phospholipid(s) is still not certain, though work in progress with Mr. J. W. Westrop should soon be conclusive for at least one tumour. The indications are that it may vary with type of tumour and with the species.

It seems that on injection it is capable of binding with protein and becoming antigenic lipoprotein. From the results of diverse immunization methods, it is clear that both tumour lipoprotein and phospholipid are antigenic in the rat, mouse and rabbit and elicit lipoprotein antibodies. Such serum antibodies have themselves some enhancing action, so that the enhancing factor effect cannot be due to fixation of tumour antibody by the excess antigen injected.

How do such antibodies in sufficient quantity abolish the normal immune response to the tumour? One of us (H. N. G.) has adopted throughout this work the hypothesis that they are blocking antibodies which render the tumour antigens inert. Our results support this; but Billingham *et al.*[10] have suggested that nucleoprotein antigens are destroyed by a mild injury which leaves the cytoplasmic antigens intact, and that antibodies to the latter inactivate the nuclear antigens emerging from the graft. Our findings also accord with this hypothesis, for the lipoproteins do elicit serum antibodies, including hæmagglutinins. Our hypothesis differs in envisaging neutralization of lipoprotein antigens in the cell membrane with possibly, though not necessarily, blocking of normal antibody. This does not easily account for the restoration of immunity in the animal treated with enhancing factor by grafting of immune lymph nodes and the fact, which we have repeatedly observed, that no enhancement is possible in the actively immunized rat (that is, after regression of a tumour). In the first case, however, normal antibody may be at such a high level when the tumour inoculum is given that it over-rides any blocking effect of incomplete antibody. In the second case, it is also likely that the injection of a slightly modified antigen would stimulate the production, already in progress, of normal antibodies. However, the fact that serum gamma-globulin from tumour-bearing rats has some enhancing action suggests that normal lipoprotein antibody is involved. The facts best fit the hypothesis of Billingham *et al.*[10], though it must be emphasized that the lipoprotein antigens are also very unstable and that antibodies to them might not unite with a pure nucleoprotein—a lipo-nucleoprotein complex in the nucleus might, however, be envisaged.

The importance of the present results, however, is their bearing on the homologous grafting of normal tissues. The facts undoubtedly apply here in some degree, for the iso-antigen(s) of tumour cells differs only quantitatively from the normal. The results of many attempts to produce tolerance to skin and other tissue grafts with normal phospholipids and lipoproteins have been erratic; but recent results are encouraging. The ultimate possibility of producing tolerance to normal tissue homografts, and even heterografts, by pre-treatment with specific lipoproteins will, when realized, profoundly affect the scope of surgery. The experiments reported here and related ones, together with their bearing on the immunological theory[2,12] of cancer, will be presented in detail later.

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DIURNAL RHYTHMS IN SEMEN YIELDS AND MATING BEHAVIOUR IN THE DOMESTIC COCK

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WELLS[1] has suggested that much avian behaviour may be based on inherent rhythms. The mating activity of the domestic cock shows a marked diurnal rhythm[2-4], in that the majority of matings occur in the late afternoon. Riley[5] and Macartney[6] found that mitotic activity in the cock's testis was greatest during the night, thus suggesting that the production of spermatozoa may not be uniform during the day. The object of this work is to investigate the relationship between semen yields and mating activity in the Brown Leghorn cock.

Twelve cocks selected on their ability to produce adequate semen samples were used as semen donors. They were kept in individual cages where they had access to mash and water at all times, and in the late afternoon they were given grain. They were divided into three groups of four, and semen was collected on three days—May 30, June 4 and June 9 —during the periods 08.30–09.30, 12.00–13.00 and 17.00–18.00 hr. Each group was tested at a different time on subsequent days of collection. This procedure was followed as it was considered, from previous experience, that over the short period of the experiment there would be no systematic changes in semen yields. Semen was collected by lumbar massage three times during the hours stipulated above, and the total volume and total absolute number of spermatozoa yielded were assessed for each cock.

To estimate the number of spermatozoa, a Spekker photo-electric fluorimeter was used as a turbidimeter, with a 1 in 500 dilution of semen and neutral filters (*H*508). The instrument had been calibrated previously against counts of spermatozoa made with a haemocytometer. The diluting fluid was a 1·025 per cent solution of sodium chloride containing 1 per cent formalin.

Two cocks of the same age and breed as the donors were used for observations on mating frequencies. They were each resident in a pen with laying hens and were each observed on two days between May 30 and June 10 during the hours of semen collection. In their pens they had free access to mash and water and were given grain at the same time as the donors.

The volumes of the semen yields for each cock are shown in Table 1. A two-way analysis of variance on these data showed that the differences between cocks were significant ($P<0{\cdot}01$) and that the differences between yields at the various times of collection were also significant ($P<0{\cdot}01$). The greatest yields were found to occur in the late afternoon.

Table 1 VOLUME OF SEMEN YIELDS (MEASURED IN ML.) COLLECTED FROM EACH COCK

Cocks	Times of collection		
	08.30–09.30	12.00–13.00	17.00–18.00
1	0·82	0·48	0·86
2	0·20	0·16	0·47
3	0·48	0·40	0·70
4	0·36	0·30	0·72
5	0·62	0·63	0·71
6	0·14	0·12	0·19
7	0·50	0·01	0·52
8	0·58	0·48	0·46
9	0·28	0·30	0·33
10	0·63	0·77	0·90
11	0·18	0·22	0·51
12	Nil	0·40	0·29

Table 2. TOTAL ABSOLUTE NUMBER OF SPERMATOZOA YIELDED BY EACH COCK

Cocks	Times of collection		
	08.30–09.30	12.00–13.00	17.00–18.00
1	$6{\cdot}333 \times 10^9$	$3{\cdot}302 \times 10^9$	$5{\cdot}798 \times 10^9$
2	1·278	1·16	2·156
3	3·487	3·478	4·473
4	2·991	2·841	6·724
5	3·014	3·255	3·428
6	0·804	0·503	0·938
7	3·208	Nil	2·637
8	3·277	2·674	2·739
9	1·657	1·675	1·705
10	5·068	5·876	7·388
11	1·000	0·900	2·385
12	Nil	2·390	1·538

The total absolute number of spermatozoa yielded by these cocks was also found to vary significantly between cocks ($P<0{\cdot}01$) and between times of collection ($P<0{\cdot}05$) when the data were analysed by means of a two-way analysis of variance. As with volume, the absolute number of spermatozoa was found to be greatest in the late afternoon (Table 2).

Nineteen matings were performed by the control cocks during the hours of observation, and of these thirteen occurred between 17.00–18.00 hours, thus showing that mating activity is high when semen yields are at their best. These results differ from those reported by Parker, McKenzie and Kempster[3]. These workers used a semen collector attached to the cloaca of the cock, which intercepted emissions from cloaca during natural matings and in the periods between matings. They reported that semen volume was greatest in the morning and that the total number of spermatozoa yielded did not differ significantly between morning and afternoon. Attempts to use a semen collector of this type on the cocks at this laboratory have been repeatedly unsuccessful due to contamination with urine and fluids from the cloacal glands, and in this study only direct reflex emissions from the ejaculatory ducts were taken to represent fowl semen, so as to avoid contamination with cloacal fluids and urine. This difference in technique may explain the variance between these results and those of Parker *et al.* (*loc. cit.*).

The relationship between semen yields and mating activity is under further investigation and will be reported elsewhere.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Increase in γ-Radiation from Powdered Milk and Beef, 1953-56

Two apparatuses consisting of cylindrically arranged high-pressure ion chambers (diameter of sample container approximately 1 m., total volume approximately 3 m.^{3}, 20 kgm. nitrogen and carbon dioxide) placed in a low-background laboratory in the rock near the city of Stockholm, and protected in all directions by 1 m. of water and more than 50 m. of granite, have been described in earlier communications[1]. In these, the results of measurements on 306 persons who have had no known contact with other than natural radioactive material of common concentration were also reported. The γ-radiation of human subjects is, in all probability, caused mainly by the potassium-40 content of the body, as has been shown by Burch and Spiers[2].

Table 1

Body weight (kgm.)	<25	25·1–35·0		35·1–45·0		45·1–55·0	
	F	M	F	M	F	M	F
1954							
Number of subjects	6	18	18	20	17	10	12
Average weight (a)	22·2	30·0	30·4	40·4	40·6	49·5	49·6
Average age	8·1	9·4	9·1	12·2	11·9	13·3	13·7
γ rad. (in ng.) (min.)	2·23	2·80	2·05	2·94	1·99	4·41	3·39
γ rad. (in ng.) (max.)	4·12	4·95	4·45	6·62	6·45	7·32	7·18
Radium eq. average (b)	3·12	3·74	3·35	4·87	4·22	5·81	5·22
10 b/a	1·41	1·25	1·10	1·21	1·04	1·17	1·05
Standard error	0·077	0·057	0·050	0·052	0·072	0·050	0·065
1956							
Number of subjects	2	13	16	27	10	5	6
Average weight (a)	21·5	31·2	31·6	40·3	39·7	50·8	47·5
Average age	10·0	10·5	10·4	12·3	12·6	13·2	13·3
γ rad (in ng.) (min.)	2·57	2·70	2·20	2·69	3·03	5·68	3·66
γ rad (in ng.) (max.)	2·63	5·35	5·17	6·39	7·01	6·25	6·45
Radium eq. average (b)	2·60	4·10	3·67	4·55	4·47	6·09	4·50
10 b/a	1·21	1·31	1·16	1·13	1·13	1·20	0·95
Standard error	0·014	0·083	0·067	0·042	0·091	0·024	0·053

The same instruments have now (May–July 1956) been used for determination of the possible amount of γ-radiating fission products in powdered milk and beef preserved during the years 1953–56. The potassium content of the powdered milk was carefully determined by the Institute of Radiophysics and the Department of Clinical Biochemistry at Karolinska Sjukhuset, entirely independently. The absorption of the radiation from potassium-40 and cæsium-137 was measured by mixing 500 gm. of potassium chloride and 0·1 μc. of cæsium-137, respectively, in the milk samples, each of which weighed 10 kgm.

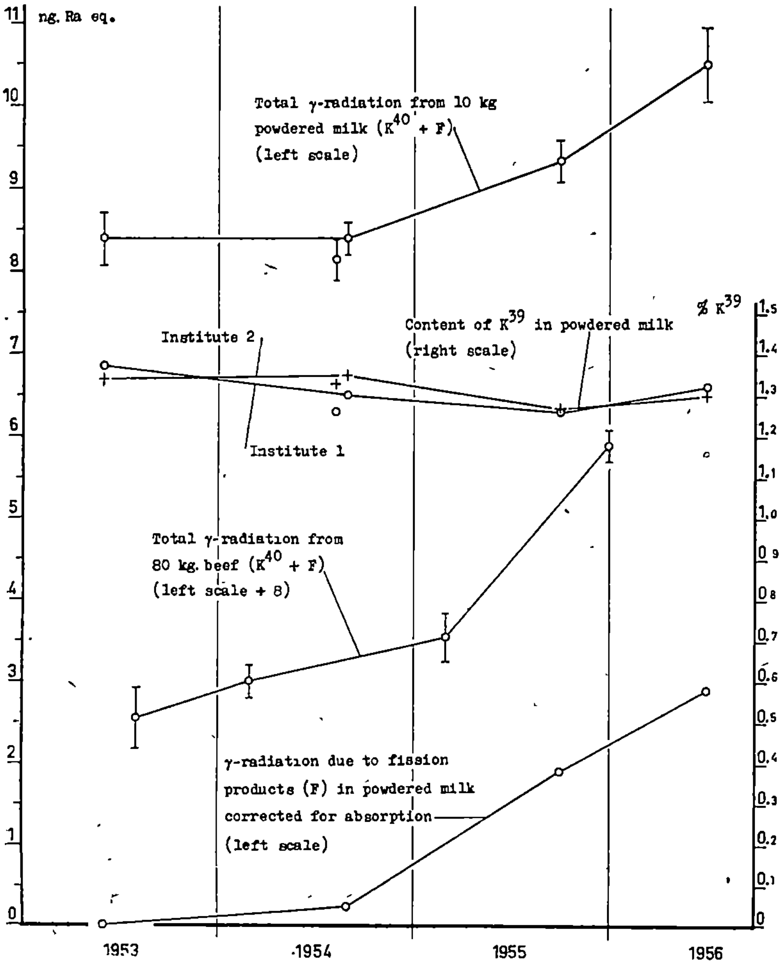

Fig. 1. Radiation from powdered milk and from beef. The observations on powdered milk were all carried out during the period May 18–July 3, 1956, and those on beef during the period July 1–9, 1956. Standard errors are indicated in respect of the observed radiation values

The results of these measurements are plotted in Fig. 1. An increased γ-radiation is obvious, which cannot have been caused by differences in the potassium content. If this increase is due entirely to cæsium-137, the concentration in the natural milk for the samples from 1956 can be calculated to be about 1 × 10^{-4} μc. per litre of milk, that is, 5 × 10^{-5} of the maximum permissible concentration. Because of the comparatively small age of the last samples it seems, however, likely that other fission products may have played the predominant part.

Beef from the years 1953–55 was also examined, each sample consisting of 80 kgm. of meat. The results are also shown in Fig. 1. Since the potassium content is probably the same in all these samples, the higher γ-radiation found in the last year here may also be attributable to an increase in fission products.

Although the quantities observed would probably be too small to cause a detectable increase in the γ-radiation from human subjects consuming milk, a series of children were investigated, and the results compared with the earlier measurements referred to at the beginning of this communication. As seen from Table 1, the two sets of observations (1954 and 1956) are well suited for such a comparison. No significant change could be detected, however, in the average γ-radiation.

The investigation is being continued.

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The Serum Gamma-Globulin-Level in Malignant Disease

Very little is known about immunity in relation to malignant disease. In animals there is evidence that resistance develops to transplanted tumours. Lumsden[1] and his co-workers were of the opinion that this resistance was due to the appearance in the serum of certain antibodies. They found that the serum of rats bearing the Jensen rat sarcoma contains a cytotoxin which is greatest in amount in those rats in which tumour regression afterwards occurs. In the human subject the development of humoral resistance to malignant tumours has not been proved conclusively. A number of workers have investigated the serum gamma-globulin-level in patients with malignant disease. Their results can be taken as a measure of the antibody-level since most antibodies are found in association with the gamma-globulin fraction of the serum protein. Petermann and Hogness[2] found that the serum gamma-globulin-level, as estimated by electrophoresis at pH 8·6, was normal in twenty-five patients with carcinoma of the stomach. Miller and Erf[3], using a similar method, found that the serum gamma-globulin was raised in twenty-four patients with carcinoma of the gastro-intestinal tract or breast.

In view of the difference between these results it was decided to perform further electrophoretic investigations on the serum gamma-globulin-level of patients with malignant disease. It was hoped by this means to determine with some degree of certainty whether the antibody-level of the serum changes in the presence of malignant neoplasms.

Twenty-two female patients from the Dartford Group of Hospitals, Kent, suffering from malignant disease, which had been verified by histological examination, were used for the present investigation. The patients were chosen at random and their ages varied from thirty-one to seventy years. The majority of the tumours were situated in the genital or intestinal tracts and were at different stages of development, some being localized while others had metastasized widely. Blood samples were taken from each patient on admission, and only the blood from those patients having normal temperatures, total and differential leucocyte counts, erythrocyte counts and hæmoglobin-levels were used. Blood samples were also taken from twenty healthy females of the same age-group to serve as controls.

The gamma-globulin-level of each of the sera was estimated by first separating the gamma-globulin fraction by paper electrophoresis at pH 8·5 using a veronal buffer. The filter-paper strips were then treated with bromphenol blue and the optical density of the protein dye complex was measured by means of a photoelectric cell. In this manner the percentage of gamma-globulin in relation to the total protein in the serum could be assessed.

No significant difference was found between the serum gamma-globulin-levels of the patients with malignant disease and those of the healthy controls. The gamma-globulin-level in each group averaged approximately 20 per cent of the total serum protein. These findings provide further evidence that the development of malignant disease in man is not associated with an increase in the antibody-level of the serum.

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The Expected Blood-Group Antibody, anti-Lu^b

The Lutheran blood group system was first described by Callender and Race[1] in 1946: an antibody, afterwards named anti-Lu^a, was found to react with the red cells of approximately 8 per cent of the English population. The antigen with which the antibody reacts is called Lu^a and can be recognized in the red cells of heterozygous as well as homozygous individuals. The corresponding gene is called Lu^a and an allele Lu^b is postulated. The antigen Lu^b has been recognizable so far only as an absence of Lu^a; thus persons of the phenotype Lu(a−) are presumed to be of the genotype Lu^bLu^b.

The results of testing large numbers of English blood samples with various anti-Lu^a sera have been brought together by Race and Sanger[2], and the following gene and genotype frequencies for the Lutheran system have been calculated.

Genes		Genotypes	
Lu^a	0·0390	Lu^aLu^a	0·0015
		Lu^aLu^b	0·0750
Lu^b	0·9610	Lu^bLu^b	0·9235

An antibody which gives the reactions expected of anti-Lu^b has now been found in the serum of a woman, Mrs. R., who has never been transfused and who has given birth to three healthy children.

In a search for compatible blood for Mrs. R. it was found that her serum agglutinated saline suspensions of the red cells of each of fifteen blood samples. The identity of the antibody was suspected when it was found that Mrs. R.'s own cells reacted very strongly with an anti-Lu^a serum and that her serum reacted less well with Lu(a+) cells than with Lu(a−) cells.

Mrs. R.'s phenotype is as follows: O, MNSs, P+, CcDEe, Lu(a+), K+ k+, Le(a− b+), Fy(a−), Jk(a+ b+). The cells react with an anti-H serum. Dr. R. R. Race kindly tested the cells with anti-U, anti-Vel, anti-Yt^a and anti-Tj^a; in each case a positive reaction was obtained.

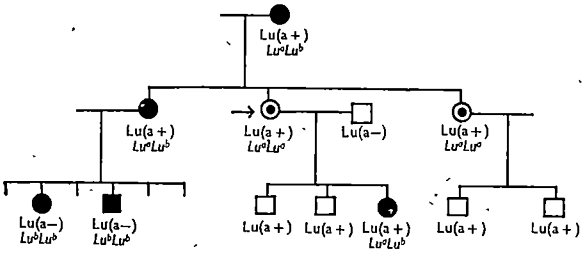

Fig. 1. The Lutheran groups and presumed genotypes of the family of the donor of anti-Lu^b. Arrow, donor; black, Lu(b+); dot, Lu(b−); blank, not tested with anti-Lu^b because of ABO incompatibility

The following findings support the hypothesis that Mrs. R. is of the rare genotype Lu^aLu^a and that her serum contains anti-Lu^b.

(1) Five Lu(a+) and sixteen Lu(a−) blood samples from adults of group O were tested against dilutions of Mrs. R.'s serum. The average titration score for the Lu(a+) samples was 16 (range 12–13); that for the Lu(a−) samples was 28 (range 20–38). The agglutination reactions were 'scored' as suggested by Callender and Race[1].

(2) Mrs. R.'s serum reacted with all of 532 unselected samples from adults of group O. From 322 of these, 64 samples which reacted weakly were selected for testing with an anti-Lu^a serum: 17 (26·56 per cent) were Lu(a+). It can be calculated that on a sample of 64, the standard error of the expected percentage (7·65) of Lu(a+) bloods is 3·3. Thus the deviation from the expected percentage is five times the standard error.

(3) Fifty blood samples known to be of the phenotype Lu(a+) were tested; one of these (from Mrs. L.) failed to react with Mrs. R.'s serum. Mrs. L.'s serum does not react with Lu(a−) cells.

(4) The blood groups of a number of Mrs. R.'s relatives were determined. Their reactions with anti-Lu^a and with Mrs. R.'s serum are shown in the pedigree (Fig. 1). One sister is of the presumed genotype Lu^aLu^a, since her cells react with anti-Lu^a but fail to react with Mrs. R.'s serum; her serum does not react with Lu(a−) cells.

Mrs. R.'s cells give a higher titration score with an anti-Lu^a serum than do the cells of her mother or those of her children.

(5) Callender and Race[1] described a family (Family 5) in which both parents and all four children were Lu(a+). As there seemed a good chance of finding a homozygote among the children, the family has been tested again: one of the children fails to react with Mrs. R.'s serum and is presumably of the genotype Lu^aLu^a. The cells of both parents react with Mrs. R.'s serum.

The antibody in Mrs. R.'s serum reacts strongly at 20° C. and less well at 37° C., as a saline agglutinin. The agglutinates are firm; but many free cells are present. The reaction is not inhibited by the saliva of secretors or non-secretors. At 37° C. the antibody gives a weak indirect anti-human globulin reaction, but only with Lu(a−) cells. Following the intravenous injection of 1 ml. of Lu(a−) red cells the antibody increased in avidity.

We should like to thank Dr. P. L. Mollison and Dr. R. R. Race for their help during this investigation, and Dr. Gertrude Plaut and Dr. T. E. Cleghorn for supplying large numbers of blood samples. Dr. A. Davis and Dr. R. J. Drummond kindly obtained blood samples from Mrs. R.'s family and from Family 5.

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Two Stages in the Formation of Active Plasma Thromboplastin

ALTHOUGH the exact role of calcium in the complex mechanism of blood coagulation is still in some dispute, it is certain that it is a basic element in some of the interactions taking place between the various blood-clotting factors which finally lead to the formation of the prothrombin-converting factor, plasma thromboplastin[1]. Recently, we[2] described an ether-precipitation method for the separation of the latter. Further work, reported herein, on the relation between this important blood-clotting factor and calcium has revealed the presence of two stages in the production of a fully active plasma thromboplastin.

A study on the effect of calcium chloride, calcium gluconate, calcium lactate, strontium chloride and magnesium chloride in the generation of plasma thromboplastin[3] showed that the latter four compounds and particularly magnesium chloride are inferior to calcium chloride (Table 1) in this respect.

Plasma thromboplastin was isolated using ether[2]. The product was dissolved in 0·9 per cent sodium chloride and its activation with each of the above compounds was determined by incubating the solution with an equal volume of 0·025 *M* of the compound under trial. At intervals (Table 2), 0·1 ml. of the mixture was taken together with 0·1 ml. of 0·025 *M* calcium chloride and both were added simultaneously to 0·1 ml. human citrated plasma at 37° C., recording the clotting time. The results presented in Table 2 show that strontium and magnesium chloride have no activating effect, while

Table 1. CALCIUM, STRONTIUM AND MAGNESIUM SALTS IN THE FORMATION OF PLASMA THROMBOPLASTIN

Compounds used	Clotting time of substrate in sec. M/ 5	10	20	40	80
Calcium chloride	15	10	8½	8	9½
Calcium gluconate	—	—	10	10	11
Calcium lactate	—	11	9½	9	10½
Strontium chloride	19	15	12½	12	16
Magnesium chloride*	—	54	50	21	23

* Maximum activity was reached after 18 min. incubation, instead of 6 min. with the other compounds.

Table 2. INCUBATION OF ISOLATED PLASMA THROMBOPLASTIN WITH CALCIUM, STRONTIUM AND MAGNESIUM SALTS

Compound used (0·025 *M*)	Clotting time of substrate in sec. Period of incubation in min. 0	1	2	4	8
Calcium chloride	26	17	14	14	14
Strontium chloride	23½	23½	23½	24	24
Magnesium chloride	24	24	24	25	25
Calcium lactate	24	21½	20	20½	21
Calcium gluconate	24	22	21	21	21½

calcium lactate and gluconate activate plasma thromboplastin although to a lesser degree than calcium chloride.

From these experiments the development of a fully active plasma thromboplastin seems to be achieved in two stages. In the first stage (or formation stage) the necessary blood-clotting factors interact to form plasma thromboplastin. For this, calcium is needed but can be replaced to a lesser degree by strontium; magnesium is a very poor substitute. In the second stage (or activation stage) the plasma thromboplastin formed is activated by the calcium, thus acquiring its full strength; strontium and magnesium ions cannot replace calcium. Additionally, at this stage the ionic state of the latter appears to affect the degree of activation produced, both calcium lactate and gluconate being less powerful than calcium chloride.

During the process of blood coagulation or in the thromboplastin generation test, the first stage could not be distinguished from the second stage, which follows instantaneously. However, ether-precipitation seems to isolate the non-activated plasma thromboplastin, that is, the product of the first stage. This would explain the apparent low recovery obtained[2]. When the isolated plasma thromboplastin is incubated with calcium chloride, a completely active plasma thromboplastin is obtained after two minutes (Table 2) and the recovery is thus practically doubled in amount.

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Estimation of Small Proportions of Fœtal Hæmoglobin in Blood

The detailed characterization of blood samples containing the genetically determined abnormal hæmoglobins[1] requires a sensitive method for estimating small traces of fœtal hæmoglobin (Hb-F) in the presence of excess of other hæmoglobins. We have applied the ultra-violet spectrographic method[2] to residues of partially denatured hæmoglobin obtained by a modified Singer procedure[3], with particular attention to the following questions: (*a*) Is the residue authentic hæmoglobin? (*b*) Does it contain fœtal hæmoglobin, and, if so, in what proportion? Residues from normal adult blood, artificial mixtures of adult hæmoglobin (Hb-A) and fœtal hæmoglobin in varying proportions, and pathological blood samples, containing varying proportions of fœtal hæmoglobin by our standard methods, have been studied.

In order to obtain residues of manageable optical density when the proportion of fœtal hæmoglobin is small, our test is carried out by mixing equal volumes of 5 per cent oxy-hæmoglobin solution and *N*/6 sodium hydroxide, giving a final *p*H of about 12·8, and neutralizing in the usual way, but after ¾ min.

Table 1

Sample	¾-min. residue* %	% Hb-F in residue	Protein/ hæm ratio of residue	Calculated % Hb-F in sample	% in sample from alkaline denaturation rate
Artificial Hb-A plus Hb-F mixtures					
Normal†	2·1 ± 1·5	Nil	2·2 ± 0·7	Nil	Nil
1·0% Hb-F	2·8	30	1·8	1·5	Nil
3·0% ,,	4·3	45	1·6	3·1	? trace
5·0% ,,	7·0	50	1·4	5·0	5
7·0% ,,	9·6	65	1·3	7·9	8
10·0% ,,	11·7	70	1·2	10·1	9
15·0% ,,	15·7	75	1·2	14·1	13
30·0% ,,	31·0	85	1·1	29·0	29
Albers–Schönberg disease	3·5	40	1·5	2·1	Nil
Sickle-cell–hæmoglobin *C* disease	6·0	30	1·6	2·9	Nil
Thalassæmia minor, Indian	6·6	25	1·4	2·4	4
Thalassæmia minor, (*a*) Burmese mother	3·3	15–20	2·0	1·1	Nil
(*b*) child of (*a*)	2·3	30	1·9	1·3	? trace
Elliptocytosis with hypochromic anæmia	6·2	Nil	1·4	Nil	Nil

* Measured against Haldane standard with Ilford 625 filter.
† Mean values for 12 normal adult bloods.

The residue from normal adult blood, examined as carboxyhæmoglobin, has a protein/hæm ratio of about 2, as evaluated from the relative absorption intensities of protein and hæm components at selected wavelengths. By the fine-structure criterion[2], the protein is entirely of the adult type in the many samples examined. The spectrographic measurements do not appear to be seriously affected by the presence of free globin.

Table 1 records the results for known mixtures of adult and fœtal hæmoglobin covering a wide range of composition. The proportion of fœtal hæmoglobin in the residue is estimated spectrographically, and that in the whole blood calculated from the percentage residue, after correcting the latter figure for the altered protein/hæm ratio. When the fœtal hæmoglobin is greater than 10 per cent, the residue is a close approximation to the actual fœtal hæmoglobin content. When the fœtal hæmoglobin is less than 10 per cent, however, the residue is higher than the true fœtal content, is no longer pure, fœtal-type hæmoglobin, and its protein/hæm ratio greatly exceeds unity (cf. ref. 4). The data in Table 1 show that errors in the estimation of fœtal hæmoglobin, based on the uncorrected ¾-min. residue, increase progressively as the proportion of fœtal hæmoglobin falls to the 1 per cent level. Similar observations have been made for unmodified Singer 1-min. residues. If corrections are applied for the actual percentage of fœtal hæmoglobin in the residue and for the protein/hæm ratio of the latter, a more accurate estimate is obtained.

Working in this way, it is possible to estimate fœtal hæmoglobin with some confidence down to a level of about 1 per cent of the whole-blood pigment, both in artificial mixtures and in pathological blood samples. At this limit of sensitivity no fœtal hæmoglobin has been found in any of the normal adult hæmoglobins which have been examined. If present, its proportion would seem to be less than 1 per cent, as is claimed by some other workers[5]. Various pathological bloods have yielded more than 2 per cent of residue, but not necessarily containing fœtal hæmoglobin. On the other hand, its presence has been confirmed in other, similar residues when the standard methods do not reveal it in the total hæmoglobin preparations. Examples are given in Table 1, including blood from a child with Albers–Schönberg disease (kindly provided by Prof. C. E. Dent), also a Burmese mother and child with thalassæmia-like anæmias, possessing traces of fœtal hæmoglobin, and small fractions (7 and 14 per cent) of hæmoglobin resembling Hb-E on electrophoresis.

It is evident that the simple and convenient Singer method gives residues of analytical value when the proportion of fœtal hæmoglobin in the sample is more than 10 per cent. When the proportion of fœtal hæmoglobin is less than 10 per cent, however, more laborious examination of the residue is required to detect and estimate the fœtal hæmoglobin which may be present.

We are grateful to the Colonial Medical Research Committee for a grant enabling one of us (M. E.) to assist in this work.

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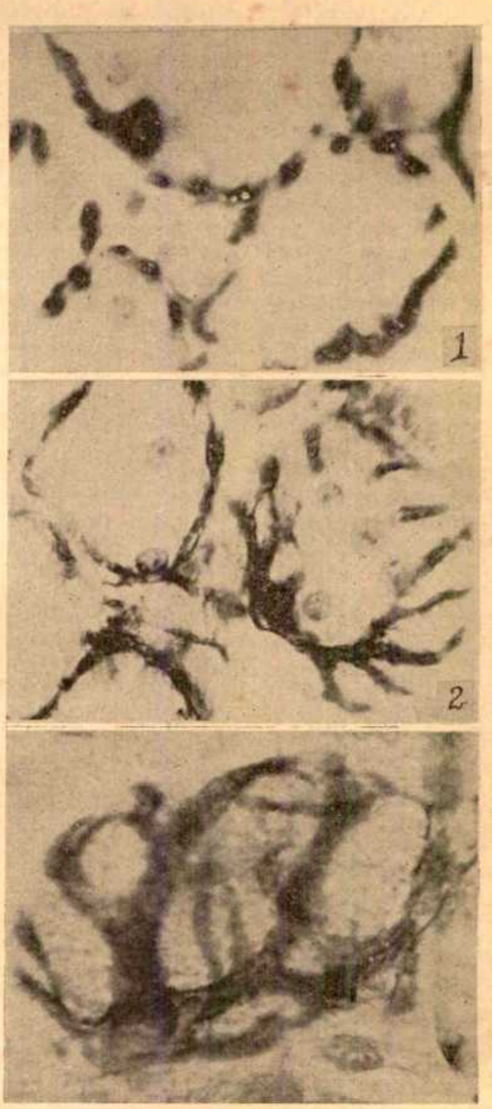
Localization of Alkaline Phosphatase in the Submaxillary Gland of the Rat

IN spite of the extensive studies which, in recent years, have been made on the histochemical distribution of alkaline phosphatase, there is a sparseness of data concerning the salivary glands, in particular the submaxillary gland. Gomori[1] commented briefly on the absence of alkaline phosphatase in the parenchymal cells of the salivary glands of man and nine other species, including rat, while Bourne[2] for the guinea pig submaxillary gland reported diffuse staining of nuclei and cytoplasm of the alveolar cells. Deane[3] found alkaline phosphatase localized in the 'basal ergastoplasm' of the serous cells of two submaxillary glands of monkey, and a similar finding was reported by Noback and Montagna[4] for the rat and mouse. The latter workers also mention a heavy reaction of the basement membrane and at other places; but these observations are clouded by the use of excessive times of incubation.

My own paraffin-embedded material of rat submaxillary glands was fixed either in cold acetone or alcohol or preserved by freeze-substitution. Results were essentially identical after any of these methods; but the acetone-fixed material gave the clearer pictures. Alkaline phosphatase was demonstrated both by Gomori's method (substrate: sodium β-glycero-phosphate) and by an azo-dye method (substrate: sodium α-naphthyl-phosphate). With Gomori's method, a two-hour incubation produced a heavy blackening around and at the base of most acini, thus apparently confirming the observations of earlier workers; but widespread nuclear staining indicated that diffusion was complicating the issue and erroneous interpretation possible[5]. To guard against this, incubation was reduced to 15–30 min. Examination of sections thus treated reveals a definite pattern of this alkaline phosphatase positive material at the base of the acini. It rarely goes right round the acinus but is arranged in an interrupted fashion inside the basement membrane, in the form of dark dots or small rings, short oblique narrow bands or bands running around the circumference of the acinus for a limited stretch (Figs. 1 and 2). Here and there the alkaline phosphatase positive material encloses a nucleus, often oval, distinct from those of the acinar cells and lying against, but inside, the basement membrane. The nature of this pattern, which is suggestive of sections through an irregularly branching network, becomes clear when tangential sections



Rat submaxillary glands fixed in acetone and stained by Gomori's method for alkaline phosphatase.
Fig. 1, Incubation time, 30 min. (× 1,010); Fig. 2, incubation time, 30 min. (× 890); Fig. 3, incubation time, 15 min. (× 1,500)

of acini are seen, showing that it is the 'basket' or myo-epithelial cells which are specifically displayed (Fig. 3). The nucleated parts of these cells when seen from the flat have often a triangular shape from which long branching and tapering processes emanate. The length and width of these agree with the sectioned appearances of the alkaline phosphatase positive material around the acini. It is worth noting that the reaction does not give a homogeneous appearance to the cytoplasm, but rather a mottled one, very often combined with a fibrillar pattern (Figs. 2 and 3).

Similar, but much smaller and less extensively ramifying, alkaline phosphatase positive basket cells were also seen in the very short intercalated ducts which are present in these glands. The remaining portions of the duct system were alkaline phosphatase negative. Blood capillaries gave—as is usual with rat tissue—an irregular and erratic reaction. When alkaline phosphatase was visualized by the azo-dye method, the result was the same.

This almost specific localization of alkaline phosphatase in the myo-epithelial cells of the rat submaxillary gland links up satisfactorily with the findings of Dempsey, Bunting and Wislocki[6], who demonstrated the presence of alkaline phosphatase in the myo-epithelial cells of the mammary gland of rat, and of Silver[7], who showed that the same holds for the mammary gland of sheep and rabbit and the sheep's parotid, but it still remains to be seen whether it is a general property of myo-epithelium.

My thanks are due to Dr. F. Jacoby for all his suggestions and helpful criticism, and to Mr. L. Jones for the microphotographs.

Addendum.—Since this communication was submitted for publication, my attention has been directed to a letter by R. L. Holmes (*Nature*, **178**, 311 (1956)).

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Antagonists of the Action of Reserpine on Smooth Muscle

We have recently directed attention to the fact that citrate antagonizes reserpine inhibition of contractions induced in the guinea pig ileum by acetylcholine chloride, histamine acid phosphate, serotonin and barium chloride[1]. A consideration of the general pharmacology of reserpine has led us to believe that this substance may have a general non-specific depressant effect upon contractile tissue[1,2].

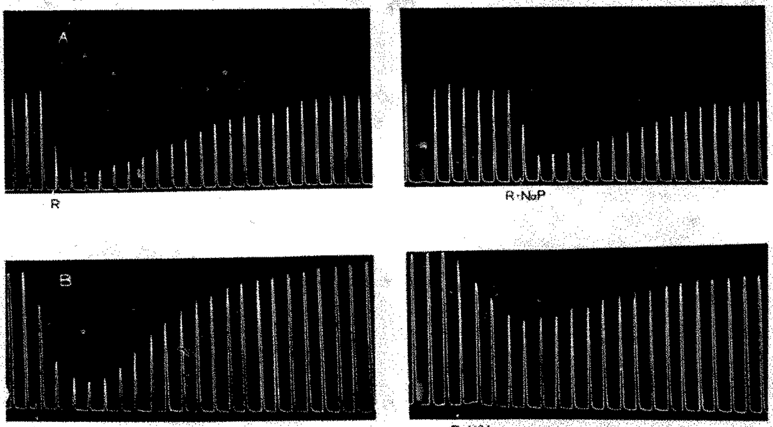

Fig. 1. (*A*) All contractions produced by 0·25 µgm. per ml. acetylcholine chloride. (*B*) All contractions produced by 0·20 µgm. per ml. histamine. At *R*, 30 µgm. per ml. reserpine added. At *R* + *NaP*, 30 µgm. per ml. reserpine and 1 mgm. per ml. sodium pyruvate added. At *R* + *KGA*, 30 µgm. per ml. reserpine and 1 mgm. per ml. α-keto-glutaric acid added

Since reserpine non-selectively antagonizes contractions due to acetylcholine chloride, histamine acid phosphate, serotonin and barium chloride in the guinea pig ileum, it appears to be affecting underlying mechanisms connected with the production and utilization of the energy necessary for the drug-induced contractions rather than specific receptors. These mechanisms probably involve the breakdown and resynthesis of carbohydrate through the glycolytic and tricarboxylic acid cycles. It seemed worth while, therefore, investigating the influence of adding known intermediates of carbohydrate metabolism to the isolated guinea pig ileum immediately before addition of reserpine

The ileum was stimulated by either acetylcholine chloride (0·2–1·0 µgm. per ml.), histamine acid phosphate (0·1–1 µgm. per ml.), serotonin (15–40 mgm. per ml.) or barium chloride (0·2 mgm. per ml.) at 3-min. intervals. Reserpine was added 1 min. before the spasmogen and the metabolite 5 sec. before reserpine. All metabolites were tested over the dose-range, 125 µgm.–1 mgm. per ml. The following were ineffective as reserpine antagonists: glucose-1-phosphate, fructose-1,6-diphosphate, fructose-6-phosphate, pyruvate (Fig. 1), fumarate, succinate and adenosine triphosphate. The following were very active: citrate, *cis*-aconitate and α-keto-glutarate (Fig. 1). Malate and oxaloacetate had intermediate activity. Maleic acid (the *cis*-isomer of fumaric acid) at doses of 500 µgm. or 1 mgm. per ml. was very active. Removal of calcium from the bath fluid by disodium dihydrogen versenate did not produce antagonism to reserpine.

The possibility of release of histamine or acetylcholine chloride by the metabolites was excluded by repeating the experiments using, where appropriate, Tyrode's solution containing either atropine sulphate (100 µgm. per litre) or mepyramine maleate (200 µgm. per litre).

Since the most active reserpine antagonists are intermediates of the tricarboxylic acid cycle, it seems not unlikely that this is a site of action of the alkaloid.

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Bleaching of Visual Purple in Solutions of Inorganic Salts

It has been stated that visual purple can be salted out of solution with magnesium and sodium sulphates[1,2]. In the present work, an attempt was made to repeat this, using moderately concentrated visual purple solutions. No precipitation occurred; but it was found that in the presence of large amounts of ammonium sulphate, ammonium chloride, magnesium sulphate and sodium sulphate the bleaching of visual purple was modified.

Solutions of frog visual purple were prepared by the addition of 1 per cent aqueous digitonin solution to whole washed retinæ. The extracts were buffered to *p*H 8·0–8·6 by the addition of sodium tetraborate solution. These extracts were then concentrated about 3–4 times *in vacuo* at low temperature, bringing the D_{500} from 0·2 to 0·6–0·8.

Saturation of these solutions with ammonium sulphate (making the salt concentration about 3·3 *M* and bringing the *p*H to about 7·2) produced only a faint opalescence. On exposure to light, such solutions bleached to a stable orange photo-product. The absorption spectra for a bleached and unbleached solution are shown respectively by curves *A* and *B* of Fig. 1. The $\lambda_{\text{max.}}$ of the unbleached solution lies at 495 mμ, and that of the bleached solution at 470 mμ. The true pigment maxima may be obtained by calculating the $D_{\text{min.}}/D_{\text{max.}}$ ratios and correcting the observed maxima accordingly[3]. When this is done, the corrected $\lambda_{\text{max.}}$ of the unbleached and bleached solutions are seen to lie at 501 mμ and 482 mμ respectively.

The orange photo-product was clearly not indicator yellow, for the $\lambda_{\text{max.}}$ of that substance, even in acid solution, is no higher than 440 mμ. If another portion of the same visual purple solution was bleached prior to saturating with ammonium sulphate a normal alkaline indicator yellow curve was obtained. This is shown in curve *C*, Fig. 1. The 'difference spectrum' of the orange photo-product is obtained by subtraction of curve *C* from curve *B*. This is shown in Fig. 2. The $\lambda_{\text{max.}}$ lies at 485 mμ, thus confirming the value of 482 mμ calculated directly from the solution. Subtraction of curve *C* from curve *A* yields a difference spectrum for visual purple. This also is shown in Fig. 2.

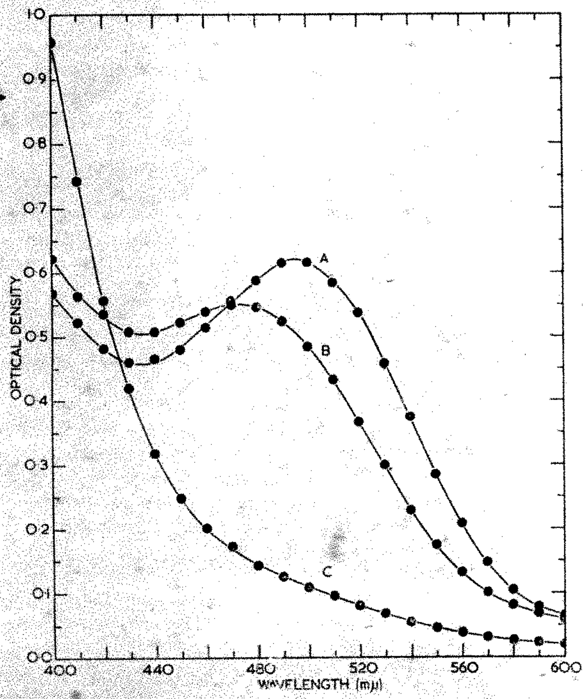

Fig. 1. Absorption spectra of visual purple extracts saturated with ammonium sulphate.
Curve *A*, Extract saturated with ammonium sulphate (*p*H = 7·19, $D_{\text{min.}}/D_{\text{max.}}$ = 0·74); curve *B*, extract after a 15 min. exposure to white light ($D_{\text{min.}}/D_{\text{max.}}$ = 0·91); curve *C*, the same visual purple extract bleached prior to saturating with ammonium sulphate

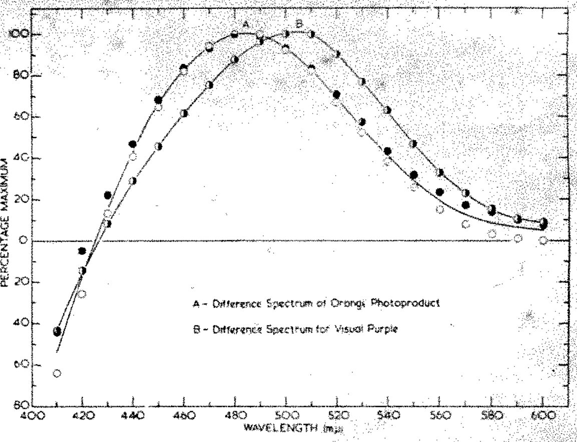

Fig. 2. Difference spectra of the orange photo-product and of visual purple.
●, Curve *B* minus *C* (Fig. 1); ○, difference spectrum, as above; the data are obtained from a similar extract (*p*H = 6·96); ◑, curve *A* minus *C* (Fig. 1)

In darkness at 20° C. the orange photo-product slowly transformed to indicator yellow over a period of about 48 hr. Heating the solution for 15 min. at 60° C. caused destruction of the orange photo-product, accompanied by the formation of a pale yellow gel. If the salt concentration were reduced by the addition, in darkness, of an equal volume of 4 per cent aqueous digitonin solution the orange photo-product changed to alkaline indicator yellow. The transformation was complete in about 20 min.

When concentrated visual purple solutions were saturated with magnesium sulphate, sodium sulphate or ammonium chloride, then exposed to light, the orange photo-product was formed initially but was more unstable. After about ½ hr. in darkness, only indicator yellow was left in solution.

Whenever these solutions were diluted or were stored for any length of time, unpredictable changes in opalescence occurred. It was often difficult, therefore, to attain the desired accuracy in the measurement of absorption spectra.

Under certain conditions visual purple is known to produce stable orange photo-products. At low temperatures, Lythgoe[4] found that visual purple bleached to form transient orange, $\lambda_{\text{max.}}$ estimated at about 470 mμ [5]. At room temperatures, visual purple in a dried gelatin film bleaches to meta-rhodopsin, $\lambda_{\text{max.}}$ 480 mμ [6].

Judged by its $\lambda_{\text{max.}}$ and its absorption properties, the orange photo-product of the present work is identical with meta-rhodopsin. One difference, however, may be noted: meta-rhodopsin which has been produced in a dried film may be converted by wetting to indicator yellow ('retinene$_1$ and protein') and 'regenerated rhodopsin'[6]. The analogous process in the present work, reduction of salt concentration by dilution, completely converts the orange photo-product to indicator yellow, there being no sign of 'regeneration'.

It is interesting to note that Lythgoe and Quilliam[7] found that the velocity constant for the thermal conversion of visual purple to indicator yellow at 36° C. was diminished about five times in the presence of 2 *M* sodium chloride. The effect was probably due to the stabilization by salt of an orange intermediate.

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Amino-Acid Sequence in a Fraction of *Bombyx* Silk Fibroin

When an aqueous solution of the fibroin of *Bombyx mori* is acted upon by chymotrypsin, a precipitate is formed[1] through the specific action of the enzyme on the α-carboxyl groups of the tyrosine residues. This precipitate contains 62 per cent of the total nitrogen and represents 58 per cent of the total weight of the protein. It consists almost entirely of glycine, alanine, and serine, together with a little tyrosine, the molar ratios of glycine to alanine to serine being 3 to 2 to 1. The fraction has a high degree of crystalline order as shown by X-rays, and a molecular weight of about 4,000.

A detailed analysis[2] of this chymotryptic precipitate has established its formula as $\mathrm{Gly.}_{29}$ $\mathrm{Ala.}_{20}$ $\mathrm{Ser.}_{9}$ $\mathrm{Tyr.}_{1}$, and the C-terminal position has been shown to be occupied mainly by tyrosine[3].

We have recently investigated the sequence of the amino-acids in the chymotryptic precipitate. This investigation has been greatly facilitated by the absence from hydrolysates of the chymotryptic precipitate of Gly.Gly, which could not be detected even after careful search in a number of separate experiments. The absence of Gly.Gly bonds, and the analytical values showing that one half of the total residues are glycyl, mean that every alternate residue must be glycine. If the seryl residues are evenly spaced within the molecule, they will occupy every sixth position, and a repeating hexapeptide sequence of the form Ser.Gly.Ala.Gly.Ala.Gly would be a dominant feature of the molecule.

By using the N-acyl to O-acyl transformation that occurs at the seryl residues when proteins are dissolved in anhydrous mineral acids[4,5], followed by specific fission at these residues, we have been able to isolate and identify 36 per cent by weight of the chymotryptic precipitate as this hexapeptide in the form of its dinitrophenyl derivative. The yield would undoubtedly be considerably greater, but for the difficulty of preventing unwanted fission and re-combination during the treatment.

The products of the partial hydrolysis of the chymotryptic precipitate have also been examined, the dinitrophenylated mixtures being separated by column chromatography into their constituents, which were estimated quantitatively, a maximum recovery of 87 per cent, on a nitrogen basis, being obtained. The only dipeptides recovered were Ala.Gly, Gly.Ala, Ser.Gly, and a very small amount of Ala.Ala. The only tripeptides obtained were Gly.Ala.Gly, Ala.Gly.Ala, and Ser.Gly.Ala. The molar ratio of Ala.Gly to Gly.Ala in hydrolysates of periods longer than five hours was consistently 2 to 1. Serine was never recovered in peptide form except as the N-terminal residue, and was followed always by glycine, and not by alanine.

The N-terminal amino-acid residues of the chymotryptic precipitate have been determined by treating it with 1-fluoro-2 : 4 dinitrobenzene, hydrolysing, and separating and estimating the dinitrophenyl-amino-acids. Glycine occupied 84 per cent of the N-terminal amino positions, serine 10 per cent and alanine 4 per cent. Dinitrophenyl-Gly.Ala, dinitrophenyl-Gly.Ala.Gly, and dinitrophenyl-Gly.Ala.Gly.Ala were isolated from the N-terminal sequence, and, together with the recovered dinitrophenyl-glycine, they constituted 78·5 per cent of the total N-terminal glycine.

Consideration of all the evidence leads to the conclusion that the chymotryptic precipitate is composed mainly of a repeating sequence of the form $\mathrm{Ser.Gly.(Ala.Gly)}_n$, where *n* is usually 2, and must have, by requirement of the analytical data, an *average* value of 2. In addition to this principal constituent, a small amount of Ala.Ala is present, together with a C-terminal tyrosine residue and an N-terminal sequence in which mainly glycine provides the N-terminal amino residue.

The chymotryptic precipitate is thus composed of an aggregation of sections of the fibroin molecule, these sections having the formula

$$\mathrm{Gly.Ala.Gly.Ala.Gly.[Ser.Gly.(Ala.Gly)}_n\mathrm{]}_8 \\ \mathrm{Ser.Gly.Ala.Ala.Gly.Tyr.}$$

where *n* is usually 2, and always has a mean value of 2.

A detailed account of this work has been prepared, and is being submitted for publication elsewhere.

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Interrelation between Photosynthesis and Respiration in the Marine Flagellate, *Dunaliella euchlora*

The photosynthetic assimilation of carbon-14 from the external medium by unicellular algae appears to proceed at a rate which is equivalent to the plants' net photosynthesis (the difference between photosynthesis and respiration). This was demonstrated in experiments in which the assimilation of carbon-14 was compared simultaneously with the evolution of oxygen[1], and was most apparent under conditions of low light intensity or nutrient depletion where respiration approached or equalled photosynthesis. For example, at or below the compensation-level no significant uptake of carbon-14 could be detected in 24 hr. despite the occurrence of measurable photosynthesis by oxygen production.

Two possible physiological explanations for this behaviour have been considered. These are: (1) that newly assimilated carbon serves as an immediate substrate for respiration; (2) that respiratory carbon dioxide is used preferentially to external carbon dioxide for photosynthesis. The first of these explanations appears to be contradictory to the findings of Calvin[2] and Weigl *et al.*[3], who have reported that newly assimilated carbon-14 does not immediately enter the respiratory cycle as long as the plants are photosynthesizing.

The second possibility may be investigated by a simple experiment in which organisms are grown in a medium containing carbon-14 for a sufficient number of generations so that essentially all their carbon becomes uniformly labelled with the tracer. If the cells are then removed from their external carbon-14 source and resuspended in fresh medium, any respiratory loss of carbon must be accompanied by a loss of carbon-14 activity by the organisms. The failure to detect such a loss during photosynthesis would clearly demonstrate the re-assimilation of respiratory carbon dioxide. The details of such an experiment are as follows.

A bacteria-free culture of *Dunaliella euchlora* was inoculated into 1·5 litres of enriched sea water medium deficient in nitrogen (0·001 per cent potassium nitrate), giving an initial cell concentration of 1,500 cells/ml. 10 μc. of $^{14}CO_3$ were added and the cultures exposed to approximately 800 foot-candles of illumination at 20° C. At the same time a duplicate culture containing no carbon-14 was inoculated. After two days the cultures contained 21,000 cells/ml. and, for practical purposes, all the carbon of the cells in the isotope-enriched culture was uniformly labelled with the tracer. Exponential growth continued for four days and growth stopped after the fifth day. During the growth period sufficient carbon dioxide was added daily to keep the *p*H below 8·0. This was not necessary after growth had stopped. The growth-curve for the two duplicate cultures is shown in Fig. 1, each point representing the mean concentration of cells in the two cultures.

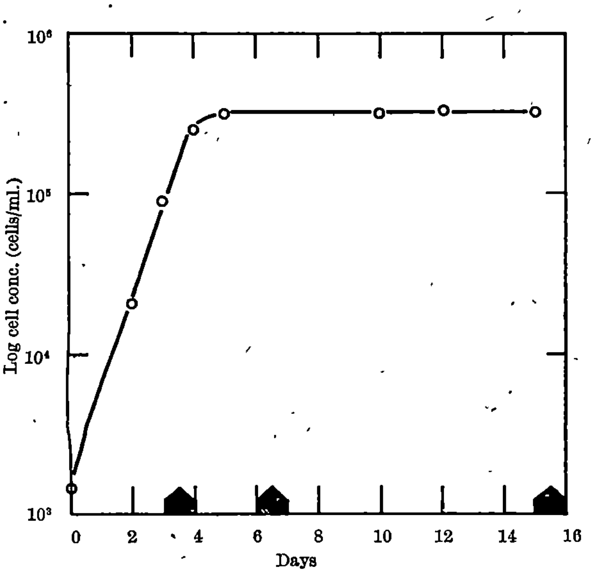

Fig. 1. Growth curve of duplicate *Dunaliella* cultures. Arrows denote days on which experiments were performed.

Table 1. The Loss of Activity in *Dunaliella* tagged with Carbon-14 in the Light and Dark in relation to Photosynthesis and Respiration

Age of culture (days) (see Fig. 1)	*P* (ml. O_2/l./hr.)	*R* (ml. O_2/l./hr.)	*P* : *R*	% Loss activity/24 hr. Light	% Loss activity/24 hr. Dark
3	0·36	0·03	12·0 : 1	−0·3*	20·9
6	0·09	0·02	4·5 : 1	1·6*	22·9
15	0·03	0·015	2·0 : 1	1·5*	20·0

* Attributable in each case to random counting error.

On the third, sixth and fifteenth days aliquots of the culture tagged with carbon-14 were centrifuged. The cells were then washed in filtered sea water and resuspended in the filtered medium of the culture containing no carbon-14, adjusting the density to give 25,000 cells/ml. The tagged cells were thereby removed from their external source of carbon-14 but retained in a medium physiologically identical with that in which they had grown. The *p*H was adjusted to 7·0–7·5 by the addition of carbon dioxide and the new cell suspension siphoned into 35-ml. glass-stoppered bottles.

Half the bottles were used for the determination of photosynthesis and respiration by measuring the change in dissolved oxygen concentration (Winkler method) in the light (800 f.c.) and in the dark after six hours. The increase in oxygen in the light represents net photosynthesis ($P-R$), the decrease in the dark represents respiration (R) and the difference between the two is considered equivalent to total photosynthesis (P).

Of the remaining bottles, one-third were filtered immediately, one-third exposed to 800 foot-candles illumination for 24 hr. and filtered, and one-third kept in the dark for 24 hr. and filtered. The filters were then dried and their radioactivity determined. All the above measurements were made in triplicate, and the mean values are given in Table 1. The data show that the cells tagged with carbon-14 did not lose a significant amount of carbon during 24 hr. of exposure to light, while those kept in the dark for the same length of time lost approximately 20 per cent of their carbon.

Measurements of the oxygen assimilation of *Dunaliella* following its removal from light have shown that respiration proceeds at a rapid and constant rate during the first 24 hr., after which the process slows down markedly. Kok[4] observed the same behaviour in *Chlorella*, which respired as much as 15 per cent of its dry weight (or a comparable fraction of its carbon) in 20 hr., following which the rate of oxygen uptake "declined to a low and steady level of endogenous respiration".

The loss of 20 per cent of the carbon-14 content of the cells in the dark over 24 hr. may therefore be reasonably attributed to respiration. Since the rate of oxygen uptake remains constant throughout that period, it also seems reasonable to assume that respiration occurred at essentially the same rate in the organisms exposed to the light, particularly in view of the evidence presented by Brown[5] that respiration is independent of light.

Since all carbon in the organisms was tagged with carbon-14, any measurable respiration would result in a loss of activity to the cells. The fact that such a loss was not detected in the light must be interpreted to mean that somewhere within the respiratory cycle the carbon was re-assimilated by photosynthesis. This process appears to have occurred with 100 per cent efficiency regardless of the rate of photosynthesis or the ratio of $P : R$. It is noteworthy that the respiratory carbon dioxide was preferentially used despite an external partial pressure of carbon dioxide more than four times as great as that of normal sea water. Even during the period of maximum photosynthesis (on the third day) carbon dioxide assimilation did not exceed 15 per cent of the total carbon dioxide available in the medium.

These experiments provide no clue as to the biochemical state of the recycled respiratory carbon. They recall the suggestion of Franck[6], Gaffron[7] and others of a common intermediate pool for photosynthesis and respiration. However, a case may also be made on purely physical grounds for the successful competition of respiratory versus external carbon dioxide at the chloroplast. The latter is perhaps more compatible with the observations of Brown[5], who was able to neglect the preferential utilization of photosynthetically produced oxygen in his respiration experiments with *Chlorella*, indicating that the two processes are not universally linked at an intermediate level.

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Insecticide Resistance in *Anopheles gambiae* Giles: a Case of Simple Mendelian Inheritance

A STRAIN of *Anopheles gambiae* from Northern Nigeria, highly resistant to dieldrin and cross-resistant to the related chlorinated hydrocarbon insecticides (chlordane, aldrin, isodrin, endrin and gamma-BHC), but still susceptible to DDT, has recently been colonized in this Institute and the degrees of resistance to these insecticides reported[1]. A colony of the same species from Lagos and susceptible to all these insecticides has also been maintained in the same Institute for some four years.

Crossings between the two strains have now thrown light on the mechanism of the inheritance of this particular type of resistance in *A. gambiae*.

Crossings have been possible both ways (male × female and female × male), and result in hybrids which are identical and homogeneous so far as their susceptibility to insecticides is concerned (so far only gamma-BHC and dieldrin have been tried).

Table 1. MEDIAN LETHAL CONCENTRATIONS (PERCENTAGES IN RISELLA OIL) OF DIELDRIN AND GAMMA-BHC WHEN SUSCEPTIBLE, RESISTANT AND HYBRID STRAINS OF *Anopheles gambiae* ARE EXPOSED FOR 1 HR.

	Susceptible strain (*S*)		Resistant strain (*R*)		Hybrid *R*♀ × *S*♂		Hybrid *R*♂ × *S*♀	
	♀	♂	♀	♂	♀	♂	♀	♂
Dieldrin	0 08	0 05	>4 0	>4·0	2·6	1 5	2·3	1 6
Gamma-BHC	0 007	0·006	0 21	0 18	0·053	0 038	0 052	0 038

Homogeneity is indicated by the narrow range of dosages of these insecticides necessary to kill all these hybrids, the dosages being between those necessary to kill the susceptible strain and those necessary to kill the resistant strain. Table 1 shows the $LD50$ for the two strains and the two hybrids when exposed for 1 hr. to solutions of dieldrin and gamma-BHC in Risella oil[2]. The $LD50$ of dieldrin was impossible to determine for the resistant strain when exposure for 1 hr. only was made, as a saturated solution of this insecticide (4 per cent) gave no kill. By increasing the exposure time, however, it has been shown to be about 800 times as resistant to dieldrin when compared with the Lagos strain, and is also some twenty-six times as resistant to gamma-BHC [1]. The hybrids proved to be some thirty times as resistant to dieldrin and seven times to gamma-BHC. The males of both strains were slightly more susceptible than the females.

Thus it has been possible to choose two separating dosages of both insecticides, one killing all susceptibles but not hybrids or resistants, and the other killing all hybrids and susceptibles but not resistants. These dosages for an exposure of 1 hr. are 0·33 and 4·0 per cent dieldrin and 0·025 and 0·1 per cent gamma-BHC.

The usual method of determining the number of genes involved in a particular character by ascertaining the sort-out in the F_2 generation was not possible with these two strains of *A. gambiae*, because the F_1 hybrids were almost sterile. Though eggs were readily laid by the hybrid females, only a very occasional one proved to be viable. The sterility was eventually shown to be in the male hybrid.

It has been possible, however, to back-cross the two hybrid females with the parent susceptible and resistant males. The offspring of the four possible back-crosses have been exposed to the established separating dosages and the resulting proportions of susceptibles, hybrids and resistants obtained are given in Table 2. These results show quite conclusively that the inheritance of resistance to the dieldrin–chlordane–gamma-BHC group of insecticides is monofactorial with incomplete dominance.

A complete proof of this 50 : 50 separation in the offspring of the back-cross was given when the offspring of the back-cross of the hybrid female (*R*♀ × *S*♂) with the susceptible male parent were exposed to the dosage eliminating susceptibles and the survivors

Table 2. PERCENTAGES OF SUSCEPTIBLES, HYBRIDS AND RESISTANTS RESULTING FROM THE FOUR BACK-CROSSES OF THE TWO HYBRID (*RS*) FEMALES WITH THE PARENT RESISTANT (*R*) AND SUSCEPTIBLE (*S*) MALES
The actual numbers of mosquitoes involved are given in brackets

Parents	*R*♀ × *S*♂				*R*♂ × *S*♀			
Back-cross	*RS*♀ × *S*♂		*RS*♀ × *R*♂		*RS*♀ × *S*♂		*RS*♀ × *R*♂	
Back-cross offspring	Susceptible	Hybrid	Resistant	Hybrid	Susceptible	Hybrid	Resistant	Hybrid
Males	57 (384)	43 (295)	48 (167)	52 (181)	49 (195)	51 (202)	45 (133)	55 (161)
Females	49 (364)	51 (380)	51 (241)	49 (23[illegible])	56 (194)	44 (150)	49 (195)	51 (207)

were crossed with the resistant male parent. Subsequent offspring were exposed to the dosage killing hybrids and the following proportions obtained :

	Hybrids	Resistants
Males	53 per cent (86)	47 per cent (75)
Females	41 per cent (119)	59 per cent (170)

The surviving males and females from this latter exposure, on being crossed with the parent resistant strain, yielded pure resistant strains again.

In addition to the selection of this resistant strain from the back-cross of the hybrid with the susceptible parent, the offspring of this back-cross were shown to be composed of hybrids and susceptibles only, by exposing them to the dosage which kills hybrids. Such exposure resulted in 100 per cent kill. Similarly, exposure of the offspring of the back-cross of the hybrid with the resistant parent to a dosage which kills susceptibles only resulted in no kill at all.

This finding of a monofactorial inheritance of resistance indicates the necessity for a change in the method of detecting resistance in the field. The present method of comparing the *LD*50 of a particular insecticide in an insect population where resistance is suspected with that in a population where the insecticide has never been used may show only a small difference, in some cases not even statistically significant, depending on the proportions of the three groups (susceptibles, hybrids and resistants) in the population examined. Thus, in Western Sokoto, from where these dieldrin-resistant *A. gambiae* originated, the degree of resistance was recorded[3] as only eight times in 1955. The use of separating or discriminating dosages would have enabled a selection of the pure resistant strain, which is in fact some 800 times as resistant as the susceptible. It is suggested, therefore, that instead of a comparison of *LD*50 in the two populations, the minimum *LD*100 be established in the susceptible population, and the suspected population exposed to this dosage. Survivors, if any, can then be reared and their offspring exposed to higher dosages to select the resistant strain.

Alternatively, an accurate dosage/mortality regression line can be made in the suspected area, using a large number of dosages of the insecticide. If resistance is present, it will be shown by two steps in the line where increase in dosage produces no change in kill. These are the discriminating dosages between susceptibles and hybrids and between hybrids and resistants.

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Copper Deficiency in Sitka Spruce Seedlings

FOR several years a symptom referred to as 'needle tip-burn'[1–3] has been observed in Sitka spruce seedlings at the Forestry Commission Research Nursery, Sugar Hill, near Wareham, Dorset. The nursery, which occupies land formerly covered by *Calluna* and scrub pine, is on a highly leached sandy soil over Bagshot Sands (Lower Eocene), with a humus and iron pan at varying depth. To break the pan, most parts of the nursery have been subsoiled in recent years.

'Needle tip-burn' usually appears during dry hot spells in midsummer, the damage being confined to the more vigorously growing seedlings. The tips of the upper needles shrivel and turn straw colour. There is a distinct break between the normal green lower part of the needle and the withered upper part, and in many cases a ring-like structure separates the healthy from the shrunken portion. The symptom is often accompanied by a spiral twist of the upper needles. If dry hot weather persists for a long period, plants rarely recover and the growing point dies. Later in the summer the upper needles turn brown or black and carry infections of *Botrytis* or other fungi. If the hot spell lasts for only a short time and is followed by moist conditions most of the new needles that emerge are free from tip-burn, and all that is left to indicate the earlier attack is a ring of damaged needles lower down the stem.

Whereas 'needle tip-burn' is common on seedlings grown with inorganic fertilizers, damage has only rarely been observed on seed-beds treated with a compost made from hop-waste and chaffed green bracken. In an early experiment in which a variety of composts were compared, only those containing hop-waste prevented tip-burn.

The resemblance of 'needle tip-burn' to 'withered tip disease' in cereals, its mode of occurrence and the incidence of copper deficiency in fruit trees on Bagshot Sands[4–6], suggested that the symptoms in Sitka spruce might also be due to lack of copper. In June 1955, therefore, a foliar spray of copper sulphate was applied to half the plots in an experiment on Sitka spruce seedlings grown with inorganic fertilizers. The spray supplied 0·16 gm. copper per square yard in 300 ml. water, that is, a solution with about 0·05 per cent copper. Five weeks after application the untreated plots were beginning to suffer from tip-burn but the sprayed plots were completely free. Later in the season tip-burn became severe on the no-copper plots ; slight symptoms were, however, visible on the plots treated with copper sulphate. Table 1 shows visual 'scores' for needle damage taken on four different occasions, seedling height in inches at the end of the growing season and the copper content of the whole seedling.

The copper sulphate spray increased seedling height by nearly 50 per cent and copper content by 40 per cent ; but it did not completely remove the symptoms, and higher rates of application are therefore being tested in 1956.

In seed-bed experiments laid down in 1951 at Sugar Hill Nursery, Wareham, and at Kennington Nursery, near Oxford, a standard inorganic fertilizer has been compared each year with a compost made from bracken and hop-waste. In 1955 the fertilizer plots at Wareham showed considerable tip-burn but the compost plots were free. No tip-burn symptoms have ever been observed on either treatment at Kennington, a sandy loam over Jurassic Calcareous

Table 1. SITKA SPRUCE SEEDLINGS AT WAREHAM NURSERY, 1955

	Visual 'scores' for 'needle tip-burn'				Mean height (in.)	Cu in dry matter of seedling (p.p.m.)
	Aug. 4	Aug. 11	Aug. 23	Oct. 6		
Untreated	2·4	3·4	4·4	5·1	1·9	2·3
Copper spray	0·0*	0·0	1·0	2·2	2·8	4·2

*0·0 means no damage

Table 2. Sitka Spruce Seedlings 1955

	Visual 'scores' for 'needle tip-burn'		Cu in dry matter of seedling (p.p.m.)	
	Wareham	Kennington	Wareham	Kennington
Fertilizer	3	0	2·8	10·8
Compost	0	0	7·0	10·4

(0 = no damage)

Grit. Visual 'scores' and copper contents of the crops are shown for both centres in Table 2.

The results of analysis of several batches of bracken and hop-waste (Table 3) show that, whereas the copper content of bracken was around 10 parts per million, the value for hop-waste approached the 1,000 parts per million level. A sample of unextracted hops was found to contain only 95 parts per million, so that a large fraction of the copper in the hop-waste presumably came from sources at the brewery such as copper boilers used in the extraction of the hops.

Table 3. Copper Content of Hops, Bracken and Bracken Hop-waste Compost

	Cu in dry matter (p.p.m.) Range	Mean
Hops	—	95
Hop-waste ('spent hops')	865–970	910
Bracken	11–13	12
Bracken hop-waste compost	340–465	365

The absence of tip-burn on the Sitka spruce seedlings grown with bracken hop-waste compost can therefore be ascribed to the high copper content of the compost.

The experiments discussed in this communication are part of an investigation carried out in intimate collaboration with the Research Branch of the Forestry Commission.

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αε-Diaminopimelic Acid in the Peptide Moiety of the Cell Wall Polysaccharide of *Bacillus anthracis*

Bacillus anthracis contains a polysaccharide which appears to be part of the cell wall[1]. Ivanovics[2] first isolated the polysaccharide which contained galactose 34 per cent, glucosamine 34 per cent, nitrogen 4·2 per cent and α-carboxyl amino-nitrogen 0·8 per cent. Strange and Belton[3] obtained from culture filtrates of *B. anthracis* a polysaccharide which contained galactose 39–43 per cent, glucosamine 34 per cent, nitrogen 3·9 per cent and α-carboxyl amino-nitrogen 1·26 per cent. The differences between the total nitrogen and glucosamine nitrogen values together with the figures for α-carboxyl amino-nitrogen in these preparations indicated the presence of 5–10 per cent of amino-acid residues. Smith and Zwartouw[4] obtained a polysaccharide from *B. anthracis* grown *in vivo*. It contained galactose 38–43 per cent, glucosamine 38–44 per cent, nitrogen 4·0 per cent and α-carboxyl amino-nitrogen 0·3 per cent. Since this preparation satisfied a number of rigorous tests for homogeneity it was concluded that a small peptide moiety (2–3 per cent) was firmly attached to the polysaccharide. We are concerned here with the constitution of this peptide moiety.

The amino-acids detected in the polysaccharide preparations were alanine, aspartic acid, glutamic acid and glycine[3,4]. This restricted amino-acid content was peculiar and only recently recognized as resembling that of the peptides containing αε-diaminopimelic acid and an unidentified amino-sugar, which form part of the walls of some bacteria[5] and spores[6]. Two samples of the polysaccharide as isolated from *B. anthracis*[3,4] have therefore been re-examined with the object of detecting the presence of small quantities of αε-diaminopimelic acid and unidentified amino-sugar; both compounds were found.

(1) *Detection of αε-diaminopimelic acid.* Samples (25 mgm.) were hydrolysed (6 *N* hydrochloric acid, 100°, 16 hr.) and the hydrolysate after evaporation was run as a band on a paper chromatogram using collidine/lutidine/water as solvent and synthetic αε-diaminopimelic acid as standard. After examination in ultra-violet light, strips of paper in positions equivalent to the standard were eluted with water. Portions of the evaporated eluates (equivalent to at least 6 mgm. of the original polysaccharide) were compared with synthetic αε-diaminopimelic acid on chromatograms using the solvent of Rhuland, Work, Denham and Hoare[7]. αε-Diaminopimelic acid (meso and/or DD isomers) was found in both samples of polysaccharide and its approximate concentration was 0·1–0·2 per cent.

(2) *Detection of the unidentified hexosamine of Strange and Powell*[6]. Samples (20–30 mgm.) were hydrolysed (6 *N* hydrochloric acid, 3 hr., 100°) and the hydrolysate evaporated, redissolved, neutralized with *IR*-4*B*(OH) and filtered. Almost all the glucosamine was removed from the filtrates by treating them for 20 min. with *IR*-120 (2 gm.) which had been buffered at *p*H 6·05 [8]. After removal of the resin, the filtrates were analysed for hexosamine by the Elson and Morgan method and contained 0·6–1·0 per cent calculated on the weight of polysaccharide taken. In this analysis, the absorption maximum of the coloured derivatives were near

$$520\ \text{m}\mu \left(\frac{-\log T\ 530}{-\log T\ 520} = 0{\cdot}97 \text{ compared with } 0{\cdot}90\right.$$

for unidentified amino-sugar and 1·05 for glucosamine), indicating that, in addition to the small amount of residual glucosamine, the unidentified amino-sugar was present in the filtrates[8]. This was confirmed by paper chromatography. The evaporated filtrates were chromatographed using tertiary butanol/6 *N* hydrochloric acid/water in the volume ratio 70 : 1 : 29 as ascending solvent (16 hr.) on papers containing glucosamine and unidentified amino-sugar. The dried papers were sprayed with ammoniacal silver nitrate and heated. Both polysaccharide samples formed spots which corresponded with unidentified amino-sugar.

The amounts of αε-diaminopimelic acid and unidentified amino-sugar detected in the polysaccharide of *B. anthracis* indicate that the whole of the peptide moiety of the polysaccharide could be composed of the so-called 'cell wall peptide'. The presence of αε-diaminopimelic acid and unidentified amino-sugar in the polysaccharide suggest that the cell wall of *B. anthracis* consists—in part at least—of a compound of the polysaccharide and the 'cell wall peptide'. In this connexion it is recalled that a preparation from *Bacillus* '*M*' described by Guex-Holzer and Tomcsik[9] contained αε-diaminopimelic acid, unidentified amino-sugar, galactose and glucosamine as well as large quantities of phosphorus, although rigorous tests for homogeneity of the preparation were not described.

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A Pasture Response to Sodium Tungstate on a New Zealand Soil

IN an investigation of an apparent superiority of basic slag over superphosphate in stimulating pasture growth on a yellow-grey earth of the Warepa series (Otago Province), slag-treated plots were compared in 1951 with plots receiving superphosphate, (1) alone, (2) plus ⅛ oz. sodium molybdate, (3) plus 2½ oz. molybdate and (4) plus 1 lb. ammonium metavanadate per acre. Molybdenum application at both rates markedly increased pasture production, notably through the clovers, while vanadium had no effect. In September 1953 sodium tungstate (molybdenum content < 0·1 p.p.m.) was applied over one block of the experiment at 1 lb./acre. The superphosphate plot with no applied molybdenum and that with vanadium responded greatly, particularly in white clover growth, that with ⅛ oz. sodium molybdate responded slightly, while the plot treated with the heavier rate of sodium molybdate showed no additional effect from tungsten[1]. The implication was that tungsten could assume the role of molybdenum, presumably in nitrogen fixation by *Rhizobia*. A replicated trial studying the interactions of molybdenum, tungsten and vanadium, applied in proportion to their atomic weights (sodium molybdate 2½ oz./acre), has now been run on the same soil type. The trial was laid down on March 24, 1955. In the five yield cuts so far taken covering the period August 10, 1955–February 28, 1956, vanadium has had no influence either by itself or in conjunction with molybdenum or tungsten. It can therefore be disregarded in considering the molybdenum × tungsten interaction. Results are exemplified by data from the second yield cut in the tungsten × molybdenum interaction table (Table 1).

Table 1. YIELDS OF DRY MATTER LB./ACRE, OCTOBER 13–NOVEMBER 10, 1955

	No tungsten	Tungsten	Mean
No molybdenum	770	940	850
Molybdenum	1,120	1,070	1,100
Mean	940	1,010	

Sig. diff.: 5 per cent, 100; 1 per cent, 130.
Molybdenum × tungsten interaction significant at 1 per cent level.

There is a significant response to tungsten only in the absence of molybdenum. In the presence of tungsten in the above cut, response to molybdenum just achieves significance at the 1 per cent level. Two further yield cuts gave similar results while the interaction in the first and fourth was not significant. Over the whole period of 6½ months both molybdenum alone and molybdenum plus tungsten gave a 27 per cent increase in dry matter production; tungsten in the absence of molybdenum a 16 per cent increase.

In an accompanying trial, rates of sodium tungstate at 1, 2, 4, 8 and 16 oz. per acre were compared. By the third cut all rates were giving significant increases in yield of pasture, amounts above 4 oz./acre conferring no extra advantage. In the fifth cut yields were recorded increasing up to, but not beyond, the 8-oz. level.

Tungsten is probably acting as a substitute for molybdenum in its role in nitrogen fixation, but less effectively. Heavier applications, at least initially, have shown no advantage; if tungstate merely freed soil molybdate held in an unavailable form one would have expected the reverse to hold. Moreover, the anion exchange effect of the far heavier basal application of phosphate (2 × 3 cwt. superphosphate) would have tended to mask any such action.

Bortels has directed attention to tungsten and vanadium having an effect similar to, but much smaller than, molybdenum in stimulating nitrogen fixation by blue-green algæ of the genera *Anabaena* and *Nostoc*[2]. In Bortels's studies with *Azotobacter* spp. and *Clostridium butyricum*[3] tungsten increased effects of vanadium and, to some extent, of sub-optimal amounts of molybdenum, the former observation prompting the trial of tungsten in the present instance.

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Phosphine as a Phosphatic Fertilizer

SINCE ammonia gas has been highly satisfactory as a nitrogenous fertilizer it is surprising that there is no record of any experimental work on its analogue phosphine as a source of plant phosphorus. Phosphine has many obvious disadvantages; but the fact that it is more than ten times as concentrated as superphosphate, our standard arable phosphatic fertilizer, surely merits some consideration. Commercial handling may not present any more serious problems than did some of the modern phosphorus insecticides.

A preliminary glasshouse experiment on radishes and wheat showed that phosphine was not toxic to germination or growth at normal dressings and only at a rate equivalent to 18 cwt. per acre of superphosphate was some leaf discoloration noticed. Soil retention of the compound was nothing like so efficient as with ammonia ; but at all normal dressings no loss to the atmosphere should be experienced.

In a 5 × 5 latin square glasshouse experiment with radishes where superphosphate was applied at 0, 1½ and 3 cwt. per acre and phosphine at the same levels of phosphorus there was no significant difference in the response of either total fresh matter or dry matter between the two sources of phosphorus. At the higher levels, however, the uptake of phosphorus from phosphine was very highly significantly ($P < 0{\cdot}001$) better than and almost double that from superphosphate. This suggests that soil fixation may be lower with phosphine than superphosphate, and it is proposed to investigate this matter further.

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Occurrence of Peroxidase in Tension Wood of Angiosperms

Tension wood in angiosperms can be readily induced by bending stems and branches from their normal orientation, when it develops usually on the upper side of the stem or branch, in the form of a dense band (compact type), or in groups of fibres or isolated fibres scattered among the normal fibres of the tissue (diffuse type). Tension wood fibres are characterized by the fact that the fibre walls are partially or wholly unlignified[1]. The formation of tension wood thus involves a differential lignification of the xylem on the two sides of the stem or branch.

In investigations into the nature of lignification, the work of Freudenberg *et al.*[2,3], and of Siegel[4] has shown that the mechanism most probably involves oxidation of a phenyl propane type precursor by an oxidase, phenoloxidase or peroxidase. In conifers the seasonal variation in peroxidase in the zone of differentiating xylem was studied by Manskaya[5] and found to be inversely related to the coniferin content of the tissue. From this it was concluded that coniferin may form a substrate for the peroxidase, during lignification.

To examine the nature of the asymmetry of lignification in stems forming tension wood, the peroxidase distribution was studied. The method of McJunkin[6] using benzidine and hydrogen peroxide was employed to determine the peroxidase distribution. In the zone of tissue including the cambium no peripheral variation in the amount of peroxidase in stems of *Eucalyptus goniocalyx* and *Eucalyptus cladocalyx* could be seen. However, in the mature tension wood intense peroxidase activity was observed in the unlignified region of the fibre cell walls. This is illustrated in a band of tension wood of *E. goniocalyx*, shown in Fig. 1, where the area of peroxidase activity appears dark. Similar activity was observed in the fibre walls of tension wood of the diffuse type. The peroxidase reaction was not obtained if the sections were first treated with cyanide. Addition of hydrogen peroxide to the tissue did not result in the formation of any lignin-like substances. It thus appears that the failure of tension wood to lignify may result from the differential formation of the lignin precursor on the two sides of the stem. Alternatively the change in cell metabolism resulting in the formation of highly crystalline cellulose in the cell wall may fail to provide sites to which the lignin synthesized can link, since in lignified cells lignin appears to be associated with the non-cellulosic fraction of the cell wall[7].

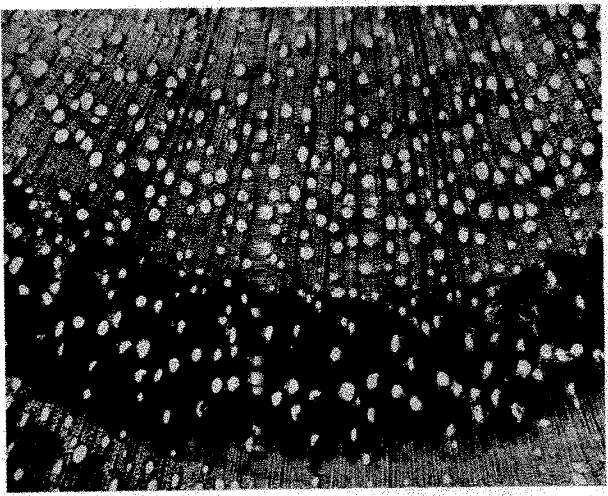

Fig. 1. *Eucalyptus goniocalyx.* A transverse section of a young stem containing a compact band of tension wood, after staining for peroxidase. (× 90)

Further investigations are in progress.

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Mating in Scorpions

The courtship dance of the scorpion has been observed and recorded repeatedly since 1810 when Maccary[1] first described it. The actual conclusion of this elaborate behaviour pattern has, however, only been surmised from circumstantial evidence. For example, both Fabre[2] and Brongniart and Gaubert[3] report that scorpions were surprised beneath stones "accouplés, ventre à ventre". Vachon[4] writes as follows : "the conclusion of these nuptial dances I have not observed but anatomical investigation bears out the statement of early writers ; the male fertilizes the female directly in a true copulation. . . .

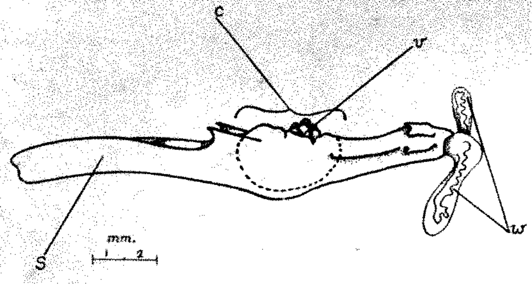

Fig. 1

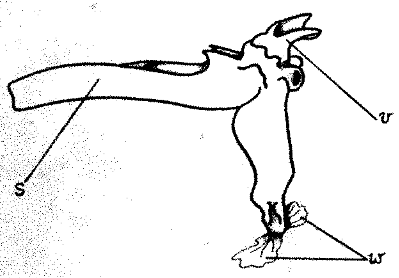

Fig. 2

In the course of this act, the male protrudes certain special organs to form a temporary penis, with which he inserts the sperm and finally places in position a vaginal plug—a kind of post-nuptial hymen".

Now it is known[5] that pseudoscorpions go through a courtship which is in many respects like that of the scorpions. During this, the male deposits on the ground a spermatophore from which the female removes the sperm mass. Lawrence[6] says, "it may be surmised that the mating act in scorpions and pedipalpi . . . follows the same general lines as that of the pseudoscorpions".

In the scorpion, *Opisthophthalmus latimanus typicus* C. Koch, the courtship has been observed repeatedly and will be described in detail elsewhere. Suffice it to say that the classical "arbre droit" is either absent or only fleetingly present; the "promenade à deux" occurs but does not usually last longer than an hour. During this latter pattern the male holds the cheliceræ of the female and not, as has been reported for other scorpions, her pedipalps. The promenade is executed over a very limited area; when the animals are performing on rough ground the male clears the soil particles from the space in which the pair are dancing but if the ground is smooth he does not show this behaviour.

In two cases recently observed in this laboratory the courtship continued to the consummatory act and the fertilization of the scorpion was witnessed. Shortly after the beginning of the promenade the genital operculum of the female was seen to be open; a little later that of the male opened as the extrusion of a spermatophore began. During the extrusion the pair continued to move backwards and forwards in the manner typical of the "promenade à deux", but with more limited excursions. As soon as the spermatophore (Fig. 1) was clear of the genital aperture of the male, he moved back slightly so that it lay free on the ground beneath him. After a few seconds he began to jerk the female violently, drawing her over the spermatophore and half-lifting her at the same time. This pattern contains the "back and forward" movement characteristic of the promenade, but the female was gradually drawn forward to a position over the spermatophore. She appeared to drop down suddenly over the capsule of the spermatophore (Fig. 1, *c*) and almost immediately rose again with the opened valves (Figs. 1 and 2, *v*) inserted into her genital aperture. The wings (*w*) were seen to be holding one end of the spermatophore firmly to the ground while the stalk (*s*) was bent through a right angle and pointed towards the male.

The two animals stood immobile for about five minutes in this attitude, the male holding the female, who held the valves of the spermatophore capsule inside her genital aperture.

The male then began to make slight retreating movements which the female appeared to resist. Suddenly the male released the cheliceræ of his partner and clutched at her with his claws, spreading his pedipalps widely. He brought his tail over and thrust his sting at her back though he did not actually insert it into her body. She responded by moving off backwards so that she was torn free of the empty spermatophore, which was left sticking to the ground (Fig. 2). The male drove her about 25 cm. from the spermatophore; she made no attempt to sting him but clutched rather feebly at him with wide-spread pedipalps. The male then turned round, rushed away and took cover.

The female moved about slowly for 30 sec. or so with her genital aperture pressed to the ground as if searching for something. When she passed over the spermatophore she ignored it. She made chewing movements with alternate cheliceræ, then suddenly appeared to lose interest in her 'search' and hurried off to cover.

Within an hour the male was observed to react favourably to another female; but when placed with the female that he had just fertilized, the pair fought violently until he retreated.

Thus *O. latimanus* shows no true copulation but a fertilization mechanism similar to that found in the pseudoscorpions—a fact in keeping with the general similarity of their genital structures, spermatophores and courtship. Furthermore, the mechanism provides a possible explanation of the "promenade à deux" of the scorpion. If the behaviour of *O. latimanus* is general for these animals, the main movement of the fertilization process is that by which the male jerks the female back and forth until she is in the correct position over the spermatophore, which she then picks up. The promenade would appear to be a prolonged intention movement of this "picking-up-the-spermatophore".

These observations were made during the tenure of a bursary awarded by the South African Council for Scientific and Industrial Research, to whom my thanks are due.

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'Taming' of the Wild Norway Rat by Rhinencephalic Lesions

THE common Norway rat is a wild, fierce, aggressive animal which fights with other rats or other animals, large or small, at apparently slight provocation. When captured and brought into the laboratory such rats show no diminution of their aggressive tendencies even after months or years of the comparative safety and ease of laboratory life. They escape at the slightest opportunity and are difficult to recapture. They must always be handled carefully and with heavy gloves to avoid serious injury.

Several years ago, while working in Baltimore, I initiated a study of the effects of destruction of the amygdaloid nuclei in the brains of wild and domesticated Norway rats. It was thought at the time that observations made upon two strains of the same species—one wild, fierce and intractable ; the other docile, friendly and easily handled—might throw some light upon the often disputed effects of such lesions upon emotional and sexual behaviour in animals.

As a result of some incidental observations on endocrine function in some of the wild rats[1], attention was diverted and only a few domesticated rats were studied. Recently, the behaviour studies on wild rats have been repeated in a different laboratory (see present address), and it now seems worthwhile to report the striking changes in the behaviour of wild rats following the placement of lesions in the amygdaloid complex. Confirmation of the original observations has also been obtained elsewhere[2].

To date, 42 wild rats with bilateral amygdaloid lesions have been studied. Control observations have been provided by : (1) both pre- and post-operative study of the behaviour of the operated rats ; (2) twelve rats which were operated unilaterally in two stages with an intervening period of several weeks or months ; (3) rats which were captured at the same time as the operated animals and were kept in the laboratory under identical conditions during the life-time of the operated animals ; (4) sham operated rats.

None of the control animals has ever shown any observable change in behaviour.

On the other hand, either surgical or electrolytic intervention bilaterally in the area of the amygdala has inevitably produced 'tameness' in wild rats. Although eleven rats reverted to their pre-operative aggressiveness after a few days or weeks, thirty-one remained 'tame' for long periods (up to three years).

The most striking change in the behaviour of these rats is that, immediately following the operation, they no longer bite the experimenter. As soon as they recover from the anæsthetic (ether) they can be handled without gloves and without fear of attack. Large (500–600 gm.) operated wild rats may be carried about for hours in the laboratory coat pocket without incident. They do not bite and they do not attempt to escape. Yet, they remain as alert and as active as before operation.

In addition to their behaviour with respect to handling, these rats have been observed when placed with other rats and with mice.

When white mice are introduced into a cage with normal wild rats, the mice are usually killed within a few seconds. On the other hand, wild rats with bilateral amygdaloid lesions rarely, if ever, molest the mice. In fact, they often exhibit a maternal-like grooming behaviour. This phase of the problem has been extensively studied and is reported elsewhere by Karli[2].

When wild rats are paired in the 'fighting chamber' designed by Richter[3], they fight when given mild electrical shocks on their feet. Such fights are vicious and often end in death for one of the pair. Following operation, these animals rarely, if ever, attack their partner. Their post-operative behaviour is indistinguishable from that of domesticated rats under the same conditions.

The brains of seven wild rats which remained 'tame' for three months or more have been sectioned ; but none has been completely reconstructed as yet. Gross inspection and microscopical study of the sections reveal that in no brain was the amygdala completely destroyed. In all cases damage was restricted to rhinencephalic structures.

Although the precise extent of the lesion necessary to produce these changes in behaviour is as yet unknown, there seems to be little doubt that damage to the brain in the area of the amygdala produces an immediate, and in most cases permanent, loss of fierceness and aggressiveness in wild Norway rats. The mechanisms involved remain completely unknown.

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Heat Regulation of MaSarwa (Bushmen)

BUSHMEN in their natural state fulfil two important criteria for acclimatization to heat[1]. They probably are unique among indigenous peoples in this regard. In the first place, they are exposed to high temperatures and fairly intense radiation. Globe thermometer readings of 140° F. in the sun and 104° F. in the shade were recorded on our excursion into the Kalahari Desert. Secondly, these men are nomadic hunters, and, in tracking down and pursuing wild game, they exercise actively in these temperatures.

Four 'wild' Bushmen volunteered and were studied near Tsetsing, some 250 miles north-west of Molepolole in the Kalahari, Bechuanaland Protectorate. The experiments were conducted in a tent to eliminate the effects of direct solar radiation and of possible variations in wind velocity. In all other respects except one the routine followed closely upon that used for developing the Predicted 4-Hourly Sweat-Rate Index[2]. The exception is that mouth and not rectal temperatures were measured as the Bushmen refused the latter. By adding 1·2° F. ± 0·6° F., mouth temperature can be converted to rectal temperature with reasonable accuracy[3].

The small size of the Bush people compared with Europeans is made clear in Table 1. The resting metabolic rate was close to that of the Singapore naval rating[4] ; but the metabolic cost of work was closer to that of the Queen's Square subjects. Hence the amount of heat to be dissipated per unit surface area by Bushmen is similar to that of Europeans. Under conditions of mild heat stress, namely, 88° F. air temperature, 72° F. wet bulb temperature and globe temperature of 92° F., which has a Sweat-Rate

Table 1

Place	No.	Height (cm.)	Weight (kgm.)	Surface area (m.²)	Rest		Work	
					O_2/min.	Cal./m.²/hr.	O_2/min.	Cal./m.²/hr.
Singapore	12	172·1	64·3	1·76	0·283	46·82	0·951	164·01
London	16	171·0	66·0	1·77	—	54·0	—	180·0
Kalahari	4	158·4	45·5	1·44	0·220	44·21	0·897 (7 mea)	183·6 (7 mea)

Table 2

Subject	No.	Initial temperature (° F.)	Highest working temperature (° F.)	Final temperature (° F.)	Sweat-rate	
					Actual	Per m.²
Europeans (acclimatized)		98·7	—	99·2	1·2	0·678
MaSarwa	4	98·4	98·7	98·4	0·890	0·618

Index rating of 1·2 l./4 hr., Bushmen regulate successfully against heat, judging by the oral temperature responses (Table 2). The actual sweat-rate is less than that of acclimatized Europeans; but is very similar when corrected to unit surface area. Using these two criteria Bushmen in their natural state are as well adapted to this degree of heat stress as are acclimatized Europeans. More severe heat stress might bring out differences such as were observed recently between Europeans and Bantu peoples[5]. It was not possible, however, to extend the studies on this excursion.

We gratefully acknowledge a grant from the South African Council for Scientific and Industrial Research, Pretoria, which enabled us to make this study. Allan Cuzen and P. Stubbs, of the Witwatersrand Native Labour Association, gave invaluable aid.

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Control of Sex Ratio in Mammals

Weir[1] selected individuals of a heterogeneous strain of mice for high and low blood *p*H and established lines averaging at *p*H 7·42 and *p*H 7·46. The sex ratio of the two lines was found to diverge from 50 : 50 to approximately 40 : 60 and 60 : 40. Acid lines produced an excess of female progeny and alkali lines an excess of males. On reciprocally crossing, Weir found that the whole of the sex ratio divergence was due to the male *p*H; the female *p*H seemed to exert no influence.

It is a matter of great interest to determine: (1) whether Weir's principle may be extended to other mammals; (2) whether blood *p*H changes occurring or induced during ontogeny are reflected in alterations of the sex ratio.

No data which directly relate blood *p*H and sex ratio, apart from Weir's, seem to be available; but in several cases it is possible to infer that the principle is operating.

(1) In man the existence of non-random influences on sex ratio has been inferred from the much-discussed data of Geissler[2]. Hewitt, Webb and Stewart[3] have found an excess of all-male, though not of all-female, sibships in a collection of English families.

That these variations could be partly due to the operation of Weir's principle is suggested by data of Heath[4]. These show a significant tendency on the part of men with a high recovery index to beget an excess of daughters. Generally, 'athletic' men deviate in this direction. While athletic exertion causes a temporary reduction in blood *p*H, it does not seem to be known whether repeated exertion induces the slight permanent lowering which may be required to influence sex ratio. Shock and Hastings[5] found variations between *p*H 7·34 and *p*H 7·45 in human blood. Individuals differed significantly from each other in regard to the acid-base balance of their blood.

(2) In cattle, data of the progeny of bulls used for artificial insemination were recorded at the Southbar Cattle Breeding Station in Scotland between 1947 and 1952. Mr. James Isbister kindly made them available to me for analysis. 37,515 calves from 32 bulls were listed; of these 18,795, that is, 50·100 per cent, were females. No less than 12 bulls deviated significantly from a 1 : 1 ratio, seven of them so far that $P < 0 \cdot 01$. The total heterogeneity was measured by $\chi^2_{[31]} = 123 \cdot 41$; $P \ll 0 \cdot 001$. This indicated that a major source of sex ratio control must lie on the paternal side. The performance of 23 bulls could be broken down into annual components; most were fairly stable, but 3 of them changed their sex ratios significantly. Again, the essential data on blood *p*H are not available, but the operation of Weir's principle should be suspected.

(3) In rats, data of Moore and Price[6] can be analysed to show that at 7,500 ft. and 9,600 ft. there was a highly significant excess of females in litters conceived after the animals had been 60 days at these stations (male, 133 : female, 180. $\chi^2 = 7 \cdot 05$; $P < 0 \cdot 01$). At 14,260 ft. there was a significant excess of males in litters conceived after the parents had been 30 days at the station (male, 33 : female, 17. $\chi^2 = 5 \cdot 12$; $P < 0 \cdot 05$). The latter result is expected, in that high altitude is supposed to induce alkalosis. The results at less-extreme altitudes would indicate acidosis, if Weir's principle is operating. In any event, we have here strong deviations in sex ratio under conditions where disequilibrium in blood *p*H should be expected.

Monge[7,8] describes marked changes in serum *p*H during chronic mountain sickness in man. He compares the physiological condition of men acclimatized to high altitude with that of athletes. In sheep at high altitude he claims that failure to conceive is due to widespread occurrence of azoospermia; some rams show wide variations in seminal *p*H "which indicates that the *p*H regulating system fails at high altitude". By selecting rams for normal seminal *p*H and sperm-motility the fertility of the flocks was improved.

(4) In mice, Bittner[9] found highly significant deficiencies of males in the progenies of inbred parents reared on a 'rolled oats' diet; these deviations remained significant even when the comparison was limited to 'undepleted' litters. Diet is clearly a factor which might affect blood *p*H.

Despite the absence of direct experimentation, (1), (2) and (3) above point to the extension of Weir's principle to mammals other than mice. (1) and (3) also suggest that slight changes in blood *p*H can be induced. From (2) it appears that the conditions influencing sex ratio in some bulls are labile.

A practical system of controlling sex ratio in economically important animals might, then, be set up by: (*a*) selecting sires for the appropriate *p*H tendency; (*b*) altering the *p*H of sires by: (1) administration of drugs; (2) changes in dietary regime; (3) modifications in oxygen tension.

Analyses of the data referred to here will be published elsewhere.

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Anharmonicity, Thermal Expansion and Thermal Resistance in a Dielectric Solid

In the limit of high temperatures ($T \gtrsim \Theta$) the thermal resistance of a dielectric solid is roughly proportional to the temperature:

$$W = W_\Theta T/\Theta$$

Two approximate formulæ[1,2] have been proposed recently expressing W_Θ in terms of equilibrium thermodynamic properties of the solid; in both formulæ W_Θ is equal to the product of the square of the coefficient of the thermal expansion and an appropriate dimensional factor derived from other properties of the solid. These formulæ can easily be shown to be essentially equivalent[3], and they are found to agree with the experimental data for many simple solids[1,2,4] within an order of magnitude, although discrepancies within a factor of 3 or 4 are not uncommon.

I wish to point out that such formulæ could only be strictly valid if there were a single parameter describing completely the 'anharmonicity' of the crystal potential, such as the parameter γ introduced by Grüneisen in his theory of thermal expansion. Now in a three-dimensional lattice there is no unique Grüneisen γ, and the quantities γ_j ($= -\mathrm{d}\log\nu_j/\mathrm{d}\log V$) obtained from the frequencies ν_j of normal modes are spread over a range of values[5]. The empirically determined value of γ is usually derived from the thermal expansion observed at 'high' temperatures ($T \sim \Theta$), and this parameter, γ_∞ say, is then the arithmetic mean $\overline{\gamma_j}$.

Let us consider now the special case of a lattice for which this mean vanishes; there do not seem to be any simple real solids for which this is true; but it is easy to derive simple theoretical models having this property. There will then be a negligibly small thermal expansion at the high-temperature limit, and the formulæ will therefore predict no thermal resistance. But actually there will still be anharmonic terms in the crystal potential, and these will give rise to coupling between the normal vibrations and hence in general to a finite thermal resistance. This implies that any formula of this type must break down when γ is sufficiently small; further, that too small a value will then be predicted for the thermal resistance. This is consistent with the observation of Leibfried and Schlömann[1] that approximations made during the derivation of their formula are not valid when γ is small.

Of course, even if the validity of such formulæ could be established for large enough γ there still seems no reason to expect the same factor of proportionality for different crystal structures and different types of atomic or molecular binding; this is borne out by the fairly wide variation of this factor observed experimentally even in substances of high γ values. However, the effect we have been considering may possibly be apparent in substances of low γ. The lowest γ values observed in simple dielectric crystals are those of the elements carbon (diamond), germanium and silicon, all with crystals of diamond structure: the formulæ predict about four times too small a thermal resistivity for diamond[6] ($\gamma \sim 1{\cdot}1$), and even greater disparities have been recently observed in germanium and silicon[7] ($\gamma \sim 0{\cdot}8$). Unfortunately, we have as yet no knowledge of the change of individual frequencies with volume in these elements; while it is unlikely that a spread of γ_j values could account for the whole of the discrepancy, it may be a relevant factor.

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Location of Free Electrons in Porphin Ring Complexes

Several molecules containing a porphin ring, of similar central structures, possess intermediate states when undergoing oxidation, and there has been considerable speculation on the actual nature of these transient compounds[1,2]. Most interest has probably been centred on the oxidation of hæmoglobin derivatives, and the action of hydrogen peroxide, potassium periodate and other oxidizing agents has

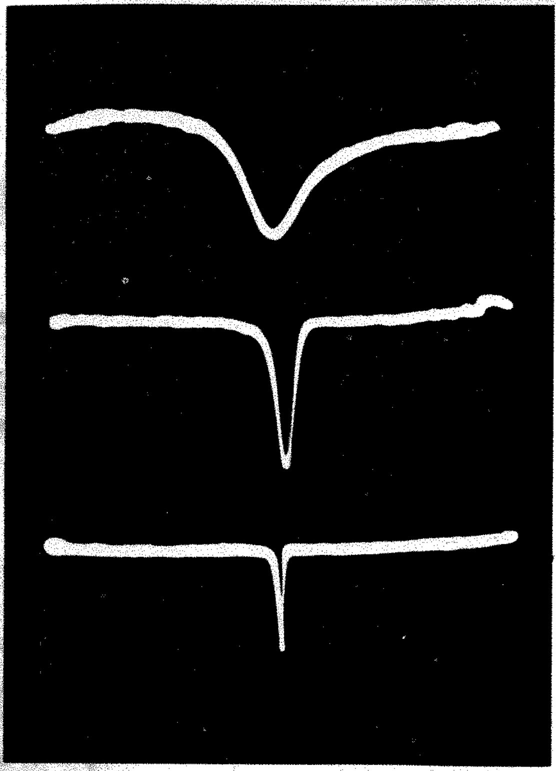

Fig. 1. Absorption lines observed from oxidation intermediates. Top, met-hæmoglobin treated with hydrogen peroxide; centre, metal-free tetra-phenyl-porphin treated with ceric oxalate; bottom, stable free radical diphenyl-picryl hydrazyl. All photographs were taken with the same field sweep

been studied in detail by George and Irvine[2]. The two possible structures for the oxidation state of the met-hæmoglobins are: (1) a radical species formed by hydrogen atom removal from some position in the conjugated ring system, or (2) a change in the valency of the central iron atom. Although several different chemical reactions were studied it was not possible to prove conclusively which of the two structures was actually present.

We have now investigated this oxidation reaction for both hæmoglobin and myoglobin by electron resonance methods, and the results show that a radical species is in fact formed with very little interaction between the unpaired electron and the central iron atom. The spectra observed can also be compared with those obtained[3] from the intermediate states formed during the oxidation of tetra-phenyl-porphin and phthalocyanine derivatives. It would appear that the orbits of the free electrons are very similar in all three cases, and embrace a considerable portion of the conjugated ring structure.

The great advantage of electron resonance techniques in such studies as these is that absorption from the unpaired electrons of the intermediate state can be observed independently of the initial and final products, and their coupling to the central metal and other atoms can be calculated from the g-value and width of the absorption line. The concentrated solution of the acid–met-hæmoglobin or myoglobin was placed in a small cup on the bottom of an H_{111} cavity[4], the oxidizing agent added and, after tuning, the whole resonator was quickly cooled in liquid air. It is possible in this way, by varying the time between addition of oxidizing agent and cooling, to study the rate of formation and decay of the intermediates. Most of the measurements were carried out at 20° K.; but the absorption lines were found to have the same width at 90° K., showing that there was no noticeable spin-lattice interaction present. Identical spectra were also observed at the two microwave frequencies employed, 25,000 Mc./s. and 36,000 Mc./s.

The absorption lines obtained from oxidized hæmoglobin and myoglobin both had a width of 25 gauss and a g-value of $2{\cdot}003 \pm 0{\cdot}001$, and a typical oscilloscope trace is shown at the top of Fig. 1. The same absorption was obtained with potassium periodate as with hydrogen peroxide, and the proximity of the g-value to that of a free electron (2·0023) is definite evidence that the oxidation state is one containing an unpaired electron mobile in the conjugated ring structure. A very similar absorption line is observed from the intermediate oxidation states of both metal-free tetra-phenyl-porphin and metal-free phthalocyanine[3]. These also have a g-value of $2{\cdot}0025 \pm 0{\cdot}0005$, with a somewhat narrower width of 9 gauss, and an example is shown in the middle curve of Fig. 1. The bottom absorption curve is that from the stable free radical diphenyl-picryl hydrazyl, with a width of 3 gauss, and acts as a comparison for the other two. The difference in width between the absorptions of the hæmoglobins and simpler porphins is probably due to exchange effects in the latter, which are absent in the hæmoglobins owing to the very large molecular size.

No hyperfine structure has been observed on any of the spectra obtained from the porphin intermediates, showing that the orbit of the unpaired electron is not confined near the nitrogens in the centre of the ring, but probably includes most of the carbon atoms. Further evidence for the mobility of the electrons in the porphin ring is also found from the hyperfine pattern observed in chlorinated tetraphenyl copper porphin[5], where an orbit embracing the π-bonds round the ring is postulated.

It is hoped that slightly more refined techniques will allow detailed rate studies on such chemical reactions as these; but the present measurements provide conclusive evidence on the nature of the oxidation states.

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Path of the Trigatron Spark

In a recent investigation[1] into the characteristics of the trigatron[2] spark gap, an interesting effect was observed in connexion with the path taken by the spark discharge between the spherical electrodes. Several hundred discharges were observed and each spark appeared to consist of two parts. The first was a straight part along the axis of the gap and reaching from one electrode to a distance of 10–50 per cent of the gap-length. The remainder was of the familiar tortuous nature of a spark discharge. The

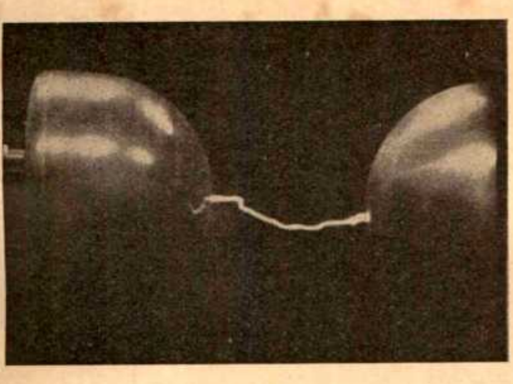

Fig. 1. Photograph of the spark channel in the trigatron gap. Left-hand electrode earthed; negative voltage on right-hand electrode

discharges were photographed from two directions at right angles, using mirrors and using the camera shutter in conjunction with a relay to trigger the spark. The effect occurred with regularity and was quite definite. It was found that the straight part of the spark was always that part adjacent to the anode, whatever the polarity of the high-voltage electrode. A typical photograph illustrating the effect is shown in Fig. 1, where the straight part of the spark is 20 per cent of the total gap-length.

Experimental evidence[1] supports the view that a streamer mechanism is operative in the breakdown of the trigatron gap, and a possible explanation of the effect described above is that breakdown depends on the propagation of a negative streamer, that is, from cathode to anode. When this streamer approaches the anode a positive streamer is initiated at the anode and comes out to meet the negative streamer. The streamers meet at a point in the mid-gap region, giving a change in direction of the spark path at this point. The theory would explain the straight nature of that part of the spark near the anode, since the negative streamer would constitute a conducting path; at the instant propagation of the positive streamer begins the system would thus be approximately equivalent to a very high over-voltage on a point-plane gap, and experimental observations with high over-voltages on point-plane gaps show that straight spark paths do in fact occur. Similar theories concerning change in direction of spark paths have also been given in connexion with lightning discharges, in which it is suggested that positive streamers might grow from the ground to meet the descending negative leader stroke.

A possible alternative explanation of the sudden change in direction of the spark path is that this path is modified by the presence of space charge. The spark tends to pass along the outside of the space charge rather than straight through the centre of the space charge region, where more uniform field conditions may prevail. A similar suggestion has been put forward by Howell[3] to explain the behaviour of the spark path in point-plane gaps.

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Enhancement of Ultra-violet Absorption of L-Ascorbic Acid in the Presence of D-Sorbitol

DURING analytical work upon certain pharmaceutical preparations of L-ascorbic acid an unusual enhancement of its ultra-violet absorption was repeatedly observed; namely, ascorbic acid in presence of various concentrations of D-sorbitol shows a considerable increase of its characteristic absorption peak both in neutral aqueous solution (*p*H 6·0) at 265 mμ and in acidic solution (*p*H 2·0) at 245 mμ.

The maxima do not shift to shorter or longer wave-lengths but the absorption curve as a whole simply behaves as if higher than actual amounts of vitamin C had been present in the solution.

Another interesting feature is the difference between the enhancement in neutral and acidic medium, which is in the former far more pronounced. This recalls a similar observation of ultra-violet absorption in irradiated solution of sugars[1]; but in our case the pure sorbitol solutions show practically no ultra-violet absorption at the concentrations examined. D-Sorbitol at *p*H 1–7 and in the presence of potassium cyanide has indeed an ultra-violet absorption of very low order which up to 10 per cent solution does not interfere with that of other solutes. The manner in which the ascorbic acid solutions have been prepared is also important; the increase can be observed only when a very concentrated solution of components of sorbitol and ascorbic acid is made at the same time. Successively, the mother solution can be diluted with water, dilute acid or dilute sorbitol until it reaches the desired final concentration and *p*H. (The diluted solution is stabilized with potassium cyanide.) In this case the reading will every time show the increase of absorption. But if, on the contrary, various amounts of pure crystalline sorbitol are added to prepared and stabilized ascorbic acid solution at a definite concentration, which is always 1 mgm. of ascorbic acid for 100 c.c. of solution, no increase will be found and the ultra-violet spectrum will remain within its normal values. There appears to be a correlation between the concentration of sorbitol and increase of absorption. Some of the values are given in Table 1.

Table 1

Conc. of D-sorbitol/100 c.c.	$E^{1\%}_{1\text{cm.}}/265$ mμ; *p*H 5·8	$E^{1\%}_{1\text{cm.}}/245$ mμ; *p*H 2·0
0·000 gm.	630	550
0·001 gm.	870	656
0·015 gm.	916	676
0·075 gm.	895	648
0·750 gm.	880	638
7·500 gm.	800	580

The reading was made on a Beckman spectrophotometer model *DU*. The solutions of ascorbic acid were controlled by potentiometric titration with dinitrophenolindophenol.

As can be seen, a maximum of increase seems to lie where the concentration of sorbitol is of 15 : 1 relation with that of ascorbic acid; but the values are too close one to another to permit the exact determination within the experimental error limits.

Undoubtedly the enhancement in neutral solution is very pronounced and reaches 48 per cent above the normal values ($E^{1\%}_{1\text{ cm.}}/265$ mμ = 620); in acidic solution the increase is also of high order but reaches only 26 per cent ($E^{1\%}_{1\text{ cm.}}/245$ mμ = 550). The absorption tends to decrease as the concentration of sorbitol increases and in acidic solution reaches 7·5 per cent sorbitol—almost the theoretical value. The higher concentrations of sorbitol have absorptions strong enough to begin to prevent exact reading.

It is known from the work of F. J. Bandelin and J. V. Tuschhoff[2], which was also confirmed by our experiments, that sorbitol in higher concentration exerts a marked stabilizing effect upon L-ascorbic acid in aqueous solution. But a similar effect was observed by us also with D-mannitol, which otherwise seems to have no influence on ultra-violet absorption of ascorbic acid. Thus the two effects, protective and enhancing ultra-violet absorption, cannot be readily accumulated and explained as the whole.

No definite theoretical explanation of the above phenomena can be given at present since the facts are relatively new and still under study. Further work will be done to cover other sugar derivatives and enediols at different values of *p*H, time and temperature.

The hypotheses about stabilizing effect on one of the possible forms of ascorbic acid can be tentatively put forward, although the persistence of increased absorption also in acid medium (*p*H $\sim$ 2) is rather difficult to explain, in view of proton migration which takes place at *p*H 4.

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Value of the *p*F Scale for Water in an Ecological Study of an Insect living in Soil

EVANS[1] demonstrated that the energy with which the soil holds water could be correlated with the loss of weight of wireworms; the energy-level was suitably expressed by Schofield's[2] *p*F scale. Evans and McL. Guild[3] then demonstrated that the rate of production and size of cocoons of earthworms were determined not by the amount of water present in the soil but by the force with which the water was held. Despite these observations the *p*F scale as a measure of available water for biological processes has scarcely been used in ecological studies of animals that live in soil. Wallace's[4] paper on the effect of hydrostatic pressure deficiency on motility of larvæ of *Heterodera schachtii* Schmidt is the only other similar study that I know.

A number of field and laboratory experiments on *Aphodius howitti* Hope, a cockchafer which inhabits sandy and loamy soils in South Australia, have suggested that oviposition is influenced by the amount of water in the soil but that expressing the results on a water-content basis for a number of soils is unsatisfactory.

The experiments were carried out with a sand and a clay loam, typical of areas in which the species is found. In one experiment beetles were confined to the two soils at various water-content levels and the numbers of eggs laid were recorded. When the results were plotted against water content of soil the numbers of eggs laid in the sand and in the clay loam could be represented by curves which were similar in form but were widely apart and hence could not be compared directly; however, when plotted against the *p*F of the soil water the curves were found to correspond closely (Fig. 1). It therefore appears that the ovipositional response is a function of the force with which the water is held rather than the amount of water present in the soil. The mean number of eggs in a batch did not vary significantly, the larger number of eggs laid in the range of optimum *p*F being due to more beetles laying all their eggs rather than all the beetles laying more eggs.

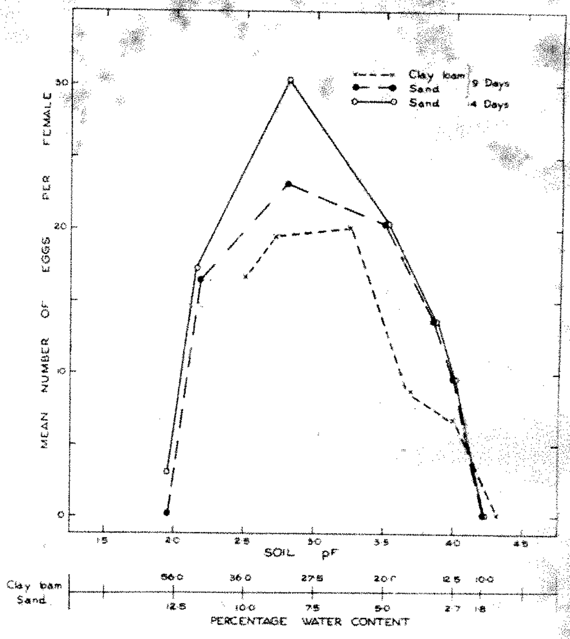

Fig. 1. The numbers of eggs laid by *Aphodius howitti* in relation to *p*F of soil. The water contents of the two soils in relation to *p*F are included for reference

Beetles were then given a choice of four different levels of water content in a series of experiments with both soils. In every case the largest aggregation of beetles and eggs was recorded at a water content corresponding to *p*F 2·8, irrespective of soil type. This *p*F value also proved to be the optimum for survival of the adults.

The consistency with which *p*F 2·8 was recorded as the optimum demonstrates the usefulness of the *p*F scale for comparing the behaviour of adults in different soils.

An investigation of the absorption of water by eggs and their survival in the two soils at various water-content levels showed further that the *p*F scale could be conveniently applied to other stages of the life-cycle. An analysis of variance yielded significant differences between *p*Fs, but no significant difference between soils.

The use of the *p*F scale has led to a better understanding of the effect of water on the types of places in which *Aphodius howitti* lives and its effect on the distribution and abundance of the species in South Australia. It is probable that it could be used to similar advantage in ecological studies of other animals that live in soil.

The details of this work will be published later.

D. A. MAELZER

Waite Agricultural Research Institute,
University of Adelaide. June 15.

[1] Evans, A. C., *Ann. App. Biol.*, **31**, 235 (1944).

[2] Schofield, R. K., Trans. Third Int. Congr. Soil Sci., **2**, 37 (1935).

[3] Evans, A. C., and McL. Guild, W. J., *Ann. App. Biol.*, **35**, 471 (1948).

[4] Wallace, H. R., *Ann. App. Biol.*, **43**, 477 (1955).

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, October 22

British Society for the History of Science (in the Lecture Theatre of the Science Museum, Exhibition Road, South Kensington, London, S.W.7), at 5.30 p m.—Dr J. S. Wilkie: "An Analysis of Buffon's article *De l'Ane*, generally believed to contain the expression of his belief in a theory of evolution".

Institution of Electrical Engineers, Radio and Telecommunication Section (at Savoy Place, London, W.C 2), at 5.30 p.m. —Informal Evening on "The Use of Transistors in Radio and Television". Talks by Dr. A. J. Biggs and Mr. E. Wolfendale.

Society of Chemical Industry, Plastics and Polymer Group at 14 Belgrave Square, London, S.W.1), at 6 30 p.m.—Dr A. Hochtlen: 'Polyurethanes"

Royal Geographical Society (at 1 Kensington Gore, London, S.W.7), at 8 30 p.m.—Mr. John Heaney and Mr Martin Holdgate: 'Expedition to Gough Island".

Tuesday, October 23

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p m.—Mr. R. H. Elvery. "The Character of Concrete as an Engineering Material".*

Chadwick Trust (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 5.30 p.m.—Dr. W. Emrys Davies: "The Message of Public Health—How it Should be Told"* (Chadwick Public Lecture).

Institution of Civil Engineers (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m —Mr. C. G. Giles: "Skidding Resistance of Roads and the Requirements of Modern Traffic".

Institution of Electrical Engineers, Measurement and Control Section (at Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion on "The Use of Electronic Computers in Nuclear Reactor Design Studies", opened by Mr. R. W. Sutton.

Institution of Mechanical Engineers (at 1 Birdcage Walk, Westminster, London, S.W 1), at 6.45 p m —"A Review of Exchange Arrangements for Engineering Students (IAESTE)". (Education Group Discussion)

Royal Aeronautical Society (at 4 Hamilton Place, London, W.1), at 7 p.m.—Discussion on "Functional Efficiency of Aircraft".

Wednesday, October 24

University of London (at the Postgraduate Medical School of London, Ducane Road, London, W.12), at 2 p m —Dr. G. Popjak: "Fat Metabolism".*

University of London (at Senate House, London, W C.1), at 5 30 p m.—Dr. J. G. ten Houten (Wageningen): "Recent Advances in Plant Pathological Research in the Netherlands".*

Society of Chemical Industry, Food Group—Nutrition Panel (at 14 Belgrave Square, London, S.W.1), at 6 30 p.m.—Debate on the motion "That in the Opinion of This Panel, Sugar is an Unnecessary Article in the Dietary".

Thursday, October 25

University of London (at Goldsmiths' College, New Cross, London, S E.14), at 5 p.m.—Prof. P. E. Vernon: "Vocational Guidance".* (Third of six lectures of "Recent Pioneer Work in Education". Further Lectures on November 1, 8 and 15.)

Institute of Refrigeration (at the Junior Institution of Engineers, Pepys House, 14 Rochester Row, Westminster, London, S W.1), at 5.30 p m.—Mr. I. F. Eyles. "Problems of Oil Separation in Refrigeration Equipment".

Institution of Electrical Engineers (in conjunction with the British Nuclear Energy Conference, at Savoy Place, London, W C.2), at 5.30 p.m.—Dr L R. Blake: "Conduction and Induction Pumps for Liquid Metals".

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Sir Gavin de Beer, F.R.S.: "Science and the Humanities"* (Rickman Godlee Lecture).

Friday, October 26

Royal Institute of Chemistry (in the Sir William Beveridge Hall, Senate House, University of London, W.C.1), at 3 p.m.—Conference on "The Education and Training of the Chemist".

Royal Society of Medicine, Pædiatrics Section (at 1 Wimpole Street, London, W.1), at 5 p.m —Dr. D. V. Hubble: "Hormonal Influences on Growth" (Presidential Address).

British Psychological Society, Education Section (at the University of London Institute of Education, Malet-Street, London, W.C.1), at 6 p m —Mr. W. A. Belson: "Educational and Psychological Aspects of Audience Research in the B.B C.".

Institution of Mechanical Engineers, Applied Mechanics and Lubrication Groups (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6 p.m —Mr. G. W. K. Ford, Mr. D M Harris and Mr. D. Pantall. "Principles and Applications of Hydrodynamic-Type Gas Bearings".

University of London (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6.30 p.m.—Sir Ronald Nesbitt-Hawes: "Educational Needs of a Technical Age"*. (Third of ten University Extension Lectures on "Technology and Industry". Further lectures on November 2, 9, 16, 23, 30, December 7 and 14.)

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. Harold C. Urey: "Diamonds, Meteorites and the Origin of the Solar System".

Saturday, October 27

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Miss Sylvia Matheson: "Time Off to Dig: an Archæological Excavation in Afghanistan".*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Analytical Chemist (with at least a first- or second-class honours degree in chemistry, good general analytical experience and preferably a special interest in physical methods) to be deputy to the Chief Analyst—The Personnel Officer, The Radiochemical Centre, U.K.A.E.A., White Lion Road, Amersham, Bucks, quoting Ref 649/34 (October 25).

Physical Chemist (with a first- or second-class honours degree in science or equivalent qualifications) in the Technological Irradiation Group of the Isotope Division, to study physical and chemical changes induced by radiation—The Establishment Officer, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting Ref. 658/2 (October 25).

Assistant Lecturer (preferably with special qualifications and interests in mineralogy and petrology) in Geology—The Registrar, University College of North Staffordshire, Keele, Staffs (October 27).

Chief Scientist (with good academic qualifications and experience in the administration of a large laboratory) in the Warwickshire Area —The Divisional Chief Staff Officer, National Coal Board, West Midlands Division, Himley Hall, Dudley, Worcs (October 27).

Chemist or Physicist (with a first- or second-class honours degree, and preferably postgraduate experience or experience with tropical soils) at the Rubber Research Institute of Malaya, Kuala Lumpur, for work on soil problems—The Secretary, London Advisory Committee for Rubber Research (Ceylon and Malaya), Imperial Institute, London, S.W.7 (October 31)

Lecturer in Mathematics—The Secretary of University Court, The University, Glasgow (October 31).

Lecturer (preferably with qualifications in organic chemistry) in Chemistry—The Registrar, Trinity College, Dublin (November 1).

Lecturer in Physics—The Secretary, The University, 38 North Bailey, Durham (November 3).

Chair of Chemistry in the University College of the West Indies—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (November 8)

Associate Professor of Physiology in the Faculty of Rural Science, University of New England, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1 (November 12)

Lecturer in Physics—The Registrar (Room 9, O.R.B.), The University, Reading (November 12).

Lecturers or Assistant Lecturers (2) in Metallurgy—The Registrar, The University, Leeds 2 (November 12).

Chair of Chemistry in Birkbeck College—The Academic Registrar, University of London, Senate House, London, W.C.1 (November 13).

Lecturer or Senior Lecturer in Dental Biochemistry at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, November 15).

Botanist (with a first- or second-class honours degree) in the Pomology Department, to work on taxonomic problems in connexion with the Institute's plant breeding work—The Secretary, Scottish Horticultural Research Institute, Mylnefield, Invergowrie, Dundee (November 17).

Research Assistant and Demonstrator (preferably with a knowledge of cytogenetics) in the Department of Botany—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (November 17).

Senior Lecturer (preferably with qualifications in applied mathematics) in Mathematics, at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, November 17)

Senior Lecturers or Lecturers in Veterinary Anatomy and Veterinary Medicine and Surgery at the University of Khartoum —The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (November 26).

Biochemist for investigational work which will include biochemical, chemical and physical analyses of tobacco from fertilizer, rotation, variety, breeding and other experiments now in progress—The Director, Tobacco Research Board of Rhodesia and Nyasaland, P.O. Box 1909, Salisbury, Southern Rhodesia (November 30).

Lecturer or Assistant Lecturer (with qualifications in biology and experience in teaching) in Education—The Registrar, The University, Leeds 2 (December 1)

Lecturer (with interests in biophysics or biochemistry) in Chemical Microbiology—The Registrar, The University, Liverpool (December 1).

Appointments Officer (with some experience and a sound scientific background) to interview applicants and recruit staff throughout the organization—Dr B. B. Goalby, British Rayon Research Association, Heald Green Laboratories, Wythenshawe, Manchester 22.

Assistant, Grade B, to teach Physics—The Principal, Technical College, Queen Street South, Huddersfield.

Computer (under 40, with a degree in mathematics) in the Lands and Survey Department, Government of Tanganyika, for the computation of surveys of a geodetic, astronomical or cadastral nature, and the keeping of records—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.107/8/06.

Entomologist at the Royal Horticultural Society's Gardens at Wisley, Surrey, for duties principally advisory and instructional, but may include research work on insect pests affecting horticultural plants—The Secretary, Royal Horticultural Society, Vincent Square, London, S.W.1, marking envelope "Confidential".

Field Officer (Agriculture) (aged 30/40, with sound tropical experience of experimental farm management and a knowledge of preparing and recording experiments) in the Tanganyika Government Agricultural Department—The Crown Agents, 4 Millbank, London, S.W.1, quoting M3A/43540/TA.

Geophysicist (preferably with a first- or good second-class honours degree in physics and mathematics and a background of geology) in the Geological Survey Department, for water supply work, mineral exploration and general geological survey—The Director of Geological Survey, P.O. Lobatsi, Bechuanaland Protectorate.

Lecturer in Physical Chemistry—The Registrar, Nottingham and District Technical College, Shakespeare Street, Nottingham.

Metallurgist or Metal Physicist in the Metal Physics Section of the Physics Department, to lead fundamental research work on liquid and solid state problems concerned with the deformation characteristics of both single crystal and polycrystalline metals, with melting and solidification and with time-dependent processes generally—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting "M.P.I.".

Research Assistant (chemistry graduate, preferably with previous analytical experience) for work on special methods of trace analysis—The Head of the Geology Department (Geochemical Prospecting Research Centre), Imperial College, London, S.W.7.

Research Assistant for research in biochemistry in connexion with the central nervous system and mental disease.—The Secretary, Institute of Psychiatry, Maudsley Hospital, Denmark Hill, London, S.E.5.

Research Assistant (with experimental aptitude and a sound knowledge of mathematics to G C.E. advanced level) in the Fluid Dynamics Section of the Physics Department in London, to take part in the investigation of boundary layer flow and other basic problems of fluid mechanics—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting "D.3".

Research Fellow (with a research degree or research experience) in Inorganic Chemistry, to investigate the chemistry of metal complexes of importance to biological systems—Prof. R. S. Nyholm, University College, London, W.C.1.

Research Student (graduate in chemistry or biochemistry) in the Department of Chemistry, to investigate the enzymes requiring pyridoxal as co-enzyme, under the supervision of Mr C. A. Vernon and Prof. R. S. Nyholm—Prof. R. S. Nyholm, University College, Gower Street, London, W.C.1.

Senior Laboratory Technician (male) in the Science Department, to be responsible for the Laboratories (chemistry, physics, biology), the other laboratory staff and all equipment and stock—The Principal, North-West Kent College of Technology, Miskin Road, Dartford, Kent.

Senior Plant Pathologist (with a good honours degree in botany, postgraduate training in plant pathology, and practical experience of investigating the problems arising from widespread attacks of plant diseases) at the West African Cocoa Research Institute, Gold Coast, to take charge of the Pathology Division and to carry out research on virus diseases of cocoa—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.197/200/01.

Senior Research Assistant (with a good honours degree in metallurgy or physics, practical experience, and/or research training) in the Faculty of Applied Science, to work in the field of creep and fatigue of ferrous materials—The Registrar, The University, Nottingham.

Senior Scientific Officer (with an honours degree in mechanical engineering or equivalent) with the Ministry of Fuel and Power, for work at Headquarters, London, in connexion with the conception and development of novel sources and uses of fuel and power, and for the supervision of a coal study laboratory, National Gas Turbine Establishment, Farnborough, Hants—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.655/6A.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

The First Fifty Years: a History of the Kettering and District Naturalists' Society and Field Club. (Published by the Society as a record of its work, 1905–1955.) Pp. 134. (Kettering: Kettering and District Naturalists' Society and Field Club, 1956. Copies obtainable from Mr. R. E. Leaton, Honorary Secretary, 11 Wordsworth Road, 1956.) 10*s*. 6*d*. [138

Building Research Station Digest. No. 89: Sound Insulation of Dwellings—2. Pp. 10. 3*d*. No. 90: Colourless Waterproofing Treatments for Damp Walls. Analysis of Water Encountered in Construction. Pp. 5. 3*d*. (London: H.M. Stationery Office, 1956.) [138

Wye College (University of London). Annual Report of the Department of Hop Research, 1955. Pp. 155. (Wye, Ashford, Kent: Wye College (University of London), 1956.) 5*s*. [138

Forestry Commission. Bulletin No. 26: Adelges Insects of Silver Firs. By Dr. Isaac William Varty. Pp. iv+75+70 plates. (London: H.M. Stationery Office, 1956.) 8*s*. 6*d*. net. [138

Colonial Office. Underground Storage of Grain. By D. W. Hall G. A. Haswell and T. A. Oxley. (Colonial Research Studies, No. 21. Pp. iv+27. (London: H.M. Stationery Office, 1956.) 2*s*. 6*d*. net. [13

Anti-Locust Research Centre. Anti-Locust Bulletin No. 23: Th Anatomy of the Red Locust (*Nomadacris septemfasciata* Serville) By Dr. F. O. Albrecht. Pp. ii+9+97 figs. (London: Anti-Locus Research Centre, 1956.) 5*s*. 6*d*. [14

Ministry of Agriculture, Fisheries and Food. Fishery Investigations Series 2, Vol. 20, No. 4: Phytoplankton and the Herring, Part 5 By D. H. Cushing. Pp. ii+20. (London: H.M. Stationery Office 1956.) 4*s*. net. [14

The Marine Algae of New Zealand. By Prof. V. J. Chapman. (*Journa of the Linnean Society of London*, Vol. 55, No. 360, 20 July 1956. Pp. 333–502+plates 24–50. (London: Linnean Society of London 1956.) 42*s*. [14

A Bibliography of the Art of Turning and Lathe and Machine Too History, with additional reference books and periodical articles whic are of interest in relation to these subjects. Compiled by Sydney George Abell, John Leggat and Warren Greene Ogden, Jr. (Translations by Henry Herbert Kolm.) Pp. vii+89. (Isleworth, Middx S. G. Abell; South Lincoln, Mass.: Warren G. Ogden, Jr., 1956 Published for the Society of Ornamental Turners.) 10*s*. 6*d*.; 1.50 dollars. [23

Guide to Evening Classes in Middlesex, Session 1956–57. Pp. 37. (London: Education Offices, Middlesex County Council, 1956.) [23

Scottish Plant Breeding Station. Annual Report, 1956. Pp. 109. (Pentlandfield, Roslin: Scottish Society for Research in Plant Breeding, 1956.) [23

Other Countries

Canada: Ministère du Nord Canadien et des Ressources Nationales. Division des Parcs Nationaux: Musée National du Canada. Bulletin No. 134: La Littérature Orale en Gaspésie. Par Carmen Roy. Pp. v+389. (Ottawa: Imprimeur de la Reine et Controleur de la Papeterie, 1955.) 3 dollars. [108

Southern Rhodesia. Report of the Director, Geological Survey, for the year 1955. Pp. 12+1 map. (Salisbury: Government Printer, 1956.) [138

United States Department of Agriculture. Technical Bulletin No. 1139: Biological Control of Insect Pests in the Continental United States. By C. P. Clausen. Pp. vi+151. (Washington, D.C.: Government Printing Office, 1956.) 45 cents. [138

Control of Johne's Disease in Cattle, Sheep and Goats. (Project No. 207.) Pp. 202. (Paris: European Productivity Agency of the Organisation for European Economic Co-operation; London: H.M. Stationery Office, 1956.) 12*s*.; 2 dollars; 600 francs. [138

Agricultural Policies in Europe and North America—First Report of the Ministerial Committee for Agriculture and Food, May 1956. Pp. 372. (Paris: Organisation for European Economic Co-operation; London: H.M. Stationery Office, 1956.) 18*s*.; 3 dollars; 900 francs. [138

Board of Grain Commissioners for Canada. Grain Research Laboratory, 1955 Report. Pp. vi+77. (Ottawa: Queen's Printer, 1956.) [148

Nyasaland Protectorate. Annual Report of the Geological Survey Department for the year ended 31st December 1955. Pp. 26. (Zomba: Government Printer, 1956.) 2*s*. 6*d*. [148

Zoology of Iceland. Vol. 1, Part 2. Pp. 206+5 plates Kr. 15. Vol. 1, Part 4. Pp. 36. Kr. 3.25. Vol. 1, Part 6. Pp. 45. Kr. 4 50. Vol 2, Part 2. Pp. 79. Kr. 7.50. Vol. 2, Part 5a. Pp. 82. Kr. 7.50. Vol. 2, Part 5b. Pp. 37. Kr. 3.25. Vol. 2, Part 6. Pp. 2. Kr. 0.15. Vol. 2, Part 7. Pp. 13. Kr. 1.25. Vol. 2, Part 8. Pp. 20. Kr. 1.85. Vol. 2, Part 9. Pp. 26. Kr. 2.75. Vol. 2, Part 10. Pp. 40. Kr. 3.75. Vol. 2, Part 11. Pp. 34. Kr. 3.75. Vol. 2, Part 16. Pp. 6. Kr. 1.75. Vol. 2, Part 17. Pp. 4. Kr. 0.75. Vol. 2, Part 19. Pp. 18. Kr. 1.25. Vol. 2, Part 20a. Pp. 15. Kr. 1.50. Vol. 2, Part 20b. Pp. 10. Kr. 1.50. Vol. 2, Part 21. Pp. 5. Kr. 0.40 Vol. 2, Part 22. Pp. 4. Kr. 0.40. Vol. 2, Part 23. Pp. 16. Kr. 1.50. Vol. 3, Part 24. Pp. 11. Kr 1.00. Vol. 3. Part 25. Pp. 31. Kr. 3. Vol 3, Part 26. Pp. 111. Kr. 10 50. Vol. 3, Part 27. Pp. 26. Kr. 2.75. Vol. 3, Part 28. Pp. 11. Kr 1.25. Vol. 3, Part 29. Pp. 24. Kr. 2.25. Vol. 3, Part 30–31. Pp. 11. Kr. 1 25. Vol. 3, Part 32. Pp. 19. Kr. 1.85. Vol. 3, Part 33. Pp 116. Kr. 10.50. Vol. 3, Part 34. Pp. 24. Kr. 1.50. Vol. 3, Part 35 Pp. 50. Kr. 4.50. Vol. 3, Part 36. Pp. 9. Kr. 0.75. Vol. 3, Part 38. Pp. 5. Kr. 0.40. Vol. 3, Part 39. Pp. 4. Kr. 0.40. Vol. 3. Part 40. Pp. 6. Kr. 0.60. Vol. 3, Part 41. Pp. 4. Kr. 0.40. Vol. 3, Parts 43–44. Pp. 23. Kr. 2.25. Vol. 3, Part 47. Pp. 7. Kr. 0 75, Vol. 3, Part 48a. Pp. 189. Kr. 18. Vol. 3, Parts 49–50. Pp. 176. Kr. 16.50. Vol. 3, Part 51. Pp. 21. Kr. 16.50. Vol. 3, Part 52a. Pp. 29. Kr. 3. Vol. 3, Part 53. Pp. 9, Kr. 0.90. Vol. 3, Part 58. Pp. 13. Kr. 1.50. Vol. 4, Part 59. Pp. 11. Kr. 0.90. Vol. 4, Part 60. Pp. 150. Kr. 14.25. Vol. 4, Part 61. Pp, 54. Kr. 5. Vol. 4, Part 62.. Pp. 5. Kr. 0.75. Vol. 4, Part 63. Pp. 116. Kr. 11. Vol. 4, Part 64. Pp. 15. Kr. 1.50. Vol. 4, Part 65. Pp. 31 Kr. 3. Vol. 4, Part 66b. Pp 3. Kr. 0 15. Vol. 4, Part 67. Pp. 11. Kr. 1.25. Vol. 4, Parts 68–69. Pp. 2. Kr. 0 25. Vol. 4, Part 70. Pp. 67. Kr. 6.50. Vol. 4, Part 71. Pp. 4. Kr. 0.40. Vol. 4, Part 71b. Pp. 25. Kr. 2.75. Vol. 4, Part 72. Pp. 150. Kr. 14 25. Vol. 4, Part 76. Pp. 52. Kr. 5. (Copenhagen: Ejnar Munksgaard, 1937–1955.) [238

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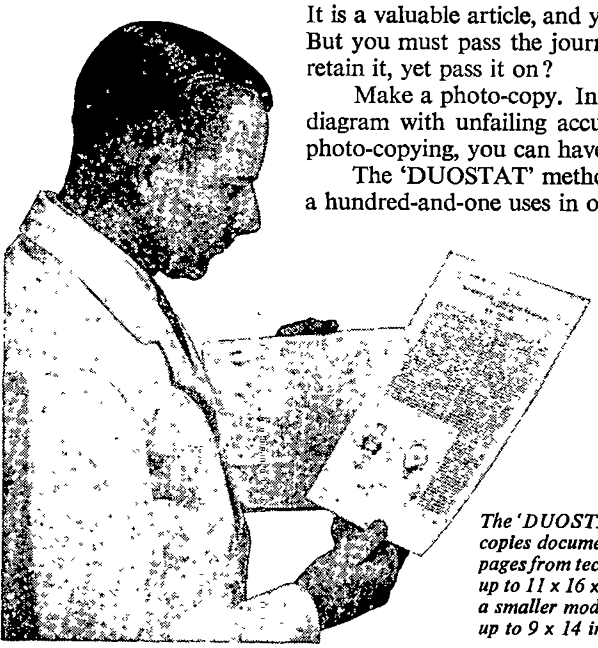

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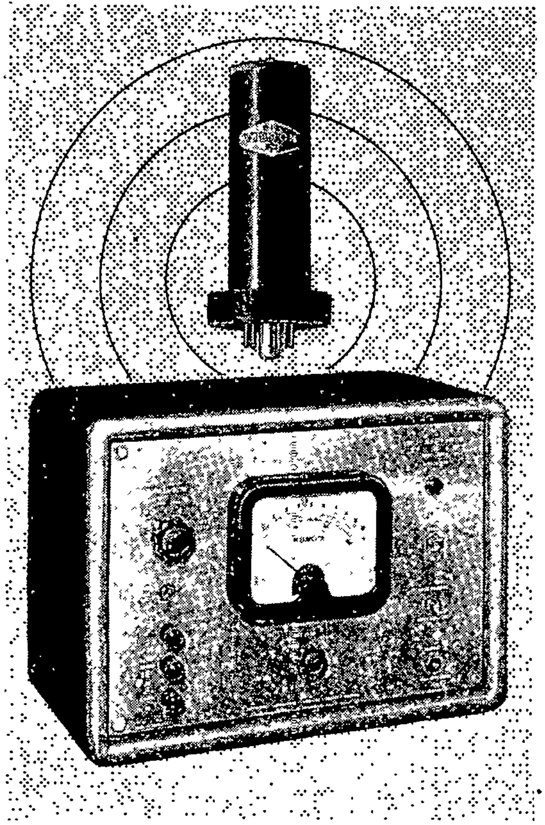

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DEPLOYMENT OF SCIENTIFIC AND TECHNICAL MAN-POWER

JUST over ten years ago, the Barlow Committee presented its report on scientific man-power in Britain, recommending that the nation should double its present output of scientists to give roughly 5,000 newly qualified scientists per annum at the earliest possible moment. The Committee's calculations visualized a demand for some 90,000 scientists by 1955, and it is common knowledge that the universities in actual fact doubled their output of scientists and technologists by 1950, though in 1956 the shortage of scientists and technologists continued unabated and, despite some unemployment among particular categories of scientists, fears as to possible over-production of scientists and engineers have been completely dispelled by events.

The Barlow Committee made no attempt to assess the demand for particular categories of scientists, recognizing that to do so would involve a formidable statistical inquiry which, if attempted, would seriously delay the presentation of its report. The then newly formed Advisory Council for Scientific Policy was charged with the responsibility "to advise the Lord President of the Council in the exercise of his responsibility for the formulation and execution of Government and scientific policy", and has in particular been asked to make recommendations about "the arrangements for securing an adequate flow of scientific man-power to meet the needs both of Government and industry". The Barlow Committee thus wisely left for later attention the determination of the demand for each particular type of scientist, and in December 1950 the Advisory Council appointed a Committee on Scientific Man-power under the chairmanship of Prof. (now Sir Solly) Zuckerman, "to study the future needs of scientific and technological manpower for employment both at home and abroad and to report to the Council from time to time".

A report from this Committee was issued as the Advisory Council's fifth annual report in May 1952, and this was followed last November by a report on the recruitment of scientists and engineers by the engineering industry. The report on scientific and engineering man-power in Great Britain which has now come jointly from the Advisory Council and the Ministry of Labour and National Service (see p. 887 of this issue of *Nature*) embodies the results of a further inquiry by this Committee and of one initiated by the Ministry of Labour which go some way towards meeting this need for further statistical detail. Admittedly there is a certain amount of conjecture and the Committee on Scientific Man-power is probably right in suggesting that it is impossible to predict the rates at which the annual flow of newly qualified people and of the total stock of scientists and engineers in employment are likely to increase, nor does it deny that there are still gaps in our knowledge as to the existing situation. The figures for scientists and engineers in manufacturing industry may still be subject to some margin of error. The exclusion of the small firm, with fewer than a hundred employees, may not seriously affect the present estimate, even although such small firms constitute by far the majority; but it could seriously affect the potential demand if Britain is to maintain its competitive position in the world's markets.

Again, the Committee points out that we have no clear idea of what proportion of science graduates take up work in their respective fields in Great Britain. It also notes that its figures for the employment of scientists in the public sector of the economy, including teaching, reflect current policy, which may well differ from future policy; nor is the assumption sacrosanct that, on the average, the number of scientists and engineers employed in industry will increase in proportion to increases in output. None the less, it believes that this view is better than any other on which it could base its calculations, and, whatever the weaknesses in its interpretation of future needs, the assessment in the present report has the undoubted merit of starting with a more accurate picture of the employment of scientists and engineers to-day.

In place of the estimated demand in 1955 of 90,000 and the 64,000 qualified scientists which were considered as likely to be available on the plans then existing (which provided for some 5,000 additional scientists and technologists annually), the present inquiry by the Ministry of Labour puts the number of scientists and engineers employed in Great Britain early in 1956 as just short of 120,000, of whom some 51,000 are scientists and just short of 69,000 engineers. It is estimated that there are a further 5,000 scientists and 10,000 engineers in fields not covered by the inquiry. While both reports use the term 'qualified scientist' in the same sense, the Barlow report made no estimate for engineering and related technologists, which before the War accounted for about 40 per cent as many engineering students as the pure science schools. It would appear, however, to include those qualified in agricultural or veterinary science, who are excluded from the present report, and also to include those working in the Oversea Civil Service, who are likewise excluded from the present report.

The Committee on Scientific Man-power is well aware of the discrepancies between the present estimate and that of the Barlow Report and other earlier inquiries, and it does not suggest that they are entirely accounted for by the omission from the present inquiry of scientists working abroad. Earlier inquiries, it is suggested, may have made insufficient allowance for women science graduates who are no longer in employment but the greater part of the difference is attributed to science graduates who have taken employment in other fields—for example, men with degrees in physics now classified as engineers, mathematicians now working as actuaries, or men and women with qualifications in science now in employment in which such qualifications are not demanded. The number of qualified engineers revealed by the inquiry, however, agrees reasonably well with other calculations based upon the number of past awards of university degrees and corresponding qualifications in the engineering sciences.

Such discrepancies are of minor importance in relation to the actual number of scientists and engineers working in Great Britain. The major interest of the report is in respect of the assessment of the probable future demand for scientific and engineering man-power. For the first time, a goal is set for the expansion of technological education and of scientific studies at the universities, based on a reasoned estimate of the future demands in Britain for scientists and technologists. Even without taking account of overseas demands, of certain relatively small categories such as agricultural and veterinary scientists and ignoring the problematic but possibly considerable and important demands of the small firms and, presumably, the requirements of management and administration for men qualified in science as well as in administration, the report is emphatic that the output of 10,000 scientists and technologists a year which the universities had achieved in four years from the appearance of the Barlow Report is quite inadequate. To come within sight of meeting the minimum needs of Britain's economy, we must aim at doubling that figure and achieve an annual output of roughly 20,000 by 1970.

In this figure, the Committee does not differentiate between scientists and engineers, and accordingly the estimate is not affected by the transference in employment from one category to another. It has, however, included an allowance of 25 per cent for overseas students, emigration, etc., as well as for the continuance of some measure of shortage. This is wise, for there are certain respects in which Britain's economic strength lies in its ability to provide trained man-power, as, for example, under the Colombo Plan and the Expanded Technical Assistance Programme, or again in relation to nuclear energy. Any realistic appraisal of Britain's needs for trained scientific and technical man-power cannot be limited to those employed in the country itself, but must take some account of overseas requirements and perhaps especially for the under-developed areas.

Before examining the distribution of scientific and technological man-power in relation to the future demand, there is one point to be noted which receives little attention in the present report. The Committee does not doubt that sufficient talented boys and girls will be available, if they choose to take up careers in science and engineering, to be trained at the rates which it recommends should now form the basis of national policy. It is not for the Committee, but for the University Grants Committee and the various education departments to consider how these probable demands for graduates in pure and applied science are to be met; but it will be noted that the Committee recommends that, provided there is no lowering of standards, the universities should attempt to provide as much as possible of the necessary expansion. In its view, there is little risk that the greatest possible combined efforts of the universities and technical colleges will result in any over-production of professional scientists and engineers during the 1960's.

The nation's demand for trained man-power depends in part on the way in which that man-power is used. That is to say, it depends on that man-power being employed in occupations in which scientific or technological training can be put to effective and efficient use. The efficient use of trained man-power requires not only the provision of necessary equipment and appropriate conditions of work but equally the provision of the appropriate ancillary technicians and facilities. If the research worker, for example, is not provided with the appropriate assistance, his time may be wasted on occupations for which much less highly trained and skilled persons could be used and which he himself performs less efficiently.

We cannot, in fact, separate consideration of the probable demand for scientific and technological man-power from that of the demand for technicians and a corollary of the present survey is, in the first place, some attempt to assess the efficiency with which scientific man-power in Britain is at present being used. It might well be found that if we used our existing resources of highly trained man-power more efficiently, the existing shortage would be less acute; and that Britain's needs could be met by some less expensive means than doubling the present number of scientists and engineers. Changes such as those which have recently been discussed in connexion with what is commonly described as automation have pointed in this direction, and the disappearing differential in salary or wage between the technician and scientist or technologist can have consequences that make it essential for closer consideration to be given to this aspect of our needs for trained man-power.

The expansion of technical education in Britain cannot be planned reasonably without some estimate of the nation's need for technicians, and here again it cannot be too strongly emphasized that any attempt to force the expansion of the technical colleges to provide professional engineers and technologists which hinders their primary and essential function of providing technicians is detrimental to the nation's interests, and may well involve waste of highly trained man-power. The Committee on Scientific Man-power does not, however, consider the question whether we have sufficient talent to provide simultaneously this doubled output of scientists and engineers, and also the output of technicians necessary to sustain that number efficiently. The present output of technicians might well require to be trebled or more, and there was no suggestion in the recent White Paper on Technical Education that the implications are appreciated by the Minister.

The picture of the present distribution of scientists and engineers in Great Britain which is given in this report has other implications in regard to the expansion of the present output. The report assumes a 100 per cent increase in the requirements of the universities over the next ten years; but its assessment of requirements for teaching in secondary schools makes no provision for any further concentration on scientific subjects, or for any improvement in existing staffing ratios. It suggests that an addi tional 4,000 science graduates would be a reasonable allowance for the latter, and this could well have an important bearing on attracting the increased number of boys and girls to take up careers in science and technology, as well as in raising standards of training.

The bearing of the quality of teaching on the supply of graduates in science and engineering appears to have received relatively little attention, and the wide variation in the proportion of those who take up teaching—in schools, colleges and universities —between different categories of scientists and engineers may not be without significance. Whereas only 5,643 out of 20,692 chemists and 4,751 out of 10,484 physicists are to be found in education, 442 out of 894 geologists, 3,381 out of 4,838 biologists and 9,302 out of 11,482 mathematicians are so occupied. Out of a grand total of 68,456 engineers, however, only 2,429 are teaching, and of these 1,712 (out of 19,533) are electrical engineers. Even when all due allowance is made for the concentration of those teaching engineering, for example, in the universities where the numerical requirements are much smaller than in the schools, and for the possibility of part-time seconding of staff from industry for teaching in the technical colleges, there may be some room for inquiry here if we are to overcome the reluctance of some parents and school authorities to encourage their pupils to enter on scientific or technical careers.

Here, of course, there operates too the differential factor in regard to salaries, and it should not be assumed too readily that the expansion recommended in this report will necessarily provide Britain with the distribution of trained man-power that is desirable unless appropriate action is taken to encourage the desired distribution.

The report estimates that, of 48,829 qualified scientists employed in manufacturing industry, 21,734 are engaged in research and development; while of 17,078 employed in the nationalized industries, only 2,526 are so engaged, of whom 1,706 are with the Atomic Energy Authority. Of the 13,850 employed by the central government, 2,350 are employed by the research departments, that is to say, the Department of Scientific and Industrial Research, the Agricultural Research Council, the Medical Research Council and the Nature Conservancy; but of the 7,600 employed by the defence departments, a number will obviously also be engaged on research. There is no indication of what proportion of the 3,250 scientists and engineers employed by the universities are engaged on research; of the total of 71,122 scientists and engineers employed in industry, only 1,397 are employed by the research associations.

There thus appears to be no firm basis for the belief that the research associations take an undue proportion of Britain's scientific and technical man-power. Nor does the report substantiate the view that, so far as scientists and engineers are concerned, an excessive proportion of trained man-power is employed on defence. Moreover, when we make an appropriate allowance for those of the 21,734 scientists and engineers engaged in research and development work in industry who are occupied on work that is development or merely the systematic exploration of a known field by recognized techniques rather than fundamental inquiry, it is clear that the proportion of men trained in fundamental investigation by industry annually is relatively small compared with those trained in the scientific outlook. This also might well bear on the character of the training given in the universities and colleges of technology, and any expansion of the order recommended in this report can scarcely fail to take account of the possibility that methods of training and particularly of the practice of teaching research may merit re-examination. Otherwise there could well be waste of man-power in teaching as well as ineffective teaching.

Some of these fears find expression in the report on the recruitment of scientists and engineers by the engineering industry, and although the Committee on Scientific Man-power does not here revert to them, it may be taken that they will not be overlooked. If we are to attract this higher proportion of Britain's youthful talent into the channels that this report recommends, we must take every care to see that the training given is appropriate to its purpose, and that the talent so trained is wisely and efficiently used and, so far as possible, where it will best serve the national need. The report establishes a reasonable case for the projected expansion of technological education in Britain and for the expansion which the universities are expected shortly to announce for the forthcoming quinquennium. It can scarcely fail to raise fresh doubts, however, as to the adequacy and even the soundness of the Minister of Education's plans for the expansion of technical education, or as to the extent to which the Government has really grasped the implications of the present situation and what is involved in the efficient use of trained man-power. At least, however, the report provides the starting point for a fresh assessment of the way in which the expansion of technological and technical education should be planned and executed, and for a further attempt to convince the Government of the dependence of the effective use of Britain's resources of scientific and technical man-power on those accessories such as the National Science Centre, the National Reference Library of Science and Technology and the National Science Lending Library, which the Advisory Council on Scientific Policy has hitherto ineffectively urged upon it.

BRITISH GRADUATES AND THEIR EMPLOYMENT

Graduate Employment

A Sample Survey. Pp. xiv+300. (London: Political and Economic Planning, and George Allen and Unwin, Ltd., 1956.) 30*s*.

STATISTICS of the output of coal, one of the few natural resources of Britain, would have little value if unassociated with figures of distribution and demand. The contrast between the knowledge we have about this vital national asset and our ignorance about the fate of the thousands of men and women who graduate year after year from British universities, but who are also in very short supply, is the point of departure of an inquiry by Political and Economic Planning into graduate employment. This sets out "to discover the jobs to which graduates leaving universities in Great Britain are going and the influences that determine their choice of employment; and to relate this information to such factors as age, sex, parental occupation, university attended, course taken and degree obtained".

The desirability of information of this kind has been recognized ever since 1946, when the Barlow Committee's Report on Scientific Man-power sowed the seeds for what has become a widespread concern about Britain's chronic shortage of scientists and engineers; about the deleterious effect of the shortage on our national position; about the scarcity of teachers of science and mathematics; and about the failure of our educational system to weave into the pattern of general culture an appreciation of scientific matters, and more important, an awareness of the incredible speed with which their influence over human affairs is growing.

The difficulty has always been, and still remains, that it is far simpler to find out what human beings do with the things they produce, than to discover how they dispose of themselves. We know that there is a shortage of scientific man-power. But we have few precise ideas about the present stock and distribution of scientists and engineers in employment as such; about the extent of the shortage in different fields of employment; about its probable duration in the light of steps that have been taken to overcome present difficulties; and about the fate of our science and engineering graduates. Until the recent inquiry instigated by the Ministry of Labour and National Service [see this issue of *Nature*, p. 887], we have had to rely on actuarial analyses of the numbers of graduates turned out in past years to get any idea about the first of these questions. So far as the last is concerned, we have had to accept the fact that it would be extremely difficult for the universities to keep a record of the subsequent careers of the men and women who graduate from them.

Just how difficult emerges from the P.E.P. inquiry, which began in 1953 under the sponsorship of a Joint Committee of the Department of Scientific and Industrial Research and the Medical Research Council, with the aid of U.S. Counterpart Funds. Because of the immense labour involved, the study was confined to a sample of one in two of the male graduates of 1950 in arts, science and technology from English, Welsh and Scottish Universities. Nearly seven thousand questionnaires were sent out; replies were received from about two in every three. For all practical purposes, therefore, this means that P.E.P. was unable to find out anything about the whereabouts of one-third of all graduates as little as four years after they had left their universities. Of the men who replied, nearly two-thirds came from grammar schools or their Scottish equivalents. An even higher proportion received some form of public financial help when at the universities. Just over half read for an arts degree; 28 per cent for a science degree; and 20 per cent for a technology degree. On graduating, the technologists tended to go straight into employment, whereas large numbers of arts men and scientists tended to stay on for further study. More than a third of those who obtained first-class degrees stayed on for at least two years; and—most interesting—half the sample started their university careers without any clear idea about what they were going to do afterwards; while two in three held that the decisions that they finally took about their future work were reached entirely independently, without outside influence. In the event, 30 per cent went into industry and 23 per cent into teaching.

These are only a few of the interesting facts that emerge from the P.E.P. study. But, as the volume itself points out, it is necessary to remember that the conclusions reached relate only to a short period in the history of one batch of graduates, and to a year, 1950, which must have included many men who had been on active service during the Second World War. The survey is, therefore, a cross-section of a particular piece of history. Because of the immense labour involved, it also had to be an incomplete cross-section. For example, the women graduates of 1950 were not included. On the other hand, the value of the work is greater than just the straightforward, even if limited, facts that it discloses. For example, it throws up this critical question. If half the people going to the universities of Britain have no clear idea about what they wish to do afterwards, and believe they are uninfluenced in their decisions as to which posts to take up after graduation, what is the value of all the propaganda that has been going on about Britain's need for more scientists and engineers? Or does its apparent ineffectiveness relate only to people who graduated in 1950? Equally important, how quickly will the market mechanism, in the form of higher salaries paid to engineers and scientists, operate against the social conventions which in some numerically small but influential corners have for so long placed a higher prestige value on a university education in the arts? But perhaps the most important issue which P.E.P.'s valuable study underlines is the need for regular, even if not detailed, returns about graduate employment in Britain. There can be little doubt that if it were possible to arrange for a steady flow of such information, the task of those who are concerned with ministering to the growth of our universities, technical and other training colleges and schools, would be greatly eased.

S. ZUCKERMAN

INTERNATIONAL ENCYCLOPÆDIA OF UNIFIED SCIENCE

International Encyclopedia of Unified Science
Edited by Otto Neurath, Rudolf Carnap and Charles Morris. (Combined edition.) Vol. 1, Part 1 (Nos. 1–5): Pp. ix+1–340. Vol. 1, Part 2 (Nos. 6–10): Pp. iv+341–760. (Chicago, Ill.: University of Chicago Press; London: Cambridge University Press, 1955.) 41*s*. 6*d*. net each part.

COMMENCED in 1938, the introductory material of the "International Encyclopedia of Unified Science" has been published at intervals by the University of Chicago and is now issued in a combined edition as Vol. 1, which is divided into two considerable parts. Each of the two parts contains five sections of seventy or eighty pages each. The idea from which the work developed was that of Otto Neurath, of Isotype fame, who conceived a scheme which should continue the work of the French "Encyclopédie" of the eighteenth century. Unified science became historically the subject of this "Encyclopedia" as a result of the efforts of the Unity of Science movement, which includes scientists and persons interested in science who are conscious of the importance of a universal scientific attitude.

The new version of the idea of unified science is created by the confluence of several intellectual currents. Empirical work of scientists was often antagonistic to the logical constructions of *a priori* rationalism bred by philosophico-religious systems; therefore 'empiricalization' and 'logicalization' were considered mostly to be in opposition: the two have now become synthesized for the first time in history. Certain empiricists began to appreciate logical analysis and construction as universal scientific aids; other thinkers, especially interested in the historical importance of scientific imagination, stress their opposition to all kinds of *a priori* reasoning and demand empirical tests for all their theories. The terms 'logical empiricism' and 'empirical rationalism' express very well this new type of synthesis. The terms 'unified science' and 'unity of science' are becoming more and more widespread in usage. The annual congresses devoted to the unity of science held first at Charles University in Prague in 1934 were disturbed by the Second World War, and a number of the leading members have since died, but the movement continues. Physicists are familiar with co-operation in the field of physics, and biologists in the field of biology: the movement for unified science stresses the need for further co-operation—physicists with biologists, biologists with sociologists, and other specialists with logicians and mathematicians.

The "International Encyclopedia of Unified Science" endeavours to show how various scientific activities such as observation, experiment and reasoning can be synthesized and how all these together help to evolve unified science. The busy research worker may not find himself in sympathy with some of the painstaking accounts of the logical and philosophical foundations on which his subject rests; but, nonetheless, they are of prime importance. The flowing tide of nineteenth-century science was too hurried to regard the work of J. S. Mill.

The editors of the present works have been fortunate in the choice of authors. Otto Neurath opens the introductory monograph with an essay on unified science as encyclopædic integration; John Dewey discusses unity of science as a social problem; Rudolf Carnap analyses the logical foundations of the unity of science; and Charles W. Morris, in his essay on empiricism, attempts to formulate a general framework for the encyclopædic enterprise as a whole. There are two short papers: by Niels Bohr on analysis and synthesis in science, and by Bertrand Russell on the importance of logical form.

In the second section, Charles W. Morris outlines the field of the theory of signs, showing the place of this within the unity of science movement. He also examines in turn the main sub-divisions of semiotic (theory of signs), syntactics, semantics and pragmatics. This is followed by Rudolf Carnap's study of the foundations of logic and mathematics, which considers the nature and interpretation of a calculus and calculi and their application in empirical science.

Leonard Bloomfield's monograph is concerned with the nature of linguistics as a science, the devices of natural languages used to attain precision, the special characteristics of the language of science, the place of linguistics in the scheme of science, and the relation of linguistics to logic and mathematics. Victor F. Lenzen deals with the various procedures of empirical science, techniques of observation and the various procedures of systematization. Part 2 has five sections: the principles of the theory of probability, by Ernest Nagel; the foundations of physics, by Philipp Frank; cosmology, by E. Finlay-Freundlich; the foundations of biology, by Felix Mainx; and finally, the conceptual framework of psychology, by Egon Brunswik.

The seven hundred and sixty pages of the two parts of Vol. 1 are not all easy reading; but it would be difficult to think of a more convenient and concentrated account of what must be regarded as a necessary foundation for any superstructure of specialized scientific knowledge, system of techniques or principles. Much of the teaching of science to-day gives us an impression of the branches and leaves of the tree of science but little of its trunk and roots.

W. L. SUMNER

LUDWIG MOND

The Life of Ludwig Mond

By J. M. Cohen. Pp. xv+295+17 plates. (London: Methuen and Co., Ltd., 1956.) 22*s*. 6*d*. net.

RARELY does the biography of a father follow that of his son by well-nigh a generation, and when that happens it is not too easy to avoid a certain amount of repetition. Mr. J. M. Cohen's book differs profoundly from Hector Bolitho's life of "Alfred Mond: First Baron Melchett" (1933), though in narrative and anecdote he has drawn to some extent on the earlier part of Bolitho's book, particularly in respect of Ludwig Mond's early days in the chemical industry, the venture at Winnington and the early association of his two sons with Winnington. Only at such points do the two books touch, however; there is the stamp of Mr. Cohen's own personality on the successive chapters in which he depicts the education of a scientist, his apprenticeship in the infant chemical industry, the conflict of interests which finally issued in Mond's settling in Britain and not in Holland and the founding and growth of the Winnington works. There emerges a vivid and fascinating picture of a great industrialist which can be read with as much ease and pleasure by the layman as by the technologist.

It is a portrait which is highly pertinent for these days when men like Sir Henry Tizard are wondering whether British manufacturers are becoming less
enterprising. Here is told [redacted] in which enterprise
is writ large and in which ths often sedulously
fostered about those capital as well as
brains and judgment ufacturing ventures
are dealt some shrew There stands out the
determination and ce of Ludwig Mond,
his versatility and nius, his devotion to
research and his for conservation and
the recovery or waste, as well as some-
thing of his id al relations, in which he
was a pioneer vine contributes a series
of technical ich give the background
of Mond's vements and review the
decline an lanc soda system, and also
a postscr very briefly, the story of
the Mon the chemical industry to
its term mpts a brief appreciation of
his ach

Yet lity of 'the old doctor', as he
was on, emerges vividly in these

pages and his achievements are mentioned, the book does not really measure his technological stature. In that respect, indeed, it falls short of Mr. J. I. Watts's admirable obituary notice in the *Transactions of the Chemical Society*. Nowhere is the reader given the clear appraisal of Mond's outstanding achievements that the chemist might expect and the layman needs. Nor does the book display at all adequately the vigour and range of Mond's own thought and philosophy, much of which is highly relevant to our own times.

This is the more unfortunate in that the book contains no list of Mond's own writings or addresses, nor any list of his nearly fifty British patent specifications. Nor is there more than incidental reference to such important contributions as the founding and development of the Society of Chemical Industry, the steady support he gave to the improvement of the Royal Society's catalogue of scientific papers and afterwards to the cataloguing of international scientific literature, and the endowment of the Davy–Faraday Laboratory at the Royal Institution, London. Failing to relate Mond's outlook and thought to our current problems, the book lacks something of the inspiration it could well have had for the younger generation, and the absence of references detracts a little from its value as a contribution to industrial history.

For all its merits, the book is not the book that H. E. Armstrong would have given us had he lived to complete the task to which he set his hand. Into whatever by-ways Armstrong might have strayed, we may be sure that he would have fully displayed the vigour of his friend's mind and the relevance to our times, for example, of Mond's ideas on the training of the scientist when he pressed the claims of a thorough grounding in theoretical science, even to the extent of disputing the value of teaching applied science, or again of his ideas as to the possibility of a science of invention. It is in such addresses as those which Mond gave at the opening of the Schorlemmer Laboratory in Manchester or as president of the Society of Chemical Industry, when he argued that the steady methodical investigation of natural phenomena is the father of industrial progress, that we find the industrial philosophy which was one of Mond's most stimulating characteristics. The achievements are displayed in Mr. Cohen's book, but something more is wanted to bring the reader easily into contact with the vigour and stimulus of Mond's thought.

R. Brightman

FRENCH AT[illegible]F THE FUNGI

Nouvel Atlas des C[illegible]s

Par Henri Romagnes[illegible] (Publié sous les auspices de la Société[illegible]de France.) Pp. 96+79 planches. (P[illegible] 1956.) 5550 francs.

It is so seldom nowada[illegible]ver is able to give whole-hearted p[illegible]paper, type and binding of a scientific[illegible]ems proper to make immediate comm[illegible]over, the author, Henri Romagnesi, [illegible]most, as he is one of the most activ[illegible] modern school of French mycologist[illegible]

The present volume is th[illegible]d the plates figure species of *Lact*[illegible]*iota*, *Psalliota*, *Amanita* and all genera with coloured spores. The second volume, which is to be published at the end of the year, will include agarics with white spores, the remainder of the Basidiomycetes, morels and other large Discomycetes. The final volume will be of rarer species and those of which no good figure has been published, and, presumably, will not be long delayed.

The introduction, eighty pages in length, gives a general summary of the nature of fungi and their classification; structure; physiology; reproduction; poisonous fungi; edible fungi (with recipes for cooking); and principal genera and sub-genera. Although this is a popular book, it is not written exclusively for beginners but is a thoroughly up-to-date, though concise, account of the matters treated therein, with a view to a wider appeal. Certainly, many who profess and call themselves mycologists will find much for thought and, indeed, not a little to learn here. (It is news to me that the cultivation of mushrooms "en cousine" is still sometimes practised in hotels in Britain.) There are twenty-two text-figures, several of them detailed and occupying a whole page.

As is perhaps to be expected in a French work, a good deal of space is devoted to classification. There is a general outline in the first chapter, and the final thirty-four pages provide details. A series of dichotomous keys gives a clear idea of the macroscopic characters useful in differentiating between different genera and sub-genera of the Agaricales. The remaining Basidiomycetes are treated in somewhat less detail. The families of Discomycetes and Tuberales are also keyed.

The seventy-nine plates depict a little more than a hundred species and varieties. They are reproduced lithographically in eight to twelve colours from originals in the collections of the French Mycological Society, and most of them are by Dr. J. Chenantais. Unfortunately, the drawings which he bequeathed to the Society did not include all the species needed for this work, so those of others were added, mostly by Col. A. Lacaze. In my view, those of Chenantais are among the best that have ever been published, rivalling in beauty and in exactness those of E. Boudier's "Icones Mycologicae", though without microscopic details.

A page of description accompanies each plate. The descriptions are clear and include all the microscopic details necessary for exact and intelligent identification. The notes on habitats are full and often contain interesting facts such as only one with Romagnesi's vast experience as a collector could supply: those on "importance pratique" are concerned solely with gastronomy.

Where a species is likely to be confused with one or more others, the contrasting characters are listed in parallel columns. Only experience shows what strange confusions sometimes arise: some of those given I have not encountered. It is only by contrasting the characters one by one that misconceptions can be straightened out and confidence gained.

Most of the fungi figured are common ones, in Britain as well as in France. There are, however, a number of varieties, particularly of poisonous species, which are rarer—some of these with no previously published illustrations.

Everyone connected with the publication of this excellent work is to be warmly congratulated.

John Ramsbottom

reasonable table of p–T values fitting the measured points with the least deviation: smoothness is ensured because the relations are analytical; the table is reasonable since the derivatives conform to those as dictated by the thermodynamical behaviour of helium-4 (cf. Fig. 2 and accompanying discussion). The equations are fitted to two types of helium-4 vapour-pressure measurements, those obtained with gas thermometers (absolute) and others used as interpolation devices (relative).

Between 1·5° K. and 4·0° K. the only existing gas-thermometer measurements independent of low-temperature (below 21° K.) fixed points are obtained from ten isotherms of gaseous helium-3 and helium-4 measured by Keller[8]. In these experiments, temperatures obtained by extrapolating the isotherm data to zero density were used for calibrating a helium-4 vapour-pressure thermometer placed in the gas sample. Amounts of gas contained in the sample pipette were determined at room temperature. Above 4·2° K., vapour-pressure data have been refined by Berman and Swenson[10], who also employed a helium-4 vapour-pressure bulb in contact with a helium-4 gas thermometer. Amounts of gas in the thermometer were generally determined at the normal hydrogen boiling point; but one series of results was referred to a temperature near the helium boiling point. These two sets of gas thermometer measurements form the basis of T_{55E}. Although the temperature ranges of the two experiments do not overlap, Clement has found that the data join smoothly according to equation (1) when 20·375° K. is taken as the boiling point of hydrogen[11]. Clement has re-analysed the Berman and Swenson points, including Swenson's recalculation[12] of the data using the second virial coefficients of helium-4 as computed by Kilpatrick *et al.*[13], and finds that equation (1) fits the data above 4·2° K. with a mean deviation of 0·0020° K. At the same time, the points of Keller are fitted by equations (1) and (2) with a mean deviation of 0·0013° K. (one point having seven times this deviation and showing complete inconsistency with magnetic measurements has been omitted from this analysis and was omitted by Clement in determining the scale).

Since the gas thermometry points are not as closely spaced in temperature as would be desired, Clement has utilized two types of measurements as interpolation devices: (1) observations of the resistance of carbon resistors vs. vapour-pressure by Clement and co-workers[14] and by Corak *et al.*[7]; and (2) data of the magnetic susceptibility of paramagnetic salts as a function of vapour-pressure by Erickson and Roberts[6] and by Ambler and Hudson[15]. T_{55E} agrees with all these measurements within experimental error when the data are normalized to the gas-thermometer points. There is no theoretical basis for the resistance-temperature relation for carbon resistance-thermometers. However, the temperature-scale measurements of Corak *et al.* are calculated with reference to the dependence on temperature of the atomic heats of the noble metals, for which there is a theoretical foundation. Hence these data assume a more significant role in that when the points below 4° K. are normalized to Keller's isotherm measurements, the points above 4° K. can be considered to have validity similar to gas-thermometer data. When treated in this manner, the points above 4° K. agree exceedingly well with the Berman and Swenson points. Whereas most of the vapour-pressure data used in determining T_{55E} was obtained from apparatus using a small amount of liquid in a closed tube, it is noteworthy that measurements of this type by Corak *et al.* are in agreement with results they obtained using the bath pressure with a correction for hydrostatic head.

Scale T_{L55}

The second scale is proposed by H. van Dijk and M. Durieux, of the Kamerlingh-Onnes Laboratory, Leyden. This scale also has not as yet been published, but was presented at the Paris Conference. Copies of the scale, along with a brief description of the method used in obtaining it, have been circulated to a number of interested persons. This scale is designated as T_{L55}.

Scale T_{L55} below 4·167° K. is derived from a vapour-pressure equation which is thermodynamic in form:

$$\ln p_{mm} = i_0 + \frac{5}{2}\ln T - \frac{L_0}{RT} - \frac{1}{RT}\int_0 S_l\,\mathrm{d}T + \frac{1}{RT}\int_0^p v\ \mathrm{d}p + \ln\left(1 + \frac{B}{v_g}\right) - \frac{2B}{v_g} \quad (3)$$

where i_0 is the chemical constant, R the gas constant, L_0 the latent heat of vaporization at 0° K., S_l the liquid entropy, v_l the liquid volume, v_g the vapour volume, and B the second virial coefficient of the gas. Between 4·167° K. and 5·2° K., van Dijk and Durieux use a slight modification of the original Berman and Swenson vapour-pressure equation.

The thermodynamic form of equation (3) is a desirable feature and endows the scale derived from the equation with an aura of respectability; I must, however, caution that the form by itself does not *ensure* a close approach to the thermodynamic temperature scale; that the accuracy of any scale calculated from the equation still depends upon the reliability of the experimental data used for the calculations. We note that the p–T relation of equation (3) depends explicitly on experimental thermal and state data and, as I shall show below, only indirectly (yet importantly) on vapour-pressure measurements. An examination of the accuracy to which the several terms of equation (3) are known reveals the following: i_0 can be accurately determined from statistical mechanics; with T the independent variable, 5/2 ln T gives no trouble; the term involving v_l makes a small contribution to ln p with v_l sufficiently well known; the terms in L_0, S_l and the gas-correction factors are large, and I consider it necessary to inquire further whether the quantities entering into them have been determined with sufficient accuracy to establish a reliable p–T relation.

L_0 has not been directly determined by experiment. To evaluate L_0, van Dijk and Durieux solve equation (3) for L_0 and, using some provisional p–T relation along with the other necessary experimental quantities, obtain L_0 at a number of temperatures between 1·5° K. and 4·2° K. A constant value of L_0 would be expected if all the data were exact. Since this constancy was not achieved, the assumption was made that the gas correction terms are accurately known, so that the entropy term as derived from specific heat data contributes the only remaining uncertainty. (For a discussion of possible uncertainties in the gas correction term, see below.) Then another thermodynamic representation for L_0 is used, namely :

$$L_0 = L_T - \frac{5}{2}RT + \int_0^T C_l \mathrm{d}T + \int_0^p v_l \mathrm{d}p - \frac{RT}{v_g}\left(B - T\frac{\mathrm{d}B}{\mathrm{d}T}\right) \qquad (4)$$

where L_T are the experimentally observed heats of vaporization[16,17] and C_l is the liquid heat capacity. In equations (3) and (4) the terms involving the heat capacity occur in the solutions for L_0 with opposite signs. When L_0's from the two equations are plotted against temperature, deviations from constant L_0 will therefore be of opposite signs in regions where the errors in C_l are dominant. From this plot between 1·5° K. and 2·2° K., van Dijk and Durieux obtain an average L_0 of 59·5 joules/mole ; they accept this value of L_0 and ascribe to it an uncertainty of 0·1 joule/mole. At higher temperatures the two evaluations of L_0 diverge from this value ; van Dijk and Durieux then adjust the specific heat data between 2·5° K. and 4·2° K. so that the two coincide in this range. The adjustment of C_l is well within the experimental error of the heat capacity measurements. In making this analysis the Keesom and Schmidt[18] value of the helium-4 boiling point, judged to be accurate within 0·002° K., was obtained.

In deriving T_{L55}, van Dijk and Durieux have used for C_l "the best Leiden values". These we presume to be gathered from the 1932 data of Keesom and Clusius[19] (1·3°–4·2° K.), the 1932 data of Keesom and Miss Keesom[20] (1·3°–3·0° K.), the 1935 data of Keesom and Miss Keesom[21] (1·22°–2·28° K.), and the recent work of Kramers, Wasscher and Gorter[22] (0·25°–1·85° K.). Apparently the measurements of Hercus and Wilks[23] between 1·10° and 2·05° K. have been passed over. These results are about 10 per cent higher than those of Kramers, Wasscher and Gorter, and to my knowledge no satisfactory explanation has been offered for the discrepancy. Incidentally, use of the Hercus and Wilks data in the above analysis for L_0 would yield a value higher than 59·5 joules/mole by more than the 0·1 joule/mole uncertainty ascribed to this number. Above 2·3° K. the 1932 C_l data are the latest available. The authors[19,20] consider their results in this region to be accurate to within 3 per cent. We conclude that the entropy values derived from these C_l data are at least uncertain by 3 per cent.

To account for the effect of gas imperfection, van Dijk and Durieux use values of B calculated by Kilpatrick, Keller and Hammel[13]. These calculations were made to fit the measured low-temperature helium-4 B values[8] ; the mean deviation of the five observed B values from the calculated ones is about 1 per cent. Since the calculations serve essentially to give a smoothing function for the measurements, they can tell us nothing about the absolute accuracy of the results. Thus we feel that the calculations cannot give B as a function of T with an uncertainty of less than 1 per cent.

Let us now examine the consequences of the above discussion of the possible errors in the quantities entering the tabulation of T_{L55}. In Table 1 is listed an uncertainty, ΔT, in temperatures calculated from equation (3) when we consider the possible uncertainty in the values of L_0, S_l and B separately. We believe that the limits of error cited are all conservative estimates.

Table 1

T° K.	ΔT due to : ± 0·15 per cent in L_0	± 3 per cent in S_l or C_l	± 1 per cent in B
2·15	0·0020	0·0010	0·0002
3·50	0·0025	0·0125	0·0017
4·00	0·0027	0·0180	0·0030

This table is presented not to imply that T_{L55} is in error by as much as 0·018° K. but to illustrate the compliancy available for fitting the data. As an example, let us assume $L_0 = 59·5$ joule/mole and B correctly known ; then we insert in equation (3) the Schmidt–Keesom helium boiling point temperature, 4·2160° K., and vary C_l to obtain the chosen L_0. Next let us change the values of L_0 and B by the respective percentages indicated in Table 1 so as to produce a maximum deviation (about 0·036° K.) from 4·2160° K. when we solve equation (3) for T. We may then return to the starting temperature by making an additional change in S_l of only about 1 per cent. With these altered values we can also calculate L_T in agreement with experiment. Using T_{L55} we can apply the same procedure in the region where the error in S_l is the dominant one, above about 2·3° K. For example, at 3·50° K. and 4·00° K. we find the corresponding maximum deviations from T_{L55} to be 0·0042° K. and 0·0057° K., when we effect a 1 per cent change in B and a 0·15 per cent change in L_0. Hence we see that above 2·3° K. we can arrive at T_{L55} by simultaneous corrections to L_0, B and S_l, whereas van Dijk and Durieux correct only S_l. In other words, it is admitted at the outset that the experimental data are not sufficiently accurate to give a reliable temperature scale consistent with thermodynamics. However, it is hoped that the data can be juggled within experimental error to give such a scale. I wish to emphasize that since the three quantities L_0, B and S_l are all to some extent uncertain, the decision to alter only the most uncertain term is indeed arbitrary and offers by no means a unique approach. Conversely, if we are trying to construct a temperature scale from these quantities we have no way of knowing *a priori* how much each of the three quantities should be corrected, and we can end up with any number of scales consistent with equation (3) within the limits described above, unless we make use of suitable additional information such as experimental vapour-pressure data. Finally, below 2·3° K. the error in L_0 becomes dominant rather than that in S_l. However, we have already seen that the value of L_0 chosen by van Dijk and Durieux is in itself strongly dependent upon the choice of specific heat data in this region.

Numerical Comparison of T_{L55} and T_{55E}

A graphical comparison of the two proposed scales is shown in Fig. 1, where $T_{L55}–T_{55E}$ is plotted against T. It is noticeable that below 4·2° K. the two scales differ by at most 0·0036° K. ; but I am struck by the fact that above 4·2° K. the difference increases to about 0·012° K. at 5·2° K., even though in this region both scales are based on the Berman and Swenson[10] data. Van Dijk and Durieux have bodily shifted the original Berman and Swenson equation by about 0·001° K. (in the direction of better agreement with T_{55E}) in order to make it join with the thermodynamic calculation at 4·167° K. However,

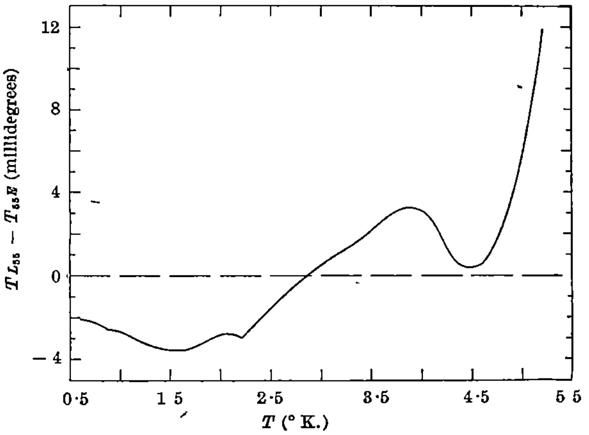

Fig. 1. Deviations of scale T_{55E} from scale T_{L55} in millidegrees plotted against the temperature in degrees Kelvin

serious difficulties are encountered in making this junction, as shown in Fig. 2, where the plots of $-\left[\frac{5}{2}T + \mathrm{d}\ln p/\mathrm{d}\left(\frac{1}{T}\right)\right]$ vs. T for the two scales are compared[24]. Since we know of no anomaly occurring above the λ-point for helium-4, we expect the curve to be smooth above this temperature. The sharp change in slope exhibited by T_{L55} at 4·167° K. is therefore entirely inconsistent with our knowledge of the thermodynamic behaviour of helium-4. From the same curves we may note that with respect to the λ-point anomaly T_{L55} is based on a third-order and T_{55E} a second-order transition. This difference has negligible effect on the temperature scale.

Clement[24] has calculated L_T and C_l using the first and second derivatives of the p–T relation for T_{55E}, together with experimental data of state for the liquid and vapour. The results agree, within experimental uncertainty, with the measured values of these quantities and at the same time differ slightly from the values associated with T_{L55}. Hence, for temperatures below the boiling point, both scales are compatible with our present knowledge of the thermal properties of helium-4.

In making a comparison between any interpolation device, such as carbon and paramagnetic salt thermometers, and a supposed absolute scale, a decision must be made as to which 'tie-down' points are to be used for normalization of the relative measurements. If the absolute scale really were entirely correct, any points would do, provided a sufficient number were taken to determine the unknown constants of the relationship between temperature and resistance (or magnetic susceptibility). However, since we do not have as yet a true thermodynamic scale, it is often best to obtain in some way an average fit. In making such averages we find that the magnetic and resistance data cannot distinguish between the two scales, except as noted earlier in connexion with the resistance data above 4° K. This failure, however, does not detract from the validity of the use of these data for interpolation. I should like to point out that earlier magnetic experiments by Ambler and Hudson[15], which apparently gave a superior fit to T_{L55}, have been repeated[25] and now agree equally well with T_{L55} and T_{55E}.

In the region of the λ-point a comparison of T_{L55} with T_{55E} reveals a subtle yet significant difference. The vapour-pressure of pure liquid helium-4 at the λ-point is measured in relation to the abrupt change in some property of the liquid and is therefore not dependent on any temperature scale. In conjunction with tables of T_{L55} van Dijk and Durieux state this pressure to be 37·67 mm. mercury at 0° C. as determined from the "most accurate Leiden measurements". On the other hand, equations (1) and (2) defining T_{55E} were made to join with continuous $\mathrm{d}p/\mathrm{d}T$ at a λ-point pressure of 37·86 mm. mercury. This figure was arrived at from an average of four recent determinations, including the Leyden value, and those of Long and Meyer[26] (37·96 ± 0·02 mm. mercury), Erickson and Roberts[6] (37·91 ± 0·05 mm. mercury), and unpublished measurements[24] made at the U.S. Naval Research Laboratory. Newer measurements by Dash and Taylor[27] giving 37·86 ± 0·05 mm. mercury substantiate the value selected for T_{55E}. We have no satisfactory explanation for the failure of van Dijk and Durieux to include some of the other data for the selection of a λ-point pressure. Since some of the properties of liquid helium change so markedly at the λ-point, it is often of importance to the experimenter to know on which side of this point his experiment is being conducted; we can imagine his dilemma when he measures a vapour pressure of 37·75 mm. mercury and sees from T_{L55} that the temperature is above the λ-point, whereas according to T_{55E} it is below the λ-point.

Conclusions and Recommendations

Now that the discussion concerning the background of the causes of dissension leading to the 'Battle of the Millidegree' is completed, I propose to assess the relative merits of each side. We cannot permit ourselves to lean back indifferently and consider that the whole affair is a tempest in a teapot, that, after all, what matter a few millidegrees, more or less! Even though both proposed scales represent a considerable improvement over the 1948 scale, we feel that the unfavourable consequences of having two scales must be avoided so far as possible. In theory, each scale is capable of closely representing the true thermodynamic temperature; but we must admit the possibility that neither does in practice; T_{L55} approaches the problem by constructing a non-unique p–T relation from the best available experimental thermal data, while T_{55E} does this from the best available experimental p–T data. We must decide to use the one scale which will best serve low-temperature research until more accurate experimental evidence of both kinds is obtained.

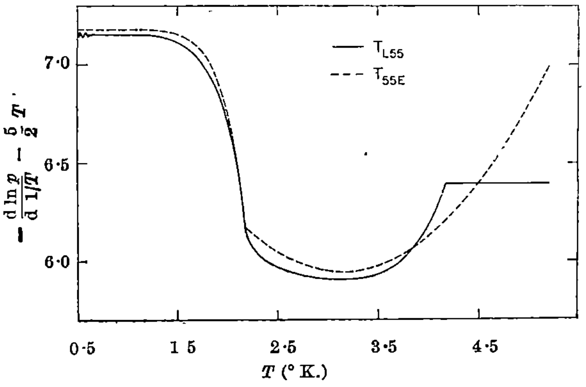

Fig. 2. A plot of $-\mathrm{d}\ln p/\mathrm{d}\,(1/T) - 5/2\ T$ vs. temperature for T_{L55} and T_{55E}

I favour T_{55E} primarily because I believe that it more closely represents actual vapour-pressure–temperature measurements as determined in the laboratory. I feel this is true not only concerning the λ-point pressure and the region between 4·2° K. and 5·2° K., as I have discussed in some detail, but also of the region below 4·2° K. as well. I consider it extremely reassuring that a single equation, such as equation (1), can fit the results of several independent investigators over so wide a temperature range with such a remarkably small mean deviation. In short, if the temperature scale is to be based on the helium p–T relation, I prefer a scale derived from data and procedures which directly match those used in obtaining temperatures in everyday experiments.

It is, of course, very desirable to tie everything up in one package, to obtain with equation (3) a complete thermodynamic description of helium-4 along the saturation curve and thereby arrive at a temperature scale. Above 4·2° K. it is at present out of the question to employ the method of van Dijk since the necessary data do not exist. Below 4·2° K. we have seen that there are uncertainties inherent in the thermal and state data such that an accurate temperature scale can be obtained only through reliance upon experimental p–T data as a guide.

From the above discussion it can be seen that a single scale could have been derived by combining T_{L55} and T_{55E} and retaining the more favourable features of each. Above 4·2° K. it is undoubtedly best to represent the scale with equation (1). Below 4·2° K., equation (3) could be made to fit the experimental vapour-pressure measurements through utilization of the considerable compliance in the thermal and state data (Table 1). This would essentially amount to using the numbers of T_{55E} and the form of T_{L55} without compromising the stated accuracy of any of the pertinent experimental data. Had such a scale been presented in place of the other two, it would have undoubtedly been favourably received; the merger can still be effected, but not without considerable effort. Lacking this reconciliation, we are forced to decide between the form and the numbers. I believe it is safe to assert that cryogenic experimenters attach more importance to the latter. The numbers exist in the tables of T_{55E}, and I recommend that these be used.

The arrival at the above conclusion is not tantamount to a proclamation of victory for either side, for the real question of which scale is overall closer to the thermodynamic scale cannot be answered on the basis of the existing evidence. It does, however, present the more reasonable interim scale for practical use and allows all concerned to withdraw from battle and go about the business of obtaining new information necessary for determining a thermodynamic scale.

I wish to state that, though the above decision was arrived at independently, my confidence in it has been bolstered by the concurrence of the staff members of the Cryogenics Group, Los Alamos Scientific Laboratory, namely, E. F. Hammel, E. R. Grilly, J. G. Dash, R. D. Taylor, R. H. Sherman, E. C. Kerr, A. F. Schuch, T. R. Roberts and S. G. Sydoriak. All the material presented has been thoroughly discussed with these individuals, and, indeed, ideas for some of the arguments given were conceived by them. I am grateful for their help and criticism. In addition, it is a pleasure to acknowledge as a source of information and stimulation helpful discussions with J. R. Clement, R. P. Hudson, E. Ambler, H. van Dijk and M. Durieux. This work was performed under the auspices of the U.S. Atomic Energy Commission.

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SCIENTIFIC AND ENGINEERING MAN-POWER IN GREAT BRITAIN

THE recently issued report on scientific and engineering man-power in Great Britain* embodies the results of two related inquiries. The results of the first, initiated by the Ministry of Labour and National Service, and carried out with the help of the Social Survey, which was concerned with the present number and distribution of scientists and engineers, and with the demands of industry and the other main users of scientific man-power in three years time, are set out in the second part of the report. The second study, the conclusions of which are given in the third part, was made by the Committee on Scientific Man-power of the Advisory Council on Scientific Policy and was concerned with the probable trend in the long-term demands for scientists and engineers. Its purpose is to set a goal for the universities and the technical colleges of Britain, so that present and future demands for trained scientific man-power may be met.

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* Scientific and Engineering Manpower in Great Britain: a Report on the Number and Distribution of Scientists and Engineers now employed in Great Britain, and a Study of the Likely Trend in the Future Demand for Scientific and Engineering Manpower. (London H.M.S O., 1956.) 1*s*. 6*d*. net.

In the present inquiry, the terms 'scientist' and 'engineer' are used to cover the basic sciences on one hand and the applied sciences in the engineering field on the other. The term 'scientist' in this report covers biology, chemistry (other than pharmacy), geology, mathematics, physics, and general science, while the term 'engineer' covers persons with a degree or other professional qualification in chemical engineering, civil and structural engineering, electrical engineering, mining engineering, mechanical, aeronautical and other branches of engineering, and metallurgy. The report thus excludes those who have studied science at the universities but qualified in agricultural science, dentistry, medicine and veterinary science, and it does not include people with specialized qualifications in certain fields of technology such as textiles and rubber. The social sciences are likewise excluded. Its attention is concentrated on the demand for 'qualified' scientists and engineers, and this is taken to mean those with a university degree in these fields or who are associates of certain bodies such as the Manchester College of Technology, or corporate or graduate members of the professional institutions listed.

The Ministry of Labour's inquiry was linked with an inquiry on behalf of the Department of Scientific and Industrial Research into the proportion of industry's resources spent on research. Information was obtained from all manufacturing establishments employing 500 workers or more, and from a samplo of those with between 100 and 499 workers. Establishments with less than a hundred workers were not approached. Slightly different sampling arrangements were used in the building and contracting industry; information was obtained from the boards of nationalized industries, central government departments and local authorities, but agriculture, the non-nationalized parts of the mining and transport industries, shipping, the distributive trades and miscellaneous service industries were not covered.

For early 1956 the inquiry gives the total of qualified scientists as 51,230 and of qualified engineers as 119,700, of whom 32,150 possess higher national certificate or diploma or its equivalent; and of these last, 22,790 are employed in manufacturing industry, 5,330 in nationalized industries (including the Atomic Energy Authority), 1,710 by the central government and 320 by local authorities. For qualified engineers as a whole, the corresponding figures are 37,000, 14,660, 8,050 and 6,330, with a further 2,430 in education; and for qualified scientists, 17,050, 2,420, 5,800, 350 and 25,610. Rough estimates put the number of qualified scientists in other employment at 5,000 and of qualified engineers at 10,000, making a grand total of 134,700. Besides this, there are about 4,700 qualified scientists and 2,300 engineers engaged in postgraduate research at the universities or at present on National Service.

Of the 134,700 qualified scientists and engineers, or about 0·6 per cent of the working population of 24 million, there are thus about 43 per cent in manufacturing industry, 12·5 per cent in the nationalized industries, 21 per cent in teaching, 10 per cent in central government establishments, 5 per cent in local government, and 8 per cent in miscellaneous occupations. Nearly half the qualified scientists are engaged in teaching, and three-quarters of the qualified engineers are in industry.

These scientists and engineers are concentrated in a relatively few industrial groups. Of 48,829 engineers and scientists in manufacturing industry, the numbers were distributed as follows: chemicals (8,300), other plant and machinery (6,700), electrical engineering (12,200) and aircraft manufacture (4,300), accounting for only three-tenths of the labour force, and include nearly two-thirds of the scientists and engineers. While the average proportion of scientists and engineers to the total employed is 0·8 per cent for all industries, it varies widely from one industry to another; from 10·9 per cent for the Atomic Energy Authority (for which the total in 1956 was 2,467, of whom 1,706 were engaged in research and development) to as little as 0·4 per cent in shipbuilding and motor manufacture and less than 0·25 per cent in cotton, wool and wood, cork, paper and printing. Only in mineral-oil refining (5·2), the electricity authorities (2·9), chemical and allied trades (2·7), electrical engineering (2·0), aircraft manufacture (1·9), constructional engineering (1·5), Gas Council and area boards (1·2), non-ferrous metal manufactures (1·1), rayon, nylon, etc. (1·1), and other plant and machinery is it 1·0 per cent or more.

Of the 13,900 scientists and engineers in government service, just over a half are in the defence departments (including the Ministry of Supply), just over a quarter in the Civil departments, and one-sixth in the Department of Scientific and Industrial Research, the Agricultural Research Council, the Medical Research Council or the Nature Conservancy. Of the 6,700 employed by local authorities (other than for teaching) 80 per cent are civil engineers. Of the 25,600 scientists and 2,400 engineers engaged in teaching, 13 per cent are in the universities, and of those teaching in schools more than a quarter are in Scottish schools.

Of those employed in manufacturing industry, about 45 per cent were engaged in research and development, 47 per cent in production, maintenance and installation and the remainder on 'other work', many of whom may not be engaged directly on any form of scientific or engineering work. So far as the figures go, they suggest that well above average proportions are engaged in research and development in the aircraft, electrical engineering, precision instruments, etc., and rayon, nylon, etc., industries, and well below average in shipbuilding and repairing, railway equipment, iron and steel, non-ferrous metal, and other plant and machinery.

Dealing next with the demand for scientists and engineers in the next three years, the report gives the 1959 requirements of industry in Britain at 94,640—an increase of 33 per cent—the increase in manufacturing industry, building and contracting, research associations and nationalized industries (including the Atomic Energy Authority) being given as 37·0, 32·0, 21·0 and 22·0 per cent, respectively. For government departments, local authorities and teaching, an increase of 14·0 per cent for 1959 to 55,400 is reported. For the central government, the increase from 13,850 to 15,850 is mainly in the research departments (23·0 per cent), compared with 12·0 per cent in defence departments and 14·0 per cent in civil departments. For local authorities an increase of 27·0 per cent is reported and for teaching 11·0 per cent, of which 34·0 per cent is estimated for the universities, though this figure is conjectural, being estimated before the University Grants Committee had received the universities estimates for 1957–62.

Among categories of scientists, the greatest numerical increase in the next three years is estimated for chemists (4,500 or 22 per cent), physicists coming next with 2,400 (23 per cent), and mathematicians with 1,500 (13 per cent). For biologists the figures are 600 (12·5 per cent); for geologists, 200 (22·0 per cent); and for other scientists, 300 (11·0 per cent). Among engineers the greatest demand in numbers is expected for mining and other engineers (8,800 or 33·0 per cent), for electrical engineers (5,100 or 23·0 per cent) and for civil engineers (3,400 or 27·0 per cent). For metallurgists the figures are 1,200 (38·0 per cent); mechanical engineers, 1,000 (26·0 per cent); chemical engineers, 700 (47·0 per cent); and for engineers in teaching, 600 (25·0 per cent).

The Committee on Scientific Man-power bases its assessment of the long-term demand for scientists and engineers on the assumption of an overall expansion of industrial output of 4 per cent a year, and that this is only possible if there is an adequate supply of scientists and technologists. This involves assumptions of increases of 7 per cent and 5·25 per cent for the chemical and engineering industries, whereas only 2·5 per cent is assumed for the textile industry. Replies received to the Ministry of Labour questionnaire indicate that, without qualification, manufacturing industry expects to employ 37 per cent more scientists and engineers in 1959 than in 1956; but this figure reflects a considerable margin for current shortages of qualified men. The Committee attempted to isolate this element by assuming that the demand for trained man-power in each industry would, at the least, rise in relation to the number now employed by the same proportion as output is expected to do over the next three years. The difference between this estimate and the figure supplied by industry is taken to represent the presumed current shortage; and an allowance for this factor has been added to the number currently employed, before making the extrapolations based on changes in output over the next ten years. The result is an estimate of the demand for scientific man-power in terms of the number of scientists and engineers necessary to permit an increase in industrial output of 4 per cent per annum.

The estimates for government departments are based on existing policies and allow only for a very modest increase over the next ten years. Sufficient teachers are postulated to deal with the increased number in secondary schools, but not for any further concentration on scientific subjects or for any improvement in existing staffing ratios, for which about four thousand additional science graduates would be a reasonable assumption. Requirements of the universities are assumed to increase by about 100 per cent over the period.

The broad conclusion is reached that an increase of rather more than 60 per cent is required—from about 135,000 to about 220,000 in 1966—the increase for engineers being about 70 per cent and for scientists about 50 per cent. The annual gross flow of those qualified in pure and applied science from the universities and technical colleges is to-day a little more than 10,000—roughly about half scientists and half engineers—and this could well rise to 12,000 by 1958–59. During the next five years, some 60,000 people qualified in science and engineering might come from the universities and technical colleges of Great Britain; but this would have to rise to 16,000 a year if the figure of 220,000 is to be reached by 1966. Allowing 25 per cent for overseas students, emigration, etc., and some continued measure of shortage, the Committee estimates that an annual output of 16,900 in 1966 and 19,900 in 1970 is required.

The Committee recognizes that its estimates involve some margin of error, but it points out that it may well have taken too conservative a view of the demand that is likely to develop in some sectors of the economy. It suggests, however, that the estimates point to a reasonable objective for the universities and technical colleges. In conclusion, the Committee emphasizes that, at the national level, an annual figure of 'graduations' in pure and applied science of about 20,000, as compared with the present 10,000, is the minimum at which we should aim over the next ten to fifteen years, if the economy of Britain is to grow at an acceptable rate.

METALS IN LIVING SYSTEMS

A SYMPOSIUM on "Metals in Living Systems" occupied the morning session on September 3 of Section B (Chemistry) during the recent Sheffield meeting of the British Association. It was opened by Sir Rudolph Peters with a few remarks about the role of metals in a variety of enzyme reactions and the importance of metals for the metabolism of all forms of life. He gave some examples of how the biochemist could elucidate the actual function of a metal in an enzymic reaction. In particular, he mentioned the importance of the complex formation between metals and sulphydryl groups as shown, for example, in the interaction of ferrous iron, cysteine and aconitase, studied in his laboratory by Morrison. Sir Rudolph emphasized the complexity of some of the problems by referring to the recent work on the composition of xanthine oxidase.

Prof. A. Neuberger (London) discussed the structure and biogenesis of porphyrins and related compounds. Simple pyrroles have so far not been found in Nature, with the notable exception of the aminomethyl pyrrole, porphobilinogen, which is an intermediate in the biosynthesis of porphyrins and is excreted in the urine of patients suffering from acute porphyria. Much more widespread—and of the greatest importance in connexion with the present discussion—are the macrocyclic tetrapyrrolic structures found in hæmoglobin, chlorophyll and vitamin B_{12}. Prof. Neuberger first discussed the porphyrins forming part of the hæmoglobin, catalase and peroxidase molecules and the type of resonance found in the porphyrin structure. He then briefly considered the types of bond formed between the central iron atom in hæm and the heterocyclic pyrrolic systems. The interaction between the hæm and protein moiety of the hæm proteins was considered and the various types of isomers arising from changes in the order of the 'outer' substituents of the porphyrin ring were mentioned. Turning to the chlorophylls, Prof. Neuberger pointed out that these contain as the central atom not iron, but magnesium, and also differ from the hæm compounds in the degree of saturation of the heterocyclic system. The work of Linstead and his co-workers on the location of the 'extra' hydrogen atom in the chlorophyll molecule was also mentioned. The third type of macrocyclic pyrrolic structure considered was that present in vitamin B_{12}. In this molecule, as shown by Dr. D. C. Hodgkin and Sir Alexander Todd, the macrocyclic system is reduced to a much greater extent than in porphyrins or chlorophyll, and not all the pyrrolic rings are linked, as in the porphyrins or chlorophyll, by methene bridges. Two of the rings are joined by a direct linkage, giving a dipyrryl structure. In addition, the central atom is cobalt.

Prof. Neuberger then traced the development of recent work on the biosynthesis of porphyrins, starting from the discovery in 1946 by Shemin and Rittenberg that the nitrogen atom of glycine is specifically used in the biosynthesis of porphyrin. He described work done in the department of Shemin and in his own laboratory, work which was mainly based on isotope techniques. The isolation of porphobilinogen by Westall and the elucidation of its structure by Cookson and Rimington in 1953 completed the overall picture. Glycine is condensed with an asymmetrically substituted derivative of succinic acid to give α-amino β-oxoadipate, which loses carbon dioxide to yield δ-aminolævulic acid. Condensations of two molecules of the latter then give porphobilinogen. While the last reaction has been shown to be catalysed by a specific enzyme which has been obtained in a purified form, the initial condensation reaction has not yet been clarified at the enzymic level. Prof. Neuberger mentioned experiments done in his own laboratory which indicated that α-amino β-oxoadipic acid is extremely unstable, and it seems uncertain whether it will ever be made by chemical methods. The possibility exists that this α-amino β-keto acid never occurs as such in the biogenesis of the porphyrin ring. The further changes involved in the conversion of porphobilinogen to the naturally occurring porphyrins were then considered. Experiments of Granick and others indicating that porphyrins are precursors of chlorophyll were then described. Prof. Neuberger concluded by saying that the initial steps in the biosynthesis of the macrocyclic system of vitamin B_{12} are probably identical with those established for porphyrins.

Dr. C. P. Whittingham (Cambridge) spoke on "The Role of Metals in the Green Plant" and started his talk by briefly referring to some nutritional problems met with in ordinary farming and horticulture. For example, potassium is required in more than trace amounts ; but other metals which have recently been shown to be important and which are needed in relatively small amounts are manganese, zinc, copper and molybdenum. The plant physiologist who wishes to find out what part a particular metal plays in the metabolism of a plant may observe the physiological effects which result from either using a deficient medium or the addition of a metal poison, that is, a substance combining with a particular metal or a group of metals. This approach was illustrated by some experiments showing the effects of the addition of such poisons to processes such as photosynthesis, nitrate reduction and respiration in *Chlorella*. Another example was the well-known experiment by Warburg in which the inhibitory effect of carbon monoxide on the respiration of yeast is partially removed by illumination. Since it is known that light of the particular wave-length used can cause dissociation of some iron carbonyl compounds, the experiment provides evidence that at least one step in the respiration is probably catalysed by an iron-containing enzyme.

The characteristics of synthetic or assimilatory processes were then discussed in general terms and compared with those of the catabolic reactions. The former are mainly of a reductive nature, such as the conversion of carbon dioxide to carbohydrate in ordinary photosynthesis, or nitrogen fixation or the assimilation of sulphate or sulphite. The catabolic processes on the other hand, in their overall effect, are oxidative. Dr. Whittingham then discussed the various types of oxidation and considered the role of the cytochromes with particular reference to the valency changes which occur in the iron atom. The term oxidation may mean addition of oxygen to an organic compound, removal of hydrogen or just removal of electrons. In the oxidation of succinic acid there is first a removal of hydrogen atoms which is mediated through a flavoprotein complex ; but ultimately there is transfer of electrons, which is catalysed by the iron–protoporphyrin complex of the cytochromes. The flavoprotein itself is complexed with a metal and transfers equivalents of hydrogen or electrons—one at a time—to the iron of cytochrome. The importance of the metal in this reaction has been demonstrated by showing that the activity of the flavoprotein is largely lost on dialysing it against cyanide. The exact manner with which the metal in the flavoprotein complex functions is still a matter for discussion.

Dr. Whittingham then discussed the oxidations, such as that catalysed by polyphenol oxidase. Reactions of this type are catalysed by copper-containing enzymes which are widely distributed in higher plants, but their biological importance is still largely undefined. This type of oxidation may be only of minor importance, but the view is held by some workers that it may constitute an important method of electron transport and be an alternative pathway to that catalysed by the cytochrome–flavoprotein system.

Some aspects of photosynthesis were then discussed in detail. Dr. Whittingham mentioned the effect of iron deficiencies on the chlorophyll content of plants and he also described some observations showing that a deficiency of magnesium affects photosynthesis not only by reducing the chlorophyll content. It is likely that this is due to the fact that magnesium is an important constituent of several enzymic systems involved in the assimilation of carbon dioxide.

In the past few years evidence has accumulated showing that cytochromes, somewhat different in structure from those of the respiratory type, are also concerned with photosynthesis. Dr. Whittingham suggested that such a cytochrome system may supply a small, but nevertheless essential, part of the energy required to convert carbon dioxide into carbohydrate. He then discussed some recent work which showed that manganese played some part, not in the reduction of water to a hydroxyl-like radical, but in the oxygen-liberating part of photosynthesis. Another metal, molybdenum, is implicated in the nitrate reductase activity of *Neurospora*. Dr. Whittingham also considered a few other enzymic reactions which involve metals, such as the decarboxylation of keto-acids. He concluded with a few remarks about the role of potassium. This metal is required for the activity of the enzymes fructokinase and pyruvic acid kinase. But it is unlikely that the major cause of its nutritional importance is due to the co-factor requirements of these enzymes alone. It appears that a purely chemical explanation of the biological activity of potassium in plants, or for that matter in animals, has still to be found.

Sir Rudolph Peters and the audience warmly welcomed Sir John Russell, who in a short talk described how the recent advances in our knowledge of the deficiencies in trace metals were made partly by intelligent interpretation of mistakes in farming, partly by accident, but to a large extent by the application of spectrographic analysis. He gave some instances such as the important economic effects resulting from the realization that certain soils in Australia and New Zealand were deficient in molybdenum, zinc, cobalt or copper, or in combinations of these. He also described briefly the use of iron chelates in Florida.

Dr. D. P. Cuthbertson, director of the Rowett Research Institute, Bucksburn, Aberdeenshire, had most generously agreed to deputize for Mr. Hedley Marston, the head of the Nutrition Division of the (Australian) Commonwealth Scientific and Industrial Research Organization, who was prevented by illness from attending the meeting. Dr. Cuthbertson surveyed in a masterly manner the importance of metals in the nutrition of plants and, in a more cursory manner, of animals, and emphasized the economic importance of the recent work on the importance of the metal content of soil and pasture for the nutrition of sheep and cattle. In the first place, he directed attention to the very specific requirements for metals of both plants and animals. Thus sodium, which is most important in the electrolyte metabolism of animals, does not appear essential for any plant species studied. Certain plants have a very specific capacity for storing certain metals and sometimes in an unexpected manner; thus, legumes are particularly rich in calcium, deciduous fruits in potassium, and some tropical crops have high contents of manganese. Hickory accumulates aluminium and zinc, and the Brazil nut stores barium. Metallic mercury has been observed in the seed capsules of *Holosteum umbellatum*. Iron, copper and vanadium are found in the respiratory pigments of hæmoglobin, hæmocyanin (Cephalopoda and Crustaceae) and hæmovanadin (Ascidae), respectively. Dr. Cuthbertson then mentioned some of the enzymes which contain metals as essential parts of their structures. Thus iron is present not only in hæmoglobin, but also in catalase, the various cytochromes and peroxidase. Zinc is present in carbonic anhydrase. Copper–protein complexes have been isolated from both animal and plant sources, some of which function as enzymes, such as polyphenol oxidase and ascorbic acid oxidase. In this connexion it is of interest to note that workers in the Rowett Research Institute have demonstrated the presence in herbage of a copper–peptide complex which has a greater biological effect than cupric ions in curing copper-deficiency in rats. Recently it has also been shown that molybdenum forms part of the prosthetic group of the enzymes xanthine oxidase and that of nitrate reductase.

Dr. Cuthbertson next discussed the deficiency diseases which may arise in plants or animals through lack of various metals Lack of magnesium in plants, for example, produces characteristic changes in foliage, and deficiency of this metal is especially serious for fruit trees. Lack of potassium has also been shown to be particularly important for fruit trees. In Australia and New Zealand traces of molybdenum have improved clover production and both there and in the United States the rectification of zinc deficiency has greatly increased the citrus crop. Deficiencies of copper and cobalt have been particularly important for ruminants, and the rectification of such deficiencies in certain areas of Australia and New Zealand particularly has increased agricultural production in certain areas by amounts equivalent in value to many millions of pounds per year. There are also areas in the United Kingdom where grazing ruminants suffer from deficiency of cobalt or copper, and there are certain areas where the growth of horticultural crops—cauliflower in particular—is affected by molybdenum deficiency in the soil. There is now a considerable body of evidence showing the importance of trace-metal interaction—effect of the character of soil and of manurial treatment on the availability of metals to plants. Examples of such antagonism are provided by the interaction of iron and manganese and the observation that a high intake of molybdenum may inhibit assimilation of copper. In conclusion, Dr. Cuthbertson emphasized the interesting relationships which are being uncovered between the identification of metals as constituents of enzymes on the level of biochemistry, the nutritional importance of metals in the nutrition of plants and animals and the application of this knowledge to practical farming all over the world.

EDMOND HALLEY: THE FIRST GEOPHYSICIST

By Sir EDWARD BULLARD, F.R.S.

THE three hundredth anniversary of the birth of Edmond Halley falls this week. When he was born on October 29, 1656, the kinematics of the solar system was understood; but the rest of physical science was little more than disconnected fragments. A few principles or laws, such as the isochronism of the pendulum and Snell's law of refraction, were known, but there was little sign of the immense power and utility of the combination of experiment and systematic theory.

By the time of Halley's death in 1742, all this was changed and a body of knowledge and speculation existed that is recognizably the basis of modern science. It is scarcely an exaggeration to say that a single generation invented the technique, and discovered the content of physical science. What is more surprising, they were, in large measure, conscious of what they were doing. They believed that any fact was worth noting and any natural or industrial process worth investigating. As a young man, at

Oxford and in London, Halley knew all the leading figures interested in this new way of approaching knowledge, and soon became himself one of the best known of them. He was interested in and wrote about everything—mathematics, astronomy, ship's tackle, meteorology, magnetism, diving, archæology, the Chinese language, and how to stop ants climbing trees.

In retrospect the science of the period is overshadowed by Newton's demonstration that the motions of the solar system are a consequence of the principles of dynamics combined with the law of gravitation, and others are apt to be judged by their relation to this achievement. By this test, Halley ranks high as the friend and helper of Newton, who provided the stimulus that led to the publication of the "Principia" and as the developer of Newton's ideas on the orbits of comets. Celestial mechanics was the fashionable subject of the succeeding century and the interest in it has somewhat obscured Halley's other work.

One of Halley's earliest interests was in terrestrial magnetism. At the age of sixteen, while still at school, he made a determination of the magnetic declination at London, finding it to be 2½° to the westward. Twenty years later he collected all the available observations and wrote two papers in the *Philosophical Transactions of the Royal Society* which are remarkable for their insight into the real difficulties of forming a satisfactory theory of the Earth's magnetic field. He correctly followed Gilbert in supposing that the Earth's field is of internal origin, but this led to a difficulty. The change in the declination at London between the earliest measurements in 1580 and those of Halley was 14°, and similar changes were taking place all over the world. He saw that such changes could not be accounted for by movements of magnetized material within the earth without "very wonderful Effects in changing the Axis of diurnal Rotation, and . . . strange alteration in the Sea's Surface, by Inundation and Recesses thereof such as History never yet mentioned". At the same time, the great areas over which the declination had the same sign suggested that the cause was at a great distance from the surface of the Earth. These considerations led Halley to suppose that the causes of the slow variation of the declination lie deep within the Earth, and to suggest that the Earth might possess a magnetized core within a magnetized shell and that the core rotates slowly relative to the shell. He saw that such a hypothesis could account only approximately for the observations and suggested that there might be a series of concentric shells within the Earth each carrying its own set of poles.

This argument and its conclusions come very close to the theories of terrestrial magnetism that are fashionable to-day, except that we can escape the necessity for multiple shells by supposing the core to be liquid and thus to be capable of more complicated motions than the rotation of Halley's solid core.

The interest of the papers is, however, not so much that Halley was largely correct in his arguments and conclusions, as in his approach to the problem. He accepts from the start that this is a complicated subject, that a great many observations are needed and that there is no quick and simple answer. He does not try, as did Bond before him and Whiston after him, to make the observations fit some simple empirical law. He requires the motions and stability of his core to be governed by Newtonian dynamics, but expects that there will be a long period of groping for the relevant factors and that he can only "propose an Hypothesis which after-Ages may examine, amend or refute".

This realization of the complexity of the problems of geophysics is characteristic of Halley, and has only been fully regained in our own day as the tidal wave of observational data has swept away so many tidy generalizations.

Halley had a real delight in collecting observations, discussing them, and devising visual presentations of them. The successive editions of his magnetic charts, with their "Halleyan lines" of equal declination, were used for many years after his death and must have been of great practical value. His wind charts show the trade winds and monsoons with great clarity and considerable detail. In discussing the results he says that, on an Earth covered with water, the north-east and south-east trade winds would doubtless circulate continually all round the Earth, but that on the actual Earth the presence of the land disturbs the regularity of the pattern and produces local phenomena such as the westerly winds of the Guinea coast and the south-west monsoon in India. This approach, with its distinction of a general circulation and local disturbances, is sound enough; but unfortunately the explanation proposed for the general circulation is incorrect. It is surprising that Halley, having studied the winds so carefully, did not anticipate Hadley in realizing the importance of Coriolis forces in atmospheric motions.

Halley's approach to lunar theory is along the same lines. It was known that after a period of 18 years and 11 days the positions and velocities of the Earth and the Moon return very closely to those that they had at the beginning of the period. Halley suggested that after this period, the errors of the lunar tables would repeat themselves, and that after observing for one such period empirical corrections to the tables could be derived and used in the future. He first devised this scheme as a young man, but only seriously started the observations in 1721 when he was sixty-five years of age and he completed the eighteen years of observations two years before his death. The tables were published posthumously in England and in France.

Several other examples could be given of investigations involving the discussion of a large body of data and its reduction to some kind of order; such, for example, as the discussion of the births and deaths at Breslau and the calculation of an annuity table from them. His work on comets involved the calculation of orbits for all those for which sufficient observations existed. In addition to the well-known discovery that some comets are periodic, he noticed that their orbital planes were distributed at random, in sharp distinction to those of the planets. To collect the observations and reduce them must have been a very great task; it is characteristic of Halley that he not only carried the work to completion, but also extracted two major discoveries from it.

Halley's great achievements in theoretical geophysics and in the discussion of observations are the more remarkable when it is remembered that he was also a naval captain, who took a 64-ft. ship southwards to the antarctic ice and also made a detailed survey of the English Channel, and that much of his time was spent in experiments on diving, in the improvement of instruments and in the translation of ancient mathematical texts from Greek, Arabic and Hebrew.

OBITUARY

Prof. Frederick Soddy, F.R.S.

FREDERICK SODDY was born at Eastbourne, the seventh child of his parents, on September 2, 1877, and died on September 22 just after his seventy-ninth birthday, and by his passing we lose a personality at once outstanding and complex. He was educated at Eastbourne College, and although destined to be a student at Oxford he was able to spend a year or more of early student activities at Aberystwyth. After graduation from Merton College, Oxford, in 1898, he considered work in Toronto; but that idea did not come to fruition. He went to Montreal and the very fruitful period of collaboration with Rutherford was commenced, which resulted in the establishment of the concept of the disintegration of the radioactive elements. It is impressive how many experiments connected with thorium and thorium emanation have been shown to be contributory to the formulation of the disintegration concept. In conjunction with Rutherford, he made this most valuable contribution to scientific conception when he was in his middle twenties. It has always been recognized that the conception was a joint effort, and, in so far as his half of the credit is concerned, it indicates a consistent feature in his manner and method of thought. In this he himself in no way minimized the place of imagination and intuition. From Montreal he went to work with Ramsay at University College, London, and from that there came the determination of association of helium and radium emanation.

An interlude of a lecture tour in Australia followed, where his talks illustrated with a quantity of radium drew audiences which were ready to yield very adequate remuneration to the lecturer. By this time the recognition by the University of Glasgow of the need of broadening the basis of chemical teaching enabled him to obtain the position of lecturer in physical chemistry and radioactivity and brought him, in the wider circle of the Chemistry Department, the pleasing and attractive friendship with Cecil Desch, who then occupied a parallel lectureship in metallurgical chemistry.

The years in Glasgow from 1904 to his translation to Aberdeen in 1914 are a very productive period for contributions to advancing science. These years were dominated by three types of activities. First, the very thorough and systematic work in which he purified substantial quantities of uranyl nitrate and then proceeded to measure the rate of growth of radium measured by the increasing quantities of radium emanation. As a series of experimental determinations, they were marked by careful systematic methods.

The second type of work to which he devoted much effort was the development of his technique as a lecturer with an appeal to a general, non-technical audience. He seemed to have the example of Sir William Ramsay in mind, and his "Free" lectures in the Botany Class Room of the University had a wide appeal and helped in a valuable way to disseminate the conceptions involved in the new ideas of radioactivity.

The third major activity was all the work and thought that was involved in the development of the conception of isotopes. Here again his intuitions played a very considerable part, and he was much concerned with the idea that had been evolved in his mind of atoms with different atomic properties, possibly different periods of life and/or different atomic weights, which would nevertheless have the same chemical properties. It was the testing of this concept and its verification that logically led to the αβ displacement law. From this also came the introduction into our language of the word 'isotope'. It was suggested by Dr. Margaret Todd, arising from a discussion that Soddy had in the house of his father-in-law, Sir George Beilby, in Glasgow.

After the work on isotopes there followed contributions on the atomic weight of lead from minerals containing radioactive elements, in conjunction with Hyman, and work on the actinium series, in collaboration with Cranston.

A Nobel Prize was awarded to Soddy in 1921 after his appointment to the Dr. Lee's chair of chemistry in Oxford, which he held during 1919–36. However, by this time he was making few, if any, contributions to scientific knowledge, and his time was devoted to riding various hobby-horses which it is difficult to imagine will ever find a permanent place in the culture of our times. Economic theory, the closest packing of spheres, mechanical means of solving differential equations all occupied his interest; in general, these activities produced results satisfactory to him but unconvincing to the expert.

It was my privilege to be close to him in numerous types of relationship: first of all as a laboratory boy, secondly as a student for graduation, and then as a research student doing postgraduate work. That was followed by a position of University demonstrator to his lectureship. While these stages were progressing, a personal friendship developed which existed until his death. In all these aspects complex emotions were involved—much generosity, some supersensitiveness, some hard hitting, much breadth of outlook. To his laboratory boy, he was kindness itself and his capacity for encouragement and leadership was unbounded. Responsibility was given freely, and when it was taken successfully it was much appreciated by him. To students working for graduation, the impression was of remoteness, and, so far as my knowledge of his three teaching appointments goes, it would be idle to suggest that he was successful. Where teaching classical chemistry was concerned, the students were in general unable to follow his methods of thought. But circumstances were wholly different when it came to postgraduate radioactive work directed to experimental determinations. There he made sure there was ample opportunity for discussion, for question and for answer and in general for complete understanding of the point at issue. For elucidation of ideas in those circumstances he was most patient, and when it came to recording results he required the maintenance of a very high standard for logical presentation and clarity of diction. With his demonstrator during a period of concentration of teaching duties, he shared routine responsibilities, so that time was always available to ensure a degree of continuity of research work.

He was elected a fellow of the Royal Society in 1910, and in 1934 the University of Glasgow conferred on him the honorary degree of LL.D.

He married Winifred Moller Beilby in 1908, and her death in 1936 was a grievous loss to him. She was a woman with sound judgment of character and much common sense. Social occasions in their home contributed much mental stimulus and have left me with the happy impression of many games started with intellectual purpose ending in a riot of discursive and witty conversation.

ALEXANDER FLECK

NEWS and VIEWS

Nobel Prize for Medicine for 1956

THE Nobel Prize for Medicine for 1956 has been divided between Dr. Werner Forssman, of Bad Kreuznach, West Germany, and Prof. Andre Cournand and Prof. D. W. Richards, jun, both of the School of Medicine, Columbia University, New York. The award has been given for their work on the catheterization of the heart and pathological changes in the circulatory system.

Institute of Personnel Management: New Director

MR. LESLIE STEPHENS, principal of Fircroft Working Men's College, Birmingham, has been appointed director of the Institute of Personnel Management in succession to Mr. M. B. Forman, who is taking up an appointment with the Staff Department at the headquarters of the National Coal Board, where he will be mainly concerned with staff planning. Mr. Stephens, who is forty-seven, is a graduate of Hertford College, Oxford, and has taken the business administration course at the London School of Economics. Before going to Fircroft Working Men's College in 1946, he was for seven years with the Factory Department of the Ministry of Labour. He is the author of an Occasional Paper (1956) of the Institute, "Employment of Coloured Workers in the Birmingham Area".

Electronic Computing Laboratory of the University of Leeds: Dr. A. S. Douglas

THE University of Leeds has recently announced that a Ferranti 'Pegasus' electronic digital computer has been ordered for installation in the autumn of 1957, and that Dr. A. S. Douglas has been appointed director of the new electronic computing laboratory within the Department of Mathematics. The 'Pegasus' is a medium-sized general-purpose computer, capable of adding or multiplying at the rate of about a thousand ten-figure numbers per second, and will be used not only for the researches of scientific and technological departments in the University but also for industrial and commercial organizations in the Leeds region which have problems calling for high-speed and complex calculations. Although this will be the first electronic computer to be installed in Leeds, members of the University already have had considerable experience of the use of the machine which has been available for some time in the University of Manchester and which is the prototype from which the design of the faster 'Pegasus' has been developed. During the past four years members of the Chemistry Department at Leeds have solved many difficult problems of molecular structure by means of the Manchester machine, and similarly in the Department of Textile Industries a problem concerning the drying processes in paper mills has been solved, one set of calculations for which took only 36 minutes on the computer compared with the many months of desk calculation formerly necessary. The computer will cost about £50,000, a large part of which is being met by a grant from the University Grants Committee; the University hopes that industrial and commercial organizations interested in high-speed computing will give additional aid.

Dr. Douglas is on the staff of the University of Cambridge Mathematical Laboratory and is a Fellow and Junior Bursar of Trinity College, Cambridge. He will take up his appointment in Leeds in September 1957, and will be available for consultation during the intervening period while the computer is being installed and the laboratory equipped and staffed.

Journal of Technology

THE first number of a new half-yearly *Journal of Technology* was published for the Bengal Engineering College in June. It is regrettable that no statement of editorial policy has been included in this number, although the cover pages include useful and detailed instructions to prospective authors. It is not, however, stated whether the *Journal* is intended to be a medium for the publication of papers from the Bengal Engineering College or whether it is intended to cater for a wider field of authors. On the other hand, it is stated on the cover page that the subject-matter is intended to include original research contributions in science and technology, and this intention is fulfilled in the first number, which includes six papers on original research in electrical engineering, geophysics, civil engineering, applied mathematics and applied mechanics. There are also two letters from the Departments of Chemistry and Metallurgy. The technical standard of the contributions is high, the English is good, except for a few minor points, and there is only a very small number of printing errors. A small page-size, 10 in. by 7 in., has been adopted and columns avoided, while a pleasing contrast has been achieved between the print and the paper. The figures are clearly printed and adequate space has been allowed for these and for the tables. At the end of the number are given about eighty short abstracts of publications in other journals. The value of these would be greatly enhanced if the basis of selection was stated. This is an attractive periodical which deserves to succeed, and which should prove valuable to British readers wishing to acquaint themselves with some of the research work being undertaken in India.

Regional Library Systems of Great Britain

THE function and structure of the regional library systems of the United Kingdom, including a section on the support received from the Carnegie United Kingdom Trust and on the work of the National Committee on Regional Library Co-operation, are described in Library Association Pamphlet No. 2, "The Regional Library Systems" (pp. 71; 7*s*., or 5*s*. to members of the Association; 1956), which is a second edition of the pamphlet that first appeared in 1950. Developments since Mr. R. F. Vollans's report on library co-operation in Great Britain was published in 1952 and current problems are discussed in a final chapter, while an introduction directs attention to certain improvements since the first edition was published, notably the general increase in book funds for public libraries and the diminished number of libraries which are borrowing books that should be available in their own stock. Four subject-specialization schemes and two more modest schemes designed to ensure regional self-sufficiency in current British books have made it easier to meet requests for new books, and the existence of the "British National Bibliography" and gradual improvement in the bibliographical training of library staffs have decreased the number of needlessly inaccurate requests. The basic problems remain, much as depicted by Mr. Vollans, and the pamphlet notes certain respects in which the establishment of regional reference libraries is likely to increase the efficiency of the regional lending-library systems. The necessity for government aid is fully recognized, and, by implication rather than by direct statement, the pamphlet is a further indictment of the Government's inaction in this field and failure to implement the recommendations of the Advisory Council for Scientific Policy. Reference is made to an even more detailed scrutiny of the work of the North Western Regional Library System and of its requirements in that area, which was contained in a report, published this year, by J. F. W. Bryan, L. L. Ardern, G. B. Cotton and A. Glencross.

New Australian Map of the Antarctic

The second edition of the general map of Antarctica on a scale of 1 : 10,000,000, produced by the National Mapping Office, Australia (Antarctic Division, Department of External Affairs, Canberra), has recently been published. The first edition was published in 1939, and comparison of the two maps shows not only that very many more named features have been added to the latest map, but also that much of the previously unexplored coast (a dotted line in the 1939 edition) has now been filled in. This is particularly noticeable in the larger-scale inset of the Australian Antarctic Territory. The map is clearly and well produced in colour; lettering is in blue and black; mountains are lightly etched in brown; and ice fronts are shown with the date of their latest known position. Political boundaries remain the same as in 1939. The map is obtainable in Britain from Australia House, London, price 2*s*.

Long Ashton Research Station : Report for 1955

Steady progress in the major activities of the Agricultural and Horticultural Research Station, Long Ashton, is recorded in its annual report for 1955 (pp. 224+12 plates. Published by the University of Bristol, 1956 ; 15*s*.). Collaboration with the Colonial Office has been further developed by the appointment of two officers, one to work on problems of practical entomology and spraying at centres in the Colonial territories and the other will be concerned with engineering problems. The Section of Pomology and Plant Breeding has so far assembled sixty species towards a working collection of *Ribes* species which will serve as breeding material for improving black-currant varieties. An attempt is also being made to clarify the classification of gooseberry varieties with due regard to the complications caused by widespread virus infection. Experiments have been continued with synthetic growth substances to study their efficiency as thinning agents, for controlling pre-harvest drop and for accelerating ripening in apples. As a result of experiments initiated in 1944, it is suggested that the economic life of blackcurrant plantations, hitherto assumed to be ten years, can be confidently raised to fifteen years under present-day methods of management. Investigations carried out by the Fruit Nutrition Section on the cure of chlorosis of fruit trees by application of iron chelate compounds to the soil have shown that complete recovery from chlorosis during the year of treatment can be obtained by soil application of iron chelates to chlorotic pear trees provided the compounds are thoroughly watered in, or placed near the rooting zone by means of liquid soil injection. It is thought, however, that the method is uneconomic, and it was found that three to four foliar applications per season will also give control of chlorosis. In the Cider and Fruit Juice Section vintage trials of cider and perry varieties have been continued, and a standard method of fermentation combined with sterile bottling has been adopted.

Arterial Arches of Birds

It has long been realized that the arteries near the heart and in the neck of birds vary very widely from species to species. Fred H. Glenny (*Proc. United States Nat. Mus.*, **104**, 463 ; 1955) has discussed the modifications of the pattern of the aortic arch system of birds and their significance. He has made a major contribution to this subject during the past sixteen years and has dissected more than 750 species and subspecies. The present memoir considers not only this work but also all that has been reported previously and what is known of the development of these vessels in birds (not a great deal). In the light of this the author has drawn up a classification of the principal patterns encountered with their sub-divisions, and so by means of a series of letters and numbers is able to express the conditions found in the different species in such a manner as to allow of ready reference and comparison. It may be noted, in passing, that the major division is into those with one or two carotid arteries. In his conclusions, he suggests that the Archaeornithes should be placed in the Sauropsida with the Reptilia, "since mere presence of feathers is not sufficient for placing them in close association with modern birds". As commonly understood, however, the Sauropsida includes Reptilia and Aves as opposed to the Theropsida, the Mammalia. This memoir contains a great deal of information in a concentrated form, and constitutes a mine of information for future reference. The eleven figures contain a large number of individual diagrams, and in view of its usefulness it is a pity that many of them are not larger and clearer. Fig. 108*e* is stated to represent the arteries in *Sphenodon punctatus*, but, so far as can be judged, bears little resemblance to the condition in that animal.

Screens for Meteorological Thermometers

The thermometers used for measuring air temperature and humidity must be at the same temperature as the surrounding air or at the correct wet-bulb temperature. The major source of a difference of temperature between the bulb and the surrounding air is radiation to or from the bulb. A shield must be provided over the thermometers to minimize radiative heat-exchange without impeding the flow of air past the bulbs. The most accurate instrument is the Assmann psychrometer, consisting of two small thermometers, one dry-bulb and one wet-bulb, in narrow parallel tubes made of highly polished metal through which a stream of air is drawn by a fan driven by a clockwork or, better, an electric motor. The Assmann psychrometer is expensive, and the screen most used is the "Stevenson" screen, which is a louvred box painted white and relatively large in comparison with the thermometers which it houses. The Meteorological Service of the West German Republic has recently made experiments (*Ber. Deutsch. Wetterdienst*, **3**, No. 19 ; 1956), to see if a screen cheaper and more easily installed than the Stevenson screen would be satisfactory for use at auxiliary meteorological stations at, for example, farms and in forests. The screens used were four in number : large, medium and small Stevenson-type screens ; and a "shade tube" (*Schattenhulse*) made of polished aluminium foil 0·2 mm. thick, 5 cm. in diameter and 45 cm. long, open at the ends, with a thermometer 32 cm. long fixed along the axis, and suspended so that it could be turned for the tube to be along the wind. The readings of the screen thermometers were checked against those of an Assmann psychrometer. 333 separate trials were made over a period of nearly four months in the late summer and autumn of 1953. It was found that the tube gave the best overall comparison with the Assmann readings, followed by the small screen; then, with an appreciable interval, the large screen; and finally, the medium screen. The aluminium tube came out best under all types of weather and change of temperature. It was best even in calm sunny weather because, though the tube is heated a little above air temperature, the thermometer has better ventilation than the thermometers in the screens, which also are heated above the air temperature.

British Society of Rheology: Officers

THE following have been elected officers for 1956–57 of the British Society of Rheology: *President*, Prof. J. G. Oldroyd; *Honorary Secretary*, N. Wookey (52 Tavistock Road, Edgware, Middlesex); *Honorary Treasurer*, D. W. Jopling; *Honorary Editor*, Dr. E. W. J. Mardles; *New Members of Committee*, C. C. Mell and Dr. J. C. Vernon.

Royal Society of Tasmania: Officers

THE officers for 1956 of the Royal Society of Tasmania are as follows: *President*, Sir Ronald Cross (Governor of Tasmania); *Vice-Presidents*, F. C. Wolfhagen and Dr. W. L. Crowther; *Council*, Prof. T. Hytten, C. Bisdee, Dr. D. Martin, Dr. W. V. Teniswood, Prof. S. W. Carey and L. W. Miller; *Honorary Secretary*, Dr. W. Bryden (Tasmanian Museum and Art Gallery, Box 416B, G.P.O., Hobart); and *Honorary Treasurer*, G. E. Hale.

The Night Sky in November

NEW moon occurs on Nov. 2d. 16h. 43m., U.T., and full moon on Nov. 18d. 06h. 44m. The following conjunctions with the Moon take place: Nov. 4d. 10h., Saturn 1° N.; Nov. 13d. 12h., Mars 7° S.; Nov. 27d. 01h., Jupiter 6° N.; Nov. 29d. 17h., Venus 4° N. In addition to these conjunctions with the Moon, Venus is in conjunction with Spica on Nov. 18d. 18h., Venus being 4·2° N. There will be a total eclipse of the Moon on November 18, partly visible at Greenwich. The Moon enters penumbra at 4h. 00m. and umbra at 5h. 03m.; totality begins at 6h. 08m. and ends at 7h. 27m. Moonset at Greenwich is at 7h. 32m. Mercury is too close to the Sun for observation. Venus is a morning star, rising at 3h. 15m., 3h. 55m. and 4h. 40m. on November 1, 15 and 30, respectively; its distance from the Earth increases from 107 to 123 million miles during the month. Mars is visible during the evenings, setting at 1h. 50m., 1h. 25m. and 1h. 05m. on November 1, 15 and 30, respectively; it continues to recede from the Earth, its stellar magnitude decreasing during the month from −1·3 to −0·4 and its distance from the Earth increasing from 53 to 73 million miles. At the beginning of the month Mars is north of ψ Aquarii, and is moving eastwards, passing into Pisces on November 22. Jupiter rises at 2h. 40m., 2h. 00m. and 1h. 05m. at the beginning, middle and end of the month, respectively, and is near β Virginis; its stellar magnitude is −1·4 and its distance about 550 million miles. Saturn is too close to the Sun for observation, being in conjunction on November 27. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: Nov. 11d. 23h. 06·6m., 44 Aqr. (*D*); Nov. 14d. 19h. 28·3m., 51 Psc. (*D*); Nov. 22d. 4h. 15·1m., 162 *B*. Gem. (*R*). *D* and *R* refer to disappearance and reappearance, respectively. The Taurid meteors are active during November 1–16; conditions are expected to be favourable, the radiant is near R.A. 3h. 36m., Dec. 14° N. The Leonid meteors are active during November 15–20, but conditions are unfavourable for observation.

Announcements

PROF. SYDNEY CHAPMAN has been appointed Gauss professor of geophysics of the Academy of Sciences at Gottingen for 1956–57. This professorship was founded in connexion with the celebration of the Gauss centenary. The Gauss professor for 1955–56 was Prof. E. Artin, of the University of Istanbul, who was unable to be in Gottingen during that year, and s also there during the present session.

THE Science Committee of the Society for Cultural Relations with the U.S.S.R. is considering the possibility of arranging a Russian-language school for British scientists to be held in Leningrad during 1957. It would be for scientists with some knowledge of Russian, would be staffed by Soviet teachers, and would last twelve days plus travelling time, six days each way, with hostel accommodation. Sight-seeing would be arranged. The overall cost would be about £80, plus 25 roubles a day spending allowance inside the Soviet Union. Those interested should write to the Society at 14 Kensington Square, London, W.8.

THE Ministry of Agriculture, Northern Ireland, has awarded the following scholarships: *Agricultural Science*, D. L. Armstrong, S. R. J. Bingham, W. M. Dunlop, H. R. Kirkpatrick, D. J. McCormick and J. S. Smith (four years at The Queen's University, Belfast); *Dairy Science*, A. G. Foote (four years at the University of Reading) and R. S. Shannon (two years at the University of Nottingham School of Agriculture, Loughborough); *Forestry*, W. D. Fyffe (three years at the University of Edinburgh), and J. M. Elliott (three years at the University of Aberdeen).

THE Gas Council awards each year five research scholarships to students who have recently graduated in physics, chemistry or engineering, and the scholarships for this year have been announced as follows: R. Salter (Department of Inorganic and Physical Chemistry, Oxford), mechanisms of vibrational activation of hydrocarbon molecules by ultrasonic dispersion measurements on vapours; A. Wint (Department of Chemical Engineering, Cambridge), interfacial transfer phenomena; J. W. Arnold (Department of Chemical Engineering, Imperial College of Science and Technology, London), energy exchange in polyatomic molecules, with particular reference to hydrocarbons; P. Owens (Department of Chemical Engineering, Birmingham), high-pressure reactions between oil and hydrogen; and D. H. Grant (Department of Chemistry, Glasgow), a fundamental chemical investigation within the field of polymer degradation reactions.

ERRATUM. In the communication entitled "Interior Deformation Markings in Copper Fatigue Specimens" by D. S. Kemsley in *Nature* of September 22, p. 653, col. 2, par. 3, line 6, for "632,400 c./min." read "632,400 cycles at 21 c./min.".

TWO NEW NATURE RESERVES IN ENGLAND

THE Nature Conservancy has announced the establishment of the following two new nature reserves in England: Morden Bog, near Wareham, Dorsetshire; and Wren's Nest, Worcestershire.

Morden Bog reserve is about a mile north of Wareham and is close to the Conservancy's research station at Furzebrook. The northern part of the reserve consists of undulating heath and a small pine wood; in the drier parts there is considerable regeneration of Scots pine. In the south of the heath in a shallow lies Old Decoy Pond. The present declaration covers an area of 168 acres and has been made under a long lease from the Drax Estate. The Bog is a unique variant of southern heathland, and carries a rich flora and fauna, both vertebrate and invertebrate. It shares many characteristics with the heaths of Purbeck and the New Forest, including some of the rarities, for example, a grasshopper *Chorthippus vagans* and an ant *Formica picea*, which nests in sphagnum bog. Two of the insects—a digging, predatory wasp *Pompilus rufus* and an ant *Formica pratensis*—are not known to occur elsewhere in Britain. Morden Bog is the most interesting remnant of the great heaths which once stretched from Dorchester to Wareham and were described in Thomas Hardy's novels as "Egdon Heath". Freedom from disturbance and the most stringent precautions against fire are essential for the reserve. Access is by permit only, applications for which should be made to the Conservancy's Regional Officer for the South West at the Furzebrook Research Station, Wareham, Dorset.

The declaration of Wren's Nest as a nature reserve has been made possible by the co-operation of the local authority owning the land, the Dudley County Borough, and negotiations are almost completed with the Coseley Urban District Council for the addition to the reserve of the northern part known locally as Mons Hill. Wren's Nest is internationally famous as a classical geological exposure of Upper Silurian rocks. The Wenlock Limestone (known also as the Dudley Limestone) has yielded a magnificent fossil fauna of probably well over three hundred species, all in a state of perfection such as no other locality in Britain exhibits. This includes the trilobites, shells, corals, sea-lilies and other marine life of the time that the strata were laid down in the sea, which is estimated to be some 330 million years ago. Fossils have been described and figured here since Dr. Plot's work of 1686. Specimens from Wren's Nest are preserved in museums all over the world, and there is a fine collection of them in the Dudley Public Library.

The area is a wooded hill with a broad flattened top (now playing fields) bounded by precipitous and deep artificial ravines which descend into great and steeply inclined caverns. The structure of the hill is a peculiar sharp anticline or arch of the rock strata, which, unlike most anticlines in Britain, can be seen to make a topographical feature. Similar structures are found concealed below ground, protruding into the Staffordshire Coalfield in the north, and Wren's Nest can help in assessing these features. The local limestone was largely won for the iron smelting of the nineteenth century and the early years of the present century. The ravines mark the surface workings, and the deep caverns record the underground exploitation, the limestone being removed by an underground canal which pierces the hill. The reserve is accessible to the public; but permission must be obtained to carry out scientific work, applications for which should be made to the Geologist at the Nature Conservancy headquarters, 19 Belgrave Square, London, S.W.1.

SALT UPTAKE IN PLANTS

THE process of mineral salts uptake by plants is being investigated independently in several laboratories in Britain at the present time. It was appropriate, therefore, that it should be the subject of a session in Section K (Botany) at the British Association meeting this year at Sheffield.

Opening the discussion, Dr. J. F. Sutcliffe (Department of Botany, King's College, London) emphasized the importance of a satisfactory knowledge of the salt relations of plant cells as a basis for an understanding of the processes of absorption and transport in intact rooted angiosperms. His contribution and that of Dr. A. B. Hope (present address: Botany School, Cambridge) were concerned with the mechanism of salt uptake at the cellular level.

From the work of a number of investigators with various experimental materials the following view of salt absorption in a vacuolated plant cell has emerged.

There is an initial uptake of ions by diffusion and exchange through the cell wall and outer protoplasmic membrane into the bulk of the cytoplasm, where they are held by the establishment of Donnan equilibria and by adsorption on to protoplasmic constituents. This physical phase of uptake, which is limited in extent, does not depend directly on an expenditure of metabolic energy. Most of the ions taken into the cell are afterwards transferred across an inner membrane (the tonoplast) and accumulated in a free state in the vacuole. Since the tonoplast is rather impermeable to exchange and diffusion, and, moreover, since movement frequently occurs against a concentration gradient, it is evident that a supply of respiratory energy is involved.

It is generally agreed that active transport takes place by the operation of some form of a 'carrier' mechanism. This probably involves the formation of complexes between the ions and some organic constituents of the cell. These complexes move across the membrane and are broken down on the inner side to release the ions and re-form the original carrier molecules. Although a mechanism of this general kind, with suitable elaboration, will explain the facts that are known about salt accumulation, the precise details of the process have not yet been established. In particular, suitable carrier molecules have not yet been identified with certainty, and it is not clear how energy is incorporated into the system.

Against this background, Dr. Sutcliffe discussed various problems of salt accumulation presented by vacuolated cells of storage tissues. The development of an absorptive ability in cells of dormant organs under the influence of experimental treatments has been related to activation or synthesis of carrier molecules. Recent work of Dale and Sutcliffe (unpublished) has indicated that the inability of freshly cut slices of red beet root tissue to accumulate potassium ions from aqueous solutions of potassium chloride is caused indirectly by the non-functioning of a chloride-transporting mechanism rather than by lack of potassium carriers.

Non-growing cells of storage tissues have a limited ability to accumulate salts and, as uptake proceeds, the rate of absorption diminishes. Evidence has been obtained that this is associated with a decrease in the activity of the transport system rather than to an increase in the rate of outward movement of salt. It was suggested that the final stage in active transport is a spontaneous breakdown of the ion-carrier complex which proceeds so long as the free energy of the system is thereby diminished. With an increase of internal concentration, the complex breaks down less readily, until, when the tissue becomes saturated, all the carrier molecules remain in a combined form, and absorption ceases.

Cells of storage tissues possess the power of discrimination between different ions, and this ability has been examined with respect to the alkali metal ions. In terms of a carrier hypothesis, it is proposed that selective absorption depends on the preferential binding of certain ions by the transporting molecules. This property may prove useful in the ultimate isolation and identification of the substances involved, which is now to be attempted. Preliminary experiments have indicated that particulate fractions from red beet and potato tissues also bind some alkali cations in preference to others, and it seems possible that mitochondria may be a rich source of binding substances similar or identical to those responsible for ion transport in the plant cell.

Dr. Hope discussed fully the processes of physical uptake in vacuolated cells. He raised the question as to which structures in the cell determine the amount and rate of uptake of salts. The cell wall, outer cytoplasmic surface, bulk of the cytoplasm, cytoplasmic inclusions and the tonoplast were considered in turn. Some recent evidence from tracer studies with radioactive isotopes on beet and carrot tissue (Hope, unpublished) indicates the absence of a membrane resisting the exchange-diffusion of ions at the surface of the cytoplasm. It is considered likely that the cytoplasm acts as a Donnan phase with an immobile anion concentration of 100–300 m.equiv./l. The effects of the sign and valency of the supplied ions and the pH of the medium on the equilibrium concentration of ions in such a phase were discussed. It has been established that some ions are bound in cell particles in a relatively non-exchangeable form. This may perhaps be associated with the presence of lipoprotein lamellæ which have been revealed by electron microscope studies. Physical uptake was estimated to account for about one-hundredth of the total inward flux during active accumulation.

Dr. L. J. Middleton (Agricultural Research Council Field Station, Compton, Berks) read a paper on "Interactions in the Transport of Ions through Whole Plants". He said that whereas in studies of salt uptake at the cellular level two phases are commonly distinguished, in intact plants a further process may be examined, namely, the passage of ions into the xylem. There have been some claims that salts may move passively into the conducting elements in the transpiration stream, but the bulk of transport appears to be under metabolic control.

In an experiment designed to discriminate between passive and active movement of salt into the xylem of young barley plants, use was made of the fact that ions are known to compete with one another in the physical and metabolic stages of uptake at the cellular level. Experimental work with disks of storage tissue has shown, for example, that strontium reduces the physical uptake of rubidium, but does not significantly depress the active absorption of these ions. In whole plants, the situation is apparently more complex since results are influenced by the salt status and transpiration-rate of the plant. It seems that salt content is a major factor controlling the gross number of ions absorbed, whereas transpiration-rate is important only when the salt content of the plant is high.

The presence of strontium reduced both the uptake of rubidium and its transport into the shoot in high-salt plants, but had no significant effect in either case with low-salt plants. It was concluded that, in the latter, active secretion of rubidium into the xylem predominates, whereas in high-salt plants physical processes attain some importance.

Finally, Dr. J. L. Harley (Department of Botany, Oxford) spoke on "Factors affecting Salt Uptake by Beech Roots". He suggested that since explanations of the ecological distribution of plants often depend on views concerning their ability to absorb nutrients from the soil, the impact of physiological studies of salt uptake on ecology should be considered. As a phase in research, conditions not met in the field are frequently employed in laboratory work. Convenient temperatures, oxygen tensions and salt concentrations are used rather than ecologically probable conditions. Using results obtained with beech mycorrhizas, sampled from natural habitats, the importance of laboratory work to field studies has been examined.

The effects of a range of temperature, oxygen tension and salt concentration on the uptake of various ions by beech mycorrhizas have been studied. High values of Q_{10} were obtained for uptake over a temperature-range from near zero to 15° C. For potassium concentrations expected in the soil an upper soil temperature of 20° C. limits the condition in which beech mycorrhizas are effective absorbing organs.

Potassium is lost from mycorrhizal tissue into distilled water or dilute solutions containing salts when the oxygen tension falls below 3 per cent. The most efficient absorption of both anions and cations occurs in gaseous mixtures containing 10–20 per cent of oxygen. The oxygen concentration found in the soil horizons in which the roots grow naturally has not been observed to fall below 19 per cent by volume. It may be noted that beech is a plant of dry soils, intolerant of water-logged or heavy soils.

When salts were supplied at a high concentration (10–100 mM) diffusion of ions through the tissues of the mycorrhiza was found to be an important phase in the process of absorption by the host. At low concentrations (0·1–1·0 mM) diffusion of salts through the fungal tissue was negligible. Using a range of phosphate concentration and temperature, and by applying metabolic inhibitors, it was shown that movement of phosphate through the fungal layer into the host plant was probably through the living cells of the fungus, when the material was suspended in dilute solutions.

It was concluded that physiological studies on salt uptake have a contribution to make to ecology, provided that due allowance is made for the differing conditions in the laboratory and in Nature.

J. F. SUTCLIFFE

STATISTICAL MECHANICS OF TRANSPORT PROCESSES

INTERNATIONAL COLLOQUIUM

THE International Union of Pure and Applied Physics arranged a five-day conference at Brussels during August 27–31, which was attended by approximately a hundred scientists who are interested in the statistical theories of irreversible processes. Twenty years earlier, this subject would neither have been worth a conference on its own nor would it have been accredited the title of 'statistical mechanics', which was reserved for the theory of equilibrium. The new name and the attendance of the conference are indications of the progress made within two decades.

The foremost subject of the conference was the problem of reconciling macroscopic irreversibility with the reversible character of molecular mechanics, Newtonian or quantal. The problem is old and its discussion earlier than 1910 is summarized in the famous article by P. and T. Ehrenfest which is even now not out of date. The discussion has only recently gained in importance after the theory of transport processes had increased its scope of validity. In technical terms, the problem put before the conference has the form of deducing the collision equation of Maxwell and Boltzmann or its quantum-mechanical analogue from the Liouville equation or the principles of quantum mechanics, respectively. In considering this subject it was assumed that both, premises and conclusion, are well established, but that the intermediate steps of the deduction are in need of clarification.

It was generally agreed that the validity of the Boltzmann equation depends upon some kind of coarse graining of the distribution in full-phase space. There was, however, no agreement with respect to the method of coarse graining. It was argued that irreversibility is the result of time-smoothing of phase-space distributions and that this process of time-smoothing can and should also be applied in the quantum mechanical theory. An alternative (not necessarily contradictory) view was put forward, according to which irreversibility arises asymptotically in the limit of 'large' time-intervals after motion started from well-defined initial conditions. These are by no means the only current views on the nature of irreversibility; but they can claim the best foundation in molecular dynamics.

It would appear that the main progress in this old discussion consists in replacing guesswork by hard-and-fast mathematical results. It was emphasized in the discussion—very much to the surprise of part of the assembly—that irreversibility is, by necessity, limited to the time interval between two characteristic times, that is, the molecular relaxation or correlation time and the period of a Poincaré cycle.

In the quantum mechanical theory, interest was primarily concentrated on the assumption of 'randomness' which has to be made in the course of the deduction. Whereas previously this assumption was, without questioning, interpreted as the necessity of taking an average with respect to the phases of the wave functions at all times, a somewhat more critical attitude emerged in recent years. In the conference it was shown that the phase-averaging can be avoided and that there are various different ways of deducing irreversibility in statistical quantum mechanics.

Another subject on the agenda concerned the fundamental theory of those transport processes—in particular, processes in liquids and solids—to which the Boltzmann equation cannot be applied. Contributions to this subject were—by its nature—less systematic and of greater originality and perhaps of greater importance for future research. To mention an example, the use in this field of electronic computation was shown; it is employed for solving a cumbersome problem in the dynamics of molecules but assumes peculiar significance as standing half-way between theory and experiment. Whereas measurements of transport coefficients reveal only an average over a large number of samples, the electronic computer produces the samples themselves and shows how their fluctuating properties are smoothed out with increasing numbers.

As another example, the use of elastic rigid spheres as models for molecules should be mentioned. This is apparently a somewhat trivial matter. It was, however, shown that the mathematics of this model have some entirely unexpected features and are likely to be of importance in handling more realistic models of molecules.

Apart from the basis of the theories, the conference had obviously to deal with their application to specific phenomena. So far as transport processes in gases are concerned, this requires appropriate solutions of the Boltzmann equation. A number of papers were read showing that these solutions are not obtained by routine procedures but by careful mathematics and plenty of physical intuition. A wide variety of systems other than gases were considered; contributions included thermal conduction in solids and liquids, relaxation of molecular oscillations, transport of charge and energy by electrons in metals, transport processes in liquid helium, viscosity of electrolytes, fission of uranium and, in some detail, the statistical hydrodynamics of turbulent flow. In these talks and discussions the progress in the theory of irreversibility was demonstrated beyond doubt.

Apart from transport processes, the modern theory of irreversibility is concerned with the extension of thermodynamics to non-equilibrium conditions. During the conference plenty of time and attention were given to the principle of minimum entropy production, which has been widely discussed and would, if fully established, have a wide range of applicability. So far, the significance of this principle has not yet been clarified. Some of the speakers presented deductions of the principle depending upon clear-cut premises; on the other hand, instances were produced in which the principle is not strictly valid. Various alternative aspects of off-equilibrium thermodynamics were presented. Conclusive new results were not offered; but there is increasing interest in the subject. Finally, a fair number of experimental papers were read, largely concerning measurements of the diffusion coefficient or thermal diffusion ratio of mixtures.

This colloquium differed in various respects from meetings of a similar kind. One of its characteristics was the interest shown in the consistency rather than in the result of deductions, an attitude frequently dismissed as 'academic'. Speakers were unanimous in their attempts at clarifying the assumptions underlying their own and other speakers' arguments, concentrating on the physical aspects of the problem and avoiding any form of mathematical pedantry. This again is an exceptional attitude, since there is a widespread habit of adorning dubious physical assumptions with a wealth of good mathematics.

Time provided for discussions was ample; speakers could state their case without any fear of being cut short by a harassed chairman. Discussions were conducted as a free exchange of views, not necessarily perfect views, and without the purpose of scoring debating points. As a consequence, subjects of interest were talked over in their widest aspects and by a large number of speakers, conveying thorough clarification and stimulating ideas to the listeners.

The theory of transport processes emerges from this colloquium as a new branch of statistical mechanics which should have a status comparable with equilibrium theory.

This new branch has to a considerable extent been initiated by the work of H. Falkenhagen, J. G. Kirkwood, L. Onsager, G. Uhlenbeck and J. Yvon, who were among the distinguished visitors attending the colloquium. Its success was largely due to Prof. I. Prigogine, partly in his capacity as organizer and even more by the contributions made by him and his school. Thanks are due to the Université Libre de Bruxelles for hospitality and to the American Air Force for generous help. R. EISENSCHITZ

CHEMICAL ENGINEERING IN THE COAL INDUSTRY

CONFERENCE AT THE COAL RESEARCH ESTABLISHMENT, NATIONAL COAL BOARD

THROUGHOUT the world there has been a renaissance in the application of scientific methods to coal and its treatment. This is not the result of a desire for science for its own sake; but is directly connected with the world-wide problems of energy supply and resources.

A notable feature of this new research work is the increasing application to the coal industry of new chemical engineering techniques developed by other progressive industries. The time seemed ripe, therefore, to bring together the research workers in different countries, from industrial and university laboratories, interested in this new outlook on coal.

An international conference on "Chemical Engineering in the Coal Industry" was therefore organized by the Coal Research Establishment at Stoke Orchard of the National Coal Board. It was held during June 26–29, and was attended by a hundred representatives from Britain and overseas.

Mr. A. H. A. Wynn (scientific member, National Coal Board) in his address of welcome to the delegates, pointed to the fact that all estimates of energy requirements, including those of the U.S.S.R., indicate that the economy of almost every country over at least the next twenty or thirty years will depend fundamentally on the prosperity and technical progress of the coal industry. Mr. Wynn underlined the great variety of coals produced in Britain and the different end-uses to which they are put. It is in the subject of efficient use, particularly of those coals not of the highest quality, that the chemical engineer can play an important part. Some of the economic problems of Western Europe, in his opinion, arise from the insufficient application of modern science to the basic industries.

Three chief problems were considered at the conference: the modification of coal to render it suitable for subsequent processing; the briquetting of coal; and the treatment of by-products resulting from new processes. A remarkable feature of the conference was that, although all the countries represented are interested in these three subjects, their interests are to a large extent directed towards different objectives. Whereas the aim in Great Britain is the production of efficient, solid smokeless fuels, in France the aim is the improvement of metallurgical coke. For both purposes, however, the carbonization of high-volatile coals in fluidized beds shows much promise. Again, there is a parallel of interests in Great Britain and Germany in the production of carbonized briquettes from those coals which are not normally considered suitable for carbonization by traditional methods. In Britain the objective is again the production of smokeless fuels; but Germany considers the process to be promising as a method of producing regular-sized hard coke for metallurgical purposes.

The conference was organized into four technical sessions, which reviewed the following topics: (*a*) the modification of coal properties by oxidation; (*b*) the briquetting of small coal; (*c*) the carbonization of powdered coal in fluid beds; and (*d*) the utilization of the by-products from new carbonizing processes. Papers were presented on both fundamental and technical aspects of these subjects.

Modification of Coal Properties by Oxidation

A paper entitled "The Controlled Oxidation of Coal", which was presented by M. A. F. Boyer (Centre d'Études et Recherches des Charbonnages de France), described some recent work on the rates of oxidation, the activation energies involved, and the depth of penetration of the oxidation reaction into coal particles.

In the production of carbonized briquettes, marked fusion and swelling of the coal is disadvantageous; but these characteristics may be modified or destroyed by a number of methods, principal among which is oxidation. The addition of as little as 1 per cent of oxygen, for example, to the coal can eliminate these adverse effects. However, the fundamental changes which occur on oxidation, particularly the mechanisms of the chemical changes, are as yet not understood. Dr. D. W. Gillings (formerly of the Coal Research Establishment, National Coal Board) pointed out that one effect of oxidation is to decrease the plasticity of the coal. M. Boyer believes this to be an unimportant effect, and considers that the important effect of oxidation is to change the shrinkage characteristics of the coal on carbonization. Dr. J. Bronowski (Coal Research Establishment) pointed out that most explanations have been centred on the amorphous constituent in coal, but that oxygen can also act on the organized graphitic structures in coal, and that further insight into the process should be gained by studying the bonding of these graphitic layers. Mr. E. H. Williams (Coal Research Establishment) directed attention to the fact that the oxidation process may take different courses with different coals, and illustrated his point by showing the differing rates of oxidation in coals of different volatile contents.

The second paper at this session, entitled "Fluidized Oxidation of Coal", concerned the design and operation of a pilot plant for the oxidation of coal at the Coal Research Establishment, and was presented by Dr. G. I. Jenkins. This plant, which operates on the dense-phase fluidized principle, has a throughput of 1 ton per hr. It is composed of four main sections: (*a*) coal grinding and drying; (*b*) hot gas supplies; (*c*) control instruments; (*d*) reactor columns. The plant is fully automatic and is equipped with recording and control instruments for bed temperature, gas flows and temperatures, oxygen concentration of ingoing and exit gases, bed-level and coal feed. Coal has been oxidized at a number of different temperatures up to 400° C., using gases with oxygen concentrations ranging between 10 and 21 per cent. Other variables investigated are distribution of coal-size and contact time. From the results, the heat of the oxidation reaction at a series of temperatures has been deduced and found to be in the range 50 B.Th.U./lb. at 250° C. to 200 B.Th.U./lb. at 375° C. In the discussion, Mr. T. Kennaway (Simon Carves, Ltd., London) described an alternative method of dilute-phase fluidized oxidation, for which he claimed simplicity of construction and of operation. Dr. Jenkins considered, however, that the dense-phase method is to be preferred because it allows more flexibility in the control of variables.

Briquetting of Small Coal

The second session opened with a paper by Dr. W. Reerink (Steinkohlenbergbauverein, Essen) entitled "Investigations into the Carbonization of Briquettes in Germany". The briquettes were designed to replace coke used in blast furnaces and cupolas. In the preparation of the briquettes from powdered coal, use is made of a special binder (*Teerpechschmelze*) applied in liquid form to the coal. This special binder is similar to a 'cut-back' pitch in that it is prepared by adding certain aromatic oils to pitch. Such a mixture, Dr. Reerink claimed, has improved properties of wetting the coal, and hence it leads to a reduction in the weight required. Dr. Kurt Baum (Kurt Baum and Co., Essen), in discussion, emphasized the need to accelerate the carbonization of the briquettes, which at present takes more than five hours. Success in this respect requires the design and adoption of continuous processes instead of traditional batch-wise methods, and attention was directed to work in progress on this subject at the Coal Research Establishment. The potential importance of the use of carbonized briquettes in furnace and foundry work was emphasized. A demand has always existed for a close-sized reactive hard coke for this purpose, and the development of suitable briquettes would meet this.

The Coal Research Establishment's work on briquetting at elevated temperatures was described in a paper by Mr. D. H. Gregory, entitled "Hot Briquetting". This work was undertaken with two objects in view. First, since the briquetting stage may follow one of pretreatment from which the powdered coal is delivered hot, it is possible to conserve heat between pretreatment and carbonization. (It also has the advantage that there is a saving in pitch, because the coal itself becomes plastic and acts partly as a binder at these temperatures.) The second object was the briquetting of chars from fluidized carbonization, and for this purpose the binder used was a coal-and-pitch mixture. This mixture eliminates many of the difficulties experienced in hot briquetting by extending the range of temperature over which the coal remains plastic There is evidence also that the resulting briquettes may be smokeless. A somewhat similar process was described by Ir. G. Kardaun (Staatsmijnen in Limburg, Netherlands), in which a high-volatile coal is used as a binder for a low-volatile coal.

Carbonization of Powdered Coal in Fluid Beds

The first paper read at the third technical session was a joint contribution entitled "A Study of Semi-Carbonization in a Fluid Bed", by P. Foch and A. Peytavy (Centre d'Études et Recherches des Charbonnages de France). This paper described their experience in operating a fluidized carbonizer having a throughput of one ton per hour. The plant has been operated chiefly around two temperatures, 500° C. and 800° C., with the object of producing a char from high-volatile coals, suitable as a blending material in the production of metallurgical coke. The two chief problems outlined by the authors were those of introducing the necessary heat at a rate in keeping with the high throughput of the plant, and of suppressing the entrainment of fine coal and char dust in the gases, where they create acute difficulties in the operation of the by-product recovery system. Mr. J. Owen (Coal Research Establishment, National Coal Board), in discussion, referred to fundamental work carried out at the Coal Research Establishment on the measurement of the heats of carbonization (Millard, D. J., *J. Inst. Fuel*, 28, 345–351; 1955; *Nature*, **174**, 1099; 1954), and described a new method whereby similar results can be obtained from the fluid carbonizing plant itself. The results showed a very steep increase in the endothermic heat of reaction at temperatures between 600° C. and 700° C. Dr. Bronowski followed this up by showing that operation at temperatures around 500° C. and around 800° C. is much more favourable from the point of view of heat requirements than operation in the temperature-range between these values; there the heat requirements are at a maximum near 700° C.

Several speakers emphasized the importance of separation of the entrained dust from the by-product stream, and the wider importance of efficient by-product recovery, since the by-products are of vital importance to the economics of the process.

The second paper presented at this technical session was entitled "The Study of Tars obtained in Fluidized Carbonization", and the authors, Dr. G. H. Watson and Mr. A. F. Williams (Coal Research Establishment, National Coal Board), gave an account of the characteristics of a tar obtained by the low-temperature carbonization of a coal (Coal Rank Code 902) in a prototype 2-in. diameter fluid-bed carbonizer. While not an exhaustive examination (the amount of tar available was only 2 kgm., and examination was complicated by the thermal instability of the tar), the study afforded much information on the constitution of the principal chemical types. In the discussion, Dr. R. J. Morley (Carbonization Department, National Coal Board) pointed out that the constitution of the tar described resembles that of a vertical retort tar, while Dr. H. Bondy (Coalite and Chemical Products, Ltd., Chesterfield) remarked on the differences between this tar and that obtained by the coalite process. Two remarkable features of the tar are that it contains a disproportionate amount of high-boiling phenols and of high-boiling neutral oils.

Utilization of the By-Products from New Carbonizing Processes

Only one paper was read at the final technical session. It was a contribution by J. L. Sabatier (Charbonnages de France, Houillères du Bassin de Lorraine) entitled "Industrial Treatment of Low-Temperature Carbonization Tars". In M. Sabatier's absence, the paper was presented by J. M. Deruelle of the same organization. This paper described the industrial-scale refining of tars obtained from French experimental carbonization plants operating in the temperature-range 500°–700° C. The treatment is conventional and consists of a primary distillation into selected fractions which are further refined by extraction, crystallization or further distillation. The tar yields 10 per cent of phenolic compounds, 60 per cent of oils and 30 per cent of pitch. The principal phenolic bodies produced for marketing are phenol, mixed *m*- and *p*-cresols and 1-2-4, 1-2-5, and 1-3-5 xylenols. Market development is still in progress and will undoubtedly lead to more exhaustive refining of the tar.

In the discussion of the low-temperature tars described, the ease with which the tars may be oxidized to form resinous and pitch-like materials was emphasized, and this was related to earlier papers on the oxidation of coal. This brought out the importance of investigating carbonization techniques in which the heat for carbonization is introduced by methods other than partial combustion of the coal and char in the carbonizing vessel.

Dr. D. McNeil (Coal Tar Research Association) emphasized that the by-products from fluidized carbonization must be the subject of intensive research and that outlets differing from those for conventional tars must be developed.

In his closing address, Dr. Bronowski summarized the discussions and drew some general conclusions. He pointed out that the coal industry, like other traditional industries, is still reluctant to adopt multi-stage processes. The basic cost of handling the raw material in and out of a plant is now so high, however, that an additional stage adds relatively little to the cost of a process. It is essential to base new stages and processes on a scientific study of the fundamental mechanisms by which the chemical and physical properties of coal are changed. The conference showed that all the nations taking part had reached much the same point in these fundamental studies; but they were not all equal in their readiness to take these scientific findings to the pilot scale and to develop them into industrial processes. If we are to benefit from the advances in coal science, we must now concentrate a major effort on development.

The conference was followed by an open day on Friday, June 29, when about 360 guests viewed the experimental work of the Establishment.

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

REPORT FOR 1955

ALTHOUGH much work had already been done by an interim organization, the European Organization for Nuclear Research (C.E.R.N.) came formally into being only in September 1954. The first annual report, covering the period to the end of 1955*, describes in some detail the substantial progress which has been made. It will be recalled that there are twelve member States: Belgium, Denmark, France, the German Federal Republic, Great Britain, Greece, Italy, the Netherlands, Norway, Sweden, Switzerland and Yugoslavia. Each pays contributions roughly according to its national income, the proportions ranging from 23·8 per cent by France and the United Kingdom to 1·79 per cent by Norway. The main aim is to produce those major experimental facilities for pure nuclear research which are too costly for many, if not all, of the member States to provide for themselves, and the present programme includes the design and construction of a 25-GeV. proton synchrotron and a 600-MeV. synchrocyclotron. The governing body is the Council, composed of delegates of member States and assisted by a scientific policy committee with eight members, selected for their qualifications without regard for nationality. A finance committee, with national representation, guides the financial administration.

The present president of the Council is Sir Ben Lockspeiser, and the director-general is Prof. C. J. Bakker, who succeeded Prof. F. Bloch in September 1955 on the latter's return to Stanford University, California. Prof. Bakker's leading collaborators are J. B. Adams (proton synchrotron), W. Gentner (synchrocyclotron), L. Kowarski (scientific and technical services), P. Preiswerk (sites and buildings), C. Møller (theoretical physics) and J. Richemond (administration). The laboratories are under construction on a site provided by Switzerland, at Meyrin, near Geneva. Most of the staff are working in temporary laboratories in Geneva, although a few have already moved to Meyrin. The theoretical physicists are at present centred in Copenhagen. Much of the design of the accelerators and buildings had been established under the interim organization, and the period under review has been occupied in pursuing these plans. The original programme called for the completion of the synchrocyclotron during 1957 and the proton synchrotron during 1960. It is expected to be maintained.

Proton Synchrotron. The main parameters of the large machine were settled at the end of 1954, and no important alterations have been made since. The radius will be 100 m., and the magnet will consist of a hundred separate units with a total weight of steel of 3,200 tons. Protons will be injected at 50 MeV. from a linear accelerator, and the final energy will be 25 GeV. at the maximum magnetic field of 12,000 gauss. The principle of alternating gradient (or 'strong focusing') will be used, each magnet unit having focusing and defocusing portions. This system is now well understood, following much theoretical and experimental work at the Organization and at the Brookhaven National Laboratory in the United States, where a similar machine is being built.

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* European Organization for Nuclear Research, C.E.R.N. First Annual Report. Pp. vi+66. (Geneva: C.E.R.N., 1955.)

These two projects, which were the first of their kind, are in roughly comparable states of progress, and there has been close collaboration between the two groups. For example, a large electron model, a major project in itself, was built at Brookhaven as an analogue of a large alternating-gradient machine, and the results obtained with it have benefited both projects. There has been interchange of staff between the two laboratories.

The magnet units have to be very accurately made to a design which takes much careful work to establish, and the magnet at Geneva is now completely designed; several full-scale models of individual magnet units were made in order to arrive at a satisfactory solution of the many difficult problems. At the time when the report was written the magnet had not been ordered; but it was expected that tenders would be invited early in 1956. The 50-MeV. injector accelerator is already being manufactured, to a design similar to that of the proton linear accelerator under construction for Harwell. Design of the building and foundations for the proton synchrotron is a major problem. The large magnet ring has to be maintained in a circle and on a plane to within an accuracy of a few tenths of a millimetre, since particle instability is easily induced by misalignment errors when alternating gradient focusing is used. Little was known about such small earth movements over long periods, and prolonged tests were made with an experimental section of ring building, together with much accurate survey work. A method has been adopted whereby a heavy concrete ring is supported by eighty concrete pillars embedded in the rock which lies some distance below the surface. Construction of the ring building is now well advanced, and excavations for the laboratories and experimental hall have been made. The ring building will be mounded over with earth for radiation shielding, and heavy adjustable concrete walls, with beam channels, will be used for separating the experimental hall from the accelerator.

Synchrocyclotron. Most of the design of the 600-MeV. synchrocyclotron had been completed under the interim organization, with Prof. Bakker leading the design team. The magnet, with a pole diameter of 5 m. and containing 2,500 tons of steel, is under construction and was due for completion in August this year. The radio-frequency accelerating system is the most difficult problem in such a large synchrocyclotron. The system adopted is similar electrically to that evolved in Berkeley, California, for the conversion of the 184-in. synchrocyclotron there. The system at Geneva, however, is quite new mechanically, and the tuning-fork type of variable condenser is machined from a solid block of aluminium alloy. This system is also under construction, as are most of the auxiliary pieces of equipment for the accelerator. The heavy fixed shielding-walls have been built, and progress is being made rapidly on the remainder of the building work. Some of the staff of the Synchrocyclotron Division have been working in other laboratories, notably in the Universities of Liverpool and of Upsala, to gain experience of nuclear research with synchrocyclotrons in time for the commissioning of the machine at Geneva.

Other activities. The Scientific and Technical Services Division has been concerned with setting up electronics and mechanical workshops, instrumentation for nuclear research with the accelerators, and library and information services. A limited programme of cosmic-ray research has been started, to help the instrumentation activities to get under way. Design work on buildings had been pursued actively long before the final Organization was set up, and building work was started in 1954. At the end of 1955, 115,000 m.^{3} of earth had been excavated, and 11,000 m.^{3} of reinforced concrete had been set. The Organization has set up its own administrative machinery with its own staff and salary structure, terms of appointment, etc. The total number of staff employed at the end of 1955 was 286, of whom 108 were working on the proton synchrotron, thirty-two on the synchrocyclotron, forty-four on scientific and technical services, six on site and buildings, thirteen on theory, and fifty-nine on administration. These numbers will increase as the work develops. Detailed figures are given for expenditure during 1955, the total being about 18·8 million Swiss francs, or just over £1·5 million. The total expenditure for the first seven-year period is now estimated to be 197 million Swiss francs, plus an allowance of 10 per cent for contingencies.

The report, which is excellently written and produced, shows that the European Organization for Nuclear Research has made very good progress during its short existence so far. It is very encouraging that a co-operative project of such complexity, involving many countries, can be developed so effectively and smoothly. The value of the Organization to science generally, and to scientific progress in the member nations in particular, should more than repay all the effort and expense.

T. G. Pickavance

COMMONWEALTH OBSERVATORY, CANBERRA

REPORT FOR 1955

The Commonwealth Astronomer's report for 1955 on the Commonwealth Observatory, Canberra*, contains nine sections, the first of which, that dealing with time service, and positional astronomy, includes an account of transit observations with the 3½-in. reversible transit circle, which gave 171 determinations of clock error on 170 nights. Other matters referred to are: time signals, which were sent out four times each day, the average correction for the transmitted signal being 29 m.sec.; clock comparisons, maintained as in previous years, reports of which are forwarded to the Bureau International de l'Heure as a contribution to the determination of variations in the Earth's rotation; propagation of radio signals; and lastly, declination of *FK*3 stars. As the Munich observers completed their series of measures of declinations of southern stars with the Munich vertical circle, the instrument has been returned to its native city.

Section 2 of the report covers astrophysical investigations and is divided into various parts, the first of which is concerned with fundamental photometry; Dr. S. C. B. Gascoigne, assisted in the later stages by Dr. W. Heintz, completed the work of comparing the light from a calibrated standard lamp and that from twelve bright stars. This work is further reported under the heading of variable stars, in which Dr. Gascoigne continued the photoelectric observations of brighter galactic cepheids in two colours; the results are in course of preparation for publication, and curves for fourteen are already available. Dr. O. J. Eggen carried out photoelectric observations of short-period variables and discovered variations in four of these. Under the heading of spectroscopy, it is reported that the three-prism spectrograph at the Cassegrain focus of the Reynolds 30-in. reflector has been used for photographing more than five hundred spectra for radial velocity and about a hundred and eighty plates have been measured. This programme includes, *inter alia*, a study of the Scorpio–Centaurus cluster and some southern stars from the *N*30 Catalogue. In work on nebulæ and clusters, the theoretical studies are reported of the former Commonwealth Astronomer, Dr. R. v. d. R. Woolley, assisted by Mrs. D. A. Robertson, on the equilibrium conditions in globular clusters. Mr. A. W. Rodgers investigated obscuration in the Coal Sack region, and red and blue photographs of seven selected representative regions each approximately one square degree in area were obtained; the iris diaphragm photometer was used for measuring about two thousand stars. Under the heading of stellar atmospheres, reference is made to the work of Dr. A. Przybylski in the theoretical investigations on stellar atmospheres, on which he prepared two papers for publication.

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* Commonwealth Observatory, Canberra. Report of the Commonwealth Astronomer for the Year 1955. Pp. 5. (Canberra: Government Printer, 1956.)

In Section 3, dealing with buildings, grounds and equipment, the installation is announced of three major telescopes on which preliminary tests have been carried out: the 74-in. reflector, the 50-in. reflector which was previously the Great Melbourne telescope, and the 26-in. Yale–Columbia refractor. The first of these was officially opened by the Governor-General of Australia on November 8, 1955, and preliminary tests indicated a certain amount of astigmatism which, Hartmann tests at the prime focus suggest, is related to the method of supporting the primary mirror. The 50-in. reflector, set up as a Gregorian for a few nights for photoelectric observations, has proved satisfactory for this purpose. A plant for aluminizing the mirrors of both reflectors was in the course of delivery. The refractor has been installed, and extensive modifications by the Stromlo workshop have been carried out to such an extent that it has been possible to make preliminary tests. Among other matters referred to may be mentioned the Hilger recording microphotometer which is already in operation, and a spectrograph for use at the Newtonian focus of the 74-in. reflector, received from Carl Zeiss, of Jena.

In Section 4, in which workshop activities are reported, reference is made to the main work on the two reflectors and the 26-in. refractor, all of which have required attention from the electrical, mechanical and optical sections of the workshop. Essential maintenance was performed on telescopes, and mirrors of the 30-in. and 20-in. instruments were aluminized. A Muller-type double-image micrometer has been nearly completed.

The ionospheric prediction service (Section 5) has continued under Dr. W. Baker, and regular publication and exchange of ionospheric data have been continued. Routine measures of ionospheric characteristics were carried out at Canberra, Townsville, Brisbane and Hobart and in Macquarie Island. Dr. G. R. Ellis, working at Hobart, completed the investigations of the *Z* propagation hole in the ionosphere, and in association with Dr. G. Reber observations were made of low-frequency radio emission in the previously unexplored region below 9 Mc./s. Mr. F. E. Cook has continued the forecasting of ionospheric disturbances and has recommenced the observation of sunspots. Special ionospheric reports published include: "An Improved Method of Making High Frequency Radio Propagation Predictions", by J. Turner (Ionospheric Prediction Service *R*5); and "Forecasting of Geomagnetic Disturbances", by F. E. Cook (*R*6). Other sections of the report deal with publications, visiting astronomers and staff.

WEST AFRICAN MAIZE RUST RESEARCH UNIT

In 1949 a rust disease, hitherto unrecorded in Africa, appeared on maize in Sierra Leone. Within three years the disease, which is caused by *Puccinia polysora*, had spread right across the continent and had appeared on islands more than a thousand miles from the east coast. The West African Maize Rust Research Unit, Ibadan, was instituted late in 1952, and the first annual report (1953) of this Unit gives an account of its first year's work. The general background to the problem is given in a foreword by Mr. D. Rhind, the sponsor of the scheme. The Unit is small, being staffed by two scientists, Dr. W. R. Stanton (geneticist) and Mr. R. H. Cammack (mycologist), who have the assistance of a locally recruited technical staff. The main centres of the work are Nigeria and the Gold Coast. The volume of data here accumulated pays tribute to the foresight of the authorities in establishing the scheme, as well as to the energetic activities of those undertaking the work. The three articles from the scientific staff of the unit are backed by a detailed body of information in the form of appendixes.

The plan of the work falls into two sections; first, observations on the course and causes of the epidemic; secondly, the breeding of resistant varieties of maize. The observations on the disease and the associated factors are thorough, and are well tabulated for ease in examination. The record forms an impressive catalogue of the facts that have been considered. The initial spread of the disease, with details of date first recorded in different countries, and with notes on severity and distribution within these countries, is well documented, forming a clear example of the severity with which a new disease may attack and spread. This disease is likely to become a classic to future generations of students of plant pathology. However, purely academic interest is not for long allowed to remain: the economic effects of the disease as quoted appear quite serious. Even before the Research Unit was instituted interim palliative measures, suggested by field observations, were applied, and had somewhat improved the situation. The value of the field observations presented in the report is increased due to the use of a highly standardized, quantitative field assessment method for determining the intensity of rust on a plant or plot, with a minimum of subjectivity. An early observation from plot experiments revealed that intensity of rust was variable with the site of the plot in the territory; this variation in intensity has now been correlated with rainfall and humidity factors. Some further interesting associations are found between time of planting and intensity of rust, time of onset of rust, rate of spread of rust, and yield of the plant. Reduced host vigour later in the season, and increase in potential inoculum of the pathogen, are probably effective in the increased susceptibility of late planted maize. However, fast correlation of disease intensity with specific predisposing factors has not yet been made. Experiments on the effects of host vigour on susceptibility are promised. Such experiments may prove of wide importance, since soils in the maize-growing areas of West Africa, in common with those of other parts of the region, are poor in many of the properties regarded as desirable for the growth of plants. A comparative table of the major differences between *P. polysora* and the more common rust fungus which attacks maize, *P. sorghi*, is presented. This information should help to prevent the confusion between the disease caused by the two species which has apparently been possible in the past. It is shown that the two species differ in the physiology of their urediospores in respect of qualities relevant to infection in this part of the world. The greater virulence of *P. polysora* may be attributable in part to this factor.

The major part of the future work of the Unit would appear to be directed towards the breeding of resistant varieties of maize. So far only the uredial and telial states of the fungus are known: should the rust be truly hemicyclic then there is a high probability of the breeding programme being successful. One appendix to the report gives a list of more than three hundred seed acquisitions originating from most of the world's maize-growing areas. These have been tested under local conditions for resistance to the rust and for yield, and lines from New World sources show a generally high level of resistance. A score of lines promising in several characters, including resistance to other local diseases, have been selected for further work. The report emphasizes that the breeding project aims at a broader end than rust-resistance, the ultimate object of the Unit being to improve on the maize varieties that are currently grown in the region. With this aim in view a comprehensive discussion of the factors affecting maize yields in West Africa is given; in addition to the expected climatic, edaphic and husbandry factors, this discussion includes attention to peculiar local problems such as "elephant and monkey damage". A solution to some of the agronomic and cultural problems discussed here will be invaluable to the future development of the region as a whole.

Although this rust fungus appeared with great suddenness, and found local conditions and host plants favourable for its attack and spread, yet one feels from this report that the problem of the disease is well in hand.

DAVID PARK

ELECTRON SPIN RESONANCE IN MYOGLOBIN AND HÆMOGLOBIN

Orientation of the Hæm Group in Myoglobin and its Relation to the Polypeptide Chain Direction

IN experiments on two crystal forms of myoglobin, Bennett and Ingram[1] have found that the orientation of the hæm groups (one per molecule in myoglobin) relative to the crystal axes can be determined with considerable accuracy by measurements of electron spin resonance. The methods which they used are similar to those described in the following communication on hæmoglobin. They have now extended their investigations to include three further forms of myoglobin crystal (Bennett, Gibson and Ingram, data to be published), and in this paper we shall show how the results can be correlated on one hand with optical measurements of dichroic ratio, and on the other with indications of the predominant polypeptide chain directions derived from Patterson syntheses computed from X-ray diffraction data.

The hæm group contains a planar system of conjugated double bonds. Accordingly, one would expect it to act as a weak absorber of light when the electric vector of the incident (polarized) ray is normal to the plane of the group, and strongly when it lies in the plane. If it were known exactly how the absorption characteristics of a single hæm group varied with direction, then the three absorption coefficients of any myoglobin crystal could be calculated from the orientation of the hæm groups found by electron spin resonance. In the absence of precise data, one must make simplifying assumptions: the results to be quoted here indicate that in the met-form of the protein, it is a fair approximation to treat the hæm group as a two-dimensional circularly symmetrical absorber. It follows that if the direction cosines of the normal to the hæm group are l, m and n (relative to the crystal axes), and if, for example, the crystal is viewed in a direction parallel to c^*, the dichroic ratio is $(1-m^2)/(1-l^2)$ (this result is true for both monoclinic and orthorhombic crystals, the orthogonal axes of reference being taken as a, b and c^* in the former case). Table 1 gives the predicted and observed dichroic ratios for five different crystal forms of myoglobin; in all of them the agreement is satisfactory (except in type D, where the magnetic results are less accurate than the rest, and where the arrangement is such that the calculated dichroic ratio is very sensitive to

Table 1

Type	Species	Space group	Direction cosines of hæm group normals l	m	n	Dichroic ratio			Direction cosines of rod directions l	m	n	Angle between rod direction and hæm normal	hæm plane
							Calc.	obs.					
A	Sperm whale	$P2_1$	0·89	0·36	0·28	(‖c^*)	4·2	4·0	0·44	0·34	0·78	40°, 59–65°	50°
						(‖a)	1·15	1·15					
B	,, ,,	$P2_12_12_1$	0·07	0·95	0·29	(‖c)	0·09	0·08–0·14	0	0·41	0·91	50°, 83°	40°
C	Seal	$A2$	0·69	0·20	0·69	(‖c)	1·8	1·8					
D	Blue whale	$P2_12_12_1$	0·7	0	0·7	(‖c)	0·7–1·3	1·4	0·57	0·46	0·68	43°, 83–89°	47°
F	Finback whale	$P2_12_12$	0·57	0·50	0·66	(‖c)	1·1	1·2	0	0	1	49°	41°

the exact orientation assumed). With crystals of derivatives of myoglobin other than met-myoglobin the agreement is much less good; thus the dichroic ratio of imidazole–myoglobin crystals is always less, and that of reduced crystals is always considerably greater, than the values quoted (Kendrew, J. C., and Parrish, R. G., unpublished results). Presumably in these derivatives the absorption characteristics of the hæm group must be more complicated than those postulated above.

We turn now to the question of polypeptide chain direction. Patterson syntheses of a number of crystal forms of myoglobin have been shown to contain rod-like regions of high vector density 10 A. apart[2]. These rods are most clearly visible in a three-dimensional Patterson synthesis of type *F* crystals (Bluhm, M. M., and Kendrew, J. C., unpublished results), in which the orientation of the molecules is particularly favourable, the rod direction being one of the crystal axes. In two-dimensional projections (usually all that are available) the rods are often obscured by other features of the vector structure, and may appear crossed at various angles to one another. However, it is sometimes possible to deduce unique orientations for the rods in (vector) space which are consistent with the features of all three principal projections. It has been postulated that these rods are the vector equivalents of a set of roughly parallel polypeptide chains forming a prominent feature of the molecule. In Table 1 we have listed the direction cosines of the rods deduced in this manner, together with those of the normals to the hæm groups, for all the crystal forms (except type *C*, where the interpretation of the Patterson projections is doubtful). We have calculated the angle between hæm normal and rod direction, with the results shown in the penultimate column. In general, alternative results are obtained, since we do not know which hæm group is associated with which set of rods (the unit cell may contain two or four of each, depending on the symmetry of the crystal). It will be seen that a value of 40–50° is consistent with the results for all the forms (the rod directions cannot be determined within 10°). The complement of this angle is the angle between the plane of the hæm group and the rod direction: the favoured solutions are listed in the last column.

The good agreement between the results for these four crystalline forms suggests that the angle between rods and hæm group is a characteristic feature of the myoglobin molecule even as derived from different species of animal. They suggest also that the rods in the Patterson projections are the vector equivalents of some feature of the molecules which has definite physical reality. If it be accepted that this feature is most probably a set of more or less parallel polypeptide chains, one is led to the interesting conclusion that in myoglobin these chains are oriented at an angle of 40–50° to the plane of the hæm group. Finally, the results for a given form are sufficient to determine uniquely the orientation of the molecules in the unit cell, and are thus a powerful aid in establishing the packing of the molecules in the different forms, a matter which will be enlarged upon in a subsequent publication.

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Aug. 17.

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Orientation of the Four Hæm Groups in Hæmoglobin

THE relation between the four hæm groups in hæmoglobin has been a subject of interest and speculation for a considerable time. The initial electron resonance measurements on single crystals of acid-met and fluoride hæmoglobin and myoglobin derivatives[1,2] indicated that the spectra are particularly favourable for accurate determination of orientation, since there is a large variation of *g* value from 6·0 to 2·0 as the applied magnetic field is rotated from a direction in the hæm plane to its normal axis. This variation forms the basis of the present analysis. All that is necessary, in principle, is to discover which crystallographic directions give the minimum *g* value of 2·0, and these are then known to be the directions of the normals to the hæm plane. In practice, the magnetic field is rotated around a convenient crystallographic plane and the orientation of the hæm normals found from the variation of *g* value with azimuth, the *g* value at any angle θ between the plane and the hæm normal being given[2] by $g^2 = 4(1 + 8 \sin^2 \theta)$. In an orthogonal system, it is therefore possible to determine the orientation of the axes from the results in a single plane; but for crystals of lower symmetry measurements in more than one plane may be necessary.

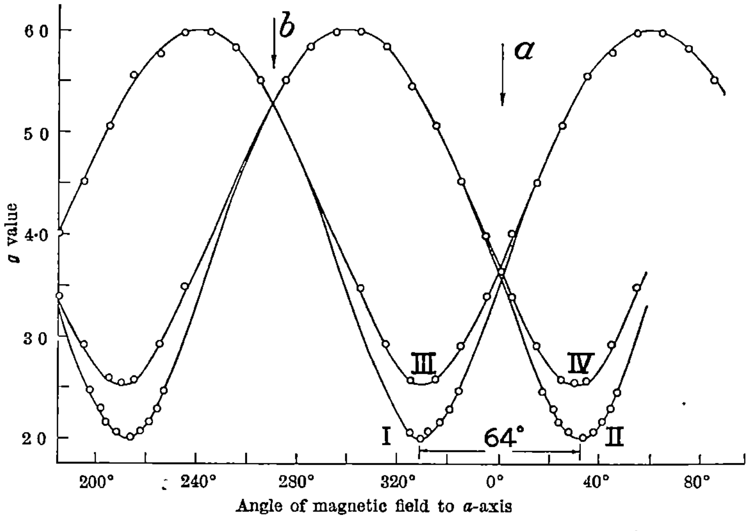

Fig. 1. Variation of *g* values with the direction of the magnetic field in the (001) plane of horse methæmoglobin

The measurements were made at a frequency of 36,000 Mc./sec. and at liquid-hydrogen temperatures, as for the myoglobin crystals[2], and standard methods of detection and display were employed[3]. Horse methæmoglobin crystals were chosen since they present a particularly favourable case. They are monoclinic and belong to the space group $C2$, with only two molecules in the unit cell[4]. The orientation of the two molecules is the same, each being placed on an axis of dyad symmetry. We should thus expect the four hæm groups belonging to each molecule to be arranged in two pairs symmetrically related by a dyad axis. The angular variation of g value obtained with a crystal mounted with the (001) plane horizontal (rotation about c^*) is shown in Fig. 1. All four curves have the same maximum g value of 6·0, since any arbitrary plane will always pass through the plane of the hæm group. Near the high g values the curves coalesce to form two pairs; but they separate near the low g values, showing that different hæm groups are inclined at different angles to the (001) plane. Two of the curves (I and II) are seen to reach the minimum value of 2·0, and hence two hæm normals are immediately located as lying in the (001) plane and at ± 32° to the a axis, which corresponds to the [110] and [1$\bar{1}$0] directions. The other two curves (III and IV) each have a minimum g value of 2·55 ± 0·10, corresponding to $\theta = 16 \pm 3°$. Their hæm normals must therefore enclose an angle of about 16° with the (001) plane, projecting on to it at an angle of 32° to the a-axis. These results are illustrated in a stereogram. (Fig. 2).

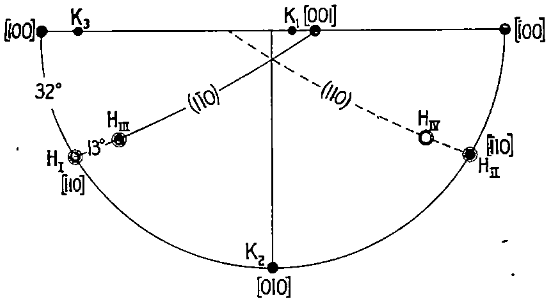

Fig. 2. Stereographic projection showing the poles of the normals to the hæm groups (H) relative to the monoclinic crystal axes. K_1, K_2 and K_3 refer to the principal directions of optical absorption

Another crystal was then mounted on the (110) face. In this case it was found that two of the curves had g values which remained close to 6·0, indicating that their hæm normals enclose a large angle with (110); these would correspond to the normals I and III in Fig. 2. The other two curves, corresponding to the normals II and IV in Fig. 2, both fall to the minimum of $g = 2·0$, showing that these two hæm normals lie in the (110) plane. However, the angle between the two minima is 13 ± 1°, which is more accurate than the angle of 16° deduced from the g value of curve IV in the (001) plane. The angles between the minima II and IV and the [001] and [1$\bar{1}$0] directions were then determined from the orientation of the crystal edges on the (110) face. One of the minima was found to coincide with [1$\bar{1}$0] as expected, and the other to enclose an angle of 13° with [1$\bar{1}$0] in the obtuse angle β. Other crystals were mounted to rotate about the a- and b-axes, with results confirming the above determinations. The orientations of the four hæm normals with respect to the crystallographic axes are therefore as shown in Table 1.

Table 1. ANGLES BETWEEN HÆM NORMALS AND CRYSTALLOGRAPHIC AXES

	a	b	c^*	c
Hæm normals I and II	± 32°	± 58°	90°	108°
Hæm normals III and IV	± 36°	± 57°	77°	95°

Fig. 3 is a perspective drawing in which the members of the two pairs are shown separately and in relation to the external shape of the hæmoglobin molecule[5].

The present measurements place no restrictions on the actual location of the hæm groups along the four normals, nor on their position in space, except that these must conform to the dyad symmetry of the crystal. Many different arrangements are thus compatible with our results. Three alternative kinds are illustrated in Fig. 4. In (a) and (b), the hæm groups are placed near the points of contact between neighbouring molecules in the (001) plane, whereas in (c) they are put next to the SH groups as suggested by Riggs[6].

In the preceding communication, Ingram and Kendrew show that in a variety of different forms of

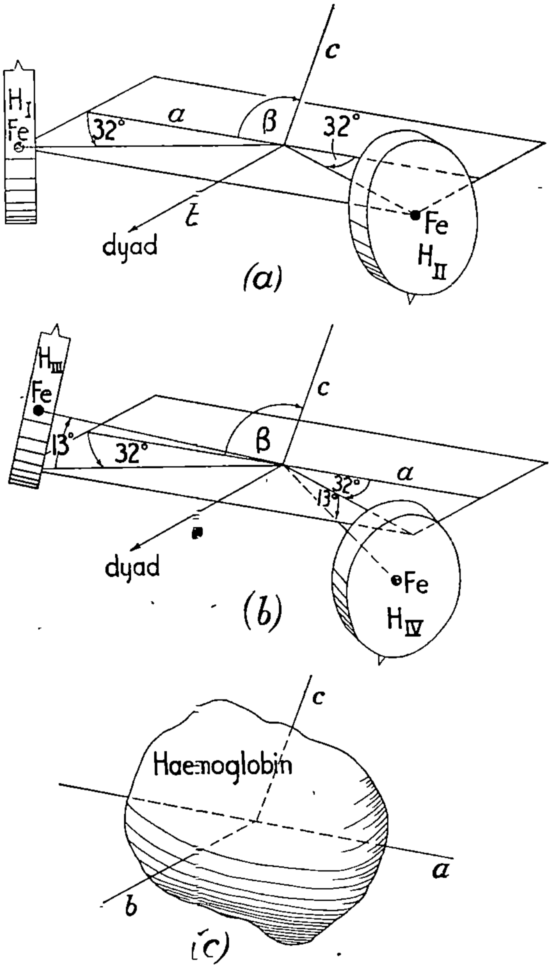

Fig 3. Perspective drawing of the orientation of the hæm groups with respect to the crystal axes and the hæmoglobin molecule. (a) and (b) show the two pairs of hæm groups related by the dyad axis; (c) shows the external shape of the molecule, as determined by Bragg and Perutz (ref. 5), drawn on a much smaller scale than the hæm groups

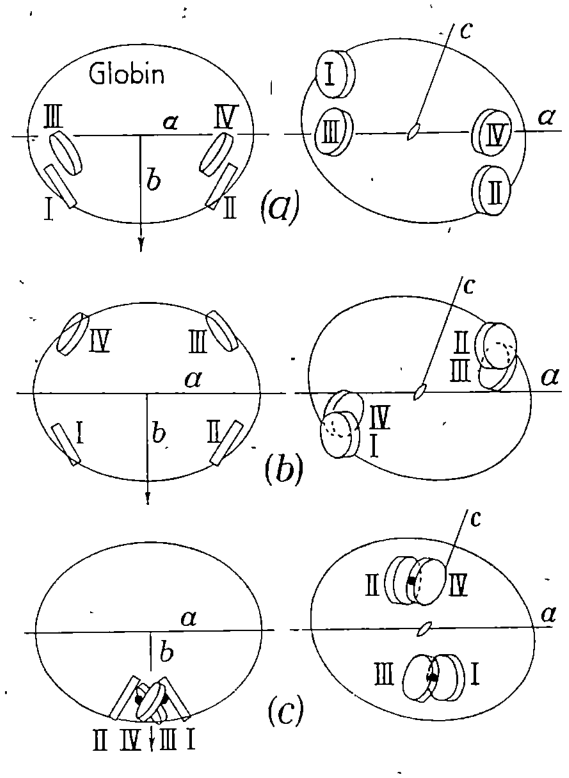

Fig. 4. Three of the many possible arrangements of the four hæm groups in the hæmoglobin molecule, represented diagrammatically as a spheroid. In each pair of drawings the left-hand one shows the molecule in projection normal to the dyad axis, and the right-hand one shows the same arrangement seen along the dyad axis. The small black points in (c) represent the positions of the SH-groups deduced from X-ray analysis

myoglobin the planes of the hæm groups enclose an angle of 40–50° with the polypeptide chain direction deduced from X-ray analysis. In hæmoglobin this angle is somewhat smaller (32° and 36°), so that there is no exact correspondence between the results obtained from the two proteins.

Ingram and Kendrew also show that the polarization dichroism of myoglobin crystals can be predicted from the results of electron spin resonance, by using the assumption that the hæm groups act as ideal two-dimensional absorbers. This calculation is useful both for the intrinsic interest of being able to predict the optical properties of a crystal and also as an independent check on the results—a check which is very sensitive, because the calculated dichroic ratios change by a large amount for a small change in the angles of the hæm normals. Horse methæmoglobin exhibits polarization dichroism of the negative uniaxial kind with dichroic ratios of $K_1/K_3 = K_2/K_3 = 2{\cdot}6$, and with K_3, the direction of least absorption, enclosing an angle of 10° with [100] in the obtuse angle β (Fig. 2)[7]. The results of electron spin resonance should thus allow one to predict both the angular orientation of K_1 and K_3 in the (010) plane and the dichroic ratios. Fig. 2 shows that K_3 lies roughly at the centre of the area marked out by the four hæm normals, which is the expected position; calculation shows that it actually lies within 3° of the predicted angle. The calculated dichroic ratios come to $K_1/K_3 = 3{\cdot}5$ and $K_2/K_3 = 2{\cdot}6$, which is probably as good agreement with the observation as can be expected in view of the simplicity of our assumptions.

It will be interesting to see if electron spin resonance can be obtained from reduced hæmoglobin, which has a different crystal structure and a dichroic ratio[7] of 4·5.

We should like to thank Dr. H. M. Dintzis and Mrs. T. M. Haughton for a supply of very large hæmoglobin crystals.

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POSSIBLE ROLE OF GROWTH INHIBITORS IN THE DORMANCY OF SEED OF *XANTHIUM* AND LETTUCE

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THE dormancy phenomena shown by the seeds of *Xanthium* species have been the subject of many investigations during the past fifty years[1]. The fruits of *Xanthium pennsylvanicum* each contain two seeds, the 'lower' of which germinates readily after a period of dry storage, whereas the 'upper' seed remains dormant when sown under similar conditions. The dormancy of the 'upper' seed is considered to be due to the relative impermeability of the testa to oxygen, and is generally quoted as the classical example of dormancy due to this cause. Recent experiments by us, however, suggest that the dormancy of *Xanthium* seeds also involves certain germination inhibitors present in the embryo, as well as oxygen effects.

The leaves, fruit-coats and other parts of the plants of *X. pennsylvanicum* have been shown to contain a highly active growth-inhibitor, referred to as 'xanthinin'[2]. Preliminary experiments by us showed that although very little 'xanthinin' appears to be present in the seeds, the latter contain other inhibitors not present in other parts of the plant. These inhibitors from the seeds could not be extracted by solvents such as diethyl ether or absolute ethanol,

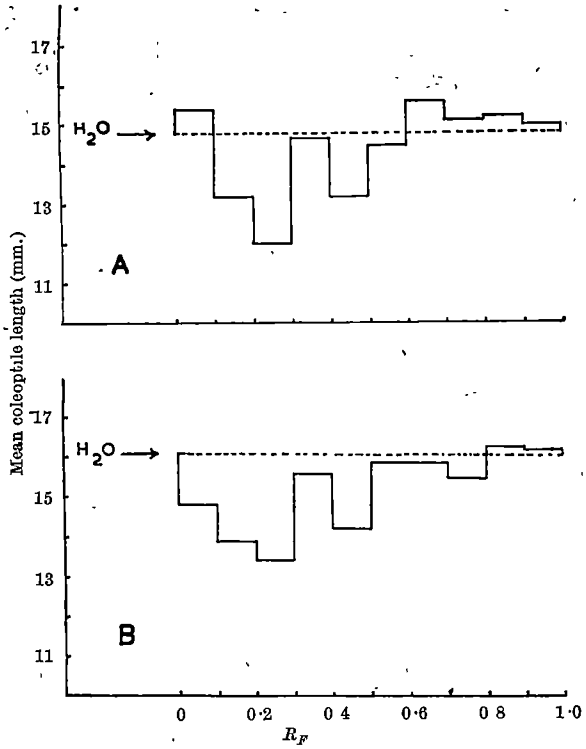

Fig. 1. Growth activity of aqueous extracts of (*A*) *Xanthium* seed and (*B*) lettuce seed, after separation by paper chromatography, using 75 per cent isopropanol + 25 per cent aqueous ammonia (0·88 S.G. × 1/100) as running solvent. Abscissæ: R_F value. Ordinates: growth of 10 mm. wheat coleoptile sections. The dotted horizontal line indicates the growth of control sections in water. Ordinates below this line indicate growth inhibition

but were readily extracted by water or 50 per cent aqueous ethanol. The concentrated extracts were chromatographed on paper, using 75 per cent isopropanol + 25 per cent aqueous ammonia (specific gravity, 0·88 × 1/100) as a solvent. The chromatograms were assayed for growth-activity using primarily the 'straight-growth' method with coleoptiles of oats or wheat. Two highly active growth-inhibiting zones (referred to as *A* and *B*) were found to occur at R_F 0·1–0·3 and 0·4–0·5, respectively (Fig. 1). The high activity of these inhibitors is shown by the fact that an extract of the inhibitor *A* from 1 gm. of seed in 10 ml. of water brings about 58 per cent reduction of growth of the coleoptiles. The *A* inhibitory zone shows a bright green fluorescence, while the second zone *B* gives a blue fluorescence, so that the position of the zones can be determined visually as well as by growth-activity. The *A* and *B* zones were also found to be strongly inhibitory to the growth of cress roots, the germination of lettuce seeds, and the growth of the radicles of *Xanthium*. Most of the growth-inhibiting activity present in the seeds is contained in the embryo itself, and is present in both the cotyledons and the radicle. The inhibitors were found to appear during the later stages of development of the embryo, and to disappear rapidly during germination.

The presence of highly active inhibitory fractions in the embryo raises the question as to whether they may play a part in the dormancy of the seeds. It seemed possible that the presence of the testa may promote dormancy by preventing leaching of the inhibitors from the embryo, apart from any effect it may have on gaseous exchange. This hypothesis is supported by the observation that whereas the inhibitors are rapidly leached out of the isolated embryos by water, very little inhibitory activity can be extracted from the *intact* seeds by leaching. A number of further experiments were carried out to test the 'inhibitor hypothesis'. For this purpose it was found that freshly harvested seeds provided very favourable material. Immediately after harvesting, both upper and lower intact seeds are dormant and cannot be induced to germinate so long as the testas are intact.

An experiment was carried out with two series of freshly harvested seeds, which were soaked in a large volume of water for 48 hr. The testas were removed from one series of seeds before the period of soaking, while the other series was soaked with the testas present. After the period of soaking, the testas were removed also from the second series of seeds. Both series were then sown in Petri dishes under conditions which would preclude any further leaching during the germination test. It was found that the embryos from which the testas were removed prior to soaking germinated readily, whereas those which retained the testas during soaking did not germinate. When the 'leaching' experiment was repeated and the embryos maintained in an atmosphere of pure oxygen after sowing, both series of embryos germinated. This latter result establishes two important points, namely: (1) failure of the unleached embryos to germinate in air is evidently not due to inadequate water-uptake during the period of soaking of the intact seed; (2) when precautions are taken to avoid any leaching after sowing, unleached embryos require increased oxygen tensions for germination even in the absence of the testa. Thus, the requirement of the intact, upper seeds for increased oxygen tensions cannot be ascribed wholly to impermeability of the testa to oxygen. On the other hand, the effect of soaking the isolated embryos suggests that dormancy of the freshly harvested and after-ripened seeds may be removed by the leaching out of water-soluble inhibitory substances, which are prevented from being leached out in the presence of the testa. Determination of the activity levels of the inhibitors in leached and unleached embryos confirmed that leaching does, indeed, result in a marked decrease in the inhibitor-content. Dormancy may thus be overcome either by leaching or by increasing the oxygen supplies to the tissues.

Further experiments were carried out to determine whether the effects of increased oxygen could be related to changes in inhibitor content. It was found that when isolated embryos were maintained in pure nitrogen they remained dormant and the fluorescent inhibitory material in the radicles remained present. When, however, the embryos were maintained in an atmosphere containing sufficient oxygen for germination, then the fluorescent material in the radicles became greatly reduced within a period of 30 hr., before any appreciable radicle elongation could be detected. This observation suggested that the inhibitors may undergo enzymically controlled breakdown in the presence of oxygen. Cell-free extracts were prepared from the radicles of germinating seedlings by extracting the macerated tissue with water, followed by precipitation with acetone. On re-dissolving the precipitate in water, it was shown that the extract was capable of bringing about the rapid breakdown, *in vitro*, of the fluorescent inhibitory material, when mixed with the latter. This breakdown *in vitro* can only occur in the presence of atmospheric oxygen. The activity of the cell-free extract was destroyed by boiling. Cell-free extracts from the leaves of older plants of *Xanthium* were also shown to bring about breakdown of the seed inhibitors. These observations suggest that an oxidase system is present in the tissues, which is capable of bringing about breakdown of the inhibitor in the presence of oxygen. It seems possible, therefore, that the stimulation of germination by increased oxygen tensions is due to a specific effect upon the breakdown of the inhibitors, rather than to an increase in the rate of respiration and general metabolism.

Experiments were carried out to determine whether any difference in inhibitor content could be detected (1) between freshly harvested (dormant) and after-ripened (non-dormant) lower seeds, and (2) between upper (dormant) and lower (non-dormant) *after-ripened* seeds; but no appreciable difference in inhibitor content could be detected as between these various types of seed. It would appear, therefore, that the changes in the depth of dormancy occurring during after-ripening in dry-storage are not primarily ascribable to differences in inhibitor-content, but may involve activation of the enzyme-system which brings about the breakdown of the inhibitors.

There is a close parallelism between the dormancy phenomena occurring in *Xanthium* seed and in those of birch[3] and certain varieties of lettuce. We have found, moreover, that when lettuce seed is extracted and separated by the same chromatographic technique as used for *Xanthium* seed, inhibitory zones appear at the same R_F values as the *A* and *B* inhibitors of *Xanthium* seed (Fig. 1), and show the same fluorescence properties as the latter. By analogy with the phenomena in *Xanthium*, it would thus seem that inhibitors may also play a part in the dormancy of lettuce seed.

It has not hitherto been reported that *Xanthium* seed is light-sensitive; but we have recently found that dormant, intact upper seeds can be induced to germinate if exposed to 18-hr. daily photoperiods of an intensity of 5,000 lux at 25° C. Under 10-hr. photoperiods the germination is much reduced, and the seeds remain completely dormant if maintained in darkness. The day-length effect is enhanced if the seeds are subjected to temperatures alternating between 25° and 18° C. How far this is a true photoperiodic phenomenon requires further investigation. The demonstration that germination of *Xanthium* seed is promoted by light indicates a further resemblance with dormancy effects in birch and lettuce seed.

These studies will be published in detail elsewhere.

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GLASSES BASED ON THE OXIDES OF MOLYBDENUM, TUNGSTEN AND URANIUM

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IN previous publications from this Laboratory, attention has been directed to glasses of unusual composition based on the oxides of tellurium and vanadium[1-4]. This article describes the development of further unusual glasses based on the oxides of molybdenum, tungsten and uranium.

The first stage of the work was to investigate the glass-forming behaviour of melts in a large number of binary systems. A very small quantity (10–20 mgm.) of each mixture was melted in a V-shaped kink in a resistance-heated platinum alloy wire. When the mixture was completely molten it was quenched by switching off the heating current. The melt was observed using a stereoscopic microscope with a magnification of 25. The method will be described in more detail elsewhere.

Binary mixtures of MoO_3 with the following oxides were investigated: Li_2O, Na_2O, K_2O, CaO, SrO, BaO, PbO, ZnO, MnO, Al_2O_3, Bi_2O_3, P_2O_5 and V_2O_5. Glass formation was observed in the systems Li_2O–MoO_3, Na_2O–MoO_3, K_2O–MoO_3 and BaO–MoO_3, the glass-forming compositions containing about 91, 87, 63 and 80 per cent of MoO_3, respectively. These glasses, which were transparent and coloured amber, devitrified very easily and could not be made on a scale larger than 20 mgm. The composition range of glass formation in each system was very narrow—about 5 per cent. Glass formation was also observed in the MoO_3–P_2O_5 system with all mixtures containing more than 11 per cent P_2O_5. These glasses, which were coloured black, did not devitrify easily. Stable glasses can also be made in the system MoO_3–TeO_2, and the properties of these glasses have already been described[3].

Very similar results were obtained in the binary systems containing WO_3. Binary systems of WO_3

Table 1. Compositions of Molybdate and Tungstate Glasses melted on the Scale of 20 gm.

Glass No.	Composition—Wt. per cent						Colour	Thermal expansion coefficient (10^{-7}/°C.)
	WO_3	MoO_3	P_2O_5	BaO	K_2O	Na_2O		
*W*1	75·6	—	20·0	—	—	4·4	Black	74
*W*2	66·7	—	27·4	—	—	5·9	Black	92
*M*1	—	76·5	19·3	—	—	4·2	Black	136
*BM*1	—	57 0	22 8	15·3	—	4·9	Black	145
*PM*3	—	69 6	15·4	—	11 7	3·3	Black	204
*PW*1	71·1	—	11·8	—	14·7	2·4	Amber	180

with the following oxides were investigated: Li_2O, Na_2O, K_2O, Tl_2O, Cu_2O, MgO, CaO, SrO, BaO, PbO, ZnO, CdO, MnO, NiO, B_2O_3, Fe_2O_3, As_2O_3, Bi_2O_3, SiO_2, TiO_2, GeO_2, P_2O_5, V_2O_5, Nb_2O_5, MoO_3. Colourless glasses which devitrified very readily were obtained in the systems Na_2O–WO_3 and K_2O–WO_3, the glass-forming compositions containing about 80 and 82 per cent of WO_3, respectively. Much more stable glasses were obtained in the system WO_3–P_2O_5 with all mixtures containing more than 11 per cent of P_2O_5. These glasses, like the MoO_3–P_2O_5 glasses, were black. A few WO_3–P_2O_5 glasses have been described previously by Rothermel, Sun and Silverman[5]. Stable WO_3–TeO_2 glasses can also be made[3].

Binary mixtures of UO_3 with the following oxides were investigated: Li_2O, Na_2O, K_2O, Cs_2O, CuO, MgO, CaO, SrO, BaO, ZnO, CdO, PbO, B_2O_3, Al_2O_3, SiO_2, GeO_2, TeO_2, P_2O_5, V_2O_5, As_2O_3, Sb_2O_3, Bi_2O_3, Nb_2O_5, Ta_2O_5, Fe_2O_3, NiO, MnO, WO_3 and MoO_3. It was found that the glass-forming behaviour of UO_3 is different from that of MoO_3 and WO_3, in that it more readily forms glasses with acidic oxides. Glasses were formed in the UO_3–V_2O_5 system with UO_3 contents between 20 and 60 per cent. These glasses, which were black, devitrified fairly readily; the most stable glass contained 30 per cent UO_3. Black glasses were also obtained in the UO_3–MoO_3 system with UO_3 contents between 40 and 55 per cent. These glasses devitrified readily and there was considerable volatilization at the melting temperature. Some indication of glass formation was observed in the UO_3–WO_3 system at the composition 50 per cent UO_3, 50 per cent WO_3. Finally, glass formation was observed in the UO_3–TeO_2 system with mixtures containing 10–20 per cent of UO_3; these glasses were yellow. Further small-scale experiments indicated that high percentages of UO_3 could be introduced into sodium borate, sodium silicate and sodium phosphate glasses. UO_3 could be most easily introduced into the Na_2O–P_2O_5 system, and glasses could be made containing up to 40 per cent UO_3.

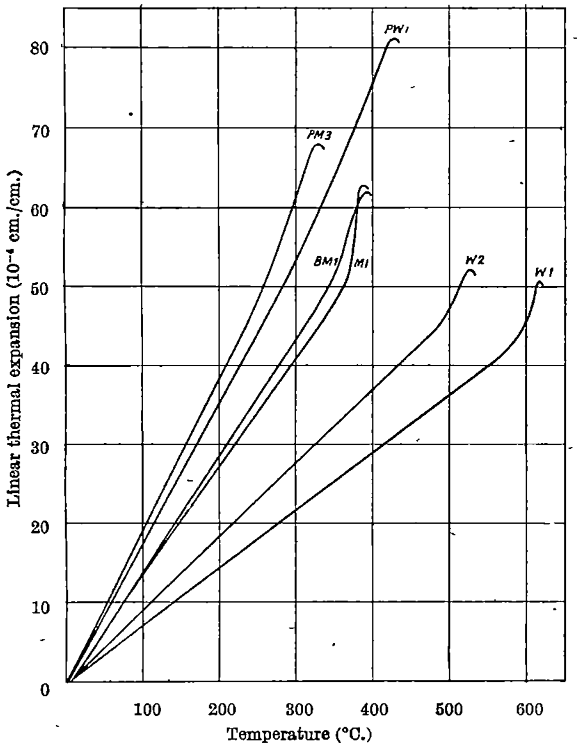

Fig. 1. The thermal expansion curves of some molybdate and tungstate glasses

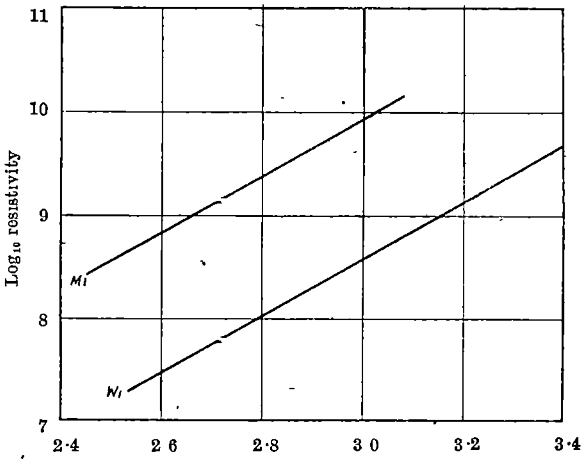

Fig. 2. The change in resistivity with temperature for a molybdate and a tungstate glass.

The K_2O–WO_3, K_2O–MoO_3, BaO–MoO_3 and UO_3–V_2O_5 melts which formed glasses when melted on a scale of 20 mgm. devitrified on cooling when melted on a scale of 1–2 gm. Experiments were carried out to determine whether the glasses could be stabilized by the addition of a third component. By far the most promising results were obtained by additions of P_2O_5, and it was found, for example, that with an addition of 10 per cent P_2O_5 to BaO–MoO_3 melts it was possible to make glasses on the scale of 20 gm. The addition of 5 per cent of P_2O_5 or TeO_2 was sufficient to stabilize melts in the V_2O_5–UO_3 system and glasses were obtained on the scale of 20 gm. Although glasses could not be made even on a 20-mgm. scale in the system WO_3–UO_3, the addition of 5 per cent P_2O_5 gave stable glasses which could be melted on a scale of several grams. An additional effect of adding P_2O_5 was to widen the composition range of glass formation.

The compositions of six tungstate and molybdate glasses are given in Table 1 together with their thermal expansion properties. Thermal expansion curves, and curves showing the change in electrical resistivity with temperature are shown in Figs. 1 and 2. The glasses were melted on the scale of about 20 gm. in silica crucibles at 1,000° C. The black colour and relatively low resistivity coupled with the absence of d.c. polarization effects indicate that the glasses of low alkali contents containing WO_3 and MoO_3 are semiconductors. This is presumably due to the presence of some of the molybdenum and tungsten in lower valency states. No attempt has yet been made, however, to establish the valency state of the molybdenum, tungsten and uranium in these glasses.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Absolute Configuration and Optical Rotation of Folded (α) Polypeptides

Since Pauling and Corey[1] proposed the α-helix for the structure of some folded polypeptides, evidence for the essential correctness of this structure has accumulated; but agreement between the observed X-ray diffraction pattern of oriented fibres and that calculated from the model has not been obtained. As Brown and Trotter[2] have recently shown, with α poly-L-alanine ($(CO.CH.CH_3.NH)_n$), where the scattering centre of the side-chain is fixed with respect to the helix, the agreement along the layer lines is very poor. In this case, the X-ray reflexions can be indexed on a unit cell through which only one chain passes, and it was assumed that both the sense of the helix (right- or left-handed) and the direction of the peptide sequence were identical for all chains. The fit was so poor that it could not be concluded with certainty whether the helices were right- or left-handed.

Since the α-helix conforms accurately to the conditions for minimum energy and also has dimensions which are almost exactly those required to fit the unit cell of poly-L-alanine, it seems likely that the atomic parameters of this helix must be very nearly correct. We have accordingly examined more general arrangements of eighteen-residue, five-turn helices (fibre repeat 27 A.), using the reflecting optical diffraction spectrometer which was described recently[3]. The fibre repeat in poly-L-alanine is longer than this[2], but the effect of the longer repeat on the optical transform is not appreciable. Like-handed hexagonal arrangements of helices which have near six-fold screw axes pack with the observed inter-chain distance whether all chains have the same direction of peptide sequence or not; the necessary condition is that the β-carbon atoms of the methyl side-chain groups should be in identical crystallographic positions. A random arrangement of the direction of the peptide sequence of the individual chains (which is very probable in the absence of strong polarizing forces) will produce the diffraction pattern of a primitive unit cell, though there is, in the strict sense, no unit cell. This arrangement of right-handed helices (corresponding to βC_1[4]) gives diffraction patterns in much better agreement with the observed X-ray pattern than does a left-handed one. The refinement of co-ordinates is not yet complete, but enough has been done to show that satisfactory agreement may be expected with quite minor changes in the co-ordinates originally given by Pauling and Corey[5]. It is most unlikely that any appreciable proportion of left-handed helices contributes to the crystallite reflexions. It is possible, however, that left-handed helices contribute to the observed layer-line streaks; but in this case the proportion would be small. We believe, therefore, that in poly-L-alanine the helices are mainly right-handed, and presumably α-helices of other L-amino-acid polymers will also be right-handed.

The specific optical rotation of an α-helix of poly-glycine (using a very simplified model) has recently been calculated by Fitts and Kirkwood[6]; for right-handed helices this is found to be +132°, in an aqueous solution with index of refraction 1·35. Poly-L-(or poly-D)-alanine is not soluble in non-polar solvents, and since in polar solvents the chains may be random coils (at least at low polymer concentrations) a direct measurement of the specific rotation of an α-helix of poly-L-alanine cannot well be made. However, a *meso* polymer containing a small proportion of one enantiomorph is slightly soluble in chloroform. From measurements on such material, the specific rotation of poly-L-alanine is about +50°, which is considerably less than the figure given by Fitts and Kirkwood for a right-handed helix without active side-groups. Unless their estimate is grossly in error, it would appear that the contribution of the side-chain opposes the form optical rotation of the helix. This would account for the generally low value of the specific rotation of polypeptides in conditions which favour the α-helix form. Fitts and Kirkwood[7] have recently, from similar considerations of optical rotation, also concluded that α-polypeptides form right-handed helices.

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An Improvement of the Hydrazine Method for Determination of C-Terminal Amino-acids

Hitherto, investigators using the hydrazine method of Akabori and co-workers[1] found it necessary to treat the peptides or protein with anhydrous hydrazine at not less than 100° for about 10 hr. in order to break all peptide bonds[2-4]. This severe treatment causes complete decomposition of cysteine, cystine and poor yields of arginine, aspartic acid and glutamic acid, with the result that they cannot be determined satisfactorily as C-terminal amino-acids. It is now shown that by the addition of an acid catalyst it is possible to decompose peptides under much milder conditions so that all the common amino-acids can be recovered in fair yield.

About 10 mgm. peptide or amino-acid and 26 mgm. $N_2H_4H_2SO_4$ were dried for about 3 hr. at room temperature under vacuum conditions (about 10^{-4} mm. mercury), 0·2 ml. 100 per cent N_2H_4 distilled in, the tube sealed, heated at 60° for 16 hr. and the excess hydrazine evaporated off over concentrated sulphuric acid in a vacuum desiccator. The residue was dissolved in about 1 ml. dilute hydrochloric acid, shaken with 0·4 ml. benzaldehyde for 2 hr., the aqueous solution separated by centrifugation and dinitrophenylated by Levy's method at 40° in $M/2$ carbonate buffer[5,6]. The aqueous solution (about 8 ml.) was extracted with ether (4 × 5 ml.), acidified with hydrochloric acid and extracted five times with 5 ml. ethyl acetate. The dinitrophenyl-amino-acids and unchanged peptides were separated by one-dimensional paper chromatography using the toluene, phosphate and *t*-amyl alcohol solvents[7]. (With lysozyme it was necessary to remove the dinitrophenol by vacuum sublimation at 40° prior to one- and two-dimensional chromatography). The spots were cut out, eluted with 1 per cent sodium bicarbonate and the optical density measured at 360 mμ (385 mμ for dinitrophenyl-proline) with a Unicam spectrophotometer. These values were converted to percentage yields (accuracy ± 10 per cent) using the results from dinitrophenylation, extraction and chromatography of each amino-acid or peptide separately.

From Fig. 2 it is clear that the hydrazinolysis of DL-leucylglycine is virtually complete after 16 hr. at 60° in hydrazine containing 1·0 *M* hydrazine sulphate but requires 80° for 16 hr. in the absence of catalyst. Since the yields of glycine are approximately the same by both methods (see Fig. 1) the milder acid-catalysed reaction is of no advantage in this particular case. However, it is to be preferred in general because of the greatly increased stability of some of the amino-acids at 60°. From Table 1 it is clear that all the reactive amino-acids, except tryptophan and histidine, are recovered in much better yields, particularly arginine, aspartic acid, cysteine, cystine and glutamic acid. A number of peptides are included to show the application of the method in this field. A 45 per cent yield of leucine was obtained from lysozyme (molecular weight 14,900), and further work on proteins, which is now in progress, will be reported later.

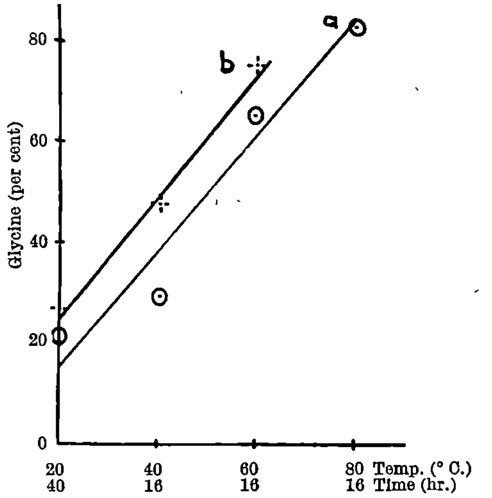

Fig. 1. Yield of glycine on hydrazinolysis of DL-leucylglycine: *a*, no catalyst; *b*, 1·0 *M* $N_2H_4H_2SO_4$

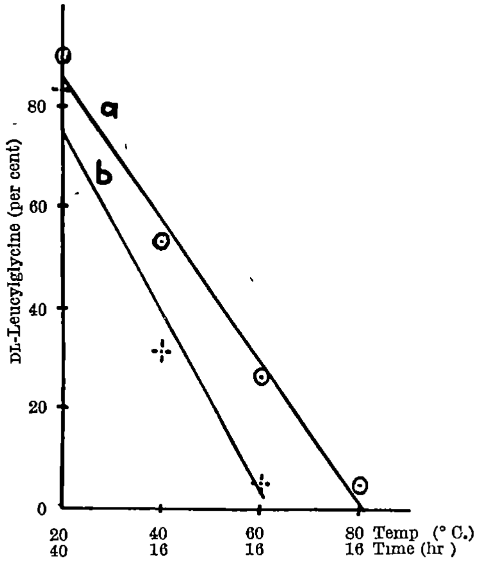

Fig. 2. Yield of unchanged DL-leucylglycine on hydrazinolysis of DL-leucylglycine: *a*, no catalyst; *b*, 1·0 *M* $N_2H_4H_2SO_4$

Table 1. YIELD OF C-TERMINAL AMINO-ACID OR AMINO-ACID ON HYDRAZINOLYSIS OF PEPTIDES AND AMINO-ACIDS

Material	C-Terminal amino-acid (%)	
	60°–16 hr. 1·0 *M* $N_2H_4H_2SO_4$ in N_2H_4[a]	100°–8 hr. N_2H_4, Niu and Fraenkel-Conrat (ref. 3)
L-Arginine hydrochloric acid	60[b]	25[b]
L-Aspartic acid	99	19
DL-Cysteine hydrochloric acid	86[c]	0
L-Cystine	78	0
L-Glutamic acid	76	16
DL-Histidine	53	43
L-Lysine hydrochloric acid	90	47
DL-Methionine { met.	66	0
DL-Methionine { met. sulphoxide	35	56
DL-Proline	97	52
DL-Serine	96	39
DL-Threonine	105	52
DL-Tryptophan	46	39
DL-Alanylglycine	92	39
DL-Glycylleucine	69	
DL-Glycylphenylalanine	98	
L-Glycyltryptophan	20[d]	
L-Glycyltyrosine	65	
DL-Leucylglycine	75	
Glutathione	91 gly	

a, Yield of unchanged peptide always < 5 per cent; *b*, L-arginine completely destroyed and determined as ornithine (ref. 3); *c*, DL-cysteine completely oxidized to cystine and determined as such; *d*, 56 per cent yield in absence of $N_2H_4H_2SO_4$, hence the breakdown of tryptophan must be catalysed by acid.

I wish to thank Dr. M. Lipson for his interest in this work, Miss Ruth M. Dedman for technical assistance and Dr. E. O. P. Thompson for helpful discussions and the supply of lysozyme.

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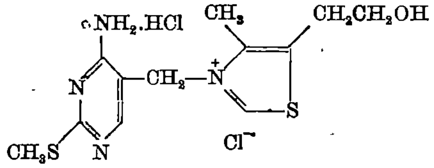
A New Antagonist of Thiamine

4-AMINO-5-hydroxymethyl-2-methylthiopyrimidine[1,2] (I) is an inhibitory antagonist of the pyrimidine moiety of vitamin B_1 (II)[3]. However, a thiamine-requiring mutant of *Escherichia coli* (strain *M*70–17) which can use II for growth will grow in the presence of I if the thiazole moiety of thiamine is also supplied. One possible explanation of this is that, under these conditions, the pyrimidine I is being converted to a functional thiamine-like compound. Consequently, it was decided to synthesize the thiamine analogue derived from I, which would differ from thiamine only in the nature of the 2-substituent, and



III

which, on the basis of a recently proposed mechanism of thiamine action[4], might be expected to have thiamine activity.

4-Methyl-5-(β-hydroxyethyl)-N-(4-amino-2-methylthiopyrimidyl-(5)-methyl)-thiazolium chloride hydrochloride (III) was synthesized by standard methods[5] from I, and its analysis was found to be satisfactory. Instead of replacing thiamine as a growth factor, III was found to be an inhibitory antagonist of thiamine in *E. coli*. The molar ratio of competition (inhibitor/thiamine) was of the order of 100 at concentrations which gave 50 per cent inhibition of growth. Thus, growth of strain *M*70–17 obtained with 0·0001 μgm./ml. of thiamine was inhibited 50 per cent by 0·01 μgm./ml. of III and 100 per cent by concentrations over 0·1 μgm./ml. An increase in the concentration of thiamine required a proportional increase in the concentration of III to give the same level of inhibition.

The corresponding 2-ethylthio compound has been tested on *Amoebae* and is inactive[6]. It would appear that enzyme systems have much more specific structural requirements than the chemical system studied by Breslow[4].

In view of recent work on the metabolic interaction of vitamins B_1 and B_6 [7], it may be of interest that the pyrimidine I has also been found to be an antagonist of pyridoxine[3].

This work was supported by grants from the U.S. Public Health Service. It is hoped to publish full details elsewhere.

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Factors favouring Restriction to 1,2 Glycols of Materials coloured by the Periodic Acid–Schiff Reaction

While periodate oxidation was reported first as a histological method for the demonstration of mucin[1], subsequent studies showed its utility for the colouring of glycogen[2] and other carbohydrates or carbohydrate-containing materials[3] in tissue sections. In its present histochemical use, periodate oxidation of tissue sections produces aldehyde presumably from certain specific linkages, chiefly 1,2 glycols and amino, alkyl-amino or ketone substituents of 1,2 glycols. The aldehydes produced by periodate oxidation are coloured with Schiff's reagent.

The initial confidence that only materials containing large numbers of 1,2 glycol linkages, presumably carbohydrates, were being coloured by Schiff's reagent after periodic acid (the PAS reaction[4]) was somewhat tempered by the fact that serine, threonine and 'hydroxylysine' would produce aldehyde after periodate oxidation[5] and quite possibly give a positive periodic acid–Schiff reaction. It was soon indicated that the susceptible linkages would not be available for oxidation in the polypeptide chain of the usual protein molecule and that only terminal serine, threonine and hydroxylysine would be expected to produce aldehyde on periodate oxidation[3]. Since the original publications on periodate oxidation in histochemistry, a number of relevant studies have appeared in the chemical literature without particular notice by histochemists. These are sufficiently important to be mentioned in this communication. The whole subject of periodate oxidation in histochemistry has been reviewed *in extenso* in a separate publication.

The originally described solution of periodic acid for histochemistry, and that which is most commonly used, is 0·5 per cent in distilled water. This has a molarity of 0·022 and a *p*H of 2·1 [6].

α-Glycols, hydroxyaldehydes, hydroxyketones and diketones are oxidized fastest in a slightly acid medium (*p*H 3–5)[7], while α-amino alcohol, amino aldehydes, amino ketones and diamines require a neutral or slightly alkaline medium (*p*H 7–8) for optimal oxidation-rate[8]. The hydroxyaldehydes, hydroxyketones, diketones, amino aldehydes and amino ketones would be expected to produce a coloration with Schiff's reagent without prior periodate oxidation. The diamines and α-amino alcohols do not react rapidly at the *p*H present in 0·5 per cent aqueous periodic acid. Dyer[8] points out that "simple and unhindered α-glycol and α-amino alcohol groupings will be nearly completely oxidized in 5–10 min. at their *p*H of optimum reaction if a moderate excess of periodate is present". The conditions of histochemical periodate oxidation, with a section on a glass slide immersed in a container of the oxidant solution, guarantees an excess of oxidant. The oxidation time originally used was two minutes, now it is five minutes. Dyer indicates further that periods of time longer than 5–10 min. are required for the oxidation of α-hydroxyaldehydes, α-hydroxyketones, α-ketoaldehydes, α-diketones and the corresponding amino derivatives. So long ago as 1941, Van Slyke, Hiller and MacFayden[10] had reported that excess of free periodic acid was associated with slow and incomplete reaction with hydroxylysine and serine.

These data from organic chemistry concerning the influence of time, excess of reagent, *p*H and molarity on periodate oxidation reinforce the belief that materials colouring with Schiff's reagent, presumably aldehydes, which are produced in tissue sections by 5 min. oxidation with 0·5 per cent periodic acid, in all probability consist of, or contain, 1,2 glycol groups and are presumably carbohydrates. Observations to the contrary, that materials of known carbohydrate nature do not give a positive periodic acid–Schiff reaction, and notably that of Jeanloz[11] with cellobiose, can be explained, as pointed out by McManus and Hoch-Ligeti[12], by technical difficulties such as the aldehyde-blockade produced by the use of bisulphite after periodate oxidation.

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Effect of Carbon Dioxide Inhalation on the Blood-Brain Barrier

The trypan blue test has been used for studies of damage to the blood-brain barrier caused, for example, by carbon monoxide[1]; but so far as can be seen from the literature no investigation has been carried out on the effect of carbon dioxide on the barrier. Histopathological changes after prolonged exposure to carbon dioxide have been reported by Stephens[2]. They consisted mainly of swelling, chromatolysis and vacuolation of nerve cells.

The present experiments were performed on rabbits which were exposed to various concentrations (10, 15, 20 and 30 per cent) of carbon dioxide in oxygen in a gas chamber. The exposure times varied from 2 to 60 min. Ten minutes before the exposure a trypan blue solution was injected intravenously. Ten minutes after the exposure the animals were killed and their vessels were washed out with normal saline followed by a 20 per cent formalin solution for fixation. On serial frozen sections the whole brains were examined for blue stainings and hæmorrhages.

30 per cent carbon dioxide for 2 min. scarcely caused any obvious changes; but already after 3 min. exposure more consistent changes were seen. After 4, 5 and 10 min. exposure the changes were more pronounced, consisting of marked multiple stainings as well as multiple hæmorrhages. After 15 min. or more the changes often were maximal. Some of these brains were almost totally blue, and there were rich hæmorrhages in the brain substance and the meninges.

In animals exposed to the lower concentrations of carbon dioxide the changes were proportionally less pronounced and occurred only after a somewhat longer exposure. However, still with 10 per cent carbon dioxide and 15 min. exposure clear changes were seen.

The damage to the walls of the blood vessels obviously was reversible within a short time, which was shown by the fact that when trypan blue was injected a few minutes after the gas exposure, the stainings were only slight and the hæmorrhages were unstained.

It may be questioned whether the cause of the barrier damage was a vigorous dilatation of thin-walled vessels or may be a direct toxic effect on the endothelial membranes. The results indicate that hypercapnia is a factor that should not be disregarded as a cause of cerebral damage, for example, in asphyxia, where the component of anoxia sometimes seems to have been over-emphasized.

A detailed account of this work is to be published elsewhere.

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Nature of Reticulin

For a long time there has been confusion in the use of the name 'reticulin' to describe the argyrophilic fibrous structures present as basement membrane in the parenchymatous organs and also to describe fibres which are histologically similar but which are present in developing connective tissue. Recently, however, a number of workers[1-3] have shown that the basement membrane type of reticulin is a complex composed of collagen, carbohydrate and lipid which are released only after acid hydrolysis. Windrum *et al.*[3] have questioned the assumption that the two types of reticulin are identical. We now report evidence which suggests that they are indeed different structures.

In the early stages of development of a granuloma produced by subcutaneous injection of carrageenin[4], the fibres present are largely of the reticulin type. Such tissue has been subjected to a differential extraction procedure[4] and examined histologically after each extraction. The histological examination showed that: (*a*) after extraction with $0 \cdot 2$ *M* sodium

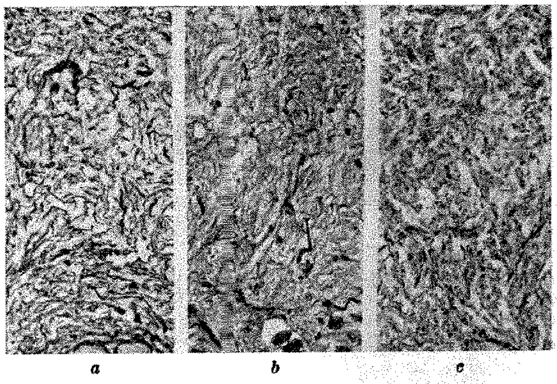

Fig. 1. Carrageenin granuloma after six days.
a, Normal control showing abundant silver staining reticulin fibres; *b*, after neutral salt extraction the fibres lose their argyrophilia and stain red with Van Gieson; *c*, extraction with citrate buffer after neutral salt gives almost complete removal of fibres.
All stained under identical conditions by silver impregnation/Van Gieson. (× *c.* 120)

chloride, pH 7·4, the fibres failed to stain with silver but took up the Van Gieson stain for normal collagen fibres; (*b*) following this with extraction with citrate buffer pH 3·6 removed the fibres almost completely (Fig. 1). The process extracts citrate-soluble collagen from the tissue[4], and this has been shown to contain little or no carbohydrate[5] and no lipid (unpublished data). Hence this type of reticulin is different from the reticulin of the parenchymatous organs. Extraction with 0·2 *M* sodium chloride removes neutral salt-soluble collagen[6], and it may be that the silver staining is due to the presence of a layer of this collagen type which is not yet incorporated firmly into the collagen fibre structure, although it has been shown recently that coating mature collagen fibres with a number of substances induces them to stain with silver[7].

This investigation will be reported in detail elsewhere.

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An Isotope-Derivative Method for the Detection and Estimation of Œstrogens

About ten years ago Keston and co-workers developed an isotope dilution method for the estimation of amino-acids[1]. This method, by which the amino-group of amino-acids is labelled with radioactive 'pipsyl chloride' (*p*-iodophenylsulphonyl chloride, labelled with iodine-131), was not found applicable for other types of compounds until recently. Last year, however, this method was also used for the detection and estimation of histamine[2], pyrimidines[3] and 17-hydroxycorticosterone[4]. In the last method the labelling agent was 'pipsan' (*p*-iodophenylsulphonylic acid anhydride).

In this laboratory we are interested in the detection and estimation of œstrogens in the blood of dairy cattle and other animals. Not being satisfied with the usual fluorimetric and colorimetric methods, we adapted the pipsyl chloride method to our investigation.

From our experiments it appears that the phenolic group in ring *A* reacts easily with pipsyl chloride in a 0·75 per cent solution of borax in 75 per cent acetone. The reaction is almost complete in 15 min. at room temperature if about 10 μgm. of œstrogen are esterified with 2 mgm. of pipsyl chloride in 0·4 ml. of 75 per cent acetone solution. Whether the hydroxyl groups at C_{17} (œstradiol and œstriol) and C_{16} (œstriol) are partially esterified under the given conditions has not yet been elucidated. The excess of reagent can be hydrolysed by adding a 2 per cent aqueous borax solution and heating at 50° C. for 30 min. Partition between benzene and water leaves the hydrolysed reagent in the aqueous phase, whereas the pipsyl derivatives and some both hydrolysed and non-hydrolysed pipsyl chloride are left in the benzene layer. Pipsyl chloride and the pipsyl derivatives of œstrone, œstradiol-17β and œstriol can be separated from each other by a paper chromatographic method, using Schleicher and Schüll 2043^a paper, previously dipped in a 10 per cent solution of paraffin oil in ether. An ascending technique is applied with mixtures of carbon tetrachloride/paraffin oil (7 : 2) and cyclohexane/paraffin oil (3 : 1) as the mobile phases. Complete separation is achieved after a 15 hours run (Fig. 1). The latter solvent has the disadvantage that the œstriol derivative remains on the start.

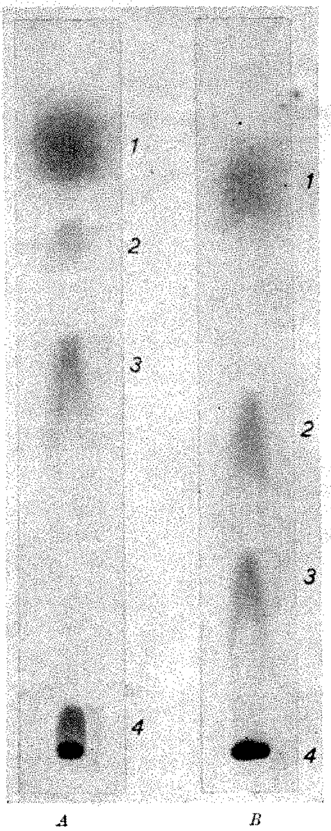

Fig. 1. Autoradiographs of the paper chromatographic separation of pipsyl chloride (1) and the pipsyl derivatives of œstrone (2), œstradiol-17β (3) and œstriol (4). Solvents: *A*, carbon tetrachloride–paraffin oil 7 : 2; *B*, cyclohexane–paraffin oil 3 : 1

So far amounts up to 0·3 μgm. œstrogen could be detected. We are continuing our experiments with more active preparations of pipsyl chloride to increase the sensitivity of the method.

In preliminary experiments blood samples of both non-pregnant and pregnant cows were examined. Extracts were prepared according to the usual methods for œstrogen determination. Each time one litre of blood was worked up. In the extracts a number of compounds which react with pipsyl chloride was detected. Whether one or more of these compounds are identical with one of the three common œstrogens is under investigation. A method for the quantitative determination of œstrogens by means of the isotope indicator method, which makes use of an indicator labelled with pipsyl chloride-^{35}S[5], is also under development.

Results and details of the method will be published elsewhere.

This work is financed by the Agricultural Research Council T.N.O. Thanks are due to Prof. L. Seekles for laboratory facilities and for his interest in the investigation, to Mr. G. H. Frederik and Mr. J. A. M. Clemens for making the autoradiographs and to Miss F. A. Schippers for technical assistance.

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Studies on the Biosynthesis of Neuraminic Acid

IN recent years neuraminic acid[1] and several of its derivatives, such as sialic acid and lactaminic acid, have been shown to be constituents of mucoproteins, gangliosides and related naturally occurring substances. Although the chemical structure of neuraminic acid has not been established as yet, its elementary composition and some of its chemical properties are known. The existence of this substance as either the free carboxylic acid or its corresponding lactone form has been demonstrated[2], and it has been postulated that a hexosamine residue is present[3]. The biological function of neuraminic acid remains obscure, although recent evidence indicates that this compound is liberated from its parent polysaccharide by the action of influenza virus or virus-receptor-destroying enzymes[3,4].

Since the biosynthetic origin of neuraminic acid has not been studied, an investigation was carried out with four objectives in mind: (1) to investigate the biosynthetic relationship between neuraminic acid and glucose and its metabolic precursors; (2) to establish on biosynthetic grounds whether a hexosamine residue is actually present in neuraminic acid; (3) to throw light, if possible, on the origin of the carbon atoms not associated with the postulated hexosamine residue; and (4) to provide carbon-14-labelled neuraminic acid which could be used to establish its chemical structure.

In the experiments to be reported here, uniformly labelled D-glucose-^{14}C with a specific activity of $4 \cdot 53 \times 10^6$ counts/min. per mgm. of carbon was injected intraperitoneally into rats in two experiments. The total carbon-14 activity injected into each rat was 14,887,000 counts/min. (8·2 mgm. of glucose-^{14}C). In the first experiment, two rats, each weighing 250 gm. and fasted for 8 hr., were injected with glucose-^{14}C in three equal doses at 2-hr. intervals. Twelve hours after the last injection the animals were killed, skinned and their combined tissues converted to a dry powder after homogenizing with acetone in a Waring blendor. The second experiment was conducted similarly but with only one rat weighing 450 gm. and fasted for 25 hr. before being given glucose-^{14}C. The carbon-14 activity of samples plated out on planchets as infinitely thin layers was measured in a gas-flow counter. Neuraminic acid, glucosamine and galactosamine were isolated from the acetone powders.

A newly devised procedure, the details of which will be published elsewhere, was used for isolating neuraminic acid. In brief, this isolation procedure involves the following steps: (1) The powdered carcass was refluxed with 5 per cent hydrochloric acid-methanol (w/v) for 5 hr. (2) After removal of the excess hydrochloric acid from the supernatant, 0·2 *N* aqueous mercuric chloride was added and the resultant precipitate discarded. The filtrate was then neutralized with 'Amberlite *IR 4B*' (OH form). (3) The filtrate and aqueous washings obtained from this resin were combined and placed on a column (2·5 cm. × 70 cm.) of 'Dowex-50', 4 per cent cross-linked, 200–400 mesh. In the upper third portion of this column, 'Dowex-50' was present in the mercuric form, whereas the lower two-thirds of the column contained the cation exchanger in its hydrogen form. The column was washed with water until the effluent solution did not show a green colour upon addition of Bial's reagent. (4) The column was now eluted with 0·3 *N* hydrochloric acid, whereupon hexosamine and the neuraminic acid were obtained in two discrete fractions. The hexosamine fraction was eluted first, and from it glucosamine and galactosamine were isolated according to the method of Gardell[5]. (5) The effluent fraction containing neuraminic acid was concentrated to a small volume after removal of hydrochloric acid. The concentrate was placed on 'Dowex-50' (H form) in a column (2·5 cm. × 40 cm.) and neuraminic acid was eluted with 0·3 *N* hydrochloric acid with a yield of approximately 12 mgm. per 100 gm. wet tissue. Neuraminic acid was crystallized after removal of hydrochloric acid from a mixture of methanol, water and petroleum ether (boiling point 30°–60°) and recrystallized first from methanol-water and then from water.

Neuraminic acid intended for use as carrier substance was isolated by the same procedure from bovine submaxillary mucopolysaccharide. The elementary analysis of this material (C, 42·49; H, 7·02; N, 4·55 per cent) was in good agreement with that reported by Klenk and Lauenstein[1]. The chemical identity and homogeneity of the unlabelled carrier substance and the radioactive material isolated was established as follows: (1) The absorption coefficient of the coloured material resulting from Bial's reaction was compared with that of an authentic sample of neuraminic acid; we are indebted to Prof. E. Klenk for supplying us with a sample of methoxy neuraminic acid for comparison with our material. (2) Paper chromatography was carried out in one of the two systems: (*a*) *sec*-butanol/acetic acid/water (4 : 1 : 5), and (*b*) *n*-butanol/acetic acid/water (4 : 1 : 1). (3) Infra-red spectra were used for comparison with an authentic sample. (4) Radiochemical purity after repeated recrystallizations served as an index of purity in the case of the carbon-14-labelled material.

In all instances, neuraminic acid was isolated as its methoxy derivative. Glucosamine and galactosamine were isolated as the hydrochlorides. The carbon-14 activity of the isolated compounds is

Table 1. CARBON-14 ACTIVITY OF NEURAMINIC ACID, GLUCOSAMINE AND GALACTOSAMINE

	Activity (counts/min./mgm. carbon)	
	Experiment 1	Experiment 2
Neuraminic acid	1,170	980
Glucosamine	1,560	
Galactosamine	2,580	

expressed as counts/min. per mgm. of carbon (Table 1). In the case of neuraminic acid, the carbon-14 activity has been corrected to eliminate the isotope dilution due to the methoxy carbon atom. In the case of the hexosamines, the carbon-14 activity represents that of the free hexosamine.

The results appear to support the thesis that the carbon atoms of glucose contribute directly to the biosynthesis of neuraminic acid, but do not warrant any conclusions as to the mechanism of biosynthesis. Since the injected glucose-^{14}C was diluted by the rat's glucose pool, which has been reported to be 130 mgm. per 100 gm. of rat tissue[6], it can be estimated that the isotope concentration in neuraminic acid has undergone a dilution of less than one hundred-fold. The extent of this dilution is interpreted as being indicative of a direct contribution of glucose carbon atoms to the biosynthesis of neuraminic acid.

A comparison of the specific carbon-14 activity of neuraminic acid with that of glucosamine and galactosamine shows that the isotope concentration of glucosamine approaches that of neuraminic acid but is less than that of galactosamine by a factor of 1·7. Although the pool-sizes of some of the intermediates as well as the rates of turnover are unknown at present, it seems reasonable to postulate that glucosamine is not a likely precursor of neuraminic acid, but that galactosamine could conceivably function in such a capacity.

This work was supported, in part, by a grant from the United States Atomic Energy Commission.

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Separation of Steroid Conjugates by Paper Electrophoresis

THE application of the principle of electrophoretic separation on paper to steroids is limited by their relatively low polarity, so that they do not readily migrate under the influence of an electric current, and also by their sparing solubility in aqueous media. By converting the steroids into derivatives with polar groupings, some separation has been achieved (Voigt and Beckmann[1], 1953, using the hemisuccinates; McKinley[2], 1955, using the mono- and di-phenylhydrazone derivatives). Our early experiments, begun before the publication of these authors' results, were along similar lines, and with somewhat similar results. It did not seem likely, however, that electrophoretic separation would be so convenient a method as chromatography, which has been adapted by Lembart and Schneider[3] for the separation on paper of mixtures of pure steroid conjugates. The natural occurrence of more polar steroid derivatives, the sulphates and glucuronides in urine, suggested to us that these might undergo electrophoretic separation on paper. Although the individual steroids could not be resolved, the two groups of conjugates were sharply separated.

The apparatus used was a simple box type, accommodating the paper strips horizontally. Of several systems tried, a veronal buffer solution of ionic strength 0·1 and *p*H 8·6 containing 20 per cent ethanol was found to give the best results. Whatman No. 31 filter paper was used, and a potential difference of 240 volts and a current strength of 0·5 m.amp. per cm. of paper was applied for 16 hr. A mixture of dehydroisoandrosterone and its sulphate subjected to electrophoresis under these conditions showed that the steroid sulphate travelled 11 cm. towards the anode while the free steroid had moved slightly towards the cathode. An extract containing both the free and conjugated steroids was obtained from urine by half saturation with ammonium sulphate followed by extraction with an ether–alcohol mixture. An amount of extract containing approximately 200 micrograms of total steroid was used for separation. After drying, the paper strip was treated with Zimmermann reagent. Two violet bands were obtained, both on the anode side of the point of application, the glucuronide fraction varying from 5 to 7 cm., and the sulphate from 8 to 10 cm. from the initial line. In addition, a very small amount of free steroid was found at, and slightly to the cathode side of, the starting point. A number of bands due to other non-steroid urinary constituents were also present; for example, a brown band of urea was always seen at about 1 cm. on the cathode side.

In addition to experiments on mixtures of known steroids, further evidence suggesting the composition of the two fractions was given by showing that the glucuronide fraction was almost completely removed by previous treatment of the urine with glucuronidase before extraction, and by demonstrating the virtual absence of glucuronic acid in the sulphate fraction. The fractions can also be quantitatively estimated after elution from an unstained strip, and this has been carried out both for normal and pathological urines and for blood. Table 1 shows the results from a normal adult urine, as an example.

Table 1

	Amount applied	Free steroids	Sulphates	Glucuronides
17-ketosteroids	140 μgm.	3 μgm.	37 gm.	99 μgm.
17-OH corticosteroids	88 μgm.	2 μgm.	6 gm.	82 μgm.

Besides affording a simple means of estimating the proportions of steroid sulphates and glucuronides in urine and blood, for which, so far as we know, there is no direct method, the procedure can also be applied for purifying the fractions prior to hydrolysis and subsequent identification of the components, and also for preparative purposes. Work along these lines is actively proceeding, and fuller details of the method and its applications will be published elsewhere.

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Effect of Di*iso*propylphosphorofluoridate on the Acetylcholine Content of Flies

Previous studies[1,2] of the action of di*iso*propylphosphorofluoridate (DFP) on insects have been primarily concerned with the inhibition of cholinesterase, but nothing has been reported about its effect on the acetylcholine (ACh) content. We have therefore examined the effect of di*iso*propylphosphorofluoridate on acetylcholine-levels in the blowfly (*Calliphora erythrocephala*) and the housefly (*Musca domestica*).

Flies were immobilized by cooling at 0° C.; 10 μgm. di*iso*propylphosphorofluoridate in 1 μl. acetone was applied to the dorsal surface of the abdomen, and, when paralysed (about 3 min.), the flies were transferred in groups to open dishes. At intervals after treatment with di*iso*propylphosphorofluoridate a group was taken for acetylcholine determination, either on the whole flies, or on the heads, thoraces or abdomina. Acetylcholine was extracted by the method of Lewis and Smallman[3], and assayed on the eserinized rectus abdominis muscle of the frog. Corresponding estimations were made on control flies treated with 1 μl. acetone only. The results are shown in Fig. 1.

In the whole fly there is a slow increase in acetylcholine content after di*iso*propylphosphorofluoridate treatment; but the distribution of acetylcholine within the insect is markedly influenced. In the head the level of acetylcholine begins to fall after about ½ hr., and at 3½ hr. it is only about 25 per cent of the control value. In the thorax there is an increase in acetylcholine content; but most striking is the accumulation of acetylcholine in the abdomen, where the level rises from less than 0·0005 μgm./abdomen in the control to about 0·07 μgm./abdomen in the poisoned fly after 3½ hr.

In comparable experiments with the housefly we have shown a similar fall in the acetylcholine content of the head of the insect poisoned with di*iso*propylphosphorofluoridate. Winteringham and Harrison[4], working with houseflies injected with 2-^{14}C-acetate, reported that of the total soluble carbon-14 in the head the proportion present as acetylcholine was doubled ½ hr. after treatment with di*iso*propylphosphorofluoridate, but after 5 hr. had fallen to the control level; and it may therefore appear that our results are in contradiction to their findings. However, these workers have also shown[5] that the total soluble carbon-14 in the head (mainly in amino-acids) is decreased ½ hr. after treatment with di*iso*propylphosphorofluoridate, so that the increase in the proportion of carbon-14 present as acetylcholine does not represent a corresponding increase in the absolute amount of acetylcholine.

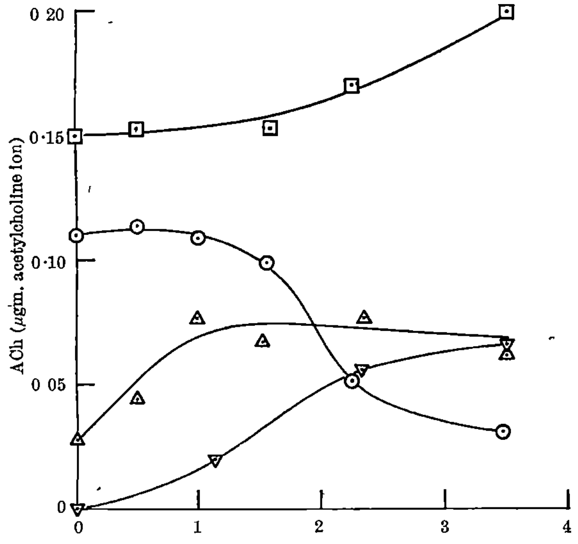

Fig. 1. Change in acetylcholine-levels in the blowfly after treatment with di*iso*propylphosphorofluoridate. (Levels in the untreated fly are plotted at zero time.) ⊡—⊡, Whole fly; ⊙—⊙, head; △—△, thorax; ▽—▽, abdomen

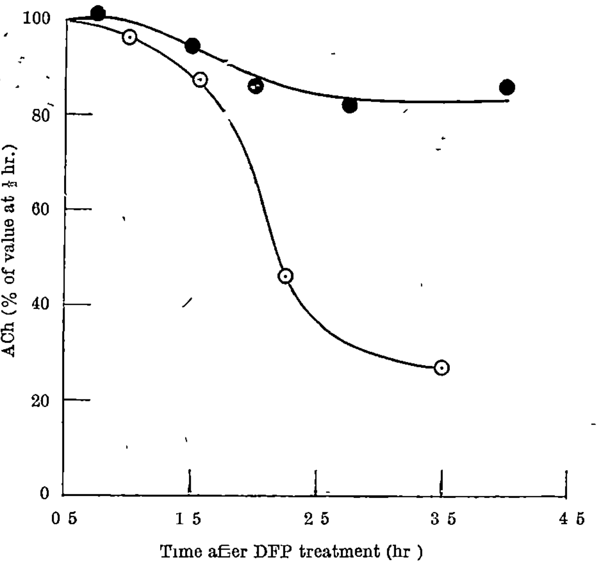

Fig. 2. Effect of decapitation on the fall in acetylcholine-level in the head of the blowfly treated with di*iso*propylphosphorofluoridate. ○—○, Head of intact fly, ●—●, head isolated ½ hr. after treatment with di*iso*propylphosphorofluoridate

We have also measured the acetylcholine content of the head of the poisoned blowfly at intervals after decapitation. Flies were decapitated ½ hr. after treatment with di*iso*propylphosphorofluoridate in groups of fifteen. Heads from one group were extracted immediately after decapitation and those from the remaining groups at intervals up to 3½ hr. The change in acetylcholine content in these heads after decapitation is shown in Fig. 2 in comparison with that occurring in the head of the intact poisoned fly over a similar period (both sets of values expressed as percentages of the acetylcholine content ½ hr. after treatment with di*iso*propylphosphorofluoridate). It is clear that the fall in the level of acetylcholine in the head of the fly treated with di*iso*propylphosphorofluoridate is largely prevented when the head is isolated from the rest of the body.

Similar experiments with abdomina cut from flies ¾ hr. after treatment with di*iso*propylphosphorofluoridate showed that the acetylcholine-level in the isolated abdomen remained constant, whereas that in the abdomen of the intact poisoned fly continued to increase.

These results suggest that the changes in the amount of acetylcholine in the head and abdomen of the fly treated with di*iso*propylphosphorofluoridate are due mainly to redistribution of acetylcholine within the insect and not to destruction or synthesis *in situ*. Although it might be expected that such a redistribution would occur via the hæmolymph, no significant amount of acetylcholine could be detected in hæmolymph from flies treated with di*iso*propylphosphorofluoridate. However, much of the acetylcholine in the abdomen was found in the contents of the hind-gut. Thus it may be that, in flies treated with di*iso*propylphosphorofluoridate, acetylcholine is in fact redistributed via the hæmolymph, but is removed from it and reconcentrated in the hind-gut, possibly by the action of the Malpighian tubules.

Fuller details of these and of other experiments on flies treated with di*iso*propylphosphorofluoridate will be reported elsewhere.

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Determination of Fat in Mutton Carcasses by Measurement of Specific Gravity

In albino rats[1], guinea pigs[2], swine[3] and cattle[4] a close relationship has been shown to exist between specific gravity and percentage fat in the eviscerated carcass. Likewise in living man[5] a relationship has been established between specific gravity and percentage fat in the body.

In the present work the relationship between specific gravity of the whole carcass and the percentage fat content of the half carcass and of certain joints has been determined on three groups of five six-year-old Romney pasture-fed ewes reared under typical New Zealand flat-country conditions. The first group of ewes was killed at the outset of the experiment. The second and third groups were killed twenty-eight days later. Animals in the second group were pasture-fed for 1 hr. and starved for 23 hr. per day for the duration of the experiment, while the animals in the third group were grazed on pasture throughout.

After chilling for approximately 18 hr. after slaughter, the specific gravity of the kidney-free carcasses was determined by weighing in air and then in water at a water temperature of 17°–20° C. The surface temperature of carcasses was 11°–12° C.

Following the determination of whole carcass specific gravity the carcasses were stored for a period in a freezing chamber. The frozen carcasses weighing 55·2–78·2 lb. were then divided down the middle of the back with a meat band saw and the right side sliced into pieces one-eighth to one-quarter of an inch in thickness, again using the band saw. These slices, consisting of bone, muscle, fat and other tissues, were then readily minced.

Obtaining a uniform mince of all the soft and hard tissues of the carcass has hitherto presented great difficulty. This has been effectively overcome by the technique just described which, so far as we are aware, has not previously been recorded in the literature. Slight modifications of this technique are also being investigated in this Department in studies of functional anatomy, parturition and whole-animal chemical determinations of meat animals.

The fat content in six samples per animal was determined by using a slight modification of the method of Barnicoat and Shorland[6]. The standard error of the mean of these six samples was ± 0·39 and the coefficient of variation was 2·5 per cent. Percentage fat from the 15 half-carcasses varied from 26·1 to 45·4, and specific gravity of the whole carcasses varied from 1·009 to 1·049.

The left side of each carcass was divided into leg and loin, described by Pálsson[7], as well as a ninth–tenth–eleventh rib cut. The bone, muscle and fat contents were determined by dissection following the method of Pálsson[7].

The linear regression equations of the dependent variables Y, Z, U and W on the independent variable specific gravity together with their standard errors of estimate and their correlation coefficients are as follows:

Where X is $\frac{1}{\text{specific gravity}}$; Y is per cent ether extract fat in half-carcass; Z is per cent dissectable fat of leg plus loin; U is per cent ether extract fat in 9–10–11 rib cut; W is per cent dissectable fat in 9–10–11 rib cut; then

$$Y = 100\left(\frac{5\cdot680}{\text{specific gravity}} - 5\cdot138\right);$$

$$S_{xy} = 3\cdot196 \text{ per cent}; \qquad r_{xy} = 0\cdot877;$$

$$Z = 100\left(\frac{4\cdot965}{\text{specific gravity}} - 4\cdot512\right);$$

$$S_{xz} = 3\cdot131 \text{ per cent}; \qquad r_{xz} = 0\cdot852;$$

$$U = 100\left(\frac{7\cdot386}{\text{specific gravity}} - 6\cdot695\right);$$

$$S_{x.u} = 4\cdot706 \text{ per cent}; \qquad r_{xu} = 0\cdot877;$$

$$W = 100\left(\frac{6\cdot479}{\text{specific gravity}} - 5\cdot810\right);$$

$$S_{x.w} = 4\cdot764 \text{ per cent}; \qquad r_{xw} = 0\cdot814.$$

These results show that the relationship between specific gravity of the whole carcass and the percentage fat content of the half-carcass and joints is high. Thus the specific gravity method of estimating percentage fat content reported for other species can be applied in the sheep.

A detailed report of this investigation will appear elsewhere.

The help of Prof. A. L. Rae, Mr. T. S. Ch'ang and Mr. D. R. Lang is gratefully acknowledged. This work was undertaken while one of us (A. H. K.) holds a New Zealand Wool Board Scholarship.

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Synthesis of Levan by Pseudomonads

THE property of forming levan from sucrose is rather common among *Bacillus* species[1] and is also found in *Streptococcus salivarius*[2] and *Aerobacter levanicum*[3,4]. Further, levan is produced by many phytopathogenic *Pseudomonas* and *Xanthomonas* species[5,6], and is said to be formed by *Pseudomonas betae-gelatae*[7], isolated from thawing sugar-beets. However, no mention has been made of levan-producing *Pseudomonas* species isolated from other than diseased or killed plant material.

In the course of an investigation on levan-synthesizing bacteria, colloidal solutions of levan in distilled water were regularly stored in the icebox at 2° C. Some of these solutions were found to have become infected by organisms, apparently capable of using levan as sole source of carbon. After isolation, however, the predominating organism proved also to be able to produce a polysaccharide on 4 per cent sucrose with 1½ per cent peptone agar. After cultivation at 25° C. for 2–3 days in liquid 4 per cent sucrose 1½ per cent peptone medium, the polysaccharide formed was precipitated by adding three parts of ethyl alcohol and identified as a levan according to the methods of Hestrin *et al.*[3]. Further examination showed the organism to be *Pseudomonas fluorescens*.

Since here a levan-synthesizing pseudomonad was found which did not originate from plant material, it seemed worth while to examine the possibility of a dependable enrichment culture for this organism. Sterile 1 per cent solutions in distilled water of levans of different origin were inoculated with garden soil, ditch water or tap water. After incubation for 2 days at 25° C. under aerobic conditions and subculturing once more in the same liquid medium, transfers were made on 4 per cent sucrose with 1½ per cent peptone agar. Several strains of the predominating, slime-producing organism were readily isolated, all of which have been proved to be levan-forming *Pseudomonas fluorescens* strains. Apparently, small amounts of impurities in the levan preparations and inoculation materials fulfil the mineral requirements of this organism. These simple growth conditions in the enrichment medium were found to be essential for its selectivity, since the mere addition of mineral salts caused a great variety of other organisms to come to the fore.

Furthermore, it has been found in this laboratory that *Pseudomonas aureofaciens* is a levan-forming bacterium, as already mentioned recently by Kluyver[8]. All strains examined possessed this property; they were isolated from mixtures of clay and kerosene (2 strains) and soil (1 strain).

On screening a number of *Pseudomonas* strains from the bacterial collection of our laboratory, four more strains, belonging to the species *Pseudomonas fluorescens* (3 of 8 strains) and *Pseudomonas chlororaphis* (1 strain), were found to be able to synthesize this polysaccharide. None originated from plant material.

No levan synthesis was found in about 80 strains of different *Pseudomonas* species, among which were: *Ps. putida, Ps. aeruginosa, Ps. fluorescens, Ps. aromatica* var. *quercito-pyrogallica, Ps. calco-acetica* and *Ps. punctata.*

Thus, in a total of three *Pseudomonas* species, levan-forming strains have been found, which did not originate from diseased or killed plant material. All these strains produce levan in considerable quantities; maximal production was shown by a strain of *Pseudomonas aureofaciens* which in one case produced 83 per cent of the theoretical yield on cultivation at 25° C. in 4 per cent sucrose with 1½ per cent peptone medium on a rotary shaker.

The greater part of the levan-synthesizing strains which have been identified as *Pseudomonas fluorescens* is able to use oxygen as well as nitrate as hydrogen acceptor. These nitrate-reducing strains appeared able to synthesize levan also in nitrate-containing sucrose media in total absence of air. Here, maximal production of levan was 49 per cent.

All the levan-producing *Pseudomonas* strains proved to have constitutive, endocellular levan-sucrases (= saccharose → levan-transfructosidase[9]); moreover, all these strains could be characterized on sucrose-containing agar media by colonies having a typical radial structure. In these respects, apparently all Gram-negative, levan-producing bacteria resemble each other closely since *Aerobacter levanicum* was found to show the same characteristics.

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Occurrence of a Malic Enzyme free of Oxalacetic Decarboxylase in Silkworm Hæmolymph

HÆMOLYMPH of the larval silkworm (*Bombyx mori* L.) contains a triphosphopyridine nucleotide-linked 'malic' enzyme that has been purified by ammonium sulphate fractionation followed by adsorption and elution from calcium phosphate gel[1,2]. It was of interest to measure the oxalacetic decarboxylase activity of the 'malic' enzyme from silkworm, since those of pigeon liver[3,4] and wheat germ[5,6] exhibit a constant ratio (approximately 1·2 : 1) between oxalacetic decarboxylase and 'malic' enzyme activities throughout all stages of their purification. Recently, a diphosphopyridine nucleotide-linked 'malic' enzyme free of oxalacetic decarboxylase was purified from homogenates of *Ascaris lumbricoides*[7]. 'Malic' enzyme activity has been reported in crude homogenates of larvæ from the blowfly[8]. These extracts also decarboxylate oxalacetate; but it has not yet been established whether both reactions are catalysed by the same enzyme.

The test system used for the spectrophotometric assay of the 'malic' enzyme of silkworm blood contained the following components (in µmoles/2·2 ml.): *tris* (hydroxymethyl) aminomethane buffer *p*H 8·5, 40; magnesium sulphate, 10; *l*-malate, 10; triphosphopyridine nucleotide, 0·5; and enzyme. The assay was carried out in quartz cells ($d = 1\cdot0$ cm.) at 21° C. in a Beckman *DU* spectrophotometer. The control cell contained all the components except triphosphopyridine nucleotide. The activity of the 'malic' enzyme was calculated from the change in optical density at 340 mμ during the third minute of incubation; the unit being defined as that quantity which causes an increase in optical density of 0·01 unit/min.[9].

The manometric assay of oxalacetic decarboxylase was performed in the Warburg apparatus using flasks of approximately 5 ml. capacity; the test mixture contained the following (in μmoles/1·25 ml.): sodium acetate buffer, *p*H 4·5, 20; manganese chloride, 2·5; oxalacetate, 20; and enzyme. The oxalacetate, which had been brought to *p*H 4·5, was placed in the side arm and tipped after an equilibration period of 10 min. The gas phase was air and the incubations were carried out at 25° C. The control vessel contained enzyme inactivated by heating in a boiling-water bath for 3 min. and the gas evolved in this vessel was approximately the same as that produced in a vessel containing the complete incubation mixture without enzyme; thus, denatured silkworm-blood enzyme did not stimulate the non-enzymatic decarboxylation of oxalacetate. The unit of oxalacetic decarboxylase is that quantity of enzyme that causes an increase over the blank of 1 μl. carbon dioxide in 10 min. at 25° C.[9]. The blank value, due to the spontaneous decomposition of oxalacetate, was approximately 32 μl./10 min. One unit of oxalacetic decarboxylase was equivalent to 0·78 unit 'malic' enzyme under the stated experimental conditions.

The enzyme preparations used here were obtained by treating whole or dialysed silkworm blood from fifth-instar larvæ with ammonium sulphate and collecting the fraction separating between 40 and 50 per cent saturation. The precipitate from 15 ml. whole blood or 30 ml. dialysed blood was dissolved in 5 ml. water and suitable aliquots were used for the assay of the 'malic' enzyme and oxalacetic decarboxylase.

The results given in Table 1 illustrate that preparations possessing 57–100 units of 'malic' enzyme activity do not show equivalent oxalacetic decarboxylase activity and, like the *Ascaris lumbricoides* enzyme[7], do not catalyse the decarboxylation of oxalacetate. The data in Table 1 also show that no activation of oxalacetic decarboxylase by triphosphopyridine nucleotide occurred with a preparation of the silkworm blood 'malic' enzyme, although it has been reported that small quantities of triphosphopyridine nucleotide stimulate the oxalacetic decarboxylase activity of the pigeon liver 'malic' enzyme[10] and inhibit that of the wheat germ[5].

Table 1. OXALACETIC DECARBOXYLASE AND 'MALIC' ENZYME ACTIVITY OF SILKWORM BLOOD PREPARATIONS

Preparation*	'Malic' enzyme (units)	Oxalacetic decarboxylase			
		Assay period (min.)	Units		
			No TPN	TPN 0·05 μmole	TPN 0·1 μmole
DB–25	57	4–10	3·0		
		10–15	0·0		
DB–26	83	2·5–5·0	0·0		
		6–10	1·0		
		10–15	1·0		
P–2	100	0–9	2·0	−3·0	−3·0
		10–15	2·0	−2·0	0·0
		15–20	2·0	0·0	−2·0

* The preparations were obtained, as described in text, by ammonium sulphate fractionation of dialysed (*DB*-series) or whole (*P*-series) silkworm blood.

It is concluded that oxalacetic decarboxylase is not associated with the 'malic' enzyme of silkworm blood.

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Ortho-Tyrosine in an Insect Cuticle

AN examination of a developing insect cuticle by means of paper partition chromatography has shown that the changes taking place in amino-acid composition primarily concern the aromatic members. Larval cuticles of *Calliphora vomitoria* have been hydrolysed at different stages of development in 6 *N* hydrochloric acid and chromatograms developed using butanol/acetic acid/water and phenol saturated with water as solvents. The positions of the amino-acid spots were located by spraying with ninhydrin. At all stages the following amino-acids were recognized: alanine, arginine, glutamic acid, glycine, leucine, lysine, proline, serine, threonine, and valine. In addition, tryptophan is present before the onset of puparium formation. The chief differences between the various developmental stages concern the presence or absence of phenylalanine and *para*-tyrosine. At the concentration of hydrolysate used, phenylalanine is only very faintly distinguishable in the cuticles of four- and five-day old larvæ; but in the seven-day old and white puparial cuticles it is abundant. Thereafter, however, in the one-day old and fully hardened puparia, it is absent. Somewhat similarly, *para*-tyrosine is present at all stages up to, and including, the white puparium, but is absent from the hardened puparial cuticle.

In addition, however, to phenylalanine and *para*-tyrosine, the cuticle of the seven-day larva yields a spot, not found in any of the other stages, which is indistinguishable from that given by an authentic sample of *ortho*-tyrosine. This appears to be the first indication of the presence of *ortho*-tyrosine in an insect cuticle, and in view of the roles which have been attributed to tyrosine in the development of the cuticle[1], this distinction between *ortho*- and *para*-tyrosine is clearly important. It is possible that the disappearance from the chromatograms of ninhydrin-positive spots corresponding to phenylalanine and *para*-tyrosine may be an indication of the participation of the amino-groups of these acids in the tanning process. But *ortho*-tyrosine disappears not only before this process begins, but even before the white puparium stage is reached; and its appearance and disappearance at about seven days may well be correlated with the preparation of the cuticle for the later hardening process.

I am grateful to Dr. C. E. Dalgliesh for the gift of an authentic sample of *ortho*-tyrosine. This investigation into the amino-acid metabolism of a developing insect cuticle is being continued, and a full account will be given in due course.

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Inhibition of Luminescence by Sodium Diethyldithiocarbamate and its Recovery by Sodium Borate in Luminous Bacteria

RECENTLY, significant roles of heavy metals which affect pigment formation in various animals have been examined in this laboratory[1,2].

I have investigated the effects of various metals and metal-chelating compounds on the luminescent reaction in a luminous strain, *Photobacterium phosphoreum*. The bacteria were cultured for 18 hr. in the nutrient medium at 25° C. Cells were harvested by centrifugation and suspended in 3 per cent sodium chloride solution. This suspension emitted a very brilliant light continuously for several hours, but if sodium diethyldithiocarbamate solution was added to this suspension (final concentration 10^{-3}–10^{-4} *M*), the luminescence ceased or decreased rapidly in a few seconds.

Among many kinds of metal-chelating compounds thus far tested, namely, sodium diethyldithiocarbamate, diphenylthiourea, ethylenediamine tetraacetate, 8-oxyquinoline, phenylthiourea, thiourea and thiouracil, the first was the most effective in stopping the bacterial luminescence. This inhibitory effect was eliminated by addition of certain metal solutions such as ferric chloride, cupric chloride, zinc chloride and sodium pyroborate.

Among the metal solutions thus far tested, sodium pyroborate solution was the most effective in the recovery of luminescence, and boric acid was as active as 60 per cent of sodium pyroborate in an equimolal concentration. Sodium diethyldithiocarbamate solution to which sodium pyroborate was added previously has little effect on the luminescent reaction.

Sodium diethyldithiocarbamate solution has two absorption maxima at 255 mμ and 280 mμ respectively ; but these peaks disappear when cupric chloride is added to the solution. On the other hand, sodium pyroborate shows no effect on the elimination of these peaks. Therefore, the concentration of sodium diethyldithiocarbamate may be estimated spectrophotometrically by examination of these absorption peaks in the case where sodium pyroborate is used.

Equal volumes of luminescent bacterial suspension were put into four tubes. Sodium diethyldithiocarbamate solution was added to the first and second tubes so that the final concentration was equal. After the luminescence of both tubes disappeared, sodium pyroborate solution was added to the first tube and the same volume of distilled water was added to the second tube as a control. The luminescence of the second tube was recovered as described before. Then the bacterial cells were removed from these four tubes by centrifugation.

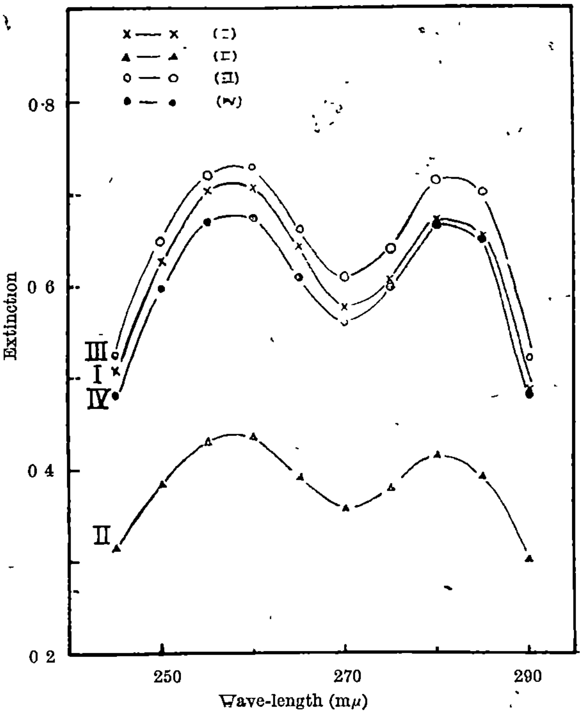

Fig. 1. Absorption spectrum of sodium diethyldithiocarbamate in the supernatant of the first tube (I), the second tube (II), the third tube (III) and the fourth tube (IV). The concentration of the carbamate and sodium pyroborate used is 10^{-4} *M*

After centrifugation, sodium diethyldithiocarbamate solution was added to the third and fourth tubes so that the final concentration was the same as before. Then sodium pyroborate solution was added to the third tube and the same volume of distilled water was added to the fourth tube.

These supernatants were assayed spectrophotometrically. The result (Fig. 1) shows that sodium diethyldithiocarbamate concentration in the supernatant layer of (II) is lower than that of (IV), but sodium diethyldithiocarbamate concentration in the supernatant layer of (I) is nearly equal to that of (III). This means that sodium diethyldithiocarbamate which is added to the bacterial suspension is absorbed by bacterial cells and removed with them by centrifugation, but it is liberated from the cells into the supernatant layer when sodium pyroborate is added.

The luminescent bacterial cell to which sodium pyroborate was previously added was not affected by the subsequent addition of sodium diethyldithiocarbamate ; but the effect of this compound was as active as the untreated cells when the cells were centrifuged and freed from sodium pyroborate prior to the addition of sodium diethyldithiocarbamate.

Judging from these results, it may be assumed that the recovery of luminescence by the sodium pyroborate is due to the removal of sodium diethyldithiocarbamate from the bacterial cells.

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Interrelationships of Germination Inhibitors and Oxygen in the Dormancy of Seed of *Betula*

IT has been shown that for 'seeds' (achenes) of *Betula pubescens* a much higher percentage germination is obtained in long days than in short days (approximately 90 and 25 per cent respectively)[1]. The effect of light is presumably on the living tissue of the embryo; but it has been found that excised embryos germinate even in complete darkness.

The alteration of the response of light-sensitive seeds to light by the removal of the seed coat is already well known; but we are still far from understanding the cause of this. It has been demonstrated that in some seeds, germination inhibitors are located in the seed coat, and it has been suggested that the embryo is allowed to germinate because of the removal of the inhibitor.

Investigations on this problem have been carried out on birch seeds. It has been possible to obtain a water-soluble inhibitor from these seeds which strongly inhibits the germination of birch embryos and lettuce seed. In later experiments extracts were made using 100 per cent methanol as solvent, thus avoiding the extraction of proteinaceous material. The extract was chromatographed on Whatman No. 1 paper using a solvent composed of 99 parts 70 per cent aqueous *iso*propanol to 1 part ammonia (specific gravity, 0·880). Using excised birch embryos (in the dark) (Fig. 1) and lettuce seed (var. Newmarket) for bio-assay, a non-fluorescent inhibitor has been located running between R_F 0·7 and 0·9. It was possible to extract seeds both with and without embryos, and the same inhibitor was found in both these samples, thus indicating that it must be present in the pericarp. When the embryos are planted on filter paper soaked in the inhibitor, no germination occurs in the dark, but the inhibition is overcome when the embryos are exposed to light.

The question arises as to whether this inhibitor is of functional significance in controlling the dormancy of the seed. Experiments carried out on seeds from which some, but probably not all, of the inhibitor has been leached, show that the photoperiodic response is altered by this treatment, giving a high percentage germination even in short days (70 per cent). It is not possible, however, to obtain any germination of leached seeds in the dark.

It is known that in some seeds the enclosing structures restrict the inward diffusion of oxygen[2]. One of the effects of seed-coat removal in birch, therefore, apart from the removal of the inhibitor, might be to make more oxygen available to the embryo. By slitting the pericarp and endosperm it is possible to allow of the entry of oxygen but at the same time maintain the inhibitor around the embryo. After this treatment, approximately 50 per cent of the seeds germinate in the dark, whereas intact seeds do not germinate at all. It is clear, therefore, that the behaviour of the seeds is profoundly modified by slitting the seed coat even though the inhibitor is still present. Furthermore, it was later found that approximately 20 per cent germination could be brought about in the dark simply by making one scratch, the length of the seed, in the pericarp. The results of a number of experiments suggest that these effects are due to enhanced oxygen entry, since it is possible to secure 100 per cent germination of both slit and scratched seeds in the dark if the oxygen concentration is increased to 50 per cent. Moreover, the photoperiodic response can be altered by increasing the oxygen concentration. In an atmosphere of 50 per cent oxygen, 70 per cent germination occurs in short days compared with 15 per cent for the control in air.

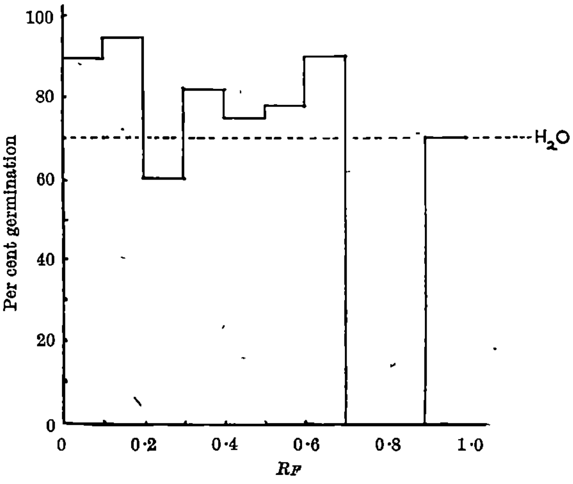

Fig. 1. Bio-assay of the chromatogram of a methanol extract of birch seed

There appear, therefore, to be two results of removing the seed coat. First, the embryo is brought into direct contact with atmospheric oxygen, and secondly, the inhibitor is removed. Presumably intact seeds do not germinate in the dark because of the presence of the inhibitor and also because the seed coat restricts the entry of oxygen.

A direct connexion between the influence of the inhibitor and the effect of oxygen is provided by the results of experiments performed with leached seeds. Scratching the pericarp of unleached seeds results in approximately 20 per cent germination in the dark in air. However, if leached seeds are scratched, the percentage germination in the dark, in air, is of the order of 60 per cent.

Thus it would seem that when some inhibitor is removed, the ordinary atmospheric oxygen tension is sufficient to promote the germination of many more scratched seeds in the dark and it is even possible to secure the germination of some, although only a small percentage, of intact leached seeds in the dark in higher oxygen tensions. Furthermore, it has been found that although completely isolated embryos germinate in the dark, in atmospheres containing only 1 per cent oxygen, the minimum oxygen requirement for germination is very much higher if the pericarp is still present, even though this has been cut away so as to bring the embryo into direct contact with the surrounding atmosphere.

One possible explanation of these results is that oxygen is involved in the deactivation of the seed-coat inhibitor, possibly by oxidation mediated by an enzyme system. On the basis of this hypothesis, it is easy to understand that although, in slit seeds, the inhibitor is still present and presumably diffusing inwards to the embryo, oxidation of the inhibitor is taking place at the same time. In scratched seeds, in air, sufficient oxygen is not entering to remove the inhibitor. But if the inhibitor has been previously leached out, the minimum oxygen requirement is less, and greater germination of scratched seeds occurs in air.

This is in agreement with results obtained by Wareing and Foda[3], who found that the inhibitor present in *Xanthium* embryos disappears in high oxygen tensions, before any visible germination changes have taken place. Furthermore, they have been able to obtain an enzyme preparation from the embryos which is capable of destroying the inhibitor *in vitro* in the presence of oxygen.

By analogy, the evidence presented above for birch seed would justify the assumption that a similar basic mechanism is operative in these seeds also, although, as yet, it has not been possible to demonstrate this.

It is unlikely that the role of light is in the destruction of the inhibitor, since one would not expect any photoperiodic effects if this were true[1]. It is more probable that light is directly involved in the production of a promotive agent which can overcome the effect of the inhibitor.

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Glutamic Acid Decarboxylase in Legumes

Since the pioneer researches of Okuniki[1,2] and Schales and his associates[3-5] on glutamic acid decarboxylase, rather scanty data have been made available on amino-acid decarboxylases of plants. Most of the work deals with glutamic acid decarboxylase of higher plants; so it was thought of interest to study the enzyme system in the case of dry seeds of legumes.

The assays were carried out by means of Warburg manometric measurements at 35° C. Healthy, well-formed seeds were freed of contamination, if any, by thoroughly cleaning them with permanganate solution followed by copious amounts of distilled water. These were dried, finely powdered and stored in sterile bottles in a refrigerator. 3 gm. seed powder was extracted with 100 ml. *M*/15 phosphate buffer (*p*H 5·8) for ½ hr. at room temperature (28° C.). The extract was then passed through muslin and the activity of 4·0 ml. suspension was determined.

Of the leguminous seeds investigated, field bean appears to be the richest source of glutamic acid decarboxylase and is being used for the preparation and purification of this enzyme. In this bean, the product of decarboxylation was identified as γ-amino-butyric acid by paper chromatography. Field bean extract lost its activity on dialysis at 4° C. for 18 hr., which could be partially restored by addition of pyridoxal-5-phosphate. Addition of pyridoxal phosphate to the original extract was also found to enhance its activity considerably. This activating influence of pyridoxal phosphate suggests that the same is the coenzyme of the decarboxylase.

Table 1

Seed	Botanical name	Activity c.mm. CO_2/20 min./gm. dry seed
Field bean	*Dolichos lablab*, L.	1,180
Double bean	*Vicia faba*, Moench	97·54
Aconite bean	*Phaseolus aconitifolius*, Jacquin	95·72
Cow-pea	*Vigna catjang*, Walp.	306·1
Green pea	*Pisum sativum*, L. (Indian variety)	30·24
Black pea	*Pisum arvense*, L. (Black variety)	28·30
Bengal gram	*Cicer arietinum*, L.	95·96
Green gram	*Phaseolus aureus*, Roxb.	346·9
Lentil	*Lens esculenta*, Moench	nil
Red gram	*Cajanus indicus*, Spreng.	58·2

Further studies on the purification of the field bean glutamic acid decarboxylase are in progress. The leguminous seeds are also being tested for other amino-acid decarboxylases.

We are thankful to Dr. K. V. Giri for the gift of γ-amino-butyric acid and to the Government of India for the award of a senior research scholarship to one of us (L. K.).

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Endosperm and Seed of *Wolffia*

Since the days of Hegelmaier[1] there has been little or no work on the embryology and seed structure of *Wolffia*. Recently[2], I pointed out the probability of a cellular endosperm in this genus. Later, the occurrence of a cellular endosperm was also confirmed in *Lemna paucicostata*[3], which contradicts Lawalrée's[4] report of a helobial endosperm in *L. minor*.

Abundant flowering material of *Wolffia microscopica*, available at Delhi, has enabled me to make further observations on the endosperm and seed structure of this plant. The first division of the primary endosperm nucleus is followed by a transverse wall resulting in the formation of a micropylar and a slightly smaller chalazal chamber (Fig. 1). At this stage the zygote is still undivided. Next, there is a transverse division in the chalazal and a vertical division in the micropylar chamber (Fig. 2); meanwhile, the zygote has divided to form the 2-celled proembryo. No free nuclear divisions occur at any time.

An interesting point concerning the structure of the mature seed is that the inner integument is completely crushed except at the micropylar end, where its apical portion forms the so-called operculum. The outer integument persists but comprises only a couple of layers, of which the outer develops reticulate thickenings.

Most of the endosperm is consumed; only one layer remains and surrounds the embryo. The cells are packed with reserve food materials except in the chalazal region.

The embryo presents a striking resemblance to that of *Lemna*. While still enclosed within the seed, it has already produced the first frond (f_1) as well as its daughter frond (f_2); and even the initials of the granddaughter frond (f_3) are recognizable. Fig. 3 shows a longitudinal section of the mature seed in which the frond has been cut in a plane at right angles to its flat surface. It is attached to the main body of the embryo by a very short pedicel. On one side it is enclosed by the 'suspensor' and on the other by the 'cotyledonary sheath'. Fig. 4 is an adjacent section in which the outline of the daughter frond

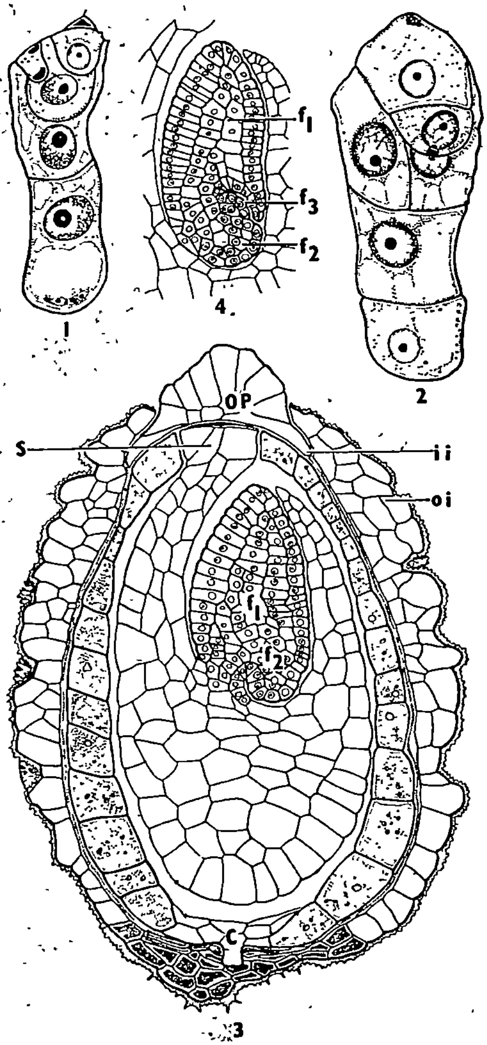

Fig. 1. Longitudinal section of ovule showing zygote and two-celled endosperm ; one synergid, remnants of the pollen tube and the degenerating antipodals are also seen (× 450). Fig. 2. Two-celled proembryo and four-celled endosperm (× 450). Fig. 3. Longitudinal section of mature seed; note the first frond (f_1) and its daughter frond (f_2) (× c. 166). Fig. 4. Part of a successive section of the same seed showing also the granddaughter frond (f_3) (× c. 166). (c, Caecum ; f_1, first frond ; f_2, daughter frond ; f_3, granddaughter frond ; ii, inner integument ; oi, outer integument ; op, operculum ; s, 'suspensor')

is more distinct, and the initials of the granddaughter frond are also recognizable. No root primordium could be distinguished.

The data presented above preclude any close relationship between the Lemnaceae and the Helobiales, as suggested by Lawalrée[4,5] ; on the contrary, they support the view that the Lemnaceae are closely allied to the Araceae.

Thanks are due to Dr. B. M. Johri for his interest in the investigation.

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Aug. 18.

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Foliar Zinc and *Oidium heveae* in Ceylon

Oidium heveae is a major pathogen on *Hevea brasiliensis* in Ceylon. Following the private communication of results on zinc deficiency in this connexion, since published by Bolle-Jones and Hilton[1], investigations were undertaken to see if this discovery had a practical bearing on the problem in Ceylon.

Three clones of *Hevea brasiliensis* were selected, namely, *LCB* 870, a high-resistant low-yielding strain ; *PB* 86, a medium-resistant high-yielding strain ; and *Tjir* 1, a highly susceptible, high-yielding strain. Five trees were selected from each clone and representative leaf samples taken, each sample being treated and analysed separately.

Two samplings were made at a fortnight's interval towards the end of the *Oidium* season. The first sampling was vacuum-oven dried and wet ashed with nitric and perchloric acids. The leaf content of zinc is expressed on the oven-dry basis. The second sampling was dry ashed in silica crucibles, and the leaf content of zinc for this sampling is expressed on the fresh weight.

Zinc was determined by the mixed colour dithizone method according to Sandell[2] using a *DU* spectrophotometer.

Tables 1 and 2 show the results obtained.

Table 1. Leaf Content of Zinc in *Hevea brasiliensis* as p.p.m. of Oven-dry Tissue

Sample	*LCB* 870	*PB* 86	*Tjir* 1
1	40	23	29
2	20	28	28
3	26	17	31
4	29	26	36
5	36	26	28
Average and S.E.	30·2 ±2 5	24·0 ±2·5	30·4 ±2·5

Table 2. Leaf Content of Zinc in *Hevea brasiliensis* as p.p.m. Fresh Tissue

Sample	*LCB* 870	*PB* 86	*Tjir* 1
1	3·6	4·2	4 7
2	2·4	6·6	4·2
3	2 4	5·7	6·1
4	3·6	4·7	5 7
5	4·7	3·3	4·2
Average and S.E.	3·54 ±0·47	4·90 ±0·47	4·98 ±0·47

There is no statistical significance in either result, though in Table 2 *Tjir* 1 is almost significantly greater than *LCB* 870 at about 18 : 1. The results are not completely conclusive in that, to obtain strictly comparable samples, leaves which had fully matured were selected. *Oidium heveae* in Ceylon is of primary importance in its attack on leaves up to the half-mature stage, when it causes defoliation. At the later stages only severe distortion of the leaf results from the attack. However, these leaves are comparable with those used by Bolle-Jones and Hilton, and it does not seem likely that the clone *Tjir* 1 could, in the course of the previous 20–30 days life of the leaf, have had a zinc concentration of the order one-eighth to one-tenth that of either of the other clones.

This work does not appear to support an alternative hypothesis for inter-clonal differences in *Oidium heveae* resistance to that already proposed by

Young[3], namely, that rate of cuticle thickening in the immature leaf is the determinant factor in the field.

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June 8.

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Plant Life in the Vindhyans

THE possibility of the existence of plant life in the Vindhyans is a century-old problem and it begins with the report of the discovery of coal by Franklin (1833)[1]. Since then investigations have been carried out by various workers, though no definite existence of vascular plants in the Vindhyans could be established until 1950, when Ghosh and Bose[2] reported on their recovery of pitted woods and monolete spores in an Olive shale of the Semri Series (lower Vindhyans). Three years later, Jacob, Jacob and Shrivastava[3] found, in specimens of Jones's original collection of Suket shales, fragments of woody elements and five or six types of spores belonging probably to the primitive pteridosperms and pteridophytes and to doubtful primitive gymnosperms. They did not, however, recover winged spores or those with surface ornamentation in their material.

Recently, I had the opportunity for examining nineteen Vindhyan rock specimens, of which five belonged to the Kaimur Series (upper Vindhyans) and the rest to the various stages of the Semri Series of the Vindhyan system. These samples were obtained through the courtesy of the Geological Survey of India. Following the usual process of maceration in Schultze solution with every possible measure against laboratory contamination, I found a wealth of vascular microflora in fifteen out of the nineteen of the above specimens, the four barren samples being an Olive shale (Semri Series), two Porcellanites rocks (Semri Series) and one Bijaigarh shale (Kaimur Series). The detailed results of this work will be published elsewhere.

The main object of this note is to report on the occurrence of winged spores or those with surface ornamentation in the Vindhyans, more particularly in the Semri. The following is a descriptive list of a few of such spores.

1. *Microreticulate spore.* 44μ in diameter, brownish-yellow in colour, surface reticulate, lumen of the net 2–3 5μ in diameter; spore wall is not clearly seen and the spore body is somewhat distorted (Fig. 1).

2. *Punctate monolete spore.* 27·5μ × 37·4μ, yellow in colour, body densely pitted or reticulate with a bulging slit of dehiscence which is 33μ long; bulging-ends 3·3μ wide, spore wall is not clear (Fig. 2).

3. *Cingulate trilete spore.* Spore axis 88μ; yellow; slit axis 33μ long and 9–11μ broad; slit-rim 2μ thick; slit opening or aperture 5·5 μ; body provided with concentric ridges; spore body brownish in colour; spore wall 1μ thick; flange 3·5μ wide, yellow and wavy (Fig. 3).

4. *Monosaccate spore.* 114μ × 60μ; body distorted; frill is 9–11μ wide, brownish-yellow, longitudinally reticulate and attached to a thick rim; the rim is deep brown in colour and is 2–2·5μ wide (Fig. 4).

5. *Monosaccate spore.* 109μ × 88μ; spore body 77μ × 55μ, pale yellow in colour; frill is dark brown, longitudinally reticulate, 18μ wide approximately, but is not attached to any rim-like structure (Fig. 5).

6. *Disaccate spore.* 42μ in extension, spore body 23μ × 23μ, yellow in colour; wings reticulate, 16·5–15·5μ × 23–22μ in size (Fig. 6).

7. *Disaccate striate spore.* 44μ in extension; spore body 15·4 × 18·7μ, brown in colour, body spirally thickened with stripes; wings yellow, reticulate, 17·6μ–22μ × 25·3–22μ in size, base of wings 2·5μ thick (Fig. 7).

8. *Disaccate striate spore.* 49·5μ in extension, body 24·2μ × 33μ in size and is provided with six stripes which are more or less equidistant and 1·5–2·5μ thick, each extending in a curved manner to meet the spore wall on either side; colour, golden-yellow; wings 23μ × 33–28·5μ (Fig. 8).

Of the spores recovered, the saccate types have been found to occur abundantly in the Kheinjua stage (Semri Series) and very sparsely in a limestone from the Rohtas stage (Semri Series) and another specimen of Kajrahat limestone (Semri Series); the trilete ones occur in abundance in the Kheinjua and Rohtas stages, very rarely in the lower Kaimur and are completely absent in the Upper Kaimur and the basal stage of the Semri Series. It may be recalled

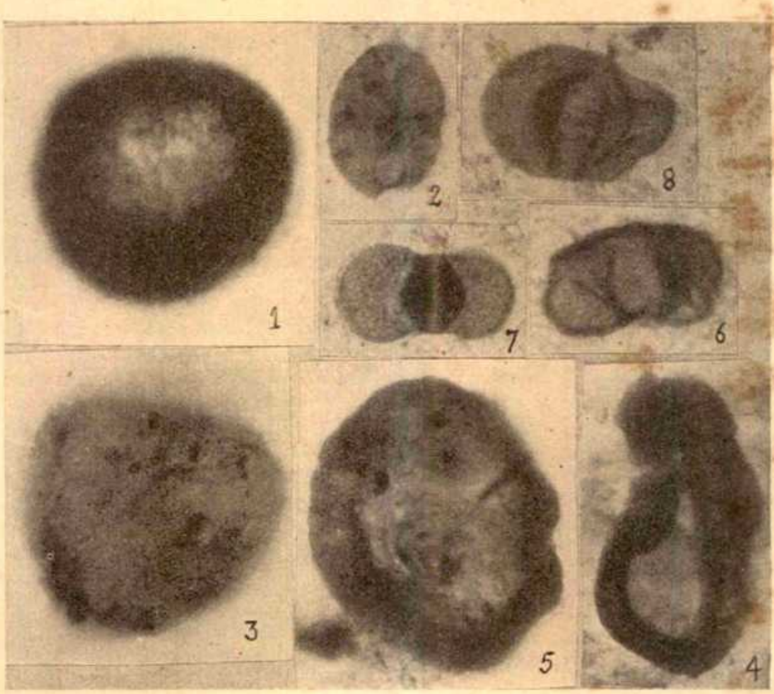

Fig. 1, × 800; Figs. 2–8, × 360

that (*a*) winged spores have been recorded in the Upper Cambrian of Spiti, Middle–Upper Cambrian of Kashmir by Jacob *et al.*[4] and the Cambrian of the Punjab Salt Range and Kashmir by Ghosh and Bose[5-7] and Bose[8]; (*b*) deltoid trilete spores have been found in the Cambrians of the Punjab Salt Range, and also in the Middle Cambrian of the United States by Ghosh and Bose[9]. On comparison, therefore, it may be suggested that the Kheinjua and Rohtas stages (Semri Series) are Middle–Upper Cambrian in age, with the consequence that (1) the Basal and the Porcellanites stages of the Semri Series become Lower Cambrian, and (2) the Kaimur Series, the Rewah Series and the Bhander Series become Late Upper–Post-Cambrian in age.

Specimens of Suket shales on which Jacob *et al.* carried out their investigation belonged to the upper part of the Semri Series; but I have done my work, as pointed out earlier, with material belonging both to the Upper and Lower Vindhyans. The various types of spores listed above prove beyond doubt that a well-developed flora of the Archegoniate group thrived in the Vindhyans and that "the Vascular land plants were in existence even as early as the Lower Cambrian"[3].

Thanks are due to Sri A. K. Ghosh for his guidance, to Dr. D. M. Bose, director of the Bose Institute, for giving laboratory facilities, and to Sri K. L. Chowdhury for photographing the plates.

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June 23.

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Status of the Two Forms of Housefly occurring in South Africa

Although evidence[1], based on laboratory crossing experiments, exists for considering the two forms of housefly which occur in the Ethiopian region to be only subspecifically distinct from each other and from *Musca domestica s. str.*, nothing has been published on how they interact in Nature when they are sympatric. It is important to know this, as it is well known that some species will interbreed in the laboratory whereas they seldom, or never, do so in Nature. The behaviour of *M. cuthbertsoni* Patton and *M. curviforceps* Saccà and Rivosecchi[1] (*vicina* auct. not Macquart), both of which occur at Johannesburg, has therefore been investigated.

Synchronous samples of the domestic population (caught in and immediately outside buildings) and the feral population (caught well away from buildings) were made on a farm some thirty miles from Johannesburg. The frons ratio (width of frons at the narrowest point/width of head at the widest point) and the shape of the paralobi (inferior forceps) of the genitalia were determined for all males. The results of the frons ratio analysis are presented graphically in Figs. 2 and 3. These and the study of the paralobi revealed that *curviforceps* occurred mainly in the domestic environment and *cuthbertsoni* mainly in the fields. Thus they are more or less ecologically isolated. Many males in both populations had, however, paralobi which were intermediate in shape between the two typical forms (Fig. 1). Since I have found that laboratory hybrids between these two forms have paralobi of intermediate shape, this is interpreted as indicating that natural hybridization does occur. These results have been confirmed by subsequent collections.

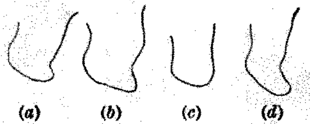

Fig. 1. Paralobi: (*a*) Hybrid. (*b*) *M. domestica curviforceps* (Johannesburg). (*c*) *M. domestica cuthbertsoni* (Johannesburg). (*d*) *M. domestica curviforceps* (Tongaland)

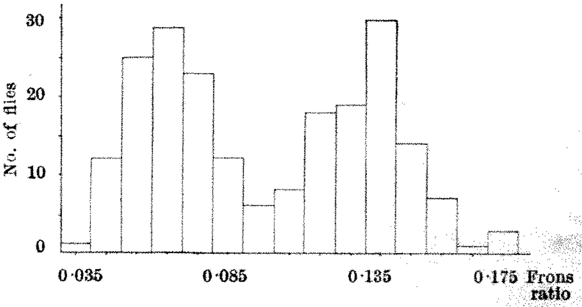

Fig. 2. Frequency distribution of the frons ratio in houseflies (domestic and feral) on a farm near Johannesburg

This evidence of the occurrence of natural hybridization between *cuthbertsoni* and *curviforceps* indicates that they are not specifically distinct, despite the fact that they are often sympatric in the original sense of the term.

Musca domestica s.str. and *curviforceps*, I can confirm, are completely interfertile in the laboratory, and, since they are allopatric, it is convenient, for the reasons given by Mayr[2], to consider them only subspecifically distinct despite their morphological differences.

It is possible that *cuthbertsoni* and *curviforceps* are now often sympatric because of extensions of range by *curviforceps* as a follower of man.

While studying the paralobi of Johannesburg *curviforceps*, it was noted that they were not as curved as those of the type series. This, I believe, may be due to the hybridization which I have shown to occur at that locality. This view receives some support from the fact that in Tongaland (lat. 27° 9′ S.; long. 32° 15′ E.) a population occurs which has very strongly curved paralobi as in the type series. These flies were caught in and about the tents of a camp in the bush. A search for *cuthbertsoni* proved fruitless. An alternative explanation is that the flies with

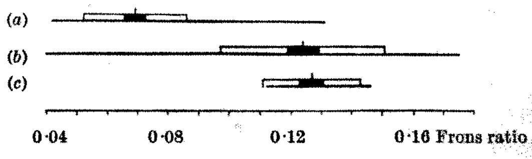

Fig. 3. Frons ratio: range of variation, mean, two standard errors of the mean on either side of the mean, and a standard deviation on either side of the mean for: (*a*) feral population, Johannesburg ($n = 99$); (*b*) domestic population, Johannesburg ($n = 109$); (*c*) domestic population, Tongaland ($n = 44$)

strongly curved paralobi are linked by an altitudinal cline to those with moderately curved paralobi. This alternative will be tested by further collecting.

A full report of this work will be published in due course. I am indebted to Prof. G. Saccà for help in various ways.

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Johannesburg. May 23.

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Occurrence of *Polydora pulchra* Carazzi in British Waters

WHILE studying the seasonal variation in plankton and hydrography of the plaice ponds at the Marine Biological Station, Port Erin, I came across a dense population of larvæ belonging to the species *Polydora pulchra* Carazzi (Polychaeta Spionidae). The identification is based on the key, descriptions and figures given by Hannerz[1]. The identification was further confirmed when the larvæ metamorphosed in the laboratory.

Carazzi[2] was the first to describe *pulchra* as a variety of *Polydora antennata* Claparède; but recently Hannerz[1] separated the variety and classed it as a distinct species with the name *Polydora pulchra* Carazzi. There are no previous records of either *Polydora antennata* or *Polydora pulchra* in British waters (Tebble, N., personal communication). Adult specimens have not yet been found in British waters.

Polydora pulchra has been very rarely reported. The only records are those of Fauvel[3] and Hannerz[1]. Fauvel found the species in the Mediterranean at Naples and in the Atlantic off northern Spain, while Hannerz found three individuals in southern Sweden. The occurrence of *Polydora pulchra* at Port Erin thus extends the known distribution of the species into the Irish Sea. Observations on the behaviour of the larvæ of *Polydora pulchra* and their resistance to changes in temperature, *p*H and salinity are being published elsewhere.

I wish to thank Dr. N. S. Jones, of Port Erin, and Mr. Norman Tebble, of the British Museum (Natural History), for confirmation of the identity of the larvæ.

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An Unusual Method of capturing Prey by a Cuttlefish

IT is usually assumed that the typical shallow-water decapod cephalopods are active hunters and seek out their prey rather than wait for the prey to [illegible] them. It does sometimes occur[1] that a[illegible] lying passive, half buried in the sea bott[illegible] when food, such as a prawn or a crab, [illegible] the tentacular arms are rapidly unf[illegible] to secure the prey. In contr[illegible]

The observation was made in the late afternoon in the Straits of Singapore, some six miles offshore, from the Fisheries Research Station's launch, the *Chermin*, during the interval between two of the routine series of plankton hauls which are made in this area. At the time, the engine was shut off and the boat was drifting with the tide in a fairly extensive patch of *Sargassum* weed. The sea was glass-calm.

Through a break in the weed a small cuttlefish of about six inches length could be seen, floating some twelve inches below the surface. It was lying horizontally, the arms typically bunched together, there being no sign of any movement except from the suckered tips of the tentacular arms. These were extended above the head, inclined slightly forward, straight, excepting the distal suckered portions, and were slightly divergent. Both the tips of the tentacular arms were pendulous and slowly waving about in the water. Since the water was so perfectly calm, and there being no movement of any part of the submerged fronds of the *Sargassum* weed, it is reasonable to assume that the cuttlefish was waving them. This assumption is supported by the distribution of colour over the body. All the body, excepting the suckered areas of the tentacular arms, was of a uniform dull brown colour, very similar to that of the *Sargassum* weed. The suckered areas of the tentacular arms were white and very prominent.

It should be added here that I am well acquainted with the appearance of moribund and dying cuttlefish, and the possibility of the cuttlefish discussed here being moribund was considered, and rejected, since there was no indication whatever of it being other than healthy and normal in its behaviour.

Several times during some ten minutes of observation, small fish, which were clustered under the *Sargassum* weed, left their place of shelter to investigate the white tentacle tips. When the fish approached close to the tentacular arms, the cuttlefish attempted to catch them by a sudden dart forwards and securing them with the arms. During the period of observation the attempts were, unfortunately, unsuccessful. The cuttlefish did not exhibit any colour changes when approached by the fish, or when attempting to catch them.

Thus, although the actual capture of the prey was not observed, it was an undoubted case of an animal, accepted as being a hunter of its prey, deliberately and successfully luring its prey to it.

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Singapore 17. May 21.

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Influence of Gamma Irradiation on the Breeding Affinities of *Lolium perenne* and *Festuca pratensis*

I HAVE recently carried out investigations to determine the possible influence of gamma irradiation on the breeding affinities of *Lolium perenne* and [illegible]*stuca pratensis*. These two diploid species have [illegible]to been considered to be extremely incom[illegible] although it so happens that during these [illegible]ons a number of highly compatible geno-

Table 1. THE EFFECT OF POLLEN IRRADIATION ON SEEDSET AND GERMINATION IN CROSSES BETWEEN *L. perenne* AND *F. pratensis*

Cross		Dose in roentgen (per cent)					
		Control	250	500	1,000	2,000	3,000
L. perenne (♀) × *F. pratensis* (♂)							
(1) $L_1 \times F_1$	Seedset	77·6	62·8	66·1	59·0	49·0	47·7
	Germination	0 0	0·0	0·0	0·0	0·0	0·0
(2) $L_3 \times F_1$	Seedset	81·5	70·5	65·2	81·1	86·3	73·1
	Germination	10·8	7·6	8·0	11·9	8 8	6·5
(3) $L_2 \times F_1$	Seedset	76·7	73·7	66·0	83·6	78·6	60·8
	Germination	46 3	25·6	6·9	17·3	31·6	20·0
(4) $L_3 \times F_2$	Seedset	76·8	76·3	74·7	76·8	67·4	66·0
	Germination	54·1	46·7	42·1	62 0	64·3	62·7
F. pratensis (♀) × *L. perenne* (♂)							
(5) $F_1 \times L_1$	Seedset	71·7	45·6	50·0	61·3	39·8	25·0
	Germination	0·9	0 0	2·1	1·8	0·0	14·3
(6) $F_1 \times L_2$	Seedset	54·8	73·2	56 6	30·7	43·4	48·0
	Germination	0·0	13·4	7·1	1·1	6·4	0 0
(7) $F_2 \times L_3$	Seedset	61·2	51·6	50·5	51·5	57·6	46·9
	Germination	0 0	0·0	0·0	0·0	0 0	0·0
(8) $F_3 \times L_3$	Seedset	60·3	57·0	50·4	56 2	52·6	50·0
	Germination	0·0	0·0	0 0	0·0	0·0	0·0

L_1, L_2 and L_3, genotypes of *L. perenne*. F_1, F_2 and F_3, genotypes of *F. pratensis*.

compatibility, ranging from combinations where none of the seeds was viable to those in which as many as 50 per cent of the caryopses germinated, that is, a high seed-compatibility[2].

Table 1 summarizes some of the results obtained after irradiating inflorescences of the two species at about 7 days prior to anthesis by means of a cobalt-60 source.

In general there is a significant reduction in seedset after 250–500 r. This is followed by an increase at 1,000–2,000 r.; but further increases in dose again result in a decline.

The effect of irradiation on seed-compatibility, although similar to that observed for seedset, showed a greater variability. Nevertheless, the results still fit into a general pattern if one takes into account first the direction of the cross and secondly the normal seed-compatibility of the genotypes involved.

In the *L. perenne* by *F. pratensis* matings the drop at 250–500 r. as well as the recovery at about 1,000 r. occurred to varying degrees in different crosses: in the normally incompatible cross (No. 1) and in the cross of low compatibility (No. 2), irradiation had little effect; in the cross of medium compatibility (No. 3) the initial drop as well as the increase at 1,000 r. was marked, but where the normal compatibility is high (No. 4) only a small reduction occurred at 500 r. Moreover, in the latter cross the germination percentage at the higher doses significantly exceeded that observed normally. Genotypic differences in the response to irradiation are therefore evident.

In crosses with *F. pratensis* as seed parent genotypic differences were again apparent in that the greater the genetic difference between the genotypes, the greater was the dose required for optimum production of viable seeds; for example, compare crosses (5) and (6). These differences were, however, partly masked by the fact that crosses showing a high degree of seed-compatibility where *L. perenne* was the femal[illegible] parent were not the most successful combina[illegible] in reciprocal matings; for example, cross[illegible] and (8).

While the results in themselves [illegible] assumed that with doses of up to 500 r. pollen-grain differentiation and germination and pollen-tube growth are not sufficiently affected to prevent fertilization, so that cytologically damaged pollen grains would participate in triple fusion. A proportion of the ovules may, however, undergo immediate degeneration, or else at some time after fertilization[3] the former results in a reduction of seedset, the latter in a decrease of seed-compatibility.

At doses higher than 500 r. selective elimination of the more severely damaged pollen grains presumably occurs either through lack of differentiation and germination[4] or possibly due to a slight disadvantage in rate of pollen-tube growth or by a combination of these factors. In consequence, seedset and germination should be higher than at 500 r.

The variable nature of the seed-compatibility data and especially the dependence of the response to irradiation on genotype suggest that irradiation has a second effect directly concerned with the degree of endosperm development. Since endosperm failure has been shown to be due to the genetic disparity which exists between the genomes of the two species (unpublished), it appears that irradiation induces changes in consequence of which endosperm development and hence germination capacity are improved. Superimposed upon the initial decrease in seed compatibility due to cytological abnormalities, we therefore presumably have changes which improve endosperm development. The latter is dependent on the initial disparity which exists between the genotypes.

The results reported form part of a general investigation into the nature of the differentiation and the barriers to successful hybridization between *L. perenne* and *F. pratensis*. They were carried out under the helpful guidance of Prof. P. T. Thomas.

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Effects of Changes of Temperature on the Respiration of Certain Crustacea

WHILE much work has been carried out recently[1] on the long-term changes which take place in poikilotherms following a change from one constant temperature to another, little is known about the respiratory changes which take place within a short time after the temperature is altered. The object of the present study was to investigate this. Experiments have been carried out on the following Crustacea: *Neomysis integer*, *Hemimysis lamornae*, eggs of *Astacus pallipes*, *Diaptomus gracilis*. A detailed [illegible] made on *Artemia salina*. The rate of [illegible] was estimated using a continuous-flow [illegible] which will be described elsewhere. Most [illegible] were kept for two days or more at [illegible]ature of the experiment. They [illegible]paratus and after a few hours

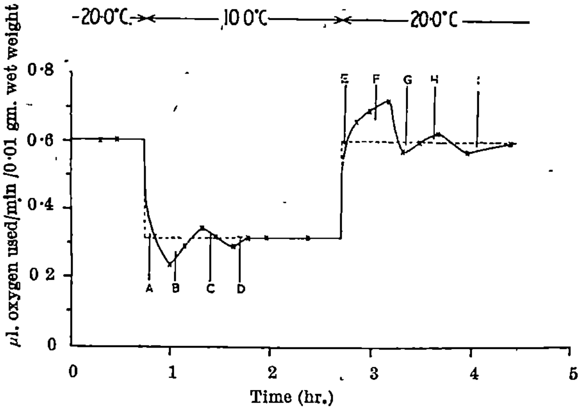

Fig. 1. Graph showing the effect of a change of temperature on the oxygen consumption of *Hemimysis lamornae*. The experimental temperature and the points at which it was altered are shown at the top of the figure

replaced at the initial temperature of the experiment. The oxygen consumption was followed throughout.

In every experiment on all the Crustacea examined it was found that the immediate effect of either a rise or a fall in temperature was to cause an overshoot in the oxygen consumption. This was usually followed by minor oscillations before a steady level characteristic of the new temperature was reached (Fig. 1). In *Artemia* the steady level was maintained for at least nine hours after the temperature was altered.

Overshoot in oxygen consumption following a change in temperature has been previously reported from a number of fish[2], *Cyclops*[3], *Planaria*[4]. It has been found in some individuals of *Astacus*, but apparently not in others[5]. In fish, however, overshoot appears to be of much longer duration than in Crustacea, and several days or even weeks pass before the steady level of oxygen consumption is reached at the new temperature.

It was found that *Artemia* anæsthetized with ether still showed overshoot in oxygen consumption even though all locomotory activity had ceased.

While the overshoot effect was found in all the oxygen consumption experiments, it could not be detected in any of the similar experiments on carbon dioxide output in *Artemia*. Here the steady level of output was reached within a few minutes at the new temperature. Because of the absence of overshoot in carbon dioxide output there are marked fluctuations in the respiratory quotient immediately following a change of temperature (Fig. 2).

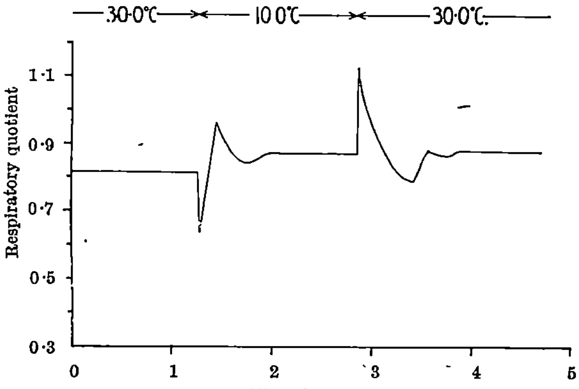

Fig. 2. Graph showing the fluctuations in the respiratory quotient in *Artemia salina* which follow changes of temperature (shown at the top of the figure)

The widespread occurrence of overshoot in oxygen consumption, and particularly its occurrence in the eggs of *Astacus*, suggests that the effect may be inherent in the organization of some organisms or tissues. All the results can in fact be satisfactorily explained if the organism is considered as behaving as a steady-state system. Several authors[6] have pointed out that the metabolism of living organisms can be interpreted in this way. According to steady-state theory the metabolic processes of an animal, when it is kept under constant environmental conditions, should tend to proceed at constant rates. When conditions are altered a new state should eventually be established in which these processes again proceed at constant rates, which are, however, different from the rates in the first state. When the level of oxygen consumption is steady at constant temperature the organism can be considered as being in such a steady state.

The properties of theoretical steady-state systems have been studied in some detail[7]. Many of the systems studied consist of sequences of consecutive or cyclical reactions connected by diffusion with constant external sources and sinks. Even in very simple theoretical systems of this type it has been shown[8] that overshoot curves may occur during the transition between two steady states. Overshoot may occur in such curves showing the relationship between rate of entry of material from an external source and time, when the temperature of the system is changed. It is possible that the observed overshoot in oxygen consumption (Fig. 1) is due to the same sort of reason, namely, a temporary piling up or a deficiency of metabolic substances. If this view is correct the fluctuations in the respiratory quotient (Fig. 2) found experimentally can also be explained, and were in fact predicted from the properties of simple theoretical systems[8]. Furthermore, a 'cost of transition' is to be expected[7,8]. That is, in Fig. 1 $(F + H - E - G - I)$ should be greater than $(B + D - A - C)$. This was the case in most of the experiments. The mean 'cost of transition' for *Artemia* for the temperature-change 20 → 10 → 20° C. was 0·545 μl. oxygen/0·01 gm. wet weight (mean of three experiments).

It would thus appear that the overshoot effect in oxygen consumption, which has been referred to as 'shock effect'[9], and 'acclimatization'[10] by some authors, can be interpreted satisfactorily in terms of steady-state theory.

These results will be published in detail elsewhere.

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Isolation of Active Nematocysts of *Metridium senile* and their Chemical Composition

DURING the past half-century, there has been recurrent interest in the chemical nature of the stinging capsules of cœlenterates. Mainly two lines of investigation have been pursued. Toxic extracts of the tentacles or whole animal have been examined[1], and histochemical studies have been made. Both these approaches have yielded interesting information for speculation, but as Hyman[2] has pointed out, "On the whole it must be concluded that the nature of the nematocyst toxin is unknown, since the extracts mentioned above include tissues as well as nematocysts . . .", and one cannot expect the histochemical approach to yield the definitive answers.

Since the toxins of nematocysts would be useful substances for testing the immune antitoxic responses of a variety of marine invertebrates, studies were undertaken to find a way of isolating active nematocysts in a purified form and in sufficient quantity to allow chemical analyses and the isolation of the toxin. A method has been found of doing this, and it has afforded some information about the chemical nature of the wall and internal contents of the nematocysts of *Metridium senile*.

Briefly, the method involves maceration of the whole anemones in a Waring blendor with an equal volume of 1 *M* sucrose in sea water (maceration in sucrose solution was originally suggested by Miss Eleanor Dodge, Zoology Department, University of Washington). The creamy suspension is passed through graded screens with openings of 1·168, 0·589, 0·295, and 0·147 mm. with the aid of suction. Tyler standard screens customarily used for geological investigations were fitted on to a Buchner funnel with the aid of masking tape. The suspension after this filtration consists of nematocysts, fine tissue debris, dissolved tissue constituents and very fine sand. The amount of sand can be greatly diminished by keeping the anemones on a wire screen for several days before macerating.

Centrifugation of the suspension at approximately 1,000 rev./min. for fifteen minutes collects the nematocysts, and they are washed with additional sucrose solution to free them of soluble materials. Differential centrifugation in a small International clinical centrifuge finishes the purification. 15-min. centrifugations are used to collect the nematocysts and free them from fine tissue fragments. 15-sec. centrifugations are used to remove the sand. After five or six such centrifugations, the material appears to be all but completely free of both the sand and tissue fragments when examined microscopically, and is chemically consistent from batch to batch with respect to total nitrogen and hexosamine content. The nematocysts may be discharged with distilled water, dilute acid or base, sodium thioglycollate, or methylene blue, and the material released is toxic to those animals tested: the barnacle, *Balanus glandula*, and the snail, *Littorina planaxis*.

Chromatographic analyses of hydrolysates of the walls and tubes after discharge have revealed the presence of eighteen amino-acids: cysteine, aspartic acid, glutamic acid, serine, glycine, histidine, lysine, arginine, threonine, alanine, tyrosine, proline, valine, methionine, phenylalanine, leucine, isoleucine, and tryptophan. Two-dimensional chromatograms were developed with phenol/water (80 : 20), followed by butanol/acetic acid/water (4 : 1 : 5). Isatin and ninhydrin were used for the detection of spots. In addition, a hexosamine resembling galactosamine and a uronic acid resembling glucuronic acid were detected in acid hydrolysates through the use of one-dimensional chromatograms with ethyl acetate/pyridine/water (2 : 1 : 2) and *p*-anisidine hydrochloride or ninhydrin for the detection of spots. Quantitative determinations[3] of these carbohydrates has revealed that they are present in an equimolar ratio which may indicate the presence of chondroitin sulphuric acid; a polysaccharide similar in solubility characteristics has been isolated. These findings suggest that the walls may be formed of a cartilagenous material.

The material released on discharge of the nematocysts in distilled water shows on hydrolysis the same amino-acids, with the exception that tyrosine and tryptophan appear to be lacking. The same hexosamine and uronic acid are present, but in this material they are in a molar ratio of four hexosamines to five uronic acids. It is still uncertain whether the internal mucoproteins are of more than one species. In addition to the mucoprotein material, two hydroxyindoles have been detected. One of these, which is extractable with ether from acidified material, resembles 5-hydroxytryptophan with regard to its colour reactions and fluorescence. The other, which is extractable with ether from basic solutions, resembles bufotenine (N dimethyl 5-hydroxytryptamine) with regard to chromatographic development in basic, neutral and acid solvents. In addition to giving the bluish Ehrlich reaction, it fails to give the greenish-yellow colour of 5-hydroxytryptamine with ninhydrin in acetone. This latter substance has recently been found in tentacle extracts of *Metridium*[1]. Further work is under way on the identification of these substances.

The analyses, which have been carried out to this point, indicate that the material injected into the prey of these anemones is a mucoprotein with either adsorbed or free hydroxyindoles. It is hoped that through the investigation of purified suspensions of nematocysts their nature will be revealed.

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Larvæ of the Polypterid Fish *Erpetoichthys* Smith

WHEN J. S. Budgett studied the *Polypterus* larva in the Niger Delta in 1903, he also searched for larvæ of the closely related *Erpetoichthys*, but did not find any. Apparently later workers have been equally unsuccessful, since there seem to be no records of juvenile *Erpetoichthys*. It was assumed that *Erpetoichthys* would possess a larval stage similar to that of *Polypterus*, with pinnate external gills; but this had not so far been confirmed.

On March 17, 1956, towards the end of the dry season, I caught two young specimens of *Erpetoichthys* at Aiyetoro about 40 km. west-north-west of Abeokuta in south-west Nigeria, both still in the larval condition. The find was made at the point where a small bridge on the Iboro Road crosses a swamp in the middle of the township of Aiyetoro. The water-level was very low, probably at its lowest, and the brook traversing the swamp was a mere trickle. The swamp itself consisted, at this point, of thick black mud, more than 50 cm. deep and with practically no water above. An enormous growth of *Pistia* was resting directly on the mud surface, the lower layers forming a fairly compact mass of decaying vegetable matter. The two young *Erpetoichthys* were found in a lump of this mud, scooped out of the swamp a few metres from the brooklet and spread on the road.

Before being killed and preserved, the specimens were kept alive in an aquarium for about three weeks at University College, Ibadan. One was about 6 cm. in length, the other about twice as long, and both had well-developed external gills resembling those of larval *Polypterus*. Frequent air gulping seemed to indicate that the lungs were already functional; this took place at short regular intervals, even in well-oxygenated water.

The finding of larval *Erpetoichthys* at Aiyetoro was unexpected as the place was outside the known area of distribution of the species. *Erpetoichthys* is said not to occur west of the Ogun River system; but the small stream draining the swamp at Aiyetoro belongs to the more western Yewa system. Moreover, and probably more important, Aiyetoro is a typical inland locality, more than 80 km. from the lagoon and coastal swamps. This is in contrast to the statements in the literature, which describe *Erpetoichthys* as a coastal form, confined to deltas, lagoons and estuaries[1], and raises the question whether this species migrates inland to spawn. If so, this would explain why searching for its young stages in the coastal region has not been successful.

A more complete account of the observations on larval *Erpetoichthys* will be published elsewhere. Field-work with the aim of throwing light on the distribution and breeding of this species is being continued.

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Rate of Heat Production by Bull Spermatozoa

DURING some work on a problem unrelated to the present communication, a microcalorimeter was developed based on the 'Callendar Radio-balance'[1]. This calorimeter has been used for measuring the rate of heat production of unbuffered bull semen under anaerobic conditions, and although the calorimeter was not ideally suited to the work some results have been obtained which might be of interest to workers in the field of fertility.

Measurements were made on unbuffered whole semen from a bull of proved fertility. The measurement showed that there was a fall in rate of heat production from approximately 200 micro-watts/ml. of semen at 1 hr. after incubation at 37° C. to approximately 35 micro-watts/ml. of semen at 3 hr. These rates of heat production were, however, close to the sensitivity limit of the micro-calorimeter (measurements made on 0·055-ml. sample) and for this reason the accuracy of the measurement is not high. T. Mann[2] has published a curve showing the normal course of fructolysis in an unbuffered specimen of good quality bull semen at 37° C. From the rate of disappearance of fructose, the rate of heat production has been estimated by making the following assumptions: (1) the process is anaerobic; (2) the principal heat-producing metabolic activity is fructolysis; (3) the semen from the bull on which the fructolysis measurements were made was similar to that on which our measurements were made as regards sperm quality, buffering capacity of semen, initial fructose content, etc.—the sperm density is known to be similar in both samples; (4) the heat liberated (ΔH) in the reaction, 1 gm. mole of fructose to 2 gm. mole of lactic acid, is 23,000 calories (ΔF is approximately $-47,000$ calories).

The value so obtained for the rate of heat production 1 hr. after beginning of incubation at 37° C. is 160 micro-watts/ml. of semen. The trend of the curve for rate of utilization of fructose compares with that for the measured rate of heat production. The agreement of the measured and calculated values is encouraging and suggests that the method might be used for throwing additional light on the nature of the metabolic process (for example, whether fructolysis is the main energy-producing metabolic process).

It is interesting to compare these figures with an estimate of the energy requirement for spermatozoa *movement* made by Lord Rothschild[3] using formulæ developed by Sir Geoffrey Taylor[4,5]. The estimates, using two separate formulæ, are $3 \cdot 74 \times 10^{-7}$ erg/spermatozoa/sec. and $2 \cdot 04 \times 10^{-8}$ erg/spermatozoa/sec. The details are given in ref. 3 and the approximations in the hydrodynamic treatment are fully discussed in refs. 4 and 5. Our measurement converted to the same units is $0 \cdot 24 \times 10^{-5}$ erg/spermatozoa/sec. It appears, therefore, that on this basis the available chemical energy is much in excess of that required for propulsion.

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Geographical Zonation of Atypical Caryotypes in Shieldbugs

BOTANISTS have postulated polyploidy as an adaptation to cold; but it has been shown that in ferns polyploids occur more frequently in Ceylon than in western Europe[1]. Little or no geographical analysis has been attempted of the occurrence of atypical caryotypes in insects outside the genus *Drosophila*, although in the shieldbug genus *Thyanta* three neotropical species have $2n = 14$ while three Nearctic species have $2n = 16$, 16 and 27 respectively[2].

From a number of sources the published values of the diploid number of 151 shieldbug species have been extracted during the course of a revision of the

Table 1. GEOGRAPHICAL DISTRIBUTION OF DIPLOID NUMBERS IN PENTATOMIDAE

	$2n = 14$	$2n \neq 14$	Total
Tropical and sub-tropical spp.	40	2	42
Temperate spp.	58	19	77
Total	98	21	119

higher systematics of the superfamily. Applying a new classification of Pentatomoidea (unpublished) and deleting species of doubtful determination or uncertain provenance, there remain 119 cytologically known Pentatomidae *sensu stricto*: these may be grouped as in Table 1. The ancestral diploid or type number, which here happens to coincide with the modal number, is 14; $12A + X + Y$ in males.

Inspection of Table 1 shows a statistically significant ($P = 0{\cdot}029$) association of atypical caryotypes with a temperate climate. The systematic positions of the atypical species and the presence of genera with a *Thyanta*-like range and caryotype pattern show that the association is not with a Holarctic distribution or monophyletic block although all the temperate forms so far examined live in the Palæarctic or Nearctic.

The present facts suggest either that: (1) rearrangements accompanying speciation in temperate climates tend, under the influence of some external factor, to be more often associated with gross caryotype changes than is the case in the tropics; or (2) gross changes, when they occur, are differentially selected and confer an enhanced survival value in temperate areas. In attempting an evaluation of these two hypotheses it must be remembered that the behaviour and general biology of shieldbugs show that the tropics provide optimum conditions for the group, while the rich fauna suggests it is also the area of maximum speciation.

Dr. R. E. Blackith, of the Imperial College of Science and Technology, London, has kindly assisted me with the statistical analysis.

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Sexual Colour Differences in *Caranx ignobilis* (Forsk.)

Caranx ignobilis (Forsk.), the largest of the Indo-Pacific carangids, is a valued food fish from the East African coast to the Hawaiian Islands. The biology of this fish is being studied by one of us (F. W.), and it has been found that maturity is reached between 500 and 650 mm. standard length.

Routine observations on catches have shown that in specimens more than 500 mm. long there is a difference in colour with sex. The male has a dusky to black body, head and fins. In the female the body and head are pale to silvery, except for slight duskiness on the back. Small black dots may or may not be present on the upper sides of the body. The fins are pale to dusky hyaline.

These colorations refer to living and freshly caught specimens, as some hours later both sexes become a uniform dusky grey.

Sex prediction tests were carried out on a sample of 88 specimens, standard length 500–1,150 mm., and were correct in 90 per cent of cases. These colour differences develop with maturity. Most errors occurred in the size range 500–700 mm., and may have been immature fish. With specimens more than 700 mm. long prediction was nearly 100 per cent correct.

To our knowledge, these are the first recorded sexual colour differences in the Carangidae.

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Low Vitamin B_{12} Concentrations in Serum in Fish Tapeworm Anæmia

VARIOUS communications have been published on the microbiological vitamin B_{12} activity in the sera from both healthy persons and patients suffering from various diseases. The concentration of vitamin B_{12} varies fairly considerably in normal people. The lower limit is 70–100 μμgm. and the upper 420–900 μμgm. vitamin B_{12}/ml. of serum, depending on the microbiological method employed. Very low values, usually less than 50 μμgm./ml., have been found in pernicious anæmia[1].

Megaloblastic anæmia in fish tapeworm (*Diphyllobothrium latum*) carriers shows a similar hæmatological picture to that of genuine pernicious anæmia. The essential factor in the origination of this anæmia would seem to be vitamin B_{12} deficiency caused by fish tapeworm which deprives the host organism of vitamin B_{12} [2]. However, there is still a lack of data on the serum vitamin B_{12} concentration in this disease. We therefore determined the microbiological activity in the serum of eight patients with fish tapeworm anæmia. Twenty convalescents who had been treated for different diseases were examined as controls.

Table 1. MICROBIOLOGICAL B_{12}-VITAMIN ACTIVITY IN SERA FROM EIGHT PATIENTS WITH FISH TAPEWORM ANÆMIA AND FROM TWENTY CONTROLS

Diagnosis	Sex	Age	Vitamin B_{12} (μμgm./ml.)
Anæmia perniciosa diphyllobothrica	♀	38	< 50
,, ,, ,,	♂	17	< 50
,, ,, ,,	♀	14	< 50
,, ,, ,,	♀	11	< 50
,, ,, ,,	♀	64	< 50
,, ,, ,,	♂	58	< 50
,, ,, ,,	♂	63	65
,, ,, ,,	♀	84	< 50
Hypertensio arterialis	♂	59	605
Cholecystitis	♂	70	428
Hernia inguinalis	♂	61	720
Anæmia perniciosa diphyllobothrica in remission induced by worm cure	♂	17	361
Apoplexia cerebri	♂	63	733
Cardiosclerosis	♀	65	320
Anæmia hypochromica	♀	63	238
Ulcus ventriculi	♂	36	583
Anæmia perniciosa in remission induced by liver extract	♂	56	420
Polycythæmia vera	♂	37	424
Pneumonia lobaris	♂	57	940
Nephritis chronica	♂	42	644
Thyreotoxicosis	♀	71	360
Cardiosclerosis	♀	62	200
Cardiosclerosis	♂	69	180
Hernia diaphragmatica	♂	69	370
Nihil	♂	23	601
Cholecystopathia	♂	52	786
Arteriosclerosis universalis	♂	76	444
Diabetes mellitus	♂	57	964

Serum vitamin B_{12} activity was determined with *Lactobacillus leichmannii* 313 (*ATCC* 7830). The method employed was the same as that described in Appendix No. 1, 1955, of the Swedish Pharmacopeia. Values less than 50 μμgm./ml. cannot be measured with sufficient accuracy with this method. Table 1 summarizes the results.

It will be seen that there is a pronounced difference in the serum vitamin B_{12} activity of patients with fish tapeworm anæmia and that of the control group. Seven out of eight anæmia patients gave concentrations less than 50 μμgm./ml. A somewhat higher value, 65 μμgm. vitamin B_{12} per ml. of serum, was found in this group in one case only. The control group displayed great variations ranging from 180 to 964 μμgm. vitamin B_{12} per ml., the average being 561 μμgm. There was no overlapping between the two groups.

To obtain the variations and the mean value of the vitamin B_{12} concentrations in the serum of fish tapeworm anæmia patients requires both more comprehensive material and a more accurate method. However, this introductory investigation shows that the vitamin B_{12} serum concentrations in fish tapeworm anæmia are of the same range as those in genuine pernicious anæmia. This supports the view concerning vitamin B_{12} deficiency in *D. latum* carriers with anæmia.

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Stem Canker (*Macrophomina phaseoli*) of Cotton Seedlings in the Sudan Gezira

IN some seasons cotton seedlings (*Gossypium barbadense* L.) in the irrigated Gezira area of the Sudan suffer considerable damage from stem canker caused by the fungus *Macrophomina phaseoli* (Maubl.) Ashby, also known as *Rhizoctonia bataticola* (mycelium) and *Sclerotium bataticola* (sclerotia).

First symptoms are the appearance of circular red spots up to about 5–6 mm. in diameter on the cotyledons of seedlings two or three weeks after emergence from the soil. Under favourable climatic conditions, notably high humidity, these spots spread and extend down the cotyledonary stalk to produce a conspicuous reddish-purple lesion at the cotyledonary node. These lesions become brown, dry and fibrous as dissolution of the parenchymatous cortical tissue of the young stem proceeds and eventually small black sclerotia develop. In severe cases the stem is completely girdled at the cotyledonary node, at which point affected plants tend to break (especially if handled), and thereafter die or suffer a severe check to growth. In warm dry weather cankered plants often recover and the disease dries out without causing much damage.

In the 1954–55 season, one of above-average post-sowing rainfall, stem canker was very prevalent in the central and southern Gezira and must have imposed a considerable check on early growth of the crop—a warning that this disease might become a major problem were earlier sowing of cotton introduced. With such earlier sowing the young crop would experience much heavier post-sowing rain than with present sowing in mid-August, by which date about two-thirds of the season's rain has normally fallen. Thus at the Gezira Research Farm in 1954 stem canker was severe and post-sowing rainfall was much heavier than usual—about 200 mm. as compared with long-term average of about 120 mm.

Although field observations strongly suggest that stem canker is favoured by excessively wet conditions in which the seedlings are exposed to prolonged water-logging, the method of infection is obscure. Attempts to produce the cotyledonary stage of the disease by spraying cultures of the pathogen and by other methods have so far failed, but characteristic stem lesions (from which the fungus was afterwards recovered) resulted from needle inoculation of the green cotyledonary node.

Pycnidia of *M. phaseoli* have not been observed on cotton in the Sudan and it is thought that seasonal infection originates from the soil, wherein the fungus survives the hot dry season in the form of small resistant sclerotia. Supporting this theory is the observation that soil fumigation with chloropicrin tended to increase stem canker incidence at the Gezira Research Farm in 1954–55. Plots fumigated with chloropicrin three to four weeks before sowing showed 24 per cent cankered seedlings (10 gallons/acre), 32 per cent (20 gallons/acre) and 45 per cent (40 gallons/acre) as compared with 24 per cent in unfumigated plots. Plots fumigated with 15 per cent methyl bromide showed 22·5 per cent (20 gallons/acre) and 23·5 per cent (40 gallons/acre), while 0·8 per cent formaldehyde drench using about 160 gallons of commercial formalin per acre gave 23·5 per cent cankered seedlings. The initial damage due to stem canker in the chloropicrin-treated plots was more than counterbalanced by the beneficial effects of fumigation, these plots producing more vigorous plants which finally yielded 32–48 per cent more seed cotton than the unfumigated plots, as compared with yield increases of 8–15 per cent for methyl bromide and 5 per cent for formalin. It is possible that the resistant sclerotia of *M. phaseoli* were able to withstand chloropicrin fumigation whereas soil micro-organisms lacking such resistant propagules were destroyed. Under the resultant conditions of reduced competition *M. phaseoli* flourished and incidence of stem canker increased, but this was not the case in fumigation with methyl bromide and formaldehyde.

S. A. J. TARR

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July 28.

Relevance of Palæomagnetic Studies of Jurassic Rocks to Continental Drift

THE early palæomagnetic studies have largely been confined to the northern hemisphere, where wide sampling of the geological column in Great Britain and North America has done much to establish the reality of polar wandering. Runcorn[1] has also suggested, on the basis of a comparison of the British and American results, that a westward drift of some 24° would account for the systematic difference he has found in the results.

Table 1

Region	Rocks sampled	Declination	Inclination	λ	K'	N
N. Yorks*	Middle Lias—Lower Corallian. Arenaceous sediments	N. 3·4° E	+66·9°	2·6°	87·5	36
Arizona	Kayenta Fm. (Lr Jur.)	N. 6·9° W	+43·5°	9·6°	50	6
North and South Rhodesia	Basalt lavas of Victoria Falls and Bulawayo	N. 30° W	−40·3°	4·6°	18·7	44
Tasmania	Intrusive dolerite sills	N. 35° W.	−85°	—	—	—

* Full details to be published.

The critical test of whether continental drift has occurred or not obviously lies in a study of the palæomagnetism of rocks of the same age in different continents. In this context the Jurassic period is of great importance, and it is now possible to assemble data from four continents as in Table 1 with the relevant statistics[2].

Although the arenaceous sediments of the British Jurassic are largely unsuitable for palæomagnetic work, being either too weak for measurement or unstable, there are sufficient which appear to be stable to give the results tabulated. Runcorn's rocks from Arizona fall in the same category, and his results, which are based on a few specimens, must be regarded with caution.

The Rhodesian basalt lavas were collected from the Bulawayo area and from the Victoria Falls, where fresh material was obtained from the second gorge with the aid of Dr. G. Bond. The basalts following above the Triassic Forest Sandstone are generally considered of lower Jurassic age. The position of the pole in the northern hemisphere (lying in Hudson Bay) is in latitude 61° N., longitude 76° W. Irving[3] carried out an extensive study of the intrusive dolerite sills of Tasmania. These sills, while certainly of Mesozoic age, have not been proved conclusively to be of Jurassic age. The ancient pole position, according to Irving, lay in latitude 50° N., longitude 23° W.

Thus it is clear that, while Britain in Jurassic times must be regarded as having approximately the same position as at present relative to the pole (the present pole lying within the circle of confidence of the Jurassic results), and the movement of America is not significant, it is equally clear that this is not the case in the southern hemisphere. The Rhodesian lavas indicate a movement of about 2,000 miles, and the Tasmanian results a movement of about 2,800 miles.

The inevitable conclusion is that continental drift must be accepted if the assumption of the coincidence of the axial dipole field with the rotational axis is accepted[4]. More exact dating of the time of drift and the relative positions of the continental blocks must depend on the more detailed work at present in hand in Great Britain, South Africa and Australia.

A. E. M. Nairn

Department of Physics,
King's College,
Newcastle upon Tyne.
July 3.

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[1] Runcorn, S. K., *Proc. Can. Geol. Assoc.* (in the press).

[2] Fisher, R. A., *Proc. Roy. Soc.*, A, **217**, 295 (1953).

[3] Irving, E., *Geophysica*, **33** (1956).

[4] Runcorn, S. K., *Trans. Amer. Geophys. Un.*, **35**, 49 (1954).

A Statistical Information Theory of Visual Thresholds

In their recent letter on this subject Gregory and Cane[1] state that "perhaps other threshold and summation phenomena may be described in terms of statistical information available in neural information channels". A survey of available data on the relationship between the Weber–Fechner fraction $\Delta I/I$ and stimulus area A certainly supports this contention[2].

Gregory and Cane make the assumption that the number of independent observations n is proportional to the stimulus area A. Admittedly this is the simplest assumption; but there would seem to be good reasons for believing that the number of independent observations would more closely approximate the number of nerve fibres, f, operating in the area A, and f is certainly not proportional to A except perhaps for a limited range of areas in the fovea. If f is the correct estimate of the number of independent observations, $\Delta I/I$ should be proportional to $1/\sqrt{f}$. Using data on the variation of visual acuity across the retina to provide an estimate of f, $\Delta I/I$ is in fact proportional to $1/\sqrt{f}$ to a good approximation, over the wide range of stimulus areas from 10′ diameter to 40° diameter. There is some tendency for $\Delta I/I$ to be larger than predicted at very small field sizes, where eye-movements are probably a complicating factor, and at very large field sizes, where there is probably mental difficulty in utilizing simultaneously all the information supplied. If $\Delta I/I$ is plotted against $1/\sqrt{A}$ the results for field sizes up to about 2° are similar; but those for larger field sizes are markedly worse. Thus, for a field size of 36°, using $1/\sqrt{f}$ the predicted value of $\Delta I/I$ is about half the actual value, but using $1/\sqrt{A}$ the predicted value is about one-ninth of the actual value.

This type of statistical approach is very useful in tackling visual problems of this nature, and if certain assumptions are made it can lead to far-reaching conclusions. For example, if it is assumed that

$$N = f_1(c) \cdot f_2(I)$$

where N is the magnitude of the physiological response evoked by a stimulus of intensity I, and c is a measure of the state of adaptation, f_1 and f_2 being any functions, then by arguments given in the paper cited

$$N = N_0 + f_1(c) I^{r/k}$$

where N_0 is a constant, and r/k is the ratio of $\Delta N/N$ to $\Delta I/I$, $\Delta N/N$ being the physiological equivalent of the Weber–Fechner fraction. The above relationship implies a linearity between $\log (N - N_0)$ and $\log I$, and electrophysiological studies show that this is approximately true if N is the number of nerve impulses per second per nerve fibre.

I am grateful to Gregory and Cane for having directed my attention (in a private communication) to a slight error in the mathematics of my paper[2]; the conclusions of the paper are unaffected, but the matter will be discussed in a short note, which I hope to publish as a correction to the original paper.

R. W. G. Hunt

Research Laboratories,
Kodak Limited, Wealdstone, Harrow,
Middlesex. July 20.

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[1] Gregory, R. L., and Cane, Violet, *Nature*, **176**, 1272 (1955).

[2] Hunt, R. W. G., *J. Photo. Sci.*, **1**, 149 (1953).

Simultaneous Occurrence of 'Dawn Chorus' at Places 600 km. Apart

We have been observing whistlers and other naturally occurring audio-frequency noise at Wellington and Dunedin, New Zealand, since July 1955. The geomagnetic latitudes of these stations are 45° S. and 50° S. respectively, the distance apart being 600 km. approximately along a geomagnetic meridian. Certain of the whistler observations have already been described[1]; this communication deals with the simultaneous occurrence at the two stations of the phenomenon known as 'dawn chorus', which has been described by Storey[2] as consisting of a multitude of rising whistles, and sounding like a rookery heard from a distance. Dawn chorus is heard most frequently in the early hours of the morning and is correlated with magnetic activity; however, at present there exists no theory relating to its production or propagation.

Normally, during a period of dawn chorus activity, the rising whistles or tones occur at a rate of one rising tone every few seconds. However, occasionally a 'burst' of dawn chorus occurs, during which the rate exhibits a sudden and spectacular increase; thus a burst consists of a group of rising tones which arrive in abnormally rapid succession. Often the tones overlap, the high-frequency components of one tone arriving at the same time as the low-frequency components of the next tone.

Simultaneous recordings on magnetic tape have been made at the above stations on a schedule of 4-min. recording every 3 hr., usually on two consecutive days per week. Of the 273 simultaneous schedules recorded to date, dawn chorus has been heard at Wellington during 106, and at Dunedin during 64 schedules. In 56 cases dawn chorus has been heard at both stations during the same schedule.

An exceptionally clear display of dawn chorus was registered during the early morning hours of March 25, 1956. In particular, the schedule commencing at 1740 G.M.T. contained fine examples of bursts. The spectrograms of a portion of this schedule which contained 5 bursts are shown in superimposed form in Fig. 1. The rectangles of finite area are so drawn for clarity of display. Each one represents a line joining the two points marking the commencement (or leading edge) and the finish (or trailing edge) of a particular frequency component in the burst. Thus the leading edge can in general be identified with the first rising tone, and the trailing edge with the last rising tone, in the burst. It is seen that the bursts occur simultaneously at the two stations to within close time limits. Accurate timing was achieved by making all measurements with reference to the times of occurrence of loud 'bonks'[3]. By consideration of the possible propagation paths involved, it is found that these 'bonks' are coincident at the two stations to within 2 m.sec. The average difference in time of occurrence at Wellington and Dunedin for the bursts in Fig. 1, for all frequencies and including both leading and trailing edges, is less than 0·01 sec., while one-half of the individual time-differences is less than 0·1 sec. in magnitude. The leading edges tend to be more closely coincident than the trailing edges, one-half of the individual time-differences for the leading edges being less than 0·06 sec. This is probably because the first rising tone in a burst tends to be stronger than the last one, the timing of which is therefore more likely to be affected by background noise.

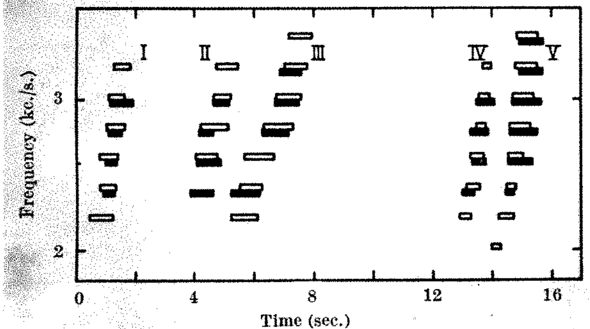

Fig. 1. Spectrograms of dawn chorus bursts. White rectangles: Wellington; black rectangles, Dunedin

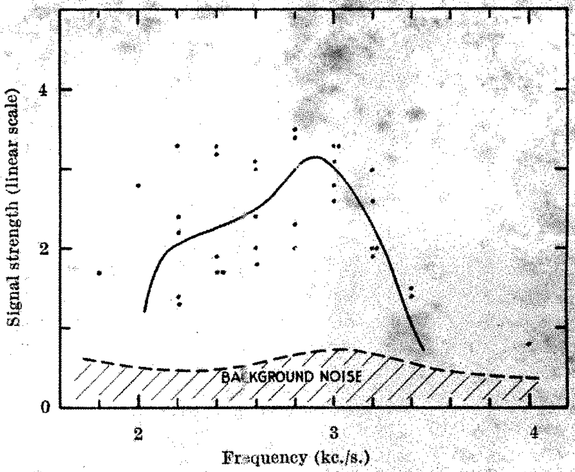

Fig. 2. Variation with frequency of the signal strength of dawn chorus bursts at Wellington

A supplementary set of spectrograms of these bursts taken at 6·6 times the normal speed did not reveal significantly closer coincidences. It is inferred, therefore, that the finite time-differences are not due to the experimental technique; but that at least the majority of these differences are real, and represent slight variations in the characteristics of the phenomenon at places separated by 600 km.

A noticeable feature of these bursts is that appreciable energy is received over a rather limited frequency range of less than an octave. Fig. 2 shows a mass plot of peak signal strength against frequency for all five bursts of Fig. 1, together with the average curve, showing a maximum of received energy just below 3 kc./sec.

No spectrograms have yet been made of an isolated rising tone. However, the detailed character of the rising tones in these bursts can be seen from Fig. 3, which shows on an expanded time-scale the shape of the leading edge of burst V of Fig. 1. The shape is also typical of both leading and trailing edges of bursts I and IV. After a relatively slow start, the pitch increases almost linearly from 2·6 to 3·4 kc./sec. This linear portion has an average slope of 2·0 kc./sec.^{2}, varying in actual cases between 1·5 and 3·0 kc./sec.^{2}. The other bursts shown in Fig. 1 (bursts II and III) do not appear at first sight to conform to the same pattern. However, aural observation shows that these latter bursts consist of a series of rising tones of even more limited frequency-range, the earlier tones in the burst containing only the lower frequencies, while in the later stages only the higher

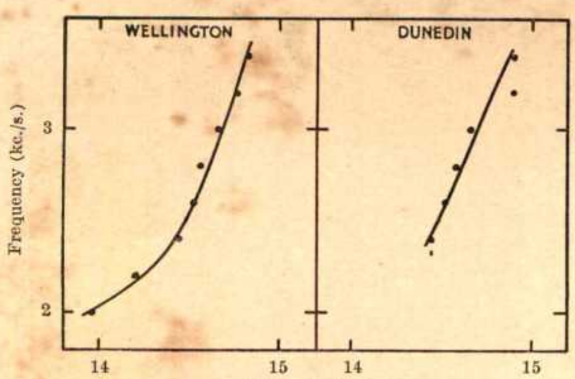

Fig. 3. Spectrograms of leading edge of burst V

frequencies are audible. This is also a feature of bursts of long duration heard at other times. The shapes of the leading edges for the lower frequencies, and of the trailing edges for the higher frequencies, generally match the respective portions of Fig. 3. Thus it is most likely that there is no basic difference in the characteristics of the rising tones throughout the schedule, apart from restriction of the frequency range in some cases.

A full discussion of these results and other data leading to a theory of dawn chorus will be published elsewhere. We are grateful to Dr. M. G. Morgan, of Dartmouth College, New Hampshire, U.S.A., for his encouragement and assistance in providing equipment for this project.

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Dominion Physical Laboratory,
Lower Hutt, New Zealand.
L. H. Martin
New Zealand Broadcasting Service,
Dunedin, New Zealand.
June 22.

[1] Morgan, M. G., and Allcock, G. McK., *Nature*, **177**, 30 (1956).
[2] Storey, L. R. O., *Phil. Trans. Roy. Soc.*, A, **246**, 113 (1953).
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Beta-Gauge for Hair Measurements

The quantitative measurement of hair is an important factor in studies of heat exchange between animal and environment. Methods currently employed consist in counting the number of hairs per unit area, measuring the mean hair length, and determining the weight of hair per unit area. In measurements of hair number or hair weight per unit area a major error arises from the difficulty of measuring precisely an area on the mobile, elastic, non-planar skin of an animal. Any method requiring the removal of the hair for measurement changes the heat-transfer characteristics of the area, and repeat measurements cannot be made on the same area. An absorption-type beta-ray gauge would appear to offer a solution to the problem of measurement of the mass of hair per unit area. It would be a rapid, non-destructive, and reasonably accurate direct measurement of the mass of hair per unit area at the point of measurement.

A transmission-type beta-gauge for *in vivo* measurement of hair areal density must consist of a radiation source that may be placed on the skin of the animal with minimum disturbance to the hair, and a sensitive receptor a fixed distance from the source. In the present design, the beta-emitter was mounted in a 0·035-in. diameter depression in the side of a 0·094-in. diameter stainless steel rod attached by a light aluminium frame to a Geiger tube (Fig. 1). The radioisotopes used (promethium-147, thallium-204) were mounted as components of a fused enamel[1]. This method of mounting allows the maximum energy of the beta-emitter to be utilized because no absorbing material is introduced between the radionuclide and the detector. These two isotopes permit measurement of a wide range of hair densities. Promethium-147 becomes unusable at about 15 mgm./cm.^{2} and thallium-204 at about 80 mgm./cm.^{2}. The thickness of the stainless steel around the source (0·04 in.) is sufficient to provide saturation back-scattering at all beta energies used and also shields the animal from the source. This was demonstrated to prevent variations in count-rate due to variations in the proximity of bone to the surface of the animal.

A mica-window Geiger tube was chosen as the detecting element so that a minimum amount of radioactivity could be used in the gauge, since the necessity of having a large open volume around the source precludes the use of radiation shielding. The particular Geiger tube used (Anton Electronic Company No. 210-*H*) is supplied with the distal end threaded and thus becomes an integral part of the structure of the gauge.

The hair measurement beta-gauge was calibrated with aluminium absorbers. Measurements of hair density were made with this beta-gauge and compared with the density obtained by weighing the hair clipped from a measured area. Examples of these measurements are shown in Fig. 2 with the aluminium calibration curve for the gauge using thallium-204.

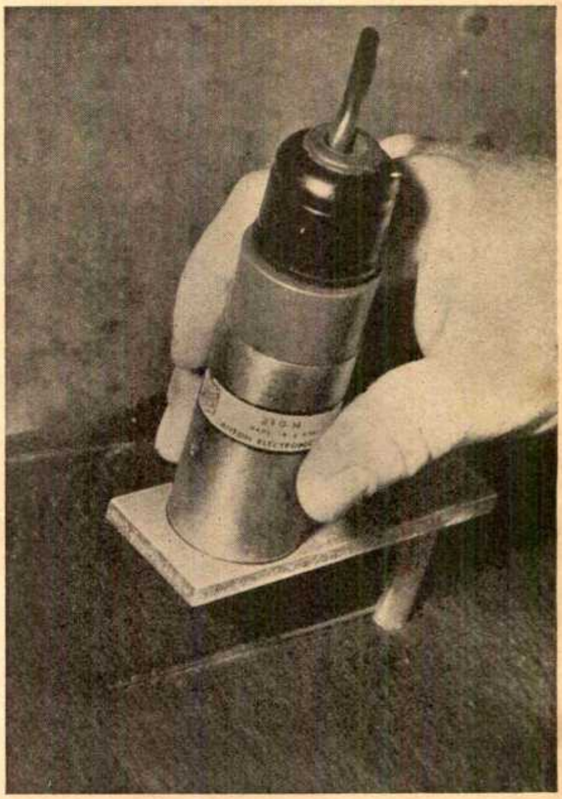

Fig. 1. Using the hair measurement beta-gauge. The thin probe is slid along the skin under the hair and the decreased count-rate noted. This is compared with a standard curve

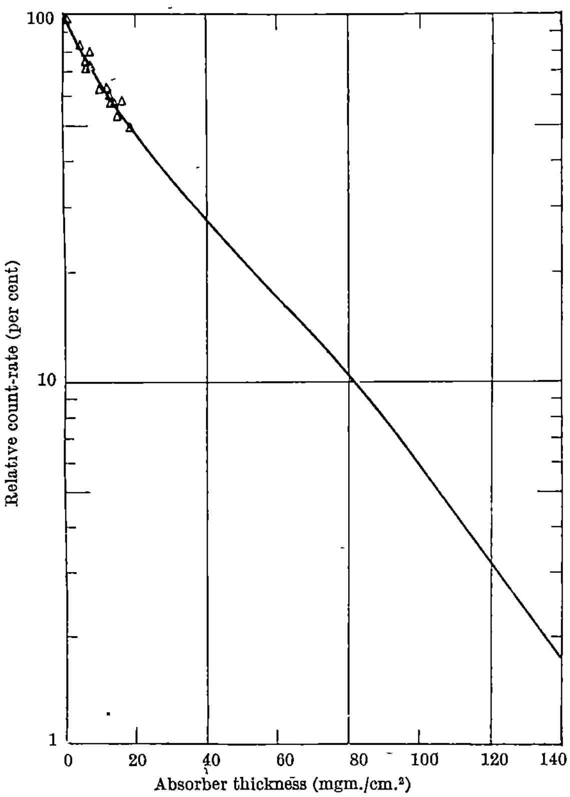

Fig. 2 Standard curve for the hair measurement beta-gauge using thallium-204. The points shown are for *in vivo* measurement of hair density in cattle

The precision of measurements obtained with the hair measurement beta-gauge was determined by repeated measurements on twelve cows. Two hundred and ninety comparisons indicate a probable error of ±4·4 per cent when the gauge was used with an integrating rate meter the time constant of which was equivalent to a standard error of ±2 per cent.

Details of construction and application of the gauge will be reported elsewhere. This investigation was supported in part by the Division of Biology and Medicine of the U.S. Atomic Energy Commission.

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[1] Blincoe, C., *Nucleonics*, 14, No. 8 82 (1956).

Effect of Alloying on the Energy-Levels of Inner Electronic Shells

When two elements such as copper and zinc are alloyed together there is a change in the distribution of the valence electrons; charge is transferred from zinc atoms to copper atoms. Thus Mott[1] has estimated that ~0·1 electron is transferred from zinc to copper in β-brass. Again, the calculated charge shift in a concentrated copper–zinc alloy is ~0·5 *c* electron transferred from each zinc cell to a copper cell, where *c* is the concentration of copper in the alloy[2]. In the latter case there is reasonably good agreement between the change in width of the valence electron energy bands for zinc and copper as observed experimentally and as calculated assuming that the energy-levels of the valence electrons in the alloy can be separated into two free-electron bands, one for zinc and one for copper, with a common Fermi energy.

However, on these simple views of alloying[2] one might expect that when, for example, electrons are transferred from zinc to copper atomic polyhedra in brass, there will be a shift towards higher energies of the whole energy band for the valence electrons of copper, plus a broadening of the band. Conversely, the zinc valence electron band may be expected to shift to lower energies coupled with a decrease in band width. One expects, then, both the upper and lower energy limits of the valence bands to change, the upper more than the lower, both bands having a common absolute upper limit—the Fermi energy.

But experimental X-ray spectroscopic measurements of dipole transitions from the valence bands to the atomic *K*-levels[3] indicate that although there are changes in intensity on the high-energy sides of the valence energy bands of copper and zinc, nevertheless the wave-length (and hence apparent energy) of the emission edge stays constant for both zinc and copper, to within experimental error. The energy band of copper broadens on alloying with zinc and hence the long wave-length (low-energy) emission of copper moves to longer wave-lengths and lower energies. Conversely, the long wave-length side of the zinc line moves to higher energies while, again, the high-energy emission edge is observed to stay constant. Similar behaviour is observed in other alloy systems which have been studied, although there are exceptions. Thus in nickel–zinc alloys a shift in the emission edge of the zinc band to lower energies is observed[4].

Experimental evidence thus largely appears to contradict the expected electronic behaviour on alloying. The following simple explanation is put forward to remove this contradiction. This is offered as an alternative to the proposal put forward by Friedel[5] to account for these observations.

Consider, once again, an alloy of copper and zinc. Charge transfer on alloying results in an electron, with a wave-function which will be a modified 4*s* function, moving away from a zinc polyhedron to a neighbouring copper cell. Now the amplitude of an *S*-state wave-function is large at the nucleus of the atom, and for a hydrogen-like 4*s* function the amount of electronic charge contained within the volume defined by the Bohr radius of the *K*-shell electrons is:

$$\varepsilon \sim \left(\frac{Z}{a_0}\right)^3 \left(\frac{a_0}{Z}\right)^3 \frac{1}{64\pi} \sim \frac{1}{200}$$

for one 4*s*-electron transferred from a zinc into a copper cell.

The energy change in the *K*-level of copper will thus be $\sim + 2.Z_{\mathrm{Cu}} \varepsilon = 13\cdot53\,n$ volts, where Z_{Cu} is the effective nuclear charge, ε is the additional very small screening introduced by one extra 4*s* electron introduced into the copper cell and *n* is the fractional charge shift. Thus if $n = \frac{1}{4}$ the energy change of the *K*-level is ~1 volt. The *K*-level of copper will be increased by ~1 volt and that of zinc will decrease by ~1 volt.

A more refined calculation using first-order perturbation theory has been carried out, and this predicts an energy increase for a 1*s*-state electron in copper to be $\sim 2 \cdot 6\,n$ volts, where n is the fraction of charge in a copper polyhedron, transferred from a zinc cell. The perturbing potential used was that due to the charge density of a 4*s* hydrogen-like wave function, and the wave function of the hydrogen-like 1*s*-state was assumed for the *K*-level. The maximum change in width of the energy band for copper in brass, that is, the difference in widths of the band in pure copper and that of very dilute copper in zinc solution, is $\sim 0 \cdot 9$ eV. Assuming that the electrons around the zinc and copper atoms have their energies distributed over a free electron spectrum based on respective ground-state energies[2], this change in width corresponds to an electron transfer of $\sim 0 \cdot 73$ electron into a copper cell for very dilute copper in zinc. The associated energy change of the copper *K*-level is thus $\sim 1 \cdot 9$ eV. Now the Fermi energy of the copper band will have its absolute energy raised by more than the increased width of the band, since it is estimated that the ground-state energy is itself raised by $\sim 1 \cdot 5$ times the increase in width of the Fermi band[2]. The Fermi energy will thus be raised in energy by an amount $\sim 2 \cdot 35$ eV., so that both it and the *K*-level increase in absolute energy (relative to an electron at rest in free space) by the same order over the whole range of alloys. In this case the emission wave-lengths for transitions from the top of the Fermi band to the *K*-shell will stay nearly constant with alloying, and the broadening of the Fermi band will appear as an increase in long wave-length transitions. The calculations are not accurate enough to predict whether the increase in absolute energies of the *K*-level and the top of the Fermi band will be the same to within experimental error; but the concept that this does occur, as discussed above, leads to a straightforward removal of a contradiction to the simple view of electron behaviour on alloying.

These arguments hold both for the emission and absorption spectra in alloys. In the former case, as Friedel has already discussed[5], the positive hole in the *K*-shell will be screened by a redistribution of the valence electrons in such a way that the Fermi-level remains constant. In this way Friedel accounts for the emission and absorption edges occurring at the same wave-length. Nevertheless, the effect described in this communication will still hold good whatever the details of the valence electron distribution.

I wish to thank Mr. A. D. Le Claire for providing the initial stimulus, and to thank him, Mr. J. Hubbard and Dr. H. M. Finniston for helpful discussions.

J. H. O. Varley

Metallurgy Division,
Atomic Energy Research Establishment,
Harwell.

July 16.

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[1] Mott, N. F., *Proc. Phys. Soc.*, **49**, 258 (1937).

[2] Varley, J. H. O., *Phil. Mag.*, **45**, 887 (1954).

[3] Bearden, J. A., and Friedman, H., *Phys. Rev*, **58**, 387 (1940).

[4] Bearden, J. A., and Beerman, W. W., *Phys. Rev.*, **53**, 396 (1940).

[5] Friedel, J., *Phil. Mag*, **43**, 153 (1952).

Effect of Pressure on the Dielectric Constant of Vitreous Silica

Since there are, to our knowledge, no reported observations of the effect of pressure on the dielectric constant of any solid, the data that we have obtained on this effect in vitreous silica may be of some interest, even though the precision of our results is low, and vitreous silica is far from being a typical solid.

In the course of calibrating a silica piezometer, we have determined the change with pressure in the capacity of the condenser formed by a silica tube with a silver coating fired on the outside, and filled with mercury extending well beyond the ends of the silver coat. This change is about ten times less than the change in the stray capacity between the silver coat and the metal shield in which the tube was mounted, and was determined by taking the difference of two runs, one with mercury in the tube and one without. The imperfect reproducibility of the stray capacity change has limited the precision of the final results to about ± 5 per cent of the maximum effect. The relative change in the dielectric constant of silica is given by $\frac{\Delta \varepsilon}{\varepsilon} = \frac{\Delta c}{c} - \frac{\Delta l}{l}$; for this computation we have used weighted means of published figures for the compressibility of silica. Fig. 1 shows $\Delta\varepsilon/\varepsilon$ to 4,000 kgm./cm.^{2}, at the temperatures 20° and 138° C. The limits of error are shown by vertical lines through the plotted points. All measurements were made at the frequency 2,500 c.p.s., with a maximum field strength of about 100 V./cm.

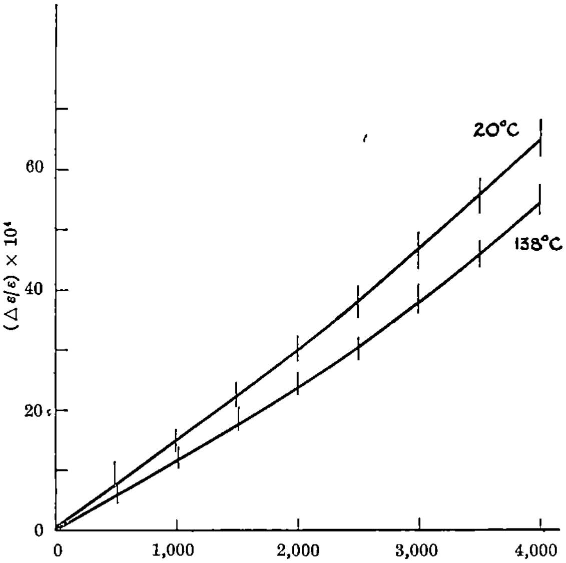

Fig. 1. $\Delta\varepsilon/\varepsilon$ vs. p for vitreous SiO_2

Within our limits of error, the molecular polarization $[P]$ of silica, proportional to $\frac{\varepsilon - 1}{\varepsilon + 2} \cdot \frac{1}{d}$, appears to decrease linearly under pressure, with a slope independent of temperature. The coefficient $\frac{1}{[P]} \cdot \frac{\delta[P]}{\delta p}$ has the value $-1 \cdot 6 \times 10^{-6}$ per kgm./cm.^{2}, about 3–10 times less than the values found for most of the non-polar liquids that have been studied under pressure.

We wish to thank Mr. Arthur K. Doolittle and the Carbon and Carbide Chemicals Co. for support of this work.

John Reitzel

Arthur D. Little, Inc.,
Cambridge, Mass.

June 15.

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, October 29

Royal Geographical Society (at 1 Kensington Gore, London, S W.7), at 5 p.m.—Mr. E. H Brown. "Physique of Wales".

Monday, October 29—Friday, November 2

Institution of Electrical Engineers, Radio and Measurement Sections (at Savoy Place, London, W.C.2).—Convention on "Ferrites".

Tuesday, October 30

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p m.—Dr. H. Kalmus · "Behaviour and Heredity"*.

Institution of Civil Engineers (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Symposium on "Side Spillways".

University of London (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Mr J. R. Shakeshaft: "Radio Astronomy"*.

University of London (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C 1), at 5.30 p m.—Prof. E. C. Amoroso: "Endocrinology and Pregnancy"*. (Sixth of fourteen lectures on "The Scientific Basis of Medicine". Further lectures on November 1, 6, 8, 15, 20, 22, 27 and 29.)

Society of Instrument Technology (joint meeting with the Control Section, at Manson House, Portland Place, London, W 1), at 7 p.m.—Mr. D S. Townend. "Control Engineering and the Automatic Process Plant".

Royal Aeronautical Society, Graduates' and Students' Section (at 4 Hamilton Place, London, W.1), at 7.30 p m.—Mr. E. P. Hawthorne: "Nuclear Power for Aircraft".

Wednesday, October 31

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p m.—Dr. W. S. Pitcher and Dr. R. C Sinha: "The Petrochemistry of the Ardara Aureole"; Mr. Bryan P. Ruxton. "Notes on Some Important Contacts in Hong Kong".

University College, London (in the Gustave Tuck Theatre, Gower Street, London, W.C 1), at 5.30 p m.—Dr. M. Dunand: "Néolithique et Enéolithique à Byblos". (First of three Special University Lectures in Archæology (to be delivered in French) Further lectures on November 1 and 2.)*

British Institution of Radio Engineers (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W C.1), at 6 p.m.—Annual General Meeting. 7.15 p.m.—Mr. George A. Marriott—Presidential Address.

Institution of Mechanical Engineers, Engineering Production Group and Education Group (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p m.—Discussion on "Selection and Training of Engineering Designers".

Thursday, November 1

Chemical Society (in the Chemistry Department, University College, Gower Street, London, W.C 1), at 2.30 p.m.—Symposium on "Newer Interpretations of Reactions and Structure in Carbohydrate Chemistry".

Linnean Society of London (joint meeting with the Systematics Association at Burlington House, Piccadilly, London, W.1), at 4 p.m.—Discussion on "The Inheritance of Acquired Characters".

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4 30 p.m.—Dr. E. F. Gale, F.R.S.: "The Biochemical Organization of the Bacterial Cell".

Mineralogical Society (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p m —General Meeting

University of London (at the Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 5 p.m.—Prof. Georges Portmann (Bordeaux) "The Physiology of Phonation"* (Semon Lecture).

Institution of Civil Engineers (at Great George Street, Westminster, London, S.W.1), at 5.30 p m.—Prof L. Dudley Stamp. "Conservation of Land". (Third of a series of six lectures on "The Conservation of Natural Resources".)

Institute of Metals, London Local Section (at the Royal School of Mines, South Kensington, London, S.W.7), at 7 p.m.—Prof F. C. Thompson: "Primitive Metallurgy".

Royal Institute of Chemistry (at the Technical College, Fassett Road, Kingston), at 7 p.m.—Dr. Tudor S. G. Jones "Chromatography".

Friday, November 2

British Psychological Society, Industrial Section (in Room 425, Department of Psychology, Birkbeck College, Malet Street, London, W.C.1), at 6 p.m —Mr. L. J. Holman: "Some Differences between Potential Officers from North and South England".

Institution of Mechanical Engineers, Internal Combustion Engine Group (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6 p.m.—Mr. P. F. Ashwood: "A Review of the Performance of Exhaust Systems for Gas-Turbine Aero Engines".

University of London (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1). at 6.30 p.m.—Mr. J. R. Gass · "Automation"*. (Fourth of ten University Extension Lectures on "Technology and Industry". Further lectures on November 9, 16, 23, 30, December 7 and 14.)

Society of Cosmetic Chemists of Great Britain (at the Royal Society of Arts, John Adam Street, Adelphi, London, W C.2), at 7.30 p m.—Mr. T. W. Watson. "Silicones in the Cosmetic Industry".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. Tom M. Harris, F.R.S. · "The Investigation of a Fossil Plant".

Saturday, November 3

British Interplanetary Society (in the York Hall, Caxton Hall, Caxton Street, London, S.W 1), at 6 p.m —Dr. R. M. Goody "The Atmosphere of Mars".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistants in Mathematics—The Secretary of University Court, The University, Glasgow (October 31).

Demonstrator (graduate in metallurgy or chemistry) in Metallurgy—The Registrar, Manchester College of Science and Technology, Manchester 1 (October 31).

Technician (A.I M L.T. or equivalent) in the Chemical Pathological Laboratory—The Group Secretary, North Middlesex Hospital, Edmonton, London, N 18 (November 3).

Divisional Physicist (with a good honours degree in physics and preferably some experience in industry), to organize and lead the Divisional Dust Suppression Team, collaborate with the areas in investigations on ventilation and illumination, and work to stimulate the adoption of scientific methods of control—The Staff Department (A.3), National Coal Board, Northern (N. and C) Division, Whitely Road, Longbenton, Newcastle-upon-Tyne 12 (November 7).

Biochemist, Senior grade, to work under the Director of the Department of Clinical Biochemistry—The Administrator, Radcliffe Infirmary, Oxford (November 10).

Lecturer in Mathematics at the University College of Rhodesia and Nyasaland—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (November 10)

Lecturer in the Department of Bacteriology—The Secretary, The University, Edinburgh (November 10).

Research Statistician (with a good knowledge of biometric techniques and a special interest in the design and analysis of experiments), to work under contract with Torry Research Station (D.S I.R Food Investigation Organization)—The Secretary, The University, Aberdeen (November 10).

Chemist (Research Officer) (with at least a university degree with first- or second-class honours, and preferably research experience in inorganic or physical chemistry) with the Australian Atomic Energy Commission, to undertake research into the effect of radiation on nuclear fuel materials and other reactor components, and to assist in a programme of nuclear fuel development—Officer-in-Charge, A.A.E.C. Research Establishment, Private Mail Bag, Sutherland, N S.W., Australia (November 12)

Public Analyst and Government Bacteriologist in the Isle of Man—The Government Secretary, Government Office, Isle of Man (November 15)

Research Assistant in Soviet Institutions—The Secretary of University Court, The University, Glasgow (November 15).

Senior Lecturer in Chemical Engineering at the University of Cape Town, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Cape Town, November 15).

Chair of Philosophy in the University of Khartoum—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C 1 (November 16).

Soil Physicist (with a good second-class honours degree in chemistry and/or physics) to carry out physical and nutrient determinations of irrigated soils; an Agronomist (with a university degree in agriculture or natural science or a diploma of an agricultural college of university status which has involved at least a three-year course of study, plus one year postgraduate or post-diploma training in agricultural science) to study and determine the agronomic and economic possibilities of both irrigated and unirrigated crops; and an Irrigation Engineer (with a good degree in agricultural engineering and specialized in land engineering) to be responsible for the preparation of fields, layout of field irrigation channels and the determination, in conjunction with the Soil Physicist and Agronomist of the times and amounts of irrigation—The Secretary for Recruitment, Gold Coast Civil Service, 13 Belgrave Square, London, S.W 1 (November 16).

Research Engineer or Physicist (with a university honours degree in mechanical or electrical engineering, or in science with physics as the major subject, or equivalent qualifications, together with some research experience) in the Sheep Biology Laboratory, Division of Animal Health and Production, Commonwealth Scientific and Industrial Research Organization, Prospect, New South Wales, Australia, to collaborate with biologists in the research programme of the climate physiology group—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W C.2, quoting Appointment No. 205/108 (November 17).

Research Officer (with an honours degree in science or equivalent qualifications with physics or chemistry as major subjects, together with some research experience) In the Division of Industrial Chemistry, Commonwealth Scientific and Industrial Research Organization, Fisherman's Bend, Melbourne, Victoria, Australia, to undertake a study of the nucleation and growth of crystals, in particular to study the growth of ice crystals from the vapour phase on such nucleating material as silver iodide—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting Appointment No. 590/601 (November 17).

Senior Lecturer (preferably with experience of research in the solid state field) on the staff of the Department of Physics, University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, November 19).

Director of the Institute for Social Research, University of Natal, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, November 23).

Bosch Chair of Histology and Embryology in the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, November 26).

Associate Professor in Mining Engineering at the New South Wales University of Technology, Sydney—The Agent General for New South Wales, 56 Strand, London, W.C.2 (Australia, November 30).

Lecturer (honours graduate in biochemistry or chemistry with postgraduate experience in biochemistry and preferably with an interest in comparative biochemistry) in Biochemistry at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C 1 (Australia, November 30).

Lecturer in Agricultural Zoology at Makerere College, University College of East Africa—The Secretary Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C 1 (November 30).

Senior Lecturer (preferably with primary interest and experience in fluid mechanics) in Mechanical Engineering at the University of Adelaide, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C.1 (Australia, November 30).

Assistant in Physiology in the Department of Physiology and Biochemistry—Joint Clerk to the University Court, Queen's College, Dundee (December 1).

Commemoration Fund Research Fellow (woman graduate of any university), for research in mathematics, natural sciences or an allied subject—The Secretary, Girton College, Cambridge (January 15).

Assistant Lecturers (2) in Physics—The Secretary, Royal College of Science and Technology, George Street, Glasgow.

Biochemist, Basic grade (graduate, preferably with experience in, and a knowledge of chromatographic methods), for research work in problems of metabolism in mental deficiency—The Physician Superintendent, St. Lawrence's Hospital, Caterham, Surrey.

Entomologists (with a good honours degree in zoology and training in entomology) in the Department of Tsetse Control, Gold Coast Local Civil Service, to investigate various aspects of the bionomics and ecology of tsetse flies in relation to man and animals and to supervise control measures under the Director of Tsetse Control—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.77/13/01.

Industrial Chemist (with an honours degree in chemistry or membership of the Institution of Chemical Engineers, and at least ten years experience as a chemist in industry since qualifying) in the Department of Heavy Industries, Eastern Region, Nigeria, to advise on the design of a laboratory and subsequently direct its work, and to undertake research into local raw materials, organic and inorganic, and their potential utilization either alone or in combination with imported material—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.461/411/02.

Laboratory Technologist (male or female, with A.I.M.L.T or equivalent, a knowledge of biochemistry and forensic and anthropological experience) in the Kenya Government Police Department—The Crown Agents, 4 Millbank, London, S.W.1, quoting M.3/43685/NF.

Laboratory Technologist (male, preferably single and preferably A.I M.L.T., and experienced in laboratory techniques and animal handling) in the Tanganyika Government Veterinary Department, for laboratory duties and field work on animal disease problems —The Crown Agents, 4 Millbank, London, S.W.1, quoting M 3/35063/NF.

Lecturer in the Department of Chemistry—The Principal, The Percival Whitley College of Further Education, Halifax.

Physicist in charge at the Northern Ireland Radiotherapy Centre—The Secretary, Northern Ireland Radiotherapy Centre. Purdysburn, Belfast.

Physicist, Senior grade (with a knowledge of X-rays, radium and radioactive isotopes) in the Radiotherapy Department, for duties concerning routine radiotherapy physics, and the applications of radioactive substances in other branches of medicine—The Secretary to the Board of Governors, Charing Cross Hospital, London, W.C 2.

Principal/Senior Scientific Officer (with a first- or second-class honours degree in mathematics, and several years postgraduate research experience in applied mechanics), to provide general theoretical assistance to a group engaged on the development of nuclear reactors for military application (Ref. No. 1299/34); and a Scientific Officer (with a first- or second-class honours degree in physics, mathematics or engineering, or equivalent qualifications), to carry out research and development work in the field of applied mechanics (Ref. No. A.1221/34)—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting appropriate Ref. No

Research Assistant (with either (*a*) a degree in chemistry or physics and an interest in the physical-chemistry of viruses and other biological macromolecules, or (*b*) appropriate laboratory experience) in the Biophysics Department—The Secretary, Research Institute (Animal Virus Diseases), Pirbright, Surrey.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Planning. Vol. 22, No. 401 (13 August, 1956): The Cricket Industry Pp. 157–172. (London: Political and Economic Planning, 1956.) 2*s.* 6*d.* [238

Air Ministry: Meteorological Office. British Rainfall 1954: the Ninety-Fourth Annual Volume of the British Rainfall Organization. (Report on the Distribution of Rain in Space and Time over Great Britain and Northern Ireland during the year 1954, as recorded by about 5,000 Observers.) Pp. iv+215. (London: H.M. Stationery Office, 1956.) 25*s.* net. [238

The International Journal of Applied Radiation and Isotopes Vol. 1, Numbers 1/2 (July, 1956). Pp. 144. Subscription per volume: (a) £6 (U.S.A. 17 dollars); (b) for individual subscribers certifying that the journal is for their private use, £3 10*s.* (U.S.A. 9.80 dollars), including postage. (London and New York: Pergamon Press, 1956.) [238

Department of Scientific and Industrial Research: Road Research Laboratory. Road Note No. 21: Tests on the Efficiency of a Twin-Shaft Paddle Mixer with various Settings of the Paddle Tips. By W. L. Russell. Pp. 12. (London: H.M. Stationery Office, 1956.) 1*s.* 6*d.* net. [238

Freshwater Biological Association. Twenty-fourth Annual Report for the year ended 31st March 1956. Pp. 70. (Ambleside: Freshwater Biological Association, 1956.) 3*s.* [238

Institute of Seaweed Research. Annual Report for 1955 and review of the Institute's Activities, 1945–1955. Pp. 52. (Inveresk, Midlothian: Institute of Seaweed Research, 1956.) [238

Bulletin of the British Museum (Natural History). Zoology. Vol 4, No. 2: The Evolution of Ratites. By Sir Gavin de Beer. Pp. 57–70+plates 5–9. 10*s.* Vol. 4, No. 3: Studies on the Trichiuroid Fishes, 3—a Preliminary Revision of the Family Trichiuridae. By Denys W. Tucker. Pp. 73–130+plate 10. 20*s.* (London: British Museum (Natural History), 1956.) [238

Other Countries

New Zealand Forest Service. Information Series, No. 19: Management of Woodlots. By W H. Jolliffe. Pp. 20+8 plates. (Wellington Government Printer, 1956.) [238

Indian Central Cotton Committee: Technological Laboratory. Technological Bulletin, Series A, No. 89: Technological Reports on Trade Varieties of Indian Cottons, 1955. By Dr. C. Nanjundayya. Pp. ii+88 (Bombay: Indian Central Cotton Committee, 1956.) Rs. 2. [238

The Isotope Index: First Complete Guide to the Isotopes. Vol. 1, No. 1 (June 1956). Pp. 64. (Indianapolis, Indiana: Scientific Equipment Corporation, 1956.) U.S.A. and Canada, 2 dollars; Foreign, 2.50 dollars. [238

New Zealand. Department of Scientific and Industrial Research Geophysics Division. Amberley Observatory—Magnetic Results for 1954. Pp. iv+56. (Wellington: Government Printer, 1955.) [238

Proceedings of the First International Conference on the Use of Antibiotics in Agriculture, held under the auspices of the Agricultural Board and the Agricultural Research Institute, National Academy of Sciences—National Research Council, 19–21 October 1955. Pp. xx+278. (Publication 397.) (Washington, D.C.: National Academy of Sciences—National Research Council, 1956.) 2.50 dollars. [238

Federation of Nigeria. Annual Report of the Department of Agriculture (Central), for the year 1953–54, Part 1. Pp. 8. (Lagos: Government Printer, 1956.) 9*d.* net [238

Federation of Nigeria. Annual Report of the Geological Survey Department for the year 1954–55. Pp. 14. (Lagos: Federal Government Printer, 1956.) 9*d.* net. [238

Canada. Department of Mines and Technical Surveys. Publications of the Dominion Observatory, Ottawa. Vol. 14, No. 16: Bibliography of Seismology, Items 8773–8947, July–December, 1954. By W. E. T. Smith. Pp. ii+339–360. (Ottawa: Queen's Printer, 1956.) 25 cents. [238

Durban Museum Novitates. Vol. 4, No. 16 (20th May, 1956): Some Records of South African Cassidinae (Col. Chrysomelidae). By S. Shaw. Pp. 257–272. 3*s.* net. Vol. 4, No. 17 (30th June, 1956): Miscellaneous Taxonomic Notes on African Birds. By P. A. Clancey. Pp. 273–292. (Durban: Durban Museum and Art Gallery, 1956.) [238

Publications de l'Observatoire de Genève. Série A: Astronomie, Chronométrie, Géophysique. Fascicule 52: Sur les Problèmes non Résols posés par l'Étude de la Marche des Chronomètres. Par G. Tiercy. Pp. ii+11. Fascicule 53: Remarques sur le Système Photomètrique de H. L. Johnson et W. W. Morgan et sur la Photometrie en Six Couleurs de J. Stebbins et A. E. Chitford. Note par M. Golay. (Estratto delle Memorie della Societe Astronomica Italiana, Vol 26–4) Pp. ii+9. Série M: Météorologie. Fascicule 30: Résumé-Météorologique de l'Année 1955 pour Genève. Par Ernest Rod. Pp. 13 Résultas des Observations de Chronomètres en 1955. Pp. 10. (Genève: l'Observatoire, 1955 et 1956) [238

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NATURE

No. 4540 SATURDAY, NOVEMBER 3, 1956 Vol. 178

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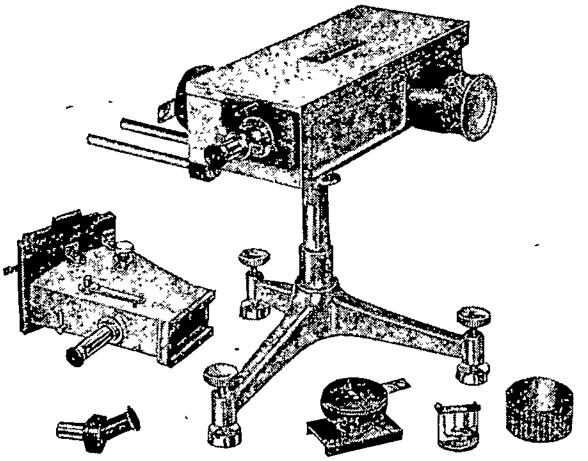

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SCIENTIFIC AND INDUSTRIAL RESEARCH IN THE UNIVERSITIES

THE problem of finding the money for carrying out research in university departments of science and technology in Britain has been growing steadily more acute, and there has been considerable discussion in recent months which has served to show both its magnitude and the difficulties inherent in meeting it. Prof. Samuel H. Beer has produced a timely little book* which demonstrates that something in the way of positive, constructive thinking is required if we are not to drift in some emergency into a situation which will endanger both the autonomy of the universities and the balance, or even the conduct, of research in general.

Prof. Beer is concerned simply with the role of the Treasury as co-ordinator of financial and economic policy, and in the first place he is impressed with the Treasury's lack of positive powers of command. But the picture he gives of the way in which the Treasury is able in practice to enforce effectively the priorities of Government policy indicates the importance of institutions or activities subject to Government control, such as the University Grants Committee or the Department of Scientific and Industrial Research, being ready and able to present a clear and reasoned argument for their needs which can be fully justified by reference to national needs. The Treasury does possess some powerful sanctions; but supporting these is a 'structure of influence' that enables it to carry out most of its wishes by persuasion. This is the important factor where such activities as research and institutions like the University Grants Committee are concerned.

In this attempt to understand the relations of the Treasury with the other great Departments of State, Prof. Beer notes a strong tendency to reach agreement at the official level which has roots in the corporate life of the Civil Service. It has frequently been suggested that one of the reasons for the smooth working of the University Grants Committee system is that the senior Civil servants concerned have themselves a university education and outlook, and a like factor can operate also in relation to Ministerial collective responsibility. Where this operates and Ministers know their own minds, the co-ordination works smoothly. Officials are able to go beyond the mere departmental view and anticipate probable decisions at Ministerial level. In its absence, however, and where Ministers cannot agree, the whole process may break down.

But Prof. Beer's tribute to the efficiency of Civil Service administration at the highest level does not deal with one vital point. If he is correct in his view that the power of the Treasury resides largely in the tendency to agreement proceeding from the professional standards of the Civil Service and from the structure of Britain's executive power, that of itself affords no assurance that the right agreements will be reached. It says nothing as to whether the Treasury is properly equipped for reaching right decisions in matters of planning, or as to whether the standards of efficiency which it applies in such matters as research, for example, are in line with modern conceptions and practice. Tendencies to agreement at any level will not ensure sound decisions unless there is clear understanding on all sides of the nature of the problem, including the scientific and technical factors involved.

Prof. Beer's little treatise is thus less reassuring than appears at first sight, and by implication his exposition of the nature of Treasury control reinforces all the arguments for ensuring that the future administrator has an adequate understanding of the nature of the scientific and technical problems in the situations and problems he will have to confront. It indicates, too, the value of making the fullest use of those scientists who possess administrative ability, and it should remind the scientist and technologist of the importance of taking care that the nature of their work and the conditions required for its effective pursuit are clearly explained to those from whom the means for its prosecution are drawn.

This question of public relations is of vital importance both in relation to university research, which clearly is not easily separated from the activities of the universities as a whole, and in relation to the nation's general research organization. Understanding and foresight are essential if the delicate balance is not to be disturbed, and waste of public resources through some ill-judged and short-sighted economy avoided. It might well be that, as was urged in the debates on the Department of Scientific and Industrial Research Bill in the House of Commons, a senior Minister, provided with an adequate staff, and charged with the responsibility for co-ordination and prosecution of our scientific and technical effort, could do something to improve the present position Apart altogether from the question whether any one man could adequately meet the demands which such a responsibility would make upon him, he could only hope to do so under exactly the conditions which Prof. Beer lays down for effective Treasury control in general, and presupposing a wide degree of understanding of the scientific and technical factors on the part of those with whom he is called upon to deal.

What needs to be emphasized is that a wide degree of public understanding is essential before we can hope to arrive at the most efficient and appropriate structure for the administration of Britain's research effort. To some extent recent debates in Parliament have assisted that process; but there is still much that the Parliamentary and Scientific Committee, for example, could do in this direction. Further, if Britain is indeed lagging behind the United States in expenditure on research, as the preliminary estimates from the survey made by the Department of Scientific and Industrial Research suggest, the situation is not likely to be improved by administrative action done in the absence of such wider understanding. A change in the climate of opinion may be an essential for the necessary financial provision to be forthcoming and for the effective presentation of research. As Sir Harold Himsworth pointed out at the Home Universities Conference held last winter, neither universities nor research organizations alone are able under modern conditions to carry the whole breadth and depth of the research required for the support and development of modern society. Both must contribute, and as partners in the full sense of the word. Whatever the future relation between them and between them and the Government, nothing should be done which impairs the independence of the universities and their freedom to develop according to their own inspirations. Prof. H. W. Melville had referred during the Conference to the possibility that the Department of Scientific and Industrial Research might provide a means of redressing the balance of fundamental research when it was found that certain subjects were neglected in the universities. It would be undesirable for any Government department to induce, by direct action, the universities to undertake investigations which they do not at present pursue, even though such researches might be in the national interest; but Prof. Melville thought that either by undertaking the investigation itself or by adopting the unit system by which the Medical Research Council and the Agricultural Research Council at present operate in the universities, the Department of Scientific and Industrial Research could exert a marked influence.

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* Treasury Control: The Co-ordination of Financial and Economic Policy in Great Britain. By Prof. Samuel H. Beer. Pp. ix+138. (Oxford: Clarendon Press; London: Oxford University Press, 1956.) 15s. net.

Here we see at once how important it is that there should be a full understanding of the nature of the Department's work and a balanced view of the country's needs, without which the necessary resources are unlikely to be forthcoming. Moreover, that applies equally to Sir Harold Himsworth's point about the access of individual universities to specialized facilities which they need but which they do not possess, and which it would be undesirable and uneconomic to duplicate in every university, particularly as they are available in many research institutes and stations. This is a particular aspect of the problem of the proper association of existing major research institutes and establishments with the appropriate university departments that can affect very considerably the return which the country receives from its expenditure on research and on the universities.

These are some of the problems which the universities, the research councils and research associations should be considering, and they determine the value which is received for expenditure on research. Moreover, while, as has been emphasized, appropriate solutions are unlikely to be found or at least applied in the absence of a wider and fuller public understanding of what is involved, that public understanding could simultaneously help to remove the most serious weakness to which the survey described by Mr. E. Rudd in a paper before Section F (Economics) at the recent Sheffield meeting of the British Association points—the much smaller expenditure on research by industry in Britain. If industry is to increase its own effort, still more to increase those benefactions to university research which can decrease the risk of excessive dependence on government support or contract research, it will only be in the light of fuller understanding of the nature of research and of the contribution which scientific advance can make to industrial development and efficiency. While the magnitude of Britain's effort in research and development may well be open to inquiry, and the structure of the national organization for research requires critical thought and inquiry, the overriding need is for fuller public understanding of what is involved, and of the dependence of our industrial effort not only upon research but equally upon technological and technical education.

GENEVA CONFERENCE ON THE PEACEFUL USES OF ATOMIC ENERGY

Proceedings of the International Conference on the Peaceful Uses of Atomic Energy

Held in Geneva, 8 August–20 August, 1955. Vol. 15: Applications of Radioactive Isotopes and Fission Products in Research and Industry. Pp. viii+327. 7.50 dollars; 54*s.*; 32 Swiss francs. Vol. 12: Radioactive Isotopes and Ionizing Radiations in Agriculture, Physiology, and Biochemistry. Pp. ix+553. 9 dollars; 63*s.*; 39 Swiss francs. Vol. 10: Radioactive Isotopes and Nuclear Radiations in Medicine. Pp. x+544. 8 dollars; 57*s.*; 34 Swiss francs. (New York: United Nations; London: H.M. Stationery Office, 1956.)

IT was said, I think first by Robert Oppenheimer, that the increase of knowledge as the result of the widespread use of radioactive tracer elements in research might bestow greater benefits on mankind than would result from the mere supply of energy from uranium fission. These three volumes present a very comprehensive review of what has been achieved thus far with tracer elements and with massive doses of radiation derived either from elements such as cobalt, left in a high-flux reactor for a long time, or from fission products. The nuclear power industry will yield tons of fission products a year in a decade, and scientists have been searching for possible uses of the thousands of millions of curies of radiation which will be available as a by-product. Before the end of the century, fission-product radiation could sterilize far more food than the population using the related nuclear energy could consume: such is the magnitude of the new source of energy.

Research with radioactive tracer elements was initiated more than forty years ago by Prof. G. de Hevesy, who was present at Geneva. Many papers on a large number of subjects have their origin in his work. Great strides have been made in chemical analysis by irradiation of samples in a neutron flux of $10^{12}n/\text{cm.}^2/\text{sec.}$; many impurity elements can then be detected in concentrations of one part in a hundred million, and for a few elements the sensitivity is a thousand times greater than this. Trace impurities can seriously affect the semiconducting characteristics of germanium and silicon, and both have benefited by activation analysis; it also offers a great advantage over other possible methods when the impurity element has chemical properties similar to the host element. Most of the papers on this subject are indicative: the authors recognize that the subject, although old, is far from fully developed, and results are offered as a guide. Tracers have been used in the study of the mechanism of chemical reactions, the function of catalysts, absorption and desorption, and in many metallurgical problems. When a radioactive metal diffuses into another metal, the influence of the grain boundary on diffusion-rates can be studied precisely.

The technological importance of isotopes is exemplified in the very large number of papers which report the use of isotopes as gauges, gauges for thickness measurements ranging from 0·0001 in. for inks, paints and electroplating up to 2 in. of steel and 15 ft. of snow. Locating gauges have been used in fluid dynamics for indicating interfaces, the degree of mixing of gases, of liquids and of solids; flow gauges to follow the movement of silt in river beds and sand in harbours; and density gauges for the manufacture of cigarettes and for liquids in pipe lines. In the study of wear and the influence of lubrication on wear, isotopes have been widely used; recent Soviet work is reported on this subject, and there is an extensive survey of the use of isotopes in the steel-making industry of the U.S.S.R.

Strong sources of radiation can replace X-ray tubes for certain radiographic purposes. Thousands of curies of iridium, emitting 600-keV. γ-rays, are used for boiler weld radiography, and in time cæsium-137 separated from other fission products will doubtless more than satisfy all possible needs for γ-rays in this energy-range. Thulium, emitting γ-rays of 84 keV. energy, has been made up into extremely portable X-ray units for field use—again, thulium may possibly be superseded by the fission product xenon. Cobalt-60 has practically ousted radium in the γ-ray energy-range of 1–2 MeV. for medical therapeutic use.

The role of fission products in human history lies n the unforeseeable future. At present we see the use of γ-rays to break chemical bonds and polymerize and cross-link many molecules such as polythene and rubbers; but only a beginning has been made. The sterilization of foods and pharmaceuticals has been studied for years with some success; but a ten-year summarizing paper still speaks very cautiously of the future possibilities of the widespread use of fission products; the direct conversion of radiation into electrical energy appears to have little future except for special restricted applications.

Those scientists who do not work in the life ciences will enjoy many fascinating papers in Vols. 10 and 12, on radioactive isotopes and nuclear adiation in medicine and in agriculture, physiology and biochemistry. There are lengthy accounts from many countries of the use of tracers in agriculture, especially in the study of root and leaf fertilizers, plant growth, and the speed of chemical processes aking place in plant life. Labelled phosphate fertilizers are now made by the ton, so great is the demand or agricultural research, and accurate information n the absorption through the leaves may revolutionize crop fertilization. Isotopes led to the discovery f extensive root-grafting of trees—a forest must be onsidered as a united community rather than as a collection of individuals—and the danger of fungus invasion by the root system is thus more obvious. It is disquieting to learn that the weedkiller 2-4-D can be absorbed by edible plants, and it is clearly important, as one review article points out, to establish that such compounds have no effect on the consumer—man or animal.

Mutations induced by irradiation are being studied in the radiation fields at Brookhaven, and in Norway, the U.S.S.R. and elsewhere. It is not easy to judge whether really important mutants have been discovered yet—mutants which have not already been developed by intensive breeding, the rust-resistant oats, the improved peanuts, the more erect variants of barley, etc. Improvements are expressed by writers only in terms of small percentages, and one wonders what commercial advantage red carnations grown on a white carnation stock will have. But patience is needed, and progress is being made on a wide front. Among the valuable uses of intense sources are to be included the eradication of the screw worm fly by sterilization of large numbers of male flies with doses of 7,500 roentgens; in this way the island of Curaçao has been freed from this damaging pest. The treatment of potatoes and carrots with a similar γ-ray dose completely inhibits sprouting and growth for a year.

Pavlov's plea for an exact knowledge of the fate of food within organisms is likely to be answered now that tracer elements are in wide use. It comes as a surprise to learn that calcium is constantly passing from blood to bone and back again. For example, one writer reports that 99 per cent of labelled calcium is deposited in the bone within one day of ingestion, and the amount of calcium exchanged to and fro is a hundred times the amount retained for growth. The speed of some reactions is very great; thus, within ten minutes of adding chlorine ions to the blood, equilibrium is established between plasma and red cells. Photosynthesis is yielding up some of its mysteries with the aid of carbon-14, and many papers are devoted to this huge subject. At first, says one contributor, it seemed that the use of isotopes would solve most of the more difficult problems of animal nutrition; many answers have been supplied by isotopes, but not the simple ones which were expected, and a more complex state of affairs has been uncovered.

Apart from an extensive use of tracers in medical research, medical diagnosis and therapy have benefited greatly from the ready availability of radioactive sources. Diagnosis by iodine uptake of the malfunctioning of the thyroid gland is one of the oldest. More recently, radioactive iodine and arsenic have been used for location of metastases of tumours; where great accuracy of location is required, as for the location of brain tumours, the positron-emitter arsenic-74 is used, and two scintillation counters placed on opposite sides of the head record coincidence counts if the two γ-rays which are emitted simultaneously and in opposite directions when the positron decays pass through the counters. Radioactive iron is used in diagnosis of diseases affecting bone marrow, and radiochromium or radiosodium is used in the study of the circulation of the blood. Many more diagnoses with radioactive elements are in the research stage and show great potential value, although few are ripe for routine laboratory use; the future for accurate diagnosis appears to the layman to be far brighter than the past has been.

Radiation therapy has benefited by the large use of strong radiocobalt sources in place of radium bombs emitting a far lower intensity of radiation. Cæsium-137, which emits a rather softer radiation of 660-keV. energy, is just becoming available from fission separation plants and will supply all conceivable needs of therapy in a decade or so. Iodine selectively absorbed can be used in large doses for therapy, and so can phosphorus; gold in colloid form has been injected locally, and a new technique involves the irradiation of intravenously injected boron in a slow-neutron beam emerging from a reactor.

Vol. 10, on the use of nuclear radiations in medicine, is one of the most remarkable volumes from the Geneva Conference, and one of the most inspiring.

T. E. ALLIBONE

SCIENCE IN PROGRESS

Science in Progress

Edited by George A. Baitsell. Ninth Series. (The Society of the Sigma Xi devoted to the Encouragement of Research in Science. Sigma Xi National Lectureships 1953 and 1954.) Pp. xviii+343. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1955.) 6.50 dollars; 52*s*. net.

THIS new volume, the ninth in the series of "Science in Progress" publications, which began with Vol. 1 in 1939, continues the firmly established function of the series: the presentation in permanent form of authoritative reports of research in both pure and applied sciences. George A. Baitsell has produced an engaging and varied mixture of topics. It would be unfair to say that the accounts are couched in popular language; but generally they are not loaded with heavy technicalities.

A reader with a grammar school knowledge of chemistry and biology will find Kenneth V. Thimann's paper on the physiology of growth tissues easy to understand; but a specialized knowledge of mathematical aerodynamics is necessary to comprehend fully the second part of D. B. Steinman's account of the stability of suspension bridges. The first part of this chapter makes exciting reading. It tells of the unexpected destruction of suspension bridges which were able to absorb energy from winds of quite moderate velocity and sustain themselves in oscillation. An example occurred in late 1940 when the Tacoma Narrows Bridge at Paget Sound, new only four months previously and built at a cost of six and a half million dollars, was destroyed. The oscillations of the bridge increased to destructive amplitude until the main span broke up and dropped into the water 208 ft. below. The problem concerning this has been solved both theoretically and practically.

In a forty-page chapter, Lawrence M. Snyder, professor of genetics in the University of Oklahoma, gives a summary of the present knowledge of human heredity, with special reference to clinical problems, some of which are of rare occurrence. This is followed by a discussion by Curt Stern, of the University of California, on the cellular physiology of differentiation by means of which an embryonic cell is transformed gradually and in the end, usually irreversibly, into a differentiated cell. His investigations, which were suggested by the arrangement of bristles on the fruit-fly, carry the knowledge of this topic further forward; but in general the nature of the mechanisms of differentiation is still obscure.

E. J. Krans, of Oregon State College, is the author of a chapter, easy to read but thoroughly sound, on the significance of ergocrines in agricultural practice. In this well-illustrated chapter the author considers the effects of the synthetic plant-hormone substances both as plant-growth stimulants and as herbicides. The processes of visual excitation provide an instance of a biological problem which is investigated on the molecular level. George Wald, of Harvard University, has given a thorough, clear and authoritative account of the biochemical and physical properties of retinal molecules and their function in seeing.

Lee E. Farr, of the Brookhaven National Laboratory, presents a paper on the impact of nuclear science on medicine. This is by no means well-trodden ground, for, among other important matters, he gives accounts of the effects of radiation on immunity mechanisms, the use of carbon isotopes for exploring the methods by which amino-acids are converted to protein in living tissues, and the radiation of brain tissue. Felix Bloch, of Stanford University, gives an account of the apparatus and methods used for investigating nuclear magnetism, which is a model of clarity and simplicity in exposition. In particular, the technique is applied to a detailed study of molecular structure.

Two other chapters maintain the high quality of the others: transistor physics, by William Shockley (Bell Telephone Laboratories); and colour and chemical construction, by Wallace R. Brode (National Bureau of Standards, Washington, D.C.). Although these two subjects have been covered adequately in papers and articles published in Britain, the American method of presenting the material should prove to be instructive.

The book is a handsome volume, well printed and illustrated, on good paper, and worthily bound.

W. L. SUMNER

THE NATURAL HISTORY OF SPACE PERCEPTION

The Child's Conception of Space

By Jean Piaget and Barbel Inhelder. Translated from the French by F. J. Langdon and J. L. Lunzer. (International Library of Psychology, Philosophy and Scientific Method.) Pp. xii+490. (London: Routledge and Kegan Paul, Ltd., 1956.) 42*s*. net.

THIS is an important book, probably the most notable of the long series of similar studies on child development which have come from Prof. Jean Piaget's laboratory. In it the developing powers of the child to manipulate and talk about objects in space are explored and systematically described. It is typical of Piaget's approach that the course of the investigation seems to have been, in part at least determined by purely logical considerations. Thus the reader moves from topological space through projective space into Euclidean space. Consequently the whole account has an orderliness that is often missing from child studies carried out elsewhere. On the other hand, the empiricist might complain that Piaget and Inhelder's data are used for illustrating rather than proving an essentially deductive set of theories and that the order is imposed, not discovered.

Since this line of criticism is perhaps the only one to which these admirable studies seem open, it may be considered further. To begin with, the detailed statistics now regarded as desirable in Britain and America are nowhere presented by Piaget and Inhelder. To be sure, one paragraph in Part 2 begins promisingly: "These experiments were carried out on 100 children, 21 between 4 and 6 : 6 years, 30 between 6 : 7 and 8 years, 33 between 8 and 9 : 6 years and 16 between 9 : 6 [should it be 9 : 7 ?] and 12 years", but in the subsequent text no attempt is made to relate the developmental stages in space perception to any given number of children of a particular age. It is clear, however, from the whole nature of this study that Piaget and Inhelder are primarily concerned with what follows what, and are not particularly interested in the precise age at which the different stages occur. If anyone wishes to construct a developmental quotient on the lines of the intelligence quotient, then he may do so and the present study will provide him with an invaluable starting-point; but the authors themselves have accomplished quite a different task.

Thus the methodological criticism may be in large measure discounted, and we can accept gratefully this richly detailed natural history of how our awareness of space grows from simple juxtaposition to the manipulation of perspectives and the arguments of geometry. A central theme of the whole account is the important part played in space perception by our own activities. We have inherited from John Locke and the empiricists a view of perception in which the outside world, as it were, imposed itself upon a passive organism. Almost all recent research has shown the untenability of this view, and the present study may perhaps serve to inaugurate a new and quite different approach.

To someone who has at one time wrestled with the original French text, the present translation seems to have been excellently carried out, and any difficulties that the reader may encounter derive from the complexity of the original and not from any defect in the expression.

NEW TECHNIQUES AND APPLICATIONS IN MOLECULAR SPECTROSCOPY

Molecular Spectroscopy

Edited by George Sell. (Report of a Conference organized by the Spectroscopic Panel of the Hydroarbon Research Group of the Institute of Petroleum, and held in London, 28–29 October 1954.) Pp. iii+234. (London: Institute of Petroleum, 1955.) 2*s*. net.

IT is not so very long ago that self-respecting spectroscopists frowned upon anything more omplex than a diatomic molecule. However, the apid development of the petrochemicals industry as given a great fillip to applied spectroscopy, which has become much more 'broad-minded' with regard to the size of molecules and the complexity of their mixtures that its adepts take in their stride.

Perhaps one of the first of the spectroscopists of the 'old school' who sensed the power of spectroscopic methods as a tool for developing industrial rocesses was Victor Henri, and indeed nowadays ultra-violet and infra-red methods are necessary tools of the petroleum industry and of many other branches of the chemical industry. To this the present volume bears witness. Yet beyond this it also sheds light on techniques which still have to prove their value for the field of hydrocarbons.

This book is a collection of nineteen papers which were read by invitation at a conference which the Spectroscopic Panel of the Hydrocarbon Research Group of the Institute of Petroleum held in London in 1954. The object of the conference was to bring together people for a discussion of newer techniques. In this endeavour, and in a laudable spirit of being non-parochial, the Panel succeeded in attracting contributions from workers in Britain and overseas. The papers are written by people with widely different interests and touch upon very different aspects of applied spectroscopy. It is only natural, therefore, that they vary considerably in length, depth and breadth.

It is interesting to learn that about two thousand infra-red spectrometers are in use to-day, that cæsium iodide prisms can be made from synthetic crystals to allow measurements to 54μ, and of the possibilities opened up by additively coloured alkali halide crystals as infra-red transmission filters. There is information on gratings for use in the 2–15μ region with line spacings varying from 15,000 to 2,400 lines/inch, on the pressed-disk technique for obtaining spectra of solid materials, on infra-red reflexion spectra from small crystals, on Raman spectrometry, and on infra-red emission from gases excited by a radio-frequency discharge. Gases can be heated to temperatures in excess of 5,000° C. in fewer than ten molecular collisions by the application of shock-waves. For analytical purposes, on the other hand, low-temperature work may become useful where mixtures solidify to transparent disordered glasses. What the analyst is looking forward to very much is to be able to transfer data from one instrument to another; that is, to assess true intensities from the measured spectra. He derives immediate benefit from a classification of the characteristic vibration frequencies of substituted benzenes. The amount and position of deuterium in mono-deutero-aromatics in the presence of their parent compounds can be determined by infra-red spectrometry. Oxidation plays a great part in the quality and shelf-life of many hydrocarbon products, and infra-red spectrophotometry can be beneficially employed as a yard-stick for the degree of oxidation.

Both Raman and ultra-violet spectrometry have their places in type analysis, and there is an interesting account of the determination of aromatic hydrocarbons in lubricating-oil fractions by work in the region of 1900 A. The future will show the part which the flash-photolysis technique and nuclear magnetic-resonance spectra can play in the field of hydrocarbons. There can be little doubt that fluorescence techniques are in the ascendancy. An article of about two thousand words, on the use of fluorescence for industrial analysis and examination, is a masterpiece of concise presentation. The book contains a record of the discussion to each paper, and a discussion on punched cards and the presentation of spectral data forms its concluding chapter.

Workers in the petroleum industry owe a debt of gratitude to the Institute of Petroleum for making available for reference purposes this fountain of information.

R. SCHNURMANN

Electromagnetically Enriched Isotopes and Mass Spectrometry

Edited by M. L. Smith. (Proceedings of the Conference held in the Cockcroft Hall, Harwell, 13–16 September 1955. Sponsored by the Atomic Energy Research Establishment, Harwell.) Pp. xvi+272. (London: Butterworths Scientific Publications; New York: Academic Press, Inc., 1956.) 45*s*.

THE appearance of this collection of papers on enriched isotopes will be welcomed by all who are interested in this field. These papers are concerned both with the technique of electromagnetic enrichment and with the applications of the enriched isotopes. Since much of the material either has not been published before or is contained in reports of limited circulation, its collection within one volume is an important contribution to the literature of the subject.

More than half the thirty papers are concerned with problems of design in the separator itself. Since the principal factor which determines whether or not an element can be processed electromagnetically is the availability of suitable ion sources and collectors, several papers are concerned with detailed discussion of their construction and of associated chemical problems. It is interesting to note that it is now possible to process in substantial quantities the stable isotopes of nearly all the elements. Abundance measurements and mass-spectrometry are surveyed in a number of papers, and interesting contributions are included on the method of dilution analysis and on a new type of mass-spectrometer employing radio-frequency methods. Other survey papers describe typical uses of enriched isotopes and give some indication of their wide field of application. Two papers direct attention to the importance of applying enrichment techniques to radioactive isotopes.

The book is well produced and contains clear diagrams and photographs. The provision of an adequate index and the inclusion of the discussions which followed the papers add greatly to its value.

M. A. GRACE

Protoplasmatologia

Handbuch der Protoplasmaforschung. Herausgegeben von L. V. Heilbrunn und F. Weber. Band 2: Cytoplasma. *A*: Morphologie. 2: Die Submikroskopische Struktur des Cytoplasmas. Von A. Frey-Wyssling. Pp. iv+244. (Wien: Springer-Verlag, 1955.) 72*s*.

DURING the past five years the electron microscope has become the main tool for investigating cellular fine structure. This change in technique is reflected in the much greater space given in this book to electron microscope results than in the earlier work by Prof. A. Frey-Wyssling on submicroscopic morphology. The section on electron microscopy, which takes up the first half of the book, will be most useful to cell biologists. It brings together, for the first time, observations on cell structure which have been scattered through a large number of journals and discusses them in terms of both cell function and molecular morphology. There is an interesting section on the structure of the ground cytoplasm in which Prof. Frey-Wyssling points out the dangers of artefacts and illustrates them with some striking photographs of reticular structure in gelatin and Liesegang rings after osmium fixation. There are a number of good reproductions of electron micrographs, but one could wish for more.

The second half of the book is concerned with those aspects of chemistry, cell physiology and biophysics which are relevant to cellular fine structure. Perhaps the best section is that which deals with the structure of proteins and nucleic acids and describes the recent work of the X-ray crystallographers in this field.

J. M. MITCHISON

Physical Chemistry

By Prof. Walter J. Moore. Second edition. Pp. xii+633. (London and New York: Longmans, Green and Co., Ltd., 1956.) 30*s*. net.

PROF. W. J. MOORE uses the thermodynamical approach to physical chemistry, and his readers need a knowledge of advanced mathematics and the ability to apply them. The first edition (1950) was reviewed and commended in these columns (see *Nature*, 168, 577; 1951). In this, the second American, but first English, edition the author, in bringing the work up to date, has accepted friendly criticism and made numerous small improvements.

The chapters dealing with nuclear chemistry and electrochemistry, and that on the structure of molecules, have all been enlarged. Prof. Moore has extended the scope of the section on photochemistry, has removed it from Chapter 17, on kinetic energy, and has made it into a new chapter on photochemistry and radiochemistry. To the curtailed Chapter 17 he has added two new sections dealing respectively with reactions in flow systems and with the mechanisms of ionic reactions. The lists of articles and books recommended for further reading have been overhauled, brought up to date and extended. Many of the newly listed articles are from the *Journal of Chemical Education* or from the Chemical Society's *Quarterly Reviews*.

The work is recommended to those studying physical chemistry at university-level who have the necessary mathematical equipment.

G. F.

Animal Breeding

By Dr. A. L. Hagedoorn. (Agricultural and Horticultural Science Series.) Fifth edition. Pp. xix+364+21 plates. (London: Crosby Lockwood and Son, Ltd., 1954.) 18*s*. net.

PROBABLY no other book has done more than this one to stimulate practical livestock breeders and students of animal husbandry to take an acute interest in genetical principles and ideas. It is fitting that in this fifth edition, with its revisions and additions made by Dr. A. L. Hagedoorn before his death, there should be a memoir of the author by Dr. John Hammond which notes his outspoken critical approach to practical problems and controversies. For his provocative decrial of "fancy points" and show-ring standards, his robust insistence on progeny testing, and his advocacy of the nucleus system of breeding are further emphasized here.

Hagedoorn's own interests in, and practical contacts with, the breeding of large and small animals ranged widely and have once more been freely used for illustrating his main themes and provide the reader with a wealth of observations. Yet the tendency—perhaps need for his purpose—to over-simplify his interpretations of the underlying principles and his advice on breeding problems and procedures remains while the book can certainly be recommended to be read, it still cannot be accepted without reserve as the full and authoritative word on this aspect o animal production.

J. E. NICHOLS

CHEMICALLY INDUCED NEOPLASMS IN FUNGI

By Prof. P. T. THOMAS, Dr. H. J. EVANS* and D. T. HUGHES
Department of Agricultural Botany, University College of Wales, Aberystwyth

A NEOPLASM may be defined as a new growth which differs characteristically from that which occurs during normal cell reproduction and differentiation[1]. The benign and malignant neoplasms of animals have naturally, owing to their great importance, been subjected to the most intensive investigations. Unfortunately, animal material is not always favourable for fundamental studies into the factors which determine the origin of these abnormal growths. For this reason attempts have been made to use other organisms, and much useful information has been obtained from the study of tumorous malformations in higher plants[2-7].

From observations and experimental work which we have carried out on a number of fungi we now wish to indicate how this group of organisms may well be particularly favourable for elucidating certain aspects of the problem of cancerous neoplasms in animals. Fungi, unlike higher plants, contain no chlorophyll, and being heterotrophic are, like animals, dependent on nutrients synthesized by other organisms. Many of their metabolic products, for example, glycogen instead of starch, are also essentially similar to those of animals. Indeed, the whole physiology of fungi has so much in common with animals that biochemists have for a long time been using them as physiological models to study "under better controlled conditions, general biochemical reactions of animal tissues"[8].

The degree of control which can be achieved is of major importance, since it includes not only better control of environmental conditions but also of the genetical constitution of the experimental organism.

Interest in this direction was first stimulated by the work of Haddow, who compared the formation of secondary colonies in senescent bacterial cultures with the emergence of a malignant variant in the cells of ageing animal tissues[9]. Later Bausch[10] produced new forms of the yeast *Saccharomyces cerevisiae* by the action of well-known carcinogenic hydrocarbons and also by camphor, which is not known to be carcinogenic in animals. The yeast cells produced were vigorous giant-celled forms and, without cytological confirmation, it was concluded that the effect was due to polyploidy.

From a cytological study of the action of camphor on the asexual yeast *Torulopsis utilis*, Thomas concluded that the significant change in the production of vigorous giant-celled forms occurred in the cytoplasm[11,12]. Multinucleate cells were sometimes produced (Fig. 1); but these were unstable and there was evidence of a 'somatic reduction' to a stable mutant form with a normal nuclear complement and a changed cytoplasm.

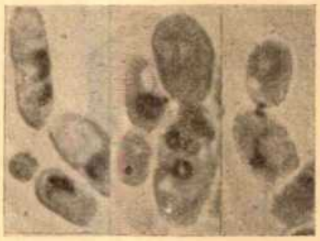

Fig. 1

From the following considerations it was concluded that there was a close analogy between the action of camphor on yeast and that of carcinogenic agents on animal cells: (1) marked increase in the concentration of nucleic acids, particularly of ribonucleic acid in the cytoplasm and nucleolus; (2) increase in the rate of cell reproduction, that is, reduction in generation time; (3) inhibition of growth during initial stages of treatment by the chemicals; (4) the chemical agents are effective only after a relatively long period of treatment. In yeast, which normally produces a new cell generation every hour or so, the mutant cells appear only after treatment for 2–3 days.

The type of change which occurs in yeast is essentially in agreement with the view that carcinogenesis involves an optimum inhibition of normal cell growth followed by an adaptation which allows the cells to continue growth[13]. Observations indicate that the chemical agent has a mitostatic effect on the yeast cell nucleus, but at the same time allows cytoplasmic activity to proceed to a new and apparently stable equilibrium.

Neoplasms are more easily recognized when the cells are organized into a tissue or into a pseudotissue as in the fructifications of the larger fungi. Fig. 2*a* illustrates a striking growth malformation produced in the cultivated mushroom *Agaricus campestris* fr. va. *bisporus*, where it has outgrown the normal pileus by at least five times. This tumorous growth is believed to have been induced by the accidental introduction of tarry fumes into a commercial mushroom house. The grower at Aberystwyth was forced to supplement the electrical heating of one of the houses by burning a mixture of coke and coal in open braziers. Between 20 and 30 per cent of the fructifications in the affected house were abnormal; but no such abnormalities were found in another, but smaller, house in which heating by electricity was adequate.

Reference to the literature showed that rather similar but less-pronounced abnormalities had been recorded for the first time in 1930 by Lambert[14]. He proposed the term 'rose-comb disease' and directed attention to its prevalence during 1930 in New York, Pennsylvania, Ohio and Missouri. From his general observations on these abnormalities he wrote as follows: "The agencies that seem most likely to be the cause of the tumours are the coal oil fumes or the fumes or oxidation products of materials containing mineral oil". Atkins, a prominent mushroom grower in Great Britain, also states that mineral oils and coal tar creosote fumes are important agents[15].

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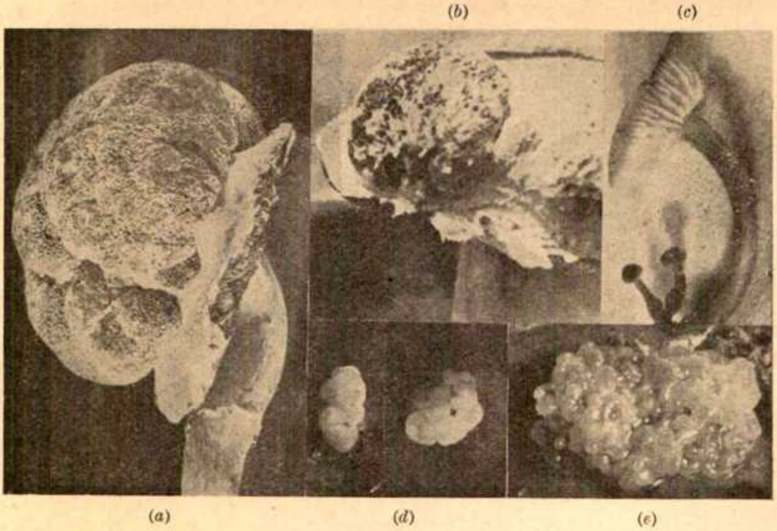

Fig. 2. *Agaric* neoplasms: *Agaricus campestris* with tumorous outgrowths of the pileus (*a*) produced in a commercial crop of mushrooms, and (*b*) induced experimentally by diesel oil vapour treatment. *Collybia velutipes* (*c*) normal fructifications after olive oil treatment. *Collybia* tumours produced after an equivalent treatment with diesel oil, (*d*) at 4 weeks, and (*e*) 8 weeks after initial treatment

One of us (H. J. E.) has carried out experiments designed to study the effects of a number of substances, under controlled conditions, on a commercial strain of the cultivated mushroom. The mushrooms were grown in 9-in. pots on a standard compost and maintained at constant temperature and humidity. Some additional experiments were conducted on mycelium grown in agar culture. A number of pure carcinogenic hydrocarbons were used; but although they had some effect on the growth of mycelium in culture they did not produce the characteristic tumorous malformations when applied to mushroom fructifications. Failure to produce any effect with these hydrocarbons may have been entirely due to technical difficulties involving, in particular, the use of solvents which were toxic to the fungus.

However, volatile mineral oils and coal-tar products could be used directly, and the amount of vapour applied was controlled. With some of these substances tumorous malformations of the type shown in Fig. 2*b* were repeatedly induced. The most striking results were obtained either by treatment with a proprietary substance containing tar acids, or with diesel oil. The latter was by far the most effective agent. Thus, in one series of experiments with diesel oil vapour, tumours were produced on 80 per cent of the mushroom fructifications, after periods of treatment ranging from three to eight days[16]. The maximum amount of tumour production was obtained after a sustained treatment with the vapour at a concentration which retarded development, but was not unduly toxic.

Tumours first appeared as protruberances of the pileus, as early as the young pin-head stage, or later when near maturity. They continued to grow even after the pileus had fully developed. Several distinct tumours could develop on a single pileus; but they often coalesced to form one large deeply lobed tumour. Sometimes, the outer tissues of a tumour differentiated into a spore-producing hymenium resembling that found in the Polyporaceae. (*cf.* Fig. 2*a* and 2*b*.)

Recently, another agaric fungus, *Collybia velutipes*, has shown certain advantages over the cultivated mushroom for experimental purposes. It is smaller in size and can be grown in large quantities in 250 c.c. flasks on a malt–agar medium. It is also found to be particularly sensitive to diesel oil, both in vapour and in liquid form. Treatment was given at the 'pin-head' stage for 14 days, after which the young tumours could be recognized (Fig. 2*d*). Further growth has been observed after up to eight weeks while still under the influence of diesel oil (Fig. 2*e*). Typically, these neoplasms have cerebiform convolutions and there is no differentiation of gill tissue. Fig. 2*c* shows normal development after an equivalent treatment with olive oil. If treatment by diesel oil is delayed until differentiation of the pileus has commenced, fruit bodies the edges of which curl up into tumorous over-growths are produced.

Cytological investigations, so far, have been largely confined to the cultivated mushroom, where comparisons between cell behaviour in normal and tumour tissue have been made[17]. Normal tissue, at the pin-head stage, is composed of closely packed, multinucleate, non-vacuolated cells, each containing an average of six to seven nuclei. Few nuclear divisions occur after the fructification has attained a diameter of about 10 mm. and further development is associated with vacuolation and increase in cell size.

Unlike the surrounding normal tissue, however, the tumours are composed of two kinds of cells, both of which contain actively dividing nuclei (Fig. 3): (i) small, non-vacuolated, multinucleate cells, with markedly basophilic cytoplasm (T_1 cells); (ii) larger vacuolated, multinucleate cells, showing less basophily of the cytoplasm (T_2 cells). In addition, intergrades between these two cell types are found.

The change from a normal to a tumorous condition involves the transformation of normally inactive pileal cells (N_1), with a comparatively low ribonucleic acid turn-over, into actively dividing basophilic T_1 cells. The T_1 cells reproduce their own type and also give rise to vacuolated, less actively dividing T_2 cells. Normal pileal tissue has an average of

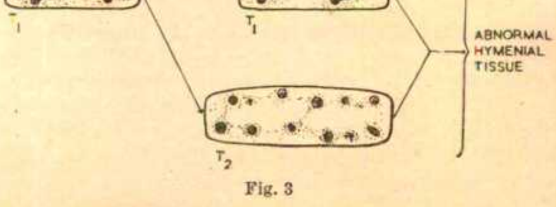

Fig. 3

$6{\cdot}44 \pm 0{\cdot}08$ nuclei per cell, whereas in the mature tumour where there is a preponderance of T_2 cells, the average number of nuclei per cell is $10{\cdot}1 \pm 0{\cdot}36$.

In addition to the increased basophily of the cytoplasm and mitotic activity of the nuclei in T cells there is hyperactivity of the nucleolus and heterochromatin. Tumour cells also show abnormal nuclear activity including endomitosis, multipolar spindles, chromosome aggregation, polyploidy, aneuploidy and micronuclei. These cytological disturbances are all characteristic of cells in animal tumours[18,19].

Our observations on a number of fungi serve to emphasize the desirability of undertaking further work on the nature of the changes that are produced by the action of various chemical agents. While fungal cells are not ideally suited for cytological study, there is little doubt that the comparison with the behaviour of cells in animal neoplasms represents something more than a mere analogy. Preliminary work on grafting neoplastic with normal tissue already indicates a promising field of research. Furthermore, the simplicity of organization of the fungi, together with their suitability for culture on synthetic media, should provide ample encouragement for biochemical studies.

We are very grateful to Prof. A. Haddow, of the Chester Beatty Research Institute, not only for his advice and encouragement, but also for supplying a number of carcinogenic hydrocarbons. Our investigations, which will be described in detail elsewhere, have been made possible by a grant from the British Empire Cancer Campaign, to which we also extend our gratitude.

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EDUCATION AND PRODUCTIVITY IN UNDER-DEVELOPED AREAS

THE main theme this year of Section L (Education) of the British Association was education in the British Colonies, and, following Sir Christopher Cox's provocative presidential address, it fell to two symposia to deal in greater detail with two of the central problems involved. These were the relationship of education to productivity, and the central educational dilemma of quantity or quality. Each was the subject of a separate symposium, and Prof. F. C. Benham, of the Royal Institute of International Affairs, opened the first with a paper on "The Allocation of Resources". He pointed out how poor the British Colonies are, with an average income per head of population of only one-tenth to one-seventh of that in Britain. Like all poor countries, they are faced with a difficult choice when they have to decide whether to spend more money on education and the social services, on one hand, or on measures for economic development, on the other. Considering briefly the case for each, Prof. Benham said that many people would urge that absolute priority be given to education, for they would say that illiterates cannot play their part properly as citizens, that children's talents and personalities need to be developed, and that we need higher education to provide leaders in society and government. But in spite of this, education is only one of the claimants among the social services; there are many others, and health and housing, for example, can also make out a very strong case.

On the other hand, the arguments for giving priority to economic development are hard to resist, for unless measures are taken to raise progressively future levels of output and income, there is no escape from a low standard of living. Referring to Lord Beveridge's point that "expenditure on education is the communal investment which in the end will bring the best return", Prof. Benham emphasized that it would be wrong to compare Britain with the Colonies in this respect, for Britain, with a population of fifty million, has a public revenue of more than ten times that of the Colonies. The latter, with a population of eighty million, have an annual income of only £50 million. Moreover, the proportion of children under fifteen years of age in Britain is only 20 per cent, whereas in the Colonies it is 40 per cent.

When a Colonial government considers how best it can use its limited resources to yield the best return, there are likely to be quite a number of projects which will give a greater and a quicker return than education. Considering the matter solely from the point of view of its yield as an investment, education might well have to take a back seat. The case for it only becomes strong when it is considered on its own merits, not as an investment but as a training for life and livelihood and as a means of character-building and raising mental stature. Even so, the Colonies are a long way from their goal, for there are three times as many children in the Colonies as in Britain, and yet only one in three receives any kind of schooling. In the educational field itself, there appear to Prof. Benham to be four outstanding priorities: an adequate flow of leaders at the university-level; teacher-training adequate both in numbers and quality; certain types of technical and vocational education; and, in some Colonies, an agricultural extension service.

Turning to the problem of finance, Prof. Benham thought there were a number of possibilities which might be considered. First, a higher proportion of public expenditure could be devoted to education; secondly, more money might be raised by taxation; thirdly, public loans for education might be raised; fourthly, more external aid might be sought; fifthly, more responsibility might be placed on local authorities; sixthly, certain measures could be taken to keep down costs. After briefly considering all these possibilities, however, he did not think he could draw hopeful conclusions from any of them. In spite of all efforts, the root of the difficulty lies in the poverty of Colonial people, and this being so, he thought the only real and permanent solution is to raise their real income by speeding up their economic development.

One of Prof. Benham's priorities was then taken up by Mr. J. C. Jones, director of education of the Regent Street Polytechnic, London, who dealt with the question of "Right Perspectives in Technical Education". Mr. Jones briefly outlined the facilities which already exist for technical education at its higher levels in the Colonies, and expressed it as his personal conviction that a good, general education is essential as a background at whatever level technological education is to be undertaken. This is of even greater importance in the Colonies than in Britain, principally because of two factors—the lack there of a mechanistic background, and the stigma which attaches to manual work. A basic solution to the problems raised by these factors is a greater introduction and emphasis upon educational handicrafts at an early age in the primary school and their continuance into all forms of secondary education. Mr. Jones then went on to describe the facilities which exist in many territories for other than higher technical education and declared that, because of the existence already in most Colonies of a nucleus of technical training facilities, he sees the possibility of a simultaneous development in technical education of both long-term and short-term policies. The former must be directed to a universal system of general education in which some provision is made for pre-vocational training at a relatively early age. The second stage must be the creation of alternative forms of secondary education providing for academic and technical streams. Industry, also, must play its part by the general introduction of apprenticeship schemes wherever conditions permit. Short-term planning, he thought, must be concerned to meet a developing situation in which the increasing demands of industry have to be set against a decreasing expatriate staff. In conclusion, Mr. Jones summarized his beliefs by saying, first, that the system of technical education as applied to under-developed areas can only succeed in so far as it is organically linked to, and continues the work of, the system of general education; secondly, that a system of technical education so applied must relate its work to the whole range of industrial need and not merely to its higher levels; thirdly, that development in technical education must always represent a compromise between long- and short-term policies, one logically conceived in the light of foreseeable economic expansion, and the other concerned primarily to meet the current need. He thought we had good reason to be proud of our past record in effecting the economic, as well as the political, independence of the Colonies.

For many years there has been criticism of the effects of Western schooling in rural, under-developed areas overseas. It has been called bookish and literary and is said to produce a dislike for agriculture, a flight from the land, a distaste for manual labour and a desire to secure black-coated employment. These and other criticisms of Western schooling were discussed by Mr. P. C. C. Evans, of the University of London Institute of Education, in a paper entitled "Western Schooling and Rural Productivity". He attempted to show that, on the whole, these charges against Western schooling are ill-founded, and that it is the humanistic spirit inherent in Western civilization which creates dissatisfaction with the low standard of living associated with the land in the Colonies. This dissatisfaction is not altogether a bad thing, for it leads to new patterns of economic endeavour which in the end will lead to increased productivity. Mr. Evans pointed out how in the past the power of the school to change society in the tropics, whether for better or for worse, has been greatly exaggerated, and that this has brought much criticism upon it for effects which are, in reality, due to the whole Western contact. Even so, in order that the standard of living may be raised, and the basic values of Western civilization find fuller expression, it is necessary that schooling at all levels should be permeated with a rural idiom, which will direct pupils' endeavours, by means of a pragmatic, problem-solving approach, to deal with the urgent problems of community living.

Perhaps the most arresting, and certainly one of the most interesting, talks of the whole symposium was that given by Mr. R. K. A. Gardiner, recently director of the Gold Coast Department of Community Development, who spoke on "Fundamental Education and Economic Development". Perhaps unconsciously, all the speakers so far had appeared to give what could have been described as a European point of view; but Mr. Gardiner, an African, showed how, in some respects, our perspectives need adjustment. He referred, for example, to Prof. Benham's insistence on the scarcity of material resources, and then pointed out that the Colonies have one rich resource which is rarely given full credit—the people themselves. Their free labour, self-sacrifice and goodwill are assets of great importance in promoting improved living, and the means of tapping these is through community development. How successful the Gold Coast Department of Community Development had been in this Mr. Gardiner illustrated in a number of striking examples. Five hundred cacao-tree sprayers had been bought by the Agricultural Department to fight swollen-shoot disease; but cocoa-farmers would not buy them. The Department anticipated that it would take about five years to sell them all. It enlisted the help of the Community Development Department, and after a short campaign by the latter all the sprayers were sold in a couple of months. Again, an important road estimated to cost a very considerable sum to build had already been half-built, with the help of voluntary labour and savings, for only £100,000. But Mr. Gardiner reminded his audience that in dealing with people it must be remembered that they are not malleable material, but human beings who matter. His eloquence and simple sincerity made a fitting conclusion to a most interesting symposium.

The task of the next symposium was to discuss "The Central Educational Dilemma in Underdeveloped Territories: Quality or Quantity", and Mr. E. W. Woodhead, chief education officer for Kent, opened it with a paper entitled "The Problem of Priorities". He pointed out how the administrator in such countries will be unlikely to have at his disposal adequate resources in money, staff or materials. Again, people on the verge of self-government see priorities differently from those a long way from it. As self-government approaches, so a desire for Utopia within a limited period grows up. A new sense of urgency arises, marked by a new relationship between government and people and often an unwillingness to recognize stubborn facts of inadequate resources, insufficiently trained staff and limited experience. Unless the administrator recognizes and accepts these new attitudes, it may not be possible to moderate harmful effects and gradually to establish worth-while standards. The approach to self-government is reflected also in the changing aims and emphasis in education, which now comes to be regarded as one of the keys to self-government and to a sense of equality with Western powers. Such aims must for a time dominate the educational scene, though other aims must not, in the process, be forgotten. For no country, said Mr. Woodhead, can reach nationhood without the development of a public morality, co-operative attitudes in its citizens and a willingness to accept responsibility. These personal aims need to be retained alongside the demand for greater knowledge and improved skills.

The growth of an education service in the Colonies, continued Mr. Woodhead, seems to pass through a number of fairly clearly defined stages. First, it provides an escape for the few from reality and the hardness of life. Then comes a mass demand for education, associated with the introduction of cash-crops or the growth of industry. This is a stage dangerous for standards, and needs to be passed through as quickly as possible. Then comes the third stage, one dominated by a political emphasis and a demand for universal primary education and the development of secondary schools. For each of these stages there must clearly be different priorities in the educationist's mind. The administrator's problem now is to ensure as wise action as possible at each stage, though, in any case, he will find his plans affected by many factors beyond his control.

In the development plans of most Colonies the goal is universal primary education with such secondary and further education as will meet urgent needs. Yet the problem is always one of how to meet new educational demands with limited resources. There are few features of life in these countries which so manifestly have such political priority as the education service. This political demand often outruns the wise use of resources and the establishment of good educational standards. The administrator is pressed, on one hand, to go ahead by the political situation, and, on the other, he is held back by economic considerations which are sometimes ignored by newly independent peoples. The chief challenge comes from such places as the Gold Coast, Nigeria and Malaya, where the pressure of the demand for education is in danger of submerging for a time the quality of the work undertaken.

Mr. Woodhead then reviewed briefly what seemed to him important priorities at each educational level. Something could be done to safeguard priorities in primary education by avoiding a complete dispersal of trained staff and by retaining a few good schools to serve as the guardians of standards. At the secondary school stage he stressed the need for alternative provision to grammar school education. Here again the maintenance of good standards lies in the hands of a few schools. These good standards, he thought, should be high on the list of priorities, especially since secondary education must for a long time be selective rather than universally available. The highest priority of all he would accord to teacher-training, for the preparation of really good teachers is the spearhead of educational progress. In dealing with educational administration and personnel, Mr. Woodhead stressed that two important priorities affecting standards and quality are the administrative framework and the adequacy and suitability of its personnel. In the former there is an important part for the voluntary agencies, private schools and the development of local authorities. Inspection and supervision also must be improved if minimum standards are to be maintained.

In conclusion, Mr. Woodhead indicated what are to him a number of keys to quality. The responsibility for both quality and quantity must rest with the government of the territory. Care must be taken when building on inadequate foundations in primary and secondary schools in preparation for sixth forms, universities and teacher-training. The key points for the preservation of quality of work and development are the grammar school and the training college. Where choice exists, emphasis must always be put on persons of quality, whether officer, teacher or child. He thought that a few really good schools and institutions for further education should be developed in order that these might leaven the whole educational service. Every effort should be made to recruit local officers with suitable training, though expatriates should be retained where necessary in order that the best experience of the past might be available in new situations.

The problem of building secondary education on insecure foundations under pressure from a quickly developing higher educational system was the theme of a talk by Sir James Robertson, rector of Aberdeen Grammar School, when he spoke on "The Demand for Higher Education". The strain on secondary education, said Sir James, comes chiefly from the fact that it is sandwiched between primary education, on one hand, and the universities on the other. He referred to the limiting factors mentioned by earlier speakers in connexion with under-developed countries —the smallness of the resources available and the stubbornness of local educational demands. At the moment the latter can conceive of secondary education only in terms of the British grammar school, and there is a tremendous demand for formal British education because it leads to enhanced personal status and advancement. But the provision for secondary education is very small. In the Gold Coast, for example, only 2 per cent of the school population is in secondary schools, and this is a country well advanced towards self-determination. Sir James sees a number of obstacles in the way of efficient secondary education—obstacles such as insufficient preparation at the primary stage, the immense gap between local conditions and Western civilization, and the great difficulty of crossing from vernacular literacy to a facility in the English language. All these are weaknesses of the primary school; but they reappear in acute form in the secondary school and lead to a situation where pupils know words but not realities, where speech becomes vague and abstract, and where an obsession develops for examination results.

In addition to these educational problems, there are the forces of nationalism and independence, which force the pace by demanding more training college staff and quicker replacement of Europeans by local people in the education service, and which lead to compulsive demands from university and technical colleges for more students. The British have written one of the great chapters in their Colonial story in setting up the new university colleges; but in some ways they have to pay the price, for national pride and aspirations are not satisfied with the meagre provision for higher education that is warranted in view of the poor schools. These latter could do with a period of patient quiet to develop; but, as it is, good teachers who could not be spared had been diverted to sixth-form work. In the end, this may prove a good thing, for sometimes it pays to be stretched educationally, and the schools will be compensated by receiving back a stream of good teachers. But for the period ahead in the development of secondary education, Sir James said that two things are necessary: schools must keep up standards in their lower forms and improve their English, and, if a rapid expansion of secondary education comes, good staffs must not be dispersed. A few good schools must be kept going while standards are being raised elsewhere.

Miss F. Gwilliam, assistant educational adviser to the Secretary of State for the Colonies, then spoke on "The Challenge to Teacher-Training". She asked three questions: Who are the teachers, what standards are they trying to preserve, and how are they meeting the challenge? The teachers themselves, said Miss Gwilliam, have greatly varying backgrounds and qualifications, and often they were of many nationalities. There are Austrian nuns, American missionaries, teachers from Britain who have gone out through the Overseas Appointments Bureau, the personnel of the Colonial Education Service and the local teachers themselves. All these, said Miss Gwilliam, are the teachers. The standards they are seeking to preserve, she thought, are of four sorts—academic, personal, professional and civic standards—and to maintain and improve them constitutes the challenge to teacher-training. In the different territories of the British Colonies this challenge is being met in a number of ways: local training colleges are being built in increasing numbers, scholarship funds are being provided to send students to Britain for training, and 'on-the-spot' vacation courses are being run for practising teachers. The teachers themselves are taking full advantage of these facilities, and in Cyprus, for example, 80 per cent of primary school teachers take part in unpaid, voluntary vacation courses. The in-service training schemes of the Gold Coast and the Malayan training colleges in Britain are other outstanding examples of the way in which the challenge is being met. Behind all these efforts, said Miss Gwilliam, lies the educational resources of Britain in inspiration, advice and help.

The symposium was brought to an end by Mr. Philip Sherlock, vice-principal of the University College of the West Indies, who spoke on "National Aspirations". Speaking with great eloquence and clarity, Mr. Sherlock, himself a West Indian, reminded his audience that Britain had long had a well-developed sense of nationhood. This the West Indies lacks. The great task there is to bring together a great variety of strains and races and to build from them a common nation. They have to fashion a new society, unlike the Gold Coast and Nigeria, who are seeking to rebuild an old one. It is in this task of nation-building that the contribution of the West Indies to the world and human understanding lies, for to do this successfully means a great emphasis on human relationships, and perhaps in this the West Indies may have something to offer others.

Mr. Sherlock paid great tribute to Britain for its help and foresight in setting up the new University College of the West Indies, for this, he said, is basic to the whole task they have in hand. The West Indies and the United Kingdom now stand as partners in the great enterprise of finding new patterns of social development. But this, he emphasized, is not a one-way process. Both sides will profit. The West Indies wants from Britain advice on an expanding secondary school system, on teacher-training, library services and other matters, and in return Britain might profit from the lessons learnt in what is a tremendous, dynamic move forward by the peoples of the Caribbean.

After each symposium there was a discussion in which the audience participated. Contributions were made by county education officers, professors of education, training college staff and local teachers, all of whom expressed the hope that there would be, in the future, even greater collaboration between Britain and the oversea territories in the task of promoting the latter's educational advancement.

P. C. C. EVANS

PHYSIOLOGY IN THE POLAR REGIONS

DURING the meeting at Sheffield of the British Association, Section I (Physiology) arranged a session on September 4 on "Polar Physiology".

The degree of physiological adaptation to cold by man is still an unsettled problem. Although there is convincing evidence that laboratory animals can be so acclimatized that they will survive at temperatures which are lethal to control animals, chronic physiological changes in man as a result of exposure to cold have not been clearly established.

Many studies have been made in climatic chambers, in which men can stay for relatively prolonged periods in a controlled environment. Changes have been looked for in the rate of body cooling, alterations of skin temperature, changes in metabolic rate, time of onset of shivering, alteration in the peripheral blood flow and shifts of the blood volume. There has been a number of reports indicating some change in one or more of these parameters as a result of repeated exposure; but there have also been many negative reports. One of the practical difficulties of experiments in climatic chambers is to persuade subjects to stay in such chambers for long periods. There are indications that some significant physiological changes develop slowly over a period of many weeks or months. It is for this reason that observations have been sought on polar explorers, who spend one to two years at high latitudes. Many of the members of polar expeditions are trained scientists and can make accurate and systematic observations on themselves. Detailed investigations of the subjects can also be made before and after prolonged sojourn in the polar regions, in laboratories in the country of origin.

Apart from low temperatures, another environmental characteristic of polar regions is of interest to physiologists. In high latitudes, the cycle of light and darkness varies greatly during the year, with approximately three months winter darkness and three months summer daylight. There are many biological diurnal rhythms, and it is of considerable interest to know how these rhythms in man may be affected by alteration in the pattern of day and night.

Dr. Harold Lewis, who accompanied the British North Greenland Expedition of 1952–54 as physiologist, showed a film illustrating some of the physiological problems encountered, and which demonstrated very vividly the effects of light and darkness. He also read a paper entitled "Sleep and Wakefulness Patterns in Men on a Polar Expedition". Records were kept by the members of the expedition of the hours spent in sleep each day. During the autumn and the spring, the patterns of sleep resembled those commonly observed in temperate countries. The majority went to bed between 10 p.m. and midnight and got up some eight hours later. When the sun disappeared for the long winter night, the pattern became increasingly disrupted, and the different individuals were going to bed or getting up at all hours. There was never a time when someone was not in bed or someone out of bed. Sleep was no longer restricted to the hours between 10 p.m. and 8 a.m. The intervals between periods of sleep varied greatly and so did the length of each period of sleep. A similar disruption of sleep was observed during the months of continuous daylight. These changes were observed in both years during which the expedition was in North Greenland. There did not appear to be any tendency for adaptation to the day–night pattern.

There are a number of interesting questions on sleep behaviour which can be asked as a result of these observations. Particularly during the winter months when opportunities for field-work were severely restricted, there was relatively little to do. There was no social compulsion to get out of bed at any particular hour, and opportunities for sleep were to all intents unlimited. The situation was analogous to that of 'demand' feeding in infants. Where records of the number of hours spent in sleep have been kept, in Britain and in the United States, the average is found to be approximately eight out of the twenty-four. On the North Greenland Expedition the number of hours of sleep averaged 7·9, and there was little difference for any month of the year. So it would appear that eight hours of sleep a day does represent a normal demand. There was no evidence that the incidence of light or darkness affected this average duration of sleep, although there was possibly an increased variation in the number of hours of sleep in twenty-four hours during the winter months.

Dr. Mary Lobban followed with a paper, "Studies on Physiological Diurnal Rhythms in Polar Regions". In the summers of 1953 and 1955, two expeditions went from Cambridge to Spitsbergen to study the effects of prolonged periods of life with abnormal time routines upon physiological diurnal rhythms in man. In Spitsbergen the climatic conditions are such that a very high latitude can be reached with comparative ease in the summer months, and human subjects can be maintained there for considerable periods of time in isolation and under conditions of almost constant daylight and environmental temperature.

In 1953 eight subjects lived for six weeks on a 2-hr. 'day', while in 1955 one group of seven subjects ved on a 21-hr. 'day' and another group of five ubjects lived on a 27-hr. 'day' for a similar period. n all three groups, urine samples were collected from the subjects at frequent intervals on experimental recording 'days' and a complete study was made of their diurnal excretory rhythms throughout the experimental period. On these recording 'days', diet, fluid intake and all physical activities were carefully controlled. During the 1955 expedition the diurnal variations in body temperature were also recorded.

From the results obtained on the two expeditions it would seem that rapid adaptation of the urinary rhythm to an abnormal time routine is an uncommon occurrence. In nearly all the subjects on all three time-scales, the intrinsic 24-hr. excretory rhythm persisted to a greater or lesser degree, and in some it was maintained unimpaired for the whole duration of the experiment. Subjects who failed to become adapted to the environmental time routine showed signs of stress, particularly at those times when their excretory rhythms became greatly disorganized. In at least three subjects on the 1955 expedition, the disorganization of their excretory rhythms was peculiarly complex, in that a complete dissociation occurred between the rhythms of the excretion of water and of potassium. Further evidence for the dissociation of physiological rhythms was provided by the body-temperature recordings; in all subjects on both 21-hr. and 27-hr. routines, the body-temperature rhythm appeared to become adapted rapidly and completely to the environmental routine, irrespective of the degree of adaptation manifested by the excretory rhythms.

These experiments provide evidence for the persistence of the intrinsic, 24-hr. rhythm of kidney function in some human subjects; they also indicate that the mechanism which controls the normal diurnal variations in body temperature is not the same as that controlling the excretory rhythm.

Dr. J. P. Masterton, who was the medical officer on the British North Greenland Expedition and collaborated with Dr Lewis in the physiological work, read a paper on "Nutrition and Energy Expenditure during a Polar Expedition".

There is still a lively controversy on the effects of temperature on food intake and food requirements. Investigations during the Second World War showed that the consumption of food by American soldiers rose as the temperature fell, and there appeared to be an inverse linear relationship between the two. Recent investigations of the diet of Eskimo and other inhabitants of arctic Canada and Alaska show that the calorie intake in cold countries may be little different from that in temperate countries. There have been only a few measurements made of energy expenditure in polar regions, so knowledge of food requirements is largely based on the accumulated experience of different expeditions.

Dr. Masterton measured the food intake of four men during the winter when they were living in the base hut. The daily individual intake was recorded for two periods of one week each, with a month's interval between the two weeks. A diary was kept of the activities of the subjects during these experimental periods, and from this, together with the measured basal metabolic rate, the energy expenditure was computed. There were wide daily variations both of expenditure and intake during this period, the range being 1,990–3,760 Calories consumed, with a mean value of 3,908. Expenditure varied from 2,220 to 5,890 Calories, the average being 3,510.

According to these calculations, the men were in positive food balance, and this finding is supported by the result of the measurements of body-weight, which showed substantial increases during the winter. Food was not limited at the base hut, and substantial snacks could be prepared by individuals apart from the regular meals.

The same subjects were out sledging for prolonged periods during the spring, and measurements were made of intake and expenditure during ten days. A high-calorie ration was provided; but the possibility of supplementing this was limited. The intake was much more constant, the range of forty observations being 4,000–5,500 Calories, with a mean of 4,800. Expenditure, on the contrary, varied much more, as weather on occasions prevented sledging, and a whole day would have to be spent in the tent; the range was 2,230–7,670 with a mean of 4,950. There was loss of weight during these long sledging journeys, which is consistent with the estimated negative calorie balance.

Although it is not possible on the basis of these results to be dogmatic about the effects of cold on food intake, they form a valuable basis for future work. A mean daily calorie expenditure of nearly 5,000 Calories represents very hard work, and it will be of great interest to have accurate metabolic measurements.

A food intake of 3,900 Calories in the base hut is also high, although not so high as some predictions of the effect of cold might indicate.

Dr. Masterton started his measurements because it was noted that the huskies ate human fæces voraciously in spite of the apparently adequate diet provided for them. It was considered possible that there might be a considerable excretion of fat in the fæces, in view of the high fat content of the diet both at base and while sledging. Analysis of the fæces showed, however, that the fat content was low, so the reason for this dietary habit of the dogs remains unexplained. There are a number of problems concerning the nutrition and energy expenditure of huskies which have not been previously studied. Mr. Julian Taylor described briefly some of the work he had done during the past two years while he was a member of the Falkland Islands Dependencies Survey, and specially studied dog physiology. He calculated energy expenditure during sledging by measuring the pull exerted, and recorded body-weight changes together with the food intake. Although the food consumption was high, being of the order of 2,800–3,000 Calories per day, there was considerable loss of weight during long journeys. Mr. Taylor estimated that the energy output was of the order of 4,000 Calories per day. This is a very large figure, as the weight of the dogs was of the order of 90 lb. Examination of the fæces showed that there was relatively poor utilization of the diet. Mr. Taylor emphasized the need for further studies on the physiology of husky dogs, and pointed out that dog teams still play an essential part in polar travel.

Studies on acclimatization to cold were presented by Dr. Paul Massey, who acted as medical officer for the Falkland Islands Dependencies Survey. He used Mackworth's *V* test for measuring changes in local acclimatization to cold in the fingers. By means of this test, the tactile discrimination of the finger is measured before and after the standard exposure to cold, and Dr. Mackworth has shown that there is a diminishing loss of finger numbness during repeated exposure of subjects in a cold chamber. Dr. Massey was able to study members of the Falkland Islands Dependencies Survey on Graham Land, some of whom were newcomers and others who had already spent a year or more in the Antarctic. Initially there was a marked difference between the two groups, those with antarctic experience having a much smaller loss of sensation in the finger after exposure to cold. This difference diminished during the first six weeks in Graham Land, and thereafter there was little difference between the two groups.

These results indicate that there is a fairly rapid local adaptation to cold. However, Dr. Massey believes there is probably a longer-term adaptation, as on several occasions there was mild frostbite of the exposed fingers during the test. These, however, only occurred in the newcomers.

Dr. Allan Rogers, who has been appointed as physiologist and medical officer to the Trans-Antarctic Expedition, 1955–58, described the programme of physiological research which he plans to carry out on the Expedition. He pointed out that this is a unique opportunity for physiological investigations, as the journey itself will probably occupy some four months and involve a considerable degree of exposure to cold. The work to be done on this expedition is a direct continuation of physiological work carried out on the British North Greenland Expedition, and has been planned with the help of the Medical Research Council. It is not possible to carry out elaborate experiments, for the working conditions during the crossing will be difficult, and the physiologist will also act as medical officer and dentist and will have the responsibility of veterinary work for dog teams. No heavy or bulky apparatus can be taken, as food and fuel will occupy almost the whole of the available space during the crossing.

In view of the practical importance and theoretical interest of the effect of cold on food intake and energy expenditure, the main investigation on the fifteen members of the Expedition will be an attempt to make an energy balance. Dr. Rogers will be taking with him an instrument designed by H. S. Wolff—the integrating motor pneumotachograph—for the measurement of oxygen consumption. The advantage of this apparatus is that it can be worn for long periods of time without interfering with the activity of the subject, and it has been so modified that it can be used at low temperatures. It is hoped that the members of the Expedition will be able to keep detailed diaries recording their activities, including hours of sleep, and also of clothing worn. Such diaries have been kept on other expeditions, and although the information so far obtained is not sufficiently systematic, it does indicate that the amount of clothing worn in the cold diminishes with prolonged life at high latitudes. This is certainly suggestive of adaptation to cold.

The experience which has been gained in the past few years by members of the Medical Research Council in developing physiological work on expeditions has shown that there are three important points to be realized: (1) that physiology must be an accepted object of the expedition; this is particularly important, as at this stage systematic observations at frequent intervals are necessary; (2) such observations should be carried out or supervised by a physiologist, or a medical officer with some special training in physiology; (3) only simple observations or experiments should be attempted; these principles were well illustrated in the case of the Trans-Antarctic Expedition, in which physiology is, thanks to the enthusiasm of Dr. V. Fuchs, an accepted object of the Expedition, and an experienced physiologist has been appointed. O. G. EDHOLM

METAL FATIGUE IN THEORY AND DESIGN

By Dr. A. J. KENNEDY

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AN international conference on the fatigue of metals, sponsored by the Institution of Mechanical Engineers, in co-operation with the American Society of Mechanical Engineers, was held in London during September 10–14. Some eighty papers were presented, covering the whole range of interests in fatigue, both academic and technological. Contributions were made by authors from Australia, France, Germany, Japan and the U.S.S.R., as well as from the United States and Great Britain. More than six hundred scientists and engineers attended the meetings, and the discussions on the papers brought in contributors from many more countries. The papers are to be read again in New York at a second conference during November 28–30, and the whole of the proceedings, with the discussions from both centres, is to be published afterwards in a single volume. The enterprise is the most ambitious of its kind yet attempted, and occurs at a significant stage in the development of fatigue theory and machine design.

The conference covered so wide a range of research that no short report could do justice to the detailed information presented. Certain general observations on the subject can, however, be made, prompted and shaped, as it were, by the discussions which took place. These can be very usefully viewed against the background of past development, and suggest the way in which the subject may evolve in the future.

Fatigue in metals, and in solids generally, has been plagued with an inappropriate title and an inaccurate popular press. As a subject it is really quite old. The early observations, being far in advance of understanding of the solid state, gave rise to a terminology, and even a philosophy, which have hampered scientific thinking ever since. Criticisms are repeatedly lavished on the scientists for their failure to communicate ideas and findings in a way which all can understand. This proves a most admirable exercise, but it seems hard that the scientist, who deals with difficult and often esoteric mathematical concepts, should be selected as the plain man's scapegoat, good material though he may be. He might reasonably, at times, ask for a little less plainness at the other end.

In the case of fatigue, however, much of the responsibility for the popular misconceptions rests squarely on the scientific exponents. Intentionally or otherwise, the doubts and dissensions within the subject are popularly interpreted as revealing a general ignorance of its nature, cause and effects. Recent failures in aircraft appeared to give point to this. In fact, there is, in certain directions, a surfeit of information on the subject; test data have been loading down the technical press for years, following the much careful and laborious experiment that has been undertaken in establishing the importance of a variety of practical factors. The general answer to the popular legend that metal fatigue is as prevalent and as little understood as the common cold is supplied by every aircraft, or every engine, which does not fail during its design life. These are the successful products of anti-fatigue methods, for which engineering science should be given every credit. Of course, there is uncertainty about the fundamental nature of fatigue. But the theories of the mechanical properties of metals generally are still very conjectural, and it needs to be remembered that the microscopic mechanics of the solid state have turned out to be far more difficult to understand than its chemistry or its metallurgy, in the structural-compositional sense. Problems involving, essentially, the structures of atoms, and the differences between such structures, supremely difficult though these may be, have gone forward more readily than those involving the forces between atoms in aggregates, whether solid or liquid. It was, of course, in order to deal with these difficulties that the idea of a crystal imperfection, or dislocation, was first introduced. While this idea fitted at once certain observations on the nature of slip in single crystals, it is only during very recent times, indeed during the past ten years, that the theory can be said to have established itself as a fruitful study in its own right. It now has a number of successes to its credit, of various kinds; but these are recent and involve fairly simple systems, such as, for example, pure single crystals under restricted conditions of stress and temperature. It is therefore unreasonable to expect that such an involved problem as the behaviour of complex alloys under complex stresses and conditions should be particularly well understood, or even that some single answer exists.

This latter assumption, that all failures under alternating stresses can be lumped together as the consequence of some unique process called fatigue, needs to be strongly dispelled. Useful mechanical metals have a complicated structure, and are subjected to a complicated thermal and stress treatment. They are made up of regions of differing composition, some of which may in turn possess a form of internal substructure. Each particular type of region, in isolation, may have quite different characteristics of deformation from the others, and the boundaries between such regions are also mechanically very different.

Nor are the internal stresses uniform. On the atomic scale, a number of mechanisms can occur in such aggregates: structural transformations of various types, diffusion, recrystallization, ageing, recovery, slip, polygonization, relative movements of boundaries, and so on. The operation of these mechanisms is frequently markedly directional, that is, a general anisotropy exists. At certain points quite distinctive changes may occur under alternating stresses characterized by an apparent concentration of plastic strain. In some alloys, it is interesting that an actual extrusion of material may occur at the slip band. Ultimately it is possible for small cracks to form at such sites, and some of these will be propagated, possibly to failure.

There are, then, two phases in the development of fatigue. First, the process of crack formation, and secondly that of crack propagation. It can be demonstrated that the crack usually appears at points of high local slip; but the development of such a crack must obviously depend in some way upon all the other processes taking place. Frequently all these processes are taken collectively to constitute what is termed fatigue. On the basis of present knowledge, this seems unnecessary and misguided. The fact is that a number of processes occur, and the partition of the stress energy between these depends greatly on such factors as stress, frequency and temperature, on the geometry of the system; and indeed on the chance arrangement of the constituents of the structure. It may be that future research will show that no special or singular mechanisms are required to explain crack formation by fatigue, but only the extension of others already recognized and established. At present the question is an open one. In any event, it will be evident from what has been said that, although we still have to explain how cracks may be formed in the slip-bands of crystals under alternating stresses, and to account for the differing nature of the local deformation as compared with uni-directional stressing, a number of possible modes of crack formation may arise in a complex alloy, giving rise to cracks at quite different sites under different conditions. Some discipline in our thinking is here much needed, for the idea of some single basic mechanism is deeply rooted. It is strange that this should be so, for we do not attempt to force the observations in other fields, such as those of brittle fracture, creep and ageing, into a single-mechanism explanation.

Once formed, and depending on the stress pattern and the nature of the material, a crack may be propagated. We might again well ask why this final phase should also automatically be brought together under the same general heading of fatigue. Cracks can be introduced in other ways, by quenching for example, and their propagation need have nothing whatever to do with the fatigue process as we imagine it. Some caution is necessary here, because the propagation is itself obviously dependent on the nature of the material traversed by the cracks, and it may be that the development of what might be termed the genuine fatigue process reduces the overall ductility and hence speeds the crack propagation. It is dangerously easy, then, to label all crack-forming processes, such as those that occur during corrosion, as fatigue, and hence to lose the significance that should be attached to the term.

In general, then, it seems that too much has been brought together under the title of fatigue, and that as a consequence the fundamental problem has become obscured. The problem remains, simply, why a fracture can occur in a pure single crystal (that is, in a regular lattice) under alternating stresses of a value which would not lead to failure if applied uni-directionally. The physicists seem reasonably agreed among themselves that dislocation theory can supply the answer. As it stands, the theory is now capable of demonstrating how vacancies may be generated by moving dislocations, and how these vacancies may bring about the observed increase in the speed of recovery from any residual straining. So far as the formation of an incipient crack is concerned, the collection of vacancies into clusters is taken to be the essential operation, and a mechanism for this has been proposed. No one would quarrel greatly with the general dynamics of the process as set out, and it is only fair that the theory should be allowed to prove its points, where relevant, by drawing on results, established elsewhere, of a rather different character. The theory may, in other words, establish a working model before it is fitted up around the fatigue problem, and this is indeed what has happened.

The engineers, for their part, can scarcely be blamed for being unconvinced by these tactics. Much of the theory they have necessarily to take on trust, and they feel that it is no solution simply to select from the several dislocation and vacancy mechanisms which are theoretically possible the one that best fits the facts. A much more critical experimental approach is required to demonstrate why a certain sequence of events takes place rather than another. To establish this it may be necessary to cast the experimental net much wider, and to bring in other properties, an understanding of which is already more firmly grounded. Electrical properties, particularly under conditions of extreme temperature, may be useful in affording such cross-links and in thus strengthening the whole theoretical structure. Generally, engineering has been little helped in its day-to-day problems by the more fundamental physical research. This is in many ways understandable, once the scale of the difficulties is appreciated. What is much more difficult to justify is the slight statistical treatment which the problem has attracted. Even if causes are difficult to sort out, the effects, whatever they may be, ought to provide plenty of good material for statistical analysis. There has in fact been work on these lines, and very excellent some of it is; but the infiltration of the methods into the design field, and the replacement of outdated design factors, is long overdue.

We have to admit that engineering advance, in the face of such difficulties as that of fatigue, has been gained largely by the application of what might be called the classical principles of design. More and more ingenuity has been required as the operating conditions have increased in severity, and some short relief has been obtained by the development of new high-temperature high-strength alloys. On the whole, the traditional methods of testing, coupled with established principles of stress relief, have enabled technological practice to keep up with the demands made upon it. There are, however, no large factors left in the equations. Even where some distinctive improvement in the properties of metals may be anticipated, it is quite certain that this will be quickly swallowed up by an immediate raising of design specifications. Fatigue, then, will always be with us. Supersonic machines, rockets and high-temperature gas turbines are already a reality, but their performance is below, well below, that required of them in the future. The conditions to which they will most certainly be subjected will not only be severe in themselves, but will also provide a combination of stress and temperature conditions under which fatigue, as a single factor, will be of no interest whatever. The important problem will be the survival of machines as a whole, under the complex working conditions imposed. This means their survival under repeated cycles of thermal shock, fatigue and creep, together with any other processes, such as corrosion, which may arise, the actual history being made up of both regular and random components. Although it is generally agreed that full-scale tests on major assemblies (such as aircraft) are here to stay, despite the cost, it seems worth remembering that in the case of high-speed flight the working conditions may not be reproducible at all in test form.

We are, then, confronted with a situation which differs from the past not merely in the degree of the problems faced, but in their quite revolutionary nature as well. We now have to design for change in machines, knowing that they will change and knowing that they will fail. The material design no longer demands simply knowledge of a set of static factors, but requires information on dynamic processes with statistical characteristics. The traditional methods will certainly go on indefinitely fulfilling their purpose in many fields, and they will improve; but if the materials barrier, as it may be called, is to be broken, a quite new philosophy of design is required. Whatever may develop in the future, it is certain that a mere scaling-up of the test resources, a continued amassing of data on individual properties, and a hand-to-mouth selection of material will be inadequate, however good the basic design may be. At present, not even the faintest framework of a solution exists; but there is a growing awareness of the need for some part of science and engineering to concern itself with the possibilities of quite new methods of design, particularly in the selection of materials. Such studies cannot be made without getting well away from particular problems of detail and seeing the full implications of the changes as they affect the methods of testing, the nature of the test data, the extraction of empirical factors and the use of such factors in actual design. Complex testing, so far as both stress and temperature are concerned, seems likely to replace much of the single-property fixed-conditions testing at present undertaken. The assembly of the data into a suitable usable form is bound to be fraught with great difficulties. But computing and data-processing techniques have transformed similar situations elsewhere, and encourage hopes of some success in this direction as well.

We may sum up somewhat as follows. Fundamental science needs to order its ideas on the processes which occur in metals under alternating stresses, and to be more rigorous in the distinctions drawn between fatigue and other parallel processes. The theories, though superficially sound, are facile and lack the conviction which only critical experiment can give them. The bulk of applied work on fatigue continues very successfully, according to established principles, and one by one the numerous engineering factors are being run through. There is an improved agreement between different centres of research following the better design of test machines and the recognition of differences between them, but there is a real need for an infusion of statistical theory. For the future, engineering design needs to be supplemented (not replaced) by a quite different approach involving new and, at present, unknown methods, in which fatigue takes its place as one of several interacting processes which combine to bring about, inevitably, a failure of the machine.

Conferences on the scale of the one recently held in London involve a prodigious amount of work and planning, both technical and administrative, and something more than a formal acknowledgment to the bodies concerned is required. The quality of the organization does all concerned great credit, and due to their efforts a real and effective contribution has been made to the subject. The final proceedings, when published, will be on a scale quite unlike anything attempted previously, and will surely in time become established as a major work of reference.

OBITUARY

Prof. John Garstang

John Garstang was born in 1876 at Blackburn, where his father, Dr. Walter Garstang, was a well-known physician. After leaving Blackburn Grammar School, he went to Jesus College, Oxford, with a mathematical scholarship, and graduated in 1899. While still an undergraduate his interest in archæology had been awakened, and from 1897 for some nine or ten years he undertook research and excavations at various sites of Roman Britain, particularly at Ribchester, Melandra Castle, Richborough and Brough.

His first visit to Egypt was in the winter of 1900, when he excavated at Mahasna and Bet Khallaf for the Egypt Research Account. In the following winter, supported by friends in Liverpool, he excavated on his own account in the same district. By this time he had been introduced to University circles in Liverpool, and in 1902 he was appointed honorary reader in Egyptian archæology in the University of Liverpool. During this and the following years Garstang campaigned tirelessly to stimulate interest in archæology in Liverpool. These were the years when the University was about to obtain its charter and his appeals were not ignored, for an influential group of Liverpool citizens was specially interested in ensuring that the new University should be established on broad lines. It was almost entirely due to his efforts that a sum of £10,000 was raised, and thus by 1904 premises had been secured, staff recruited, and the Liverpool Institute of Archæology was inaugurated. It was Garstang who conceived and planned the Institute, it was he who made it possible, he was its honorary secretary, and retained that office for more than forty years until the independent existence of the Institute ceased with its incorporation in the University School of Archæology and Oriental Studies. In 1907 he was appointed John Rankin professor of the methods and practice of archæology in the University of Liverpool, and held the chair until his retirement in 1941.

Although each year he did a certain amount of teaching and lecturing in Liverpool, his principal interest was in excavation. His energy was immense, and every year until 1914 saw him excavating at one or more sites in the Near East. The list of sites is formidable: Beni Hasan (1902–4), Naqada, Hierakonpolis, Edfu (Hissaia) and Nubia (1904–6), Abydos (1906–9), and Meroe in the Sudan (1909–14). At Meroe he conducted the first excavations on the site and uncovered a very large section of the enormous city. Most of the results of these excavations are still unpublished; but sufficient of his records has survived to encourage the hope that in the near future it will be possible to publish reasonably full details of his results.

During these busy years Garstang found time in 1907 to make a journey of survey and exploration across Asia Minor. This journey was to lead to an eventual widening and reorientation of his archæological interests. Apart from his own excavations at Sakje Geuzi in 1908 and 1911, in 1910 he published his book "The Land of the Hittites", which, together with its modernized successor "The Hittite Empire" (1929), was for many years the standard introduction to the subject.

In 1920, after a year as archæological adviser in Palestine, he became director of the British School of Archæology in Jerusalem, and the first director of the Palestine Antiquities Department. The creation and organization of that Department and of the Palestine Museum were virtually his own work, and showed his genius for organization at its best. Between 1929 and 1935 he directed excavations at Jericho: though some of his more optimistic claims, and still more those of over-enthusiastic supporters, are now no longer generally accepted, his work at Jericho greatly extended our previous knowledge and yielded results the importance of which cannot be disputed.

In 1936, thanks to a generous grant from Mr. Francis Neilson, he became director of the Neilson Expedition to the Near East. After a preliminary survey in Cilicia in 1936, during 1936–39 and again in 1947–48 he excavated the important site of Mersin in Cilicia. It was during his last campaign at Mersin that he was able to conduct the negotiations that led to the foundation of the British Institute of Archæology in Ankara. When the Institute was opened in 1948 he was appointed its first director, and in the following year he became its president, holding that office until his death. He died at Beirut on September 12, barely two days after his last visit to Mersin, where he had fulfilled his cherished wish to see once more the last site that he had discovered, and had addressed there a distinguished gathering.

Garstang was not a great academic figure and he built up no school of students; he was always the practical man and field-worker. He was a pioneer in many fields of archæological research. He had to an extraordinary degree a flair for discovering the good site, and once he had found that site there were few who could excel him in stimulating and sustaining general interest in the work. He had an instinctive understanding of how to appeal to the public, and his field-records and photographs show how always the propaganda side of his work was ever present in his mind. Most of his excavations, conducted in the name of the Liverpool Institute of Archæology, were carried out with the slightest of financial support: it was his gift for publicity, plus personality and untiring drive, together with loyal and generous supporters mainly in Liverpool, that year by year enabled him to open and explore new fields. It is not so much as an excavator but as an organizer that his name will live. The man whose vision and genius created organizations so diverse and so productive as the Liverpool Institute of Archæology, the Palestine Antiquities Department, and the British School of Archæology in Ankara has made a permanent contribution to archæological studies in the Near East.

H. W. FAIRMAN

NEWS and VIEWS

Prof. Charles Singer: Eightieth Birthday

CHARLES SINGER, historian of medicine and science, celebrated his eightieth birthday on November 2. Prof. Singer can look back on a life of striving and of achievement. His historical studies grew out of his clinical and research work. It is now fifty-one years since, returning from an expedition to Abyssinia, where he had medical and biological experience which many young men must have envied, he published his first clinical paper. There followed years of clinical work and of laboratory research, especially on gastric carcinoma. In the same week in which Fibiger announced the discovery of the parasite for which he was awarded a Nobel Prize, Singer independently discovered this parasite. He read several communications on these subjects at the International Congress of Medicine which was held in London in 1913, and that year saw the zenith of his writing on these subjects. Two years before that he had published his first historical paper, and from 1914 onwards he devoted himself to historical subjects. A short period at Oxford and some years in the R.A.M.C. during the First World War were followed by a post at University College, London, first as lecturer in, and later as professor of, the history of medicine. Though the years in London until his retirement in 1942 were full of great achievement, it is since that date that Prof. Singer has reaped his richest harvests. Besides several scholarly books which are of great importance in the history of medicine, he has contributed lavishly to a specialized branch of the history of the chemical industry, and for six years he has laboured on the monumental "History of Technology", of which he was the sole begetter, and in the production of which he has shouldered the major burden. May the approaching publication of the second volume of that five-volume work stimulate him to continue making the world his debtor.

Biochemistry in Birmingham: Prof. R. H. Hopkins

PROF. R. H. HOPKINS retired from the Adrian Brown chair of malting and brewing and applied biochemistry in the University of Birmingham on September 30. A graduate of that University, he has been closely associated with the Department for many years. Thus, he was lecturer under Prof. Adrian Brown and retained that position for several years before accepting a post at the Heriot-Watt College, Edinburgh. In 1931 he returned to Birmingham, this time as head of the Department, a position he was to occupy for twenty-five years. The retirement of Prof. Hopkins may be said to close the second epoch in the history of what was originally the British School of Malting and Brewing. In the first period, 1900–20, the School was primarily concerned with these subjects; but already a wider field was being cultivated. In the earlier days of the second epoch a new pattern was being laid down, and in the research laboratories interest centred chiefly on the biochemistry of plant products, especially polysaccharides. A new building was occupied in 1927, and when Hopkins arrived in 1931 the time was ripe for further expansion. The original *raison d'être* of the Department was never lost sight of, and with the advent of a group of workers from the Institute of Brewing, fundamental work on biochemical aspects of brewing and on yeast nutrition was actively pursued. The emphasis in the Department was changing—from static to dynamic biochemistry—never more so than in the special field of the amylases which has always claimed so much of Hopkins's time and interest. During and after the Second World War, nutritional investigations led to interest in yet another field—the vitamins of the B group, with special reference to their role in germination, malting and brewing processes, and their assay by microbiological means. An increasing preoccupation with microbiological chemistry has been observable in recent years and has resulted in useful studies in the nutrition of yeasts and bacteria. Prof. Hopkins may look back with some satisfaction on the achievements of a small department, limited in resources and with no possibility of team-work in the modern sense. Should the rumoured expansion of biochemistry in Birmingham be achieved, the Department may look forward with confidence to yet a third epoch.

Imperial College of Science and Technology, London

The Imperial College of Science and Technology has now completed the first stage of the massive expansion being undertaken at the request of the Government. The plan, announced in 1953, is to double the size of the College to accommodate three thousand students of science and engineering. There are now 2,240 students at the College, 36 per cent more than in 1953. The number of teaching staff now stands at three hundred—a rise of 33 per cent. Twenty-seven new posts as professor or reader in the University of London have been established at the College and have been filled. They cover a wide range of subjects, from aeronautical structures, applied geophysics, instrument technology, parasitology and soil mechanics to nuclear power. A new building for aeronautics and chemical engineering is already partly in use, and will be in full operation in two months time. By this, by a reconstruction of the Students' Union and by a number of other building projects, the College has already added 20 per cent to its gross floor space. Work has now been started on the preparation of sites for large new buildings for engineering and physics.

University of Leeds

The following have been appointed to lectureships in the University of Leeds: N. Brook (colliery engineering), Dr. A. J. Manuel (physics), J. McFarlane (mining and mine surveying), A. Peck (mine surveying), and Dr. J. E. Saxton (organic chemistry). The title of visiting professor in the University has been conferred upon Prof. Darrell Pratt, of the University of Florida, who will be working with Prof. F. C. Happold in the Department of Biochemistry during the session 1956–57. The following gifts, among others, have been received by the University: £2,000 over two years to the Department of Inorganic and Structural Chemistry from Imperial Chemical Industries, Ltd., for work on vanadium pentoxide systems; £500 a year for three years to the Department of Physical Chemistry from the Distillers Company, Ltd., for the support of research; £1,000 to the Department of Civil Engineering from the Steelwork Society for research into stress distribution of high-tensile bolted structural connexions; £3,000 for 1955–56 to the Department of Mining from the National Coal Board (North-Eastern Division); £2,000 for 1955–56 to the Department of Coal Gas and Fuel Industries from the Gas Plant Manufacturers' Development Council; £1,350 to the Department of Textile Industries from Courtaulds, Ltd.; £9,000 over three years to the Departments of Medical Physics and Radiology and Radiotherapy from the Nuffield Foundation, for research on the intensification of X-ray fluorescent screen images.

The total number of full-time students registered at the University of Leeds is now 3,731, which is some 260 more than at the corresponding date last session; of this increase, at least two hundred are in the Faculties of Science and Technology. The new admissions are about 180 more than at the corresponding date last session; 60–70 of these are on the arts side and about 120 in science and technology.

Royal Society of Edinburgh: Officers for 1956–57

The following have been appointed to the Council of the Royal Society of Edinburgh for the session 1956–57: *President*, Prof. James Ritchie; *Vice-Presidents*, Prof. J. Norman Davidson, Principal H. B. Nisbet, Prof. Meirion Thomas, Prof. A. C. Aitken, Dr. J. E. Richey, Prof. D. Whitteridge; *General Secretary*, Prof. Norman Feather; *Secretaries to Ordinary Meetings*, Dr. T. R. Bolam and Dr. A. W. Greenwood; *Treasurer*, Mr. A. W. Young; *Curator of Library and Museum*, Dr. Douglas Guthrie; *Councillors*, Prof. E. L. Hirst, Dr. D. E. Rutherford, Dr. D. A. Allan, Prof. G. H. Bell, Dr. D. N. McArthur, Dr. A. G. MacGregor, Prof. C. H. Waddington, Dr. J. A. Macdonald, Dr. J. R. Peddie, Dr. R. Schlapp, Dr. J. B. Tait and Prof. G. M. Wyburn.

Metallurgical Reviews: a New Quarterly Journal

To all those concerned with any aspect of metallurgy, the appearance of a new quarterly periodical, *Metallurgical Reviews* (members of the Institute of Metals, 32*s*. 6*d*. or 5 dollars per year; non-members, 42*s*. or 6.50 dollars), will be of more than usual interest. Although published by the Institute of Metals, the interests of which lie in the field of non-ferrous metallurgy, the new publication will cover the whole field with the exception of mining, the extraction of metals from their ores, and practice in iron and steel works. It is intended that these reviews should be of a comprehensive and critical nature, and relate both to the industrial and the theoretical aspects of the subject. The four reviews contained in the first issue (pp. 156) fully satisfy these conditions. Prof. J.-J. Trillat (Sorbonne, Paris) has written on the metallurgical aspects of microradiography; Prof. C. R. Soderberg (Massachusetts Institute of Technology) on mechanical properties in relation to design requirements; D. M. Lewis (Aluminium Laboratories, Ltd.) on the principles of continuous casting of metals; and B. E. Hopkins (National Physical Laboratory, Teddington) on the preparation and properties of high-purity iron. All these are valuable compilations, very well prepared and illustrated, and on the average some sixty references are given to each section of the work. The Council of the Institute of Metals is to be congratulated on performing a most valuable service to those concerned with both the technology and the theory of metallurgy.

Two New Scottish Nature Reserves

The Scottish Committee of the Nature Conservancy has recently established new nature reserves at Inchnadamph, Sutherland, and Glen Diomhan, Bute. The former consists of 3,200 acres south-east of Loch Assynt and is a typical sample of west Sutherland countryside, ranging in altitude from about 230 ft. near Inchnadamph to 1,680 ft. on the summit of Beinn nan Cnaimhseag. Loch Mhaolachcoire is included within its boundaries. The reserve lies in a tract of great geological and physiographical interest, being at the western front of an area of disturbed Durness limestone of Cambrian age. At Beinn nan Cnaimhseag is an isolated outcrop of Torridon sandstone resting upon the Durness limestone. Although some of the limestone in the reserve is covered with acid drift and peat, much of it is exposed, and about four hundred acres consists of limestone pavements and scraps. The ground is partially covered by low willow scrub consisting mainly of *Salix myrsinites*, but also includes *S. repens*, *S. aurita* and hybrids. Mountain avens (*Dryas octopetala*) is abundant on the drier limestones, and there is a rich woodland flora of northern character including globe flower (*Trollius europaeus*) in some parts. The gorge of the Traligill Burn is well known to botanists. The karst type of limestone country with sink-holes, underground streams and limestone caves is also to be found, and the famous Allt nan Uamh bone caves contain Palæolithic cave earths with a fauna of Pleistocene mammals and traces of occupation by early man. The reserve has been established under an agreement with the owner, Mr. R. A. Vestey. The Glen Diomhan nature reserve consists of 24 acres of a steep-sided, post-glacial gorge in north-west Arran, lying between Meall nan Damh (1,870 ft.) on the west and Ben Bhiorach (1,572 ft.) on the east. The area is noteworthy for the occurrence in it of two rare whitebeams (*Sorbus arranensis* and *S. pseudofennica*), both of which are confined to Arran. They grow intermixed with rowan (*S. aucuparia*). The trees are mostly confined to a short length of the glen between the 300-ft. and 600-ft. contours and are found on both banks of the stream. The reserve has been established under an agreement with the Dowager Duchess of Montrose.

Three-dimensional and Two-phase Illustrations

THE firm of Industrial Photographs, Ltd. (34 Belwell Lane, Four Oaks, Sutton Coldfield), has produced some interesting three-dimensional pictures, called 'Vectographs', in which the solid effect is produced by means of an ingenious application of polarized light. The two component images necessary for a stereoscopic picture are printed in superposition on either side of a transparent support. The nature of this support and the printing solution used results in the production of two images in which the original photographic densities are reproduced in varying degrees of optical polarization. The light passed by the first image is polarized at right-angles to that passed by the second. This composite picture is viewed through a small binocular analyser, the lenses of which are two pieces of polarizing material with their directions of polarization at right angles to one another; these lenses act as filters and are so arranged that the left and right images are visible only to the appropriate eye, thus producing a clear and striking three-dimensional effect. Three examples of subjects illustrated are the chemical structure of graphite, a shadowed carbon replica of pearlite, and a cone of *Chamaecyparis lawsonia*. By another application of the process, two different aspects of a subject are similarly superimposed. Each is visible by polarized light in one plane only, and a piece of polarizing filter (or one lens of the binocular viewer) is rotated to show either image or both, or the transition from one to the other. An example of this type of two-phase picture is one in which the two aspects are the human skull and its associated muscles and tissues. The pictures are 4¼ in. × 5¼ in. in size and are designed for educational purposes. As an alternative to passing them around the lecture-room, they can be used as slides (though they are rather large ones) and projected on to a metallized screen. Each member of the audience must, of course, have a polarizing viewer.

Antarctica Exhibition at the British Museum (Natural History)

A SPECIAL exhibition on Antarctica has been arranged in the Mineral Gallery of the British Museum (Natural History) to mark the International Geophysical Year, 1957–58 and the Trans-Antarctic Expedition. The rock specimens of the Department of Mineralogy, which form the National Collection, include many from Antarctica. Three areas have been selected for exhibition. The first area is South Victoria Land, scene of many British expeditions, culminating in those of Shackleton and Scott. South Victoria Land is now a base for New Zealand and American parties, and the final destination of the Trans-Antarctic Expedition. The second area represented is Queen Maud Land, in the Norwegian section of Antarctica. Part of this territory was explored by the Norwegian–British–Swedish Expedition, 1949–52. The third area, part of the Falkland Islands Dependencies, including Graham Land and its offshore islands, is now being surveyed by many British parties. Four historical specimens displayed are: the gizzard stones of an emperor penguin taken on sea ice by Sir James Clark Ross's Expedition (H.M.S. *Terror* and H.M.S. *Erebus*) in 1849, which included rocks of continental character, and gave the first scientific evidence for the existence of a southern continent; a boulder of gneiss, a typical continental rock, dredged from the floor of the Southern Ocean by H.M.S. *Challenger* in 1874, which provided further evidence of a southern continent; rocks collected by Captain Scott's party on their return march from the South Pole in January 1912; and the Adélie Land stony meteorite, which is the only meteorite so far recovered in Antarctica. There are also photographs, paintings and maps illustrating antarctic conditions.

Michael Faraday and Spiritualism

IN 1853, Michael Faraday conducted an investigation of certain spiritualistic phenomena then causing considerable stir. Using a few simple pieces of apparatus of his own design, he succeeded in establishing the same kinds of controls that characterized his more famous experimental researches and provided a rational explanation for the observed set of phenomena that was satisfactory to all. No new and strange forces were uncovered. Instead, Faraday demonstrated conclusively that the performers produced the observed effects by ordinary physical means. What was noteworthy in this inquiry—and the reason Faraday's explanation proved to be satisfactory to both sides—was that he discovered that the performers were deceiving not just others, but themselves as well. Although the performers produced the observed effects, they did so unconsciously.

Faraday investigated two sets of phenomena, the levitation of tables and the turning of tables. In his "Observations on Mental Education", which was delivered as a lecture in 1854, he described the phenomenon of levitation. Of his investigation of the second kind of phenomena, Faraday prepared a report which was published on July 2, 1953, in the *Athenæum*, a journal devoted to English and foreign literature, science, and the fine arts, which was founded in 1828 and which continues to-day, after several mergers, as the *New Statesman and Nation.* A copy of this interesting report and some comments upon it have been set out in *Scientific Monthly* (83, No. 3; September 1956).

National Science Foundation Fellowships

The National Science Foundation, Washington, D.C., is offering three types of fellowship awards for advanced study and research in the natural sciences during the academic year 1957–58: predoctoral fellowships for college seniors and graduates (1,600–1,800 dollars); postdoctoral fellowships for those who have already gained a doctor's degree in science (3,800 dollars); and senior postdoctoral fellowships for those who have had a doctorate for a minimum of five years and have demonstrated unusual ability for research (4,000–10,000 dollars). The awards are open to American citizens and are tenable in any non-profit institution of higher education in the United States or abroad. The fields of study may be the mathematical, physical, medical, biological, engineering and other sciences, including anthropology, psychology (other than clinical), geography, certain inter-disciplinary fields, and areas of convergence between the natural and social sciences. About a thousand awards will be made and will be announced next March. Applications for predoctoral fellowships should be made by January 7, and for postdoctoral fellowships by December 24, to the Fellowship Office, National Academy of Sciences—National Research Council, 2101 Constitution Avenue, N.W., Washington 25, D.C. For senior postdoctoral fellowships application should be made by January 14 to the Division of Scientific Personnel and Education, National Science Foundation, Washington 25, D.C.

Conference on the Biology of the Hair Follicle and the Growth of Hair

An international conference on "The Biology of the Hair Follicle and the Growth of Hair" will be held under the auspices of the British Society for Research on Ageing at the Royal Society of Medicine during August 7–9, 1957. The Congress will deal with the gross and microscopic anatomy and histochemistry of the hair follicle and the hair, studies on mitoses of the hair follicle and effects of nutrition and hormones on hair growth, vascularity and patterns of growth, production of pigment, regeneration and *de novo* formation of hair follicles. Admission is by ticket, obtainable free of charge from the Honorary Secretary, British Society for Research on Ageing, Dr. G. H. Bourne, London Hospital Medical College, Whitechapel, London, E.1.

Announcements

Dr. J. R. Price, senior principal research officer in the Organic Chemistry Section of the Commonwealth Scientific and Industrial Research Organization, Australia, has been awarded the H. G. Smith Memorial Medal for 1956 of the Royal Australian Chemical Institute. The Medal is for contributions over the past ten years to the development of chemical science in the field of organic chemistry and biochemistry, and the award to Dr. Price is for his researches on several types of compounds, and especially on the alkaloids.

The Meldola Medal, which is the gift of the Society of Maccabæans, is being offered for award early in 1957 to the chemist who, being a British subject and less than thirty years old on December 31, shows the most promise, as indicated by published chemical work brought to the notice of the Council of the Royal Institute of Chemistry before December 31. Communications should be addressed to the President, Royal Institute of Chemistry, 30 Russell Square, London, W.C.1, the envelope being marked "Meldola Medal".

Sir George Beilby Memorial awards, which are considered at intervals by administrators representing the Royal Institute of Chemistry, the Society of Chemical Industry and the Institute of Metals, are made to British scientific research workers, preference being given to investigations relating to the special interests of Sir George Beilby, including fuel economy, chemical engineering and metallurgy. In general, the awards are given to younger workers for original investigations over a number of years. For awards early in 1957, the attention of the administrators should be directed, before December 31, to work of the nature indicated, all communications being addressed to the Convenor of the Administrators, Sir George Beilby Memorial Fund, Royal Institute of Chemistry, 30 Russell Square, London, W.C.1.

Dr. R. Cockburn deputy controller of electronics, Ministry of Supply, has been appointed controller of guided weapons and electronics in the Ministry.

Mr. C. E. Lambert, representing the Colonial Territories, has been elected chairman of the Executive Council of the Commonwealth Agricultural Bureaux, in succession to Mr. J. E. C. Coventry, who represented the Federation of Rhodesia and Nyasaland. Lieut.-Colonel V. A. Nicholas, representing Ceylon, has succeeded Mr. Lambert as vice-chairman.

Prof. F. G. Gregory, of the Research Institute of Plant Physiology, Imperial College of Science and Technology, London, will deliver the Amos Memorial Lecture at the East Malling Research Station, Kent, on November 15. He will speak on "The Place of Plant Physiology in Fruit-growing".

Prof. R. B. Woodward, professor of chemistry, Harvard University, will deliver the eighth annual Ciba Foundation Lecture on December 5 at 5 p.m. in the meeting room of the Zoological Society of London; his subject will be "Recent Advances in the Chemistry of Natural Products". Admission is by ticket only, obtainable from the Assistant Secretary, The Ciba Foundation, 41 Portland Place, London, W.1

A one-day conference on "Automation, Education and Training" is being organized by the British Association for Commercial and Industrial Education, and will be held in the Royal Festival Hall, London, on December 4. Particulars can be obtained from the Association, at Management House, 8 Hill Street, London, W.1.

Erratum. In the communication entitled "Antagonists of the Action of Reserpine on Smooth Muscle" in *Nature* of October 20, p. 859, col. 2, par. 2, line 3, for "serotonin (15–40 mgm. per ml.)" read "serotonin (15–40 nanograms per ml.)".

THE DIRECTION OF RESEARCH ESTABLISHMENTS

THE scale, complexity and cost of scientific research are mounting rapidly. Laboratories are growing not only in number but also in size. To meet these ever-growing needs without waste of money or that vastly more precious commodity, scientific brain-power, a high order of organization and management is required. This is a comparatively new problem of administration—research has developed into a large-scale industry only in the past few decades—and there are almost no precedents in any field of human endeavour for showing the large-scale organization of mental and imaginative creativeness as a team effort.

The direction of research establishments was the subject of an international symposium organized by, and held at, the National Physical Laboratory during September 26–28. Delegates from seventeen countries attended. They were mainly directors of large laboratories—government, industry and public corporations—with a small representation of universities. Attendance was severely limited to 150. Papers were circulated before the conference, so that most of the conference time could be devoted to discussion.

The general plan of the symposium was that the first day should be devoted to choice of project, general problems of organization and control of research, and the personal and social factors affecting creativity in scientists. The second day provided three parallel sessions on general organization, staff and communication. The third day started with reports from, and joint discussion on, the previous day's sessions, followed by consideration of the assessment of the work of a research laboratory and a general summing up.

The proceedings were opened by Dr. G. B. B. M. Sutherland, who had just previously taken up his appointment as director of the National Physical Laboratory. The first session was then devoted to the strategy of research and the choice and termination of research projects. Prof. J. D. Bernal introduced a thought-provoking paper on "Fundamental and Applied Aspects of Research Problems". In this he emphasized that finding the problem is much more difficult than finding the solution. It is not the problem but the particular need or difficulty that stands out. It is necessary, therefore, before research is started, to reduce the immediately perceivable gap between what is known and what is required to something which can be measured scientifically. He described the working of various types of research laboratories and suggested that one of the most important aspects of the integration of research is that subsidiary problems should be referred to appropriate organizations such as research associations or national laboratories.

In dealing with invention, Prof. Bernal pointed out that its history shows that actual success depends not only on originality and imagination but also on knowing what to invent, that is, on a knowledge of requirements and of market possibilities and costs and prices. The frequent practice of firms in not allowing employees to profit directly from their invention was described as being the 'best way of killing the goose that lays the golden egg'. Prof. Bernal also thought that scientists tend to work too long on lines of traditional, set problems, whereas major advances have occurred when this rule is broken. He advocated a closer liaison between industrial and university research workers as providing two-way benefits.

The other paper in this session was by Dr. Willis Jackson, on "The Research Project—Its Choice and Termination". In this, comparisons and contrasts were drawn between the factors governing the initiation and termination of research in universities and in industry, although the outlook, approach and method of the true research worker were stated to be the same whatever his setting.

Dr. Willis Jackson gave various examples of work originating in individual inspiration which had extensive technological consequences not originally envisaged. He pointed out that the industrial research laboratory is fortunate in having ready access to the wider environment of a range of design and manufacturing activities as an outlet for its personnel. For this and other reasons he regarded it as essential for all industrial research recruits to spend a training period in carefully chosen departments of the main factory.

The first part of the second session was devoted to consideration of creativity. "Creativity and the Scientist" was introduced by Prof. Morris Stein, of the University of Chicago, and "Personality and Social Factors related to Creativity", by Prof. D. J. van Lennep, of the State University, Utrecht.

Prof. Stein surveyed the work of his team on the sociological and psychological factors related to creativity in industrial research chemists. The object of this work is the understanding of the processes involved in creativity so as to facilitate the selection of creative scientists and the administration of creative research. He stated that creativity is a process of hypothesis formation, hypothesis testing and communication of results, and that scientists can be creative in either or all of these fields. He stressed that there are differences between scientists working in different fields and in different environments, and advised employers to have a clear picture of the kind of man they want before starting to look for creativity.

Prof. van Lennep made a preliminary division of research workers under three categories: need for achievement, problem-solving ability and creativity; and he pointed out that a large research laboratory must have staff of each type. For physicists and chemists he postulated that creative workers are less dependent with respect to their environment; are less rigid and dogmatic and have a characteristic time perspective.

The final paper in this session was given by Mr. D. R. Willson, technical secretary of the Atomic Energy Research Establishment, Harwell, on "Budge s and Administrative Controls". He discussed the needs for budgets and controls in research and development establishments, and how those which are essential can best be applied.

The general organization session started with discussions of a paper by Mr. E. S. Hiscocks, secretary of the National Physical Laboratory, on "Some

'Factors affecting Laboratory Administration". In this paper Mr. Hiscocks dealt first with the changed requirements caused by the transition of research from a craft to a large-scale industry. The effects of size on the organization were then examined and the great need for devolution stressed. The division of work in large laboratories was next considered, as were also the effects on their staffing and organization of large-scale, expensive equipment.

The next paper, on "Science and the Workshop", by Dr. R. Vieweg, president of the Physikalisch-Technische Bundesanstalt, was presented by Dr. A. Scheibe, his vice-president. This discussed the place of workshops in laboratories and the types of shops and their organization to meet the requirements of modern research. This raised the controversial question of the degree of centralization of services required to produce optimum results.

The afternoon of this group session was devoted to laboratory buildings. Dr. F. M. Lea, director of the Building Research Station (Department of Scientific and Industrial Research), outlined the requirements and Mr. H. A. Snow, superintending architect, Ministry of Works, gave the architect's answer to these demands.

Punch remarked, more than twenty years ago, that the greatest of all the research problems is the people who do the research, and this was shown to be still the case by the discussions of the staff group. Dr. W. S. Bristowe, head of the Central Staff Department, Imperial Chemical Industries, Ltd., and Dr. F. T. Rosser, director of administration, National Research Council of Canada, presented papers on selection and personal assessment of staff. Dr. Rosser's account of what he described as "fantastic" methods used by employers in Canada to obtain scientists caused considerable comment in the daily press. Prof. H. A. Shepard, of the Massachusetts Institute of Technology, next discussed "Superiors and Subordinates in Research", and described the new orientations that have emerged from the work of sociologists in this field over the past twenty-five years. Prof. Shepard has himself made a significant contribution to these studies. Sir Charles Harington, director of the National Institute for Medical Research, then introduced the subject of "Staff Groupings and the Flow of Authority". The last subject discussed in this session was "Incentives". This was introduced by Mr. Stanley Mayne, secretary of the Institution of Professional Civil Servants. It was a refreshing experience for the 'managers' to hear the views of the 'managed' on this very important subject.

The third group session—that on communications—dealt first with internal communications in a large research laboratory and was introduced by Dr. C. G. Williams, director and general manager of 'Shell' Research, Ltd. This was followed by a paper "Studies in the Use of Technical Information in the Smaller Industrial Establishments", by Mr. Louis Moss and Mr. L. T. Wilkins, of the Central Office of Information. This paper described a statistical survey recently made into the dissemination of technical information in industry; and preliminary results of an investigation of the electrical and electronics industry in Great Britain were presented for discussion by Mr. Geoffrey Thomas in the unavoidable absence of Mr. Moss.

Dr. A. T. Green, director of the British Ceramic Research Association, presented a paper by himself and Dr. A. E. Dodd, information officer of the Association, on "Knowledge: Passing it on—Getting it used", and Mr. A. J. Garratt, liaison officer of the National Physical Laboratory, dealt with problems of "Extramural Communications".

Mr. M. W. Thistle, chief of the Public Relations Branch, National Research Council of Canada, presented, in his inimitable style, the last paper in this group, on "Some Fundamental Difficulties in Popularizing Science". He contended that although only perhaps 0·01 per cent of information of a highly sophisticated nature can in fact be communicated to an unsophisticated audience, the amount of information emanating from science is such that the quantity ultimately absorbed is still significant.

Dr. D. W. Hill, director of the Shirley Institute, Didsbury, was chairman of the session on general organization, Dr. J. Bronowski, director of the Coal Research Establishment of the National Coal Board, was chairman of that on staff and Dr. A. King, Department of Scientific and Industrial Research, of that on communication. These chairmen presented to the complete conference next morning admirably lucid and stimulating summaries of the previous day's discussions.

The final session considered a paper on the assessment of the work of a research laboratory by Mr. A. H. Wilson, managing director of research and development, Courtaulds Ltd., and chairman of the Industrial Research Committee, Federation of British Industries. Mr. Wilson pointed out that the standing of an academic laboratory depends largely upon subjective judgments—the æsthetic appeal of its results to the general body of academic scientists—whereas in the industrial world a laboratory is of no importance unless it exerts a positive influence on its industry, and this, ideally, is capable of measurement. On the subject of stopping research, Mr. Wilson advocated the early and continuous assessment of the whole project and its consequences—a process in which the research worker must take part and the consequences of which he should, therefore, accept. Discussion on this paper and on the conference in general was opened by Dr. A. V. Astin, director of the National Bureau of Standards, Washington.

A summing up of the conference was then given by Dr. H. W. Melville, secretary of the Department of Scientific and Industrial Research, who was chairman of this session.

It is impossible in an article of this length to summarize the many points of view put forward; but it became evident that many of the major problems of large-scale research are fundamentally the same whatever the country and whether the research is on behalf of government or industry. It was also surprising that the solutions evolved by apparently widely differing organizations bear close resemblances. This applies particularly to general organization of research services, and to the broad problems of the selection and personal assessment of staff. However, one of the major difficulties of the government research institution—what to do with the research scientist who has become less productive—is not shared to anything like the same extent by industry, where young men from the research department are continually transferred to other branches of the industry, such as technical sales, production, control, etc. The problems of internal communication are broadly similar whatever the type of industry and naturally increase with the size of the institution; but here again industry is not faced with many of the problems of external communication that are major concerns of government research for the civilian economy.

Although most of the participants in the symposium and many of the contributions came from those actually engaged in directing or administering large research establishments, considerable interest was shown in the 'research into research' papers, such as those from the psychologists, sociologists, statisticians and the trade union side. It is now clear to many research directors that, to borrow a phrase from Dr. Ellis Johnson, we should have more "operations research looking at research operations".

A surprise to the organizers of this symposium was the large number of people from many parts of the world who wished to attend, and it has become clear that discussion of problems such as those dealt with, and of the many more which time did not permit to be raised, must continue. The form which this follow-up and possible extension should take is now under consideration.

All papers presented at the symposium and summaries of the discussions will be published as soon as possible by H.M. Stationery Office, London.

E. S. HISCOCKS

INTERNATIONAL SOCIETY OF BIOCLIMATOLOGY AND BIOMETEOROLOGY

THE first business and scientific meeting of the International Society of Bioclimatology and Biometeorology was held at Unesco House, Paris, during August 29–31. Approximately sixty members, representing sixteen nations, were present. The major items covered included the drawing up of a set of statutes; the election of an executive board and a governing council; the introduction to members, through a series of area reports, of the various aspects of bioclimatological research in progress in different parts of the world; and the presentation of a small number of scientific papers.

Bioclimatology is not a new science, nor is it yet a unified one. The scope of the subject was brought out at the Paris meeting, and it speaks well of the new Society that its prime purpose should be to "unite . . . all Bioclimatologists working in the fields of Medical, General Botanical, Agricultural, Forest, General Zoological, Veterinarian, Entomological and Cosmic Bioclimatology and other future branches of Bioclimatology, . . . to facilitate the development of Bioclimatology". To achieve these ends it proposes to organize symposia, create a clearing house for publications, inaugurate a journal, institute sub-committees in specialized fields and, so far as possible, obtain funds for the fostering of research. The administration of the society is under the ægis of an executive board of seven members, assisted by a governing council of twenty-five. The following were elected to the executive board: *President*, Dr. F. Sargent (United States); *Vice-Presidents*, Prof. H. Berg (Germany), Dr. H. Boyko (Israel) and Prof. L. Emberger (France); *Secretary-Treasurer*, Dr. S. W. Tromp (Netherlands); and *Advisory Members*, Mr. W. E. Arnould-Taylor (Great Britain) and Dr. W. G. Wellington (Canada).

A total of seven area reports briefly described the work of individual bioclimatologists in North America, Western Europe, Africa, South-East Asia and Israel. Such a review provided an excellent, up-to-date account of research in progress. In addition, the width and variety of interests within the subject were made apparent through these reports, as can be seen from the inclusion of such topics as: asthma and hay-fever studies in relation to pollen, fungi and meteorological conditions of the atmosphere; the influence of climate on the behaviour and survival of forest insects; the use of weather data in connexion with irrigation; and a study of problems of clothing and resistance to extreme climates arising from pilgrimages by sea and land to Mecca.

Four sub-committees were instituted, the function of which is to collate and disseminate information on the respective specialized fields of ionic research in bioclimatology, allergy, ecological climatology and bioclimatological instruments. A proposed fifth sub-committee on nautical bioclimatology was referred to the executive board for further consideration.

It was proposed to hold a second meeting of the Society in Vienna in 1957, although a subsequent annual periodicity is not necessarily to be inferred. However, the Paris meeting showed many potential attenders to have been pre-occupied with earlier commitments, and lacunæ in some area reports suggest that scientists in certain areas and disciplines may not have fully realized the extensive nature of the Society's intentions. For these reasons and others, an early re-assembly appeared desirable.

The Society largely owes its inception to the initiative of Dr. S. W. Tromp, who got into touch with bioclimatologists in different parts of the world during the previous twelve months and also played a major part in the organization of the Paris meeting. His acceptance of the secretaryship, which he will conduct from 54 Hofbrouckerlaan Oegstgeest, Leyden, is a fortunate event for the Society.

M. J. DELANY
F. L. WATERHOUSE

YEAST IN INDUSTRY

UNDER the joint sponsorship of the Dublin and District Section, the Microbiology Group and the Food Group of the Society of Chemical Industry, a symposium on "Recent Studies in Yeast and their Significance in Industry" was held in Dublin during September 17–19. The sessions were held in the Rupert Guinness Hall by kind invitation of Arthur Guinness Son and Co. (Dublin), Ltd., on behalf of whom Sir Richard Levinge welcomed the 125 members of the symposium; some seventy-five members attended from overseas. The basis of the symposium was provided by thirteen papers, the reading of which was followed by lively discussions in which many members participated. The chair was occupied in succession by Mr. H. J. Bunker, Prof. T. Dillon, Dr. A. K. Mills, Dr. A. J. Amos and Dr. L. A. Allen.

The first paper, by Dr. A. A. Eddy (Brewing Industry Research Foundation), dealt with "Some Chemical Aspects of Yeast Growth". First, Dr. Eddy described the use of media containing L-lysine as sole major source of nitrogen for the isolation of wild yeasts and the estimation of the extent to which they contaminate brewery pitching yeasts. He then discussed three commercially important aspects of the behaviour of yeasts, namely, head retention, flocculence and finability, which are associated with the surface structure of yeast. In particular, he indicated how these aspects may vary from strain to strain and suggested the division of yeasts with respect to flocculence into those which (*a*) flocculate under the influence of chemical factors (sugars, *p*H, ethanol); (*b*) undergo mutual flocculation; and (*c*) are non-flocculent.

Presenting a paper on "Inositol Deficiency in Yeast with Particular Reference to Fat Production" on behalf of S. W. Challinor, N. W. R. Daniels and J. C. Hall (University of Birmingham), Dr. Challinor reported that the fat content of the cells of a brewer's yeast is greatly increased by growth in a medium deficient in inositol. The possible commercial value of this phenomenon is enhanced by the fact that such fatty, inositol-deficient cells are also more fragile than are normal cells, so that extraction of fat is facilitated.

In his paper on "Amylase Systems in Brewery Yeasts", Prof. R. H. Hopkins (University of Birmingham) pointed out that, although glucose, maltose and maltotriose are the only sugars of the starch series fermentable by them, brewer's yeasts elaborate (*a*) a debranching enzyme ('isoamylase') which splits α-1.6-linkages in branched structures such as amylopectin and its β-limit dextrin, and (*b*) a branching enzyme which transforms the straight-chained amylose into a branched compound. Yeasts which ferment starch and dextrin may occur as contaminants in the brewery. Such is *Saccharomyces diastaticus*, which secretes glucamylase (amyloglucosidase) at or near the cell surface. This enzyme splits successive terminal glucose residues from α-1.4-linked polyglucosans to yield β-glucose. Infection by *Sacch. diastaticus* may therefore cause 'super-attenuation' in bottled beers. In other circumstances, *Sacch. diastaticus* is potentially useful for producing ethanol from starchy materials and for carrying further the attenuation of beers.

Mr. F. W. Beech (Long Ashton Research Station) spoke on "Yeast Control in Cider Fermentation". The inoculum which initiates the fermentation of apple juice is provided by the natural microflora of the fruit. After outlining the changes in the yeast populations of fermenting ciders, Mr. Beech discussed some methods of microbiological control. Thus, a French method consists in reducing the nitrogen content of the juice. In England, aerobic spoilage organisms may be suppressed by keeping fermenting and stored ciders under anaerobic conditions, the yeast population being controlled simultaneously by mechanical methods. Sulphur dioxide, added to the original juices, effectively controls both yeasts and bacteria.

Two prominent Continental scientists provided papers to illuminate those little-understood, but fundamental, aspects of yeast behaviour which centre around the phenomenon known as the 'Pasteur effect'. Dr. H. Holzer (University of Hamburg), in his contribution, "Regulation of Carbohydrate Metabolism in Yeast Cells", adduced evidence for the theory that the key enzyme system affected by the change from anaerobic to aerobic conditions is that catalysed by triosephosphate dehydrogenase, the action of which depends on the available adenosine diphosphate and orthophosphate. Thus, there is a decrease in concentration of orthophosphate associated with the functioning of terminal respiratory processes brought into action when oxygen is introduced into a system fermenting under the action of living yeast. The resultant limitation of supply of orthophosphate will therefore restrict glycolysis. Ultimately, the Pasteur effect appears to be associated with a shift of adenosine triphosphate from the cytoplasm to the mitochondria. Dr. Holzer also discussed the occurrence of aerobic fermentation in connexion with growth. Aerobic fermentation increases when ammonium salts are added to yeast cells which are oxidizing glucose. In these circumstances, the increase in cell substance is largely due to the amination of α-ketoglutarate to glutamate catalysed by glutamic acid dehydrogenase in the presence of coenzyme I. This enzyme and the transaminase catalysing the formation of aspartate from glutamate and oxalacetate are present in yeast.

An obverse aspect of the Pasteur effect was presented by Dr. P. P. Slonimski (University of Paris) in his paper, "Respiration and Growth of Yeasts", in which he described studies involving respiratory mutants and the measurement of cell synthesis under anaerobic and aerobic conditions. *Growing* baker's yeast, even if aerated, ferments glucose: in the exponential phase, respiration is weak, the Pasteur effect is inoperative and ethanol accumulates. In this phase cytochrome synthesis is inhibited by glucose fermentation (the 'counter-Pasteur-effect'). Only in the last phase of growth, when "yeast dissimilates the alcoholic products of its own dissipation", is ethanol respired. Apart from his main thesis, Dr. Slonimski directed attention to a serious systematic error caused by absorption of carbon dioxide in work involving the measurement in conventional manometric apparatus of oxygen uptake when the ratio of carbon dioxide evolution to oxygen uptake is large, as is indeed the case with yeast. He also reported a requirement for ergosterol shown by yeast growing under strictly anaerobic conditions.

In passing, it would appear that some of the work described by Drs. Holzer and Slonimski supports the contention that the pathways of aerobic and anaerobic dissimilation in yeast are common at least up to the pyruvate stage.

Reading the paper by P. F. E. Mann, W. E. Trevelyan and J. S. Harrison (Distillers Co., Ltd.) on "Measurement of Levels of Metabolites within the Yeast Cell during Fermentation", Mr. Mann described the application of ion-exchange resins to the analysis of heat-killed yeast for intermediates and coenzymes. Such analyses promise to yield important information concerning the mechanism of regulation of the fermentation cycle. After a routine of elution has been established, separations are effected and fractions are analysed by simple techniques including measurements of ultra-violet absorption and estimations of total hexose, pentose, fructose and total phosphate. The quantitative results support the hypothesis that the enzymes which catalyse the reversible reactions of fermentation are in excess, so that, at the steady state of fermentation, their substrates are in equilibrium. Furthermore, in a simple medium, the saturation of carboxylase by its substrate, pyruvate, imposes on the rate of fermentation an absolute limitation which can be lifted by addition of thiamine. The high metabolic activity of trehalose and trehalose phosphate during the early stages of fermentation, as noted by these workers, is strong presumptive evidence that these substances play important parts in the metabolism of yeast.

Prof. E. J. Conway (University College, Dublin) contributed a paper on "Active Transport across the Yeast Cell Membrane", a subject with which his name is inseparably connected. He described how the material requirements of yeast enter the cell largely as a result of active transport during fermentation, a process requiring energy derived from other systems and effected by means of carriers, the general cationic carrier being a redox carrier of the cytochrome type. The affinity of the carrier for potassium ions is much greater than that for sodium or magnesium ions.

Aspects of yeast genetics were dealt with in two papers which followed the showing of the film, the "Life Cycle of the Yeast Cell", made for the Anheuser-Busch Co., with a commentary by C. C. Lindegren. Mr. R. B. Gilliland introduced the film and followed with a paper on "Yeast Genetics in Industry". He said that, as yet, the application of the technique of breeding yeasts for the purposes of brewing beer is disappointing, partly because of difficulties inherent in a yeast-breeding programme and partly because the assessment of desirable qualities is so difficult. The situation with respect to other yeast industries appears to be more hopeful, and the possibilities of polyploid yeasts have yet to be examined. On the more positive side, the study of yeast genetics has accumulated valuable data on the inheritance of the ability to flocculate and to ferment maltotriose, dextrin and starch. In more academic fields, the genetic analysis of yeast hybrids may find use in the separation of yeast enzymes.

In a paper on "Some Genetical Aspects of Panary Fermentation", Mr. R. R. Fowell (Distillers Co., Ltd.) presented the results of fermentometer tests on standard doughs fermented by yeasts obtained by breeding in a scheme which permitted subsequent genetical analysis. The results for the 1 hr. volume tests can be explained in terms of four major genes operating for dominance, but those for the 1–3 hr. test are complicated by action of genes operating negatively. He concluded that detailed genetical analysis of the haploid parents is necessary before the panary performance of individual hybrids could be predicted.

"The Utilization of Flour Sugars during Panary Fermentation" was discussed by Dr. R. R. McKenzie (Distillers Co., Ltd.). The subject had been studied by the application of quantitative paper chromatography to that fraction of flour extracted by aqueous ethanol. The observed changes in concentration of glucose, sucrose, glucodifructose and lævosine during fermentation were presented and their significance discussed.

The final paper, by Dr. J. White (Fardon's Vinegar Co., Ltd., Birmingham), on "Influence of Environmental Factors upon Yeast Behaviour", urged a greater appraisal of environmental effects as a step towards the production of yeasts of high fermentative capacity and good keeping qualities. The importance of such effects was illustrated by reference to the phenomenon of 'osmosensitivity', the conditions for which are developed by growth of yeasts in direct culture, but not by growth under conditions of incremental feeding. Dr. White also discussed the change in enzyme content of yeasts in relation to the capacity to ferment glucose and maltose and to secrete invertase. The enzyme content is often influenced both by the stage of harvesting of the yeast and by the nature of the sugar present in the medium.

The final summing up of the symposium was made for the brewing industry by Dr. A. H. Cook (Brewing Industry Research Foundation) and for the baking industry by Dr. J. B. M. Coppock (British Baking Industries Research Association). Dr. Cook pointed to the recent upsurge of yeast research, but also indicated the gulf which still separates pure research from the reality of technological practice. Dr. Coppock directed attention to the new questions posed as a result of every scientific advance. Both speakers brought out the value of work ostensibly carried out in one field to work in another field: in particular, the 'cross-linking' between brewing and baking had manifested itself in this symposium.

Perhaps it was surprising that no paper devoted to questions of the fundamental nutrition of yeast was presented. Such questions, of course, arose incidentally; but it is to be hoped that this deficiency does not reflect a neglected aspect of yeast research. For all that, the symposium was undoubtedly most successful: the amount and vigour of the discussion succeeding each paper testified to the interest aroused at this most informative and stimulating meeting. It is also necessary to add that splendid organization and generous hospitality, for the major part of which the symposium was deeply indebted to the firm and staff of Arthur Guinness, Son and Co. (Dublin), Ltd., contributed substantially to its success.

C. Rainbow

FREE RADICALS

SYMPOSIUM OF THE CHEMICAL INSTITUTE OF CANADA

A SYMPOSIUM on recent progress in the production, isolation and identification of free radicals was held during September 10–11 in the Chemistry Department of Laval University, Quebec. The meeting was sponsored by the Physical Chemistry Division of the Chemical Institute of Canada, and the arrangements were made by Dr. J. A. Morrison (National Research Council) and Prof. P. A. Giguère (Laval University).

The first group of papers dealt with spectroscopic studies of radicals produced by flash photolysis or shock waves. The paper by Drs. G. Herzberg and J. Shoosmith (National Research Council, Ottawa) discussed the CH_3 and CD_3 radicals. Although their spectra are predissociated, the structure of the CD_3 band at 2140 A. indicates that one state, probably the upper, is planar with $r_0(CD) = 1{\cdot}072$ A. and that the other state is slightly bent. Further work is in progress with the view of finding a predicted 'forbidden' transition in the visible which would not be predissociated.

Prof. G. Porter (University of Sheffield) presented a paper showing that simple aromatic radicals such as benzyl can be observed in vapour phase and in solution using flash photolysis, as well as in rigid media at low temperatures. He cited recent work by Bridge and Porter on the photochemistry of quinones in solution, where triplet states, semiquinone radicals and radical ions have been observed and their reactions studied.

Two papers from the National Research Council (Ottawa) dealt with triatomic radicals. In the first of these, Dr. D. A. Ramsay discussed the spectra of HCO, NH_2 and PH_2, all of which show long progressions of the bending vibration ν_2 due to a large difference in bond angle between the upper and lower states. The NH_2 radical has a $^2B_1$ ground state with $r(NH) = 1{\cdot}025$ A. and a bond angle of 103°. Its upper state is linear, probably $^2\pi_u$, and provides the first example of the interaction of the electronic angular momentum and the vibrational angular momentum of the bending mode of a linear molecule which was predicted by Renner. For PH_2 and PD_2 the bending vibrational interval in the upper state is found to pass through a minimum with increasing vibrational quantum number (v'_2). This is thought to be due to steric repulsion of the hydrogen (or deuterium) atoms at large vibrational amplitudes. The second of these papers was presented by Dr. F. W. Dalby, who showed that bands near 7500 A. tentatively assigned to DCO by Herzberg and Ramsay are due to DNO. Bands due to HNO in this region of the spectrum and lasting up to 1/10 sec. have been obtained in the flash photolysis of nitroethane, amyl nitrite and ammonia plus nitric oxide.

The only paper describing shock-wave techniques was given by Dr. N. Davidson (California Institute of Technology), who has studied the decomposition of nitrogen pentoxide in an excess of argon. In this system he was able to photograph the absorption spectrum of the NO_3 radical and to measure the rate constants of the following reactions:

$$N_2O_5 = NO_3 + NO_2$$
$$NO_3 + NO_3 = 2NO_2 + O_2$$
$$NO_2 + NO_3 = NO_2 + O_2 + NO$$

The discussion of these papers brought out both the relative advantages and limitations of these techniques and of work in rigid media, the conclusion being that they were complementary to each other.

The second group of papers dealt with the mass-spectrometric detection of free radicals and atoms produced in a variety of ways. Drs. W. A. Bryce, D. J. Fabian and K. U. Ingold (University of British Columbia) used the pyrolysis of mercury dimethyl to produce methyl radicals which reacted with oxygen in a quartz vessel designed to eliminate the need of a carrier gas. CH_3, CH_2, CH_3O_2, CH_3O, OH and HO_2 were among the radicals detected. In his paper, Dr. F. P. Lossing (National Research Council) described the detection of free radicals in the mercury photosensitized decomposition of acetaldehyde, acetone, ethylene, etc., using a flow system; by varying the length of the irradiated zone it was possible to distinguish between primary processes and secondary reactions. Dr. Lossing also showed that recent calculations of free-radical ionization potentials by Dr. J. A. Pople were in good agreement with the experimental values.

The electric discharge was the source favoured by Drs. S. N. Foner and R. L. Hudson (Johns Hopkins University) and by Drs. J. Herron and H. I. Schiff (McGill University, Montreal). The former have studied the formation of the HO_2 radical in a variety of systems and have found that an important homogeneous reaction is

$$OH + H_2O_2 = HO_2 + H_2O$$

The latter have studied the reaction of oxygen atoms with various species and find a rate constant of 3×10^{10} ml. mole^{-1} sec.$^{-1}$ for bimolecular reaction with nitric oxide.

The papers by Drs. P. LeGoff and L. P. Blanchard (University of Nancy) and Dr. A. J. B. Robertson (King's College, London) discussed processes occurring on hot metal surfaces in the presence of gases at low pressures. The former authors observed such species as CCl_2 from CCl_4 and CS from CS_2. Dr. Robertson discussed the adsorption of ethane and oxygen on platinum surfaces, and showed that the decomposition of the former was not in accordance with the transition-state theory. This point was further brought out in discussion, as was a general agreement over the mechanism of the formation and removal of the HO_2 radical which is still eluding the spectroscopists. Dr. C. K. Jen (Johns Hopkins University) reported unsuccessful searches over a wide range of the microwave region, and, in a later paper, Prof. P. A. Giguère and Dr. K. B. Harvey (Laval University) reported their failure to date to obtain the infra-red spectrum of HO_2 at low temperatures by condensing the products of a discharge through water vapour.

The next two papers described work at the National Bureau of Standards (Washington, D.C.) on the products from a microwave discharge through nitrogen collected on a surface at liquid-helium temperature. Dr. A. M. Bass discussed the experimental side of the work, the most striking feature of which is a green glow from the condensed solid with a half-life of about 15 sec. after the discharge has been switched off. Dr. C. M. Herzfeld showed that this spectrum arises from the $^2D \to {}^4S$ atomic transition of nitrogen, the position of which is shifted by the presence of molecules within one or two angstroms. Also present are bands attributed to a $^5\Sigma_g^+ \to A^3\Sigma_u$ transition of N_2, the $^5\Sigma$ state arising from normal atoms and having a very shallow minimum. Dr. G. C. Pimentel (University of California, Berkeley) described infra-red studies of radicals trapped during the photolysis of hydrazoic acid in an inert matrix at 30° K. There is strong evidence for NH_2 and N_3 radicals in this system. This produced a lively discussion, and Pimentel's work agrees with that of Dr. B. A. Thrush (Cambridge), who has found the ultra-violet absorption spectra of N_3, NH and NH_3 in flash photolysis of hydrazoic acid. N_3 was probably absent in the work at the Bureau of Standards, as its ultra-violet spectrum was not observed. It is surprising that N_3 is not formed from a metastable N atom and an N_2 molecule in this system; but Herzfeld has estimated the binding energy of the atom to be only a few hundred wave-numbers.

Dr. P. Smith (Purdue University, Indiana) presented evidence from various sources for the existence of the HO_3 radical and H_2O_4. No one present had any direct experimental evidence of these species.

The last three papers dealt with paramagnetic resonance. Dr. R. Livingston and H. Zeldes (Oak Ridge, Tennessee) pointed out the importance of using single crystals if trapped radicals were to be positively identified in irradiation experiments at low temperatures. They had, however, good evidence for OH radicals in the glass obtained by condensing the products of a discharge through water vapour. Drs. C. K. Jen, S. N. Foner, E. L. Cochran and V. A. Bowers (Johns Hopkins University) studied the products condensed from a discharge through hydrogen at liquid-helium temperatures. They found two triplets and a quartet near the free-electron resonance, and suggested that these might be due to H_3 or triplet H_2.

Dr. J. E. Wertz (University of Minnesota) discussed the hyperfine structure of the resonance spectra of semiquinone radicals; this is determined by the number and distinguishability of the protons present in the radical and greatly facilitates identification of the steps in quinone reactions. The discussion showed that this technique had great sensitivity and could well be applied to short-lived species.

The credit for the success of the meeting must be shared between the organizers and the authors of the nineteen papers presented, which dealt with very recent advances in fields that were, almost without exception, completely unknown ten years ago.

B. A. Thrush

INSPECTION OF INDUSTRIAL POLLUTION IN BRITAIN

REPORT FOR 1955

The ninety-second report on alkali, etc., works in England and Wales and in Scotland by the chief inspectors, covering 1955*, records 921 works in England and Wales registered under the Act at the end of the year, operating 1,794 processes, which is a decrease of six in the number of works and an increase of ten in the number of processes. The 3,894 visits and inspections made during the year included 165 special visits by the chief and deputy chief inspectors; of the total, 521 visits were to or in connexion with works not registered under the Act, and a further 60 visits were to or in connexion with colliery, spoil-banks. During the inspections, 2,057 quantitative analyses were made of gases evolved from processes in operation, and 827 special samples were submitted for detailed examination to the Government Chemist. Complaints and requests for technical advice and assistance involved a hundred registered and ninety-four non-registered works, the corresponding figures for 1954 being seventy and ninety, respectively; the increase is attributed not to deteriorated conditions but to a greater public awareness of the desirability of cleaner air. During the past few years there has been an increase in what are conveniently termed "area complaints", the complaint being directed against emissions from a highly industrial area or one of intensive production, such as Trafford Park, Manchester, and the Thames-side cement area, rather than against that from individual works.

On twenty-one occasions the total acidity of gases escaping to the atmosphere exceeded the statutory limits, and a further twenty-seven infractions related to failure to use "best practicable means". Since on formal notification of infraction suitable action ensued, there was no occasion to institute proceedings. Visits were paid both to the oil-fired Bankside and the coal-fired Battersea electricity generating stations, both of which are in London, to assess the efficiency of the installations for washing flue gas. While the position at Bankside was most satisfactory, the problem at Battersea is more difficult and has to contend with a doubling of the ash content of the coal since before 1939.

The high demand for cement has continued, and all kilns have operated at full output even when their associated dust-arrestment plants are undergoing repair, so that it was not surprising, especially in view of the fine summer, that there were complaints from most cement-making areas. The inspectorate continued its general policy of ensuring that all de-dusting plant is kept in as efficient a state as possible, that shut-downs are kept to the absolute minimum and that standards of supervision and "housekeeping" are as high as possible. The operation and maintenance of electrical precipitators still give real difficulty at many works. The production of sulphuric acid as monohydrate reached a record in Britain of 1,899,000 tons, an increase of 61,000 tons over 1954, and there was a spectacular increase in the usage of anhydrite for the dual production of sulphuric acid and cement clinker—from 177,000 tons in 1954 to 382,000 tons—and this process involves a serious problem of mist in the final escapes to air.

The Chief Inspector for Scotland reports no change in the number of works (82) registered under the Acts; but the number of processes operated increased by three to 119. On the 195 visits made to registered works, 92 chemical tests of flue emission were made involving the analysis of 116 samples, 14 by the Government Chemist; a further 166 visits were made which were not directly related to the provisions of the Acts. The Chief Inspector remarks that recent research has thrown more light on the dispersal of gases and dust from chimneys, and it seems desirable that the results of this work should be applied more generally, if only to test their validity; he cites an instance in which recently published work on dispersal of dust from high chimneys was particularly useful in connexion with dust emission from a power station in the west of Scotland which is fired with pulverized fuel.

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* Ministry of Housing and Local Government; Department of Health for Scotland. Alkali, etc., Works Regulation Act, 1906, and Alkali, etc., Works Orders 1928–1950. Alkali, etc., Works Regulations (Scotland) Acts, 1906 and 1951. Ninety-second Annual Report on Alkali, etc., Works by the Chief Inspectors, 1955. Pp. 51. (London: H.M.S.O., 1956.) 2s. net.

BIRD SEMANTICS

Most birds have a rudimentary language. A crow, for example, gathers its flock by uttering a distinctive 'assembly call' and disperses it by squawking an 'alarm call'. The flock will respond to tape recordings of these calls just as it does to the cries of a live bird.

Two research groups, one in the United States, the other in France, recently exchanged tapes on which they had recorded the calls of their native crows. Their object was to learn whether French 'crows' (rooks, jackdaws and carrion crows) would understand the language of the American eastern crow, and vice versa (*Sci. Amer.*, August 1956). Roosting French 'crows' consistently ignored the alarm call of American crows; but more than half the French birds were aroused by the broadcast of an American 'gathering' call. American crows were wholly unmoved by the plaintive cries of nestling rooks or the strident assembly call of adult jackdaws—commands which all three species of French crow invariably obey.

In a further experiment, the French investigators broadcast the food-finding and alarm calls of the American herring gull, a bird that also dwells on French coasts. The French gulls paid no heed to the American calls. From these experiments the investigators concluded that birds learn the language of their kind from older birds of their own group. The investigators included R.-G. Busnel, J. Giban and Ph. Gramet, of the French National Institute for Agricultural Research; the Americans were Hubert and Mabel Frings and J. Jumber, of Pennsylvania State University and the Mount Desert Island Biological Laboratory.

PAN INDIAN OCEAN SCIENCE CONGRESS

THE Pan Indian Ocean Science Association was formed in January 1951, at Bangalore, India, when thirty-six delegates representing nine countries met for the first Pan Indian Ocean Science Congress. The 1951 meeting was mainly devoted to drafting a constitution for the Association, and in arranging working committees in each of the member countries. Much consideration was also given to the major scientific problems affecting these nations. This initial survey enabled the national committees during the 1951–54 inter-congress period to prepare many reports on problems of the Indian Ocean zone and on researches which had been carried out upon them. These reports provided material for the symposia and discussions of the second Pan Indian Ocean Science Congress, which was held in Perth, Western Australia, in August 1954 and attended by 527 people. Indonesia and Pakistan were admitted to membership of the Association at Perth; the other member countries are Australia, Burma, Ceylon, France, India, Madagascar, Malaya, the Netherlands and Portugal.

The Proceedings of the Congress, which appear in eight volumes, contain some of the original papers and an account of some of the discussion. The first volume contains the whole presidential address and also gives details of the constitution and membership of the Congress as well as recommendations by the whole Congress or by the separate sections of the physical sciences; biological sciences; geological sciences; agricultural sciences; economics, education, and social sciences; geography and oceanography and human ecology. The scientific papers of the various sections are set out in the remaining volumes.

The president at Perth was Prof. A. P. Elkin, professor of anthropology in the University of Sydney, who spoke about "The Natural History of Man".

The recommendations of the Congress give an indication of the wide-ranging scope of its deliberations and of the practical efforts made to secure co-operation in research and development for the whole area. Among the many important recommendations were the following.

Recognizing the importance of the preparation of detailed information on the distribution of plants and animals, particularly in coastal areas, the Congress recommended that co-operation be instituted with the Pacific Science Association in a similar project which the latter is undertaking, and that in future work more attention be devoted to the study of biocœnoses.

The Congress also recommended that continuous records of temperature, rainfall, humidity and sunshine for a range of type localities in each country be kept, and directed attention to the need for international agricultural quarantine regulations for the Indian Ocean region.

The Congress recommended collaboration in the preparation of climatic and other maps on a uniform basis, so that results obtained in any one country could be applied more systematically in other countries; collaboration in the collection of wild and cultivated forms of economic plants indigenous to the Indian Ocean region; collaboration in plant exploration in extra-regional areas of special significance for the Indian Ocean countries; and visits by and interchange of agricultural scientists of the Association countries with a special knowledge of plant introduction requirements and possibilities and thus able to stimulate useful exchanges of plant material.

Recognizing that the improvement of tropical grasslands offers great scope for improving the world's food supply and involves problems common to all Indian Ocean countries, the Congress recommended that information gained in these countries on this subject should be interchanged.

As mixed farming can play an important part in the development of tropical agriculture, the Congress recommended that there be concerted action in research on problems relating to this system of land use in the Pan Indian Ocean area.

The Congress suggested that the Association should undertake the preparation of a general handbook presenting in broad terms the present state of scientific knowledge of the Indian Ocean area as a whole; while Unesco was to be asked to assist in the development of facilities within existing stations of the area to train and interchange personnel.

The Unesco proposal to create a legally constituted inter-governmental organization for oceanographic research in the Indo-Pacific region was strongly supported.

Food problems were discussed, and the Congress recommended that exchange of information on the principles of food management should be organized; that a study of food habits and 'food fads' be made in the area; and that a study of elementary nutrition be included in primary education programmes. After considering tuberculosis and leprosy, the Congress recommended that an attack on socio-economic conditions, particularly housing, should be considered as the most effective factor in tuberculosis control and that primary education in living habits, with particular reference to spitting, and secondary education to produce trained personnel, should be emphasized in any tuberculosis-control programme; the institution of an effective method of prevention of leper migration to unaffected areas was recommended.

The secretary of the Congress is Prof. A. D. Ross, from whom at "Balnagown", Golf Links Road, Albany, Western Australia, copies of the full Proceedings may be obtained, price 37*s*. 6*d*. The next Congress is to be held at Tananarive, Madagascar, in September 1957.

METHODS FOR THE STUDY OF HUMAN RELATIONS IN INDUSTRY

DURING the War and the post-War period, in Western countries and more especially in the United States, there has been a gradual awareness of the need for a more adequate social-psychological approach to problems of human motivation and adjustment in industry. This approach is concerned with the satisfactions and motivations existing among the members of different groups in industries and how these can be improved by suitable changes in the groups and organizational structure. Psychology has contributed the maximum toward the development and refinement of techniques for study of human relations problems.

The psychologist, in his study of these problems, uses one or more of three distinct approaches. These are: (1) the attitude survey approach; (2) the group dynamics approach; and (3) the clinical psychology approach.

Each technique has its usefulness in its own field. The survey technique is particularly useful in the discovery of principles underlying problems of organizing and managing human activity. The Survey Research Centre of the Institute for Social Research at Ann Arbor is using it with advantage for the study of "social and interpersonal determinants of organizational effectiveness and employee satisfaction".

The group dynamics approach, developed on the conceptualizations of Kurt Lewin, is specially useful for the understanding of determinants of inter-group relations and of relations among members of a group. This approach, in combination with the sociometric technique, has made possible careful observation and analysis of group behaviour.

Psychotherapy is highly useful in specific cases; but its utility lies perhaps not in any improvement of human relations in industry by treating all those suffering from emotional maladjustments (there are not enough therapists for that even in the United States), but in analysing the effects of different types of personalities on the organizational structures set up by them, the top man's methods of dealing with people in the organization and the way it influences their attitude.

The ultimate object of various studies made along the above lines is to have an integrated theory of organized human effort which will be useful to society in general and to industry in particular. This can best be achieved by a close integration of ideas from different social sciences, psychology, sociology, economics, anthropology, etc. So far as human relations in industry are concerned, approaches are being made from different sides; substantial inter-professional collaboration is yet to be achieved.

Studies based on the above techniques and the changes based on findings from such studies that the psychologist attempts to introduce in the organizational structure carry some implicit value assumptions of what is desirable, what is good. As yet, little attempt has been made to make them explicit or justify them. Harish Chandra Ganguli suggests that this is all the more necessary for psychologists of countries other than the United States who try to use these techniques mostly developed in America and permeated with American values in a setting culturally and socially very much different from that of the country of origin (*Sci. and Cult.*, 21, No. 12; June 1956).

PLANT GROWTH-REGULATING ACTIVITY IN CERTAIN CARBOXYLIC ACIDS NOT POSSESSING A RING STRUCTURE

By DR. C. H. FAWCETT, PROF. R. L. WAIN and DR. F. WIGHTMAN

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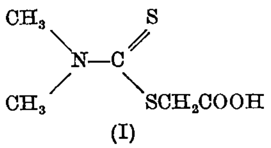
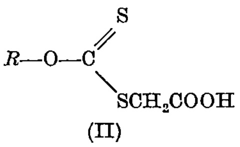
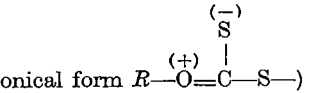
CHEMICAL structure in relation to plant growth-regulating activity of carboxylic acids has been the subject of much research over the past twenty years, and until recently it was considered that, in addition to the —COOH group, another essential requirement for activity was an unsaturated ring structure[1]. The discovery by van der Kerk and co-workers[2] that carboxymethyl dimethyldithiocarbamate (I) and certain of its analogues can show appreciable plant growth-regulating activity indicates that an unsaturated ring system may not be essential. These workers suggested, however, that the activity observed in these compounds is associated with the N—C bond acquiring double-bond character due to internal electron shifts, thus resulting in a type of 'ring' system[2]. This possibility has since been questioned[3].



(I)



(II)

We have synthesized a series of carboxymethyl O-alkyxanthates (II) and the tertiary butyl derivative ($R = (CH_3)_3C$—) was found to be significantly active in promoting the growth of 1-cm. wheat coleoptile sections (Table 1). The technique was exactly as described for the *Avena* cylinder test[4] except that wheat coleoptiles (var. Eclipse) were used. The fact that in the xanthates the O—C bond acquires comparatively little double-bond character[3] (as in the canonical form  $R{-}\overset{(+)}{O}{=}\overset{\overset{(-)}{S}}{\overset{|}{C}}{-}S{-}$) provides further evidence that a ring or partial ring is not essential for growth-regulating activity. Again, the small but significant activity reported by Bennet-Clark for dimethylacetothetin chloride[5] is consistent with the view that a ring system need not be present. The interesting possibility has been raised that the activity of the thetin is related to its known behaviour as a methyl donor[5]. Betaine hydrochloride, known to be less active in transmethylation, is inactive in the wheat test (Table 1).

In a study on the growth-promoting activity of chloro- and methyl-substituted acetic acids in the wheat coleoptile test, significant activity was found in a number of instances. Thus, for example, all three chloro-acids were active (Table 1); though no activity was shown by these or any other compounds of this group in the pea curvature test. The slight activity previously reported for trichloroacetic acid in the pea test[6] has not been observed in the present work.

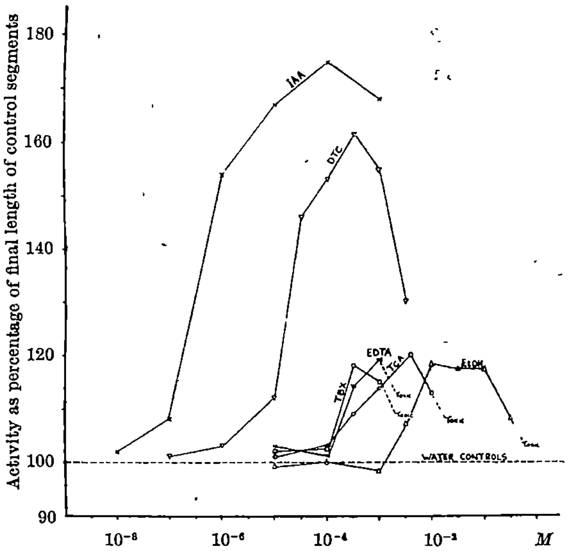


Fig. 1. Activity in the wheat cylinder test after 24 hr. of certain non-ring compounds relative to 3-indolylacetic acid. All acids tested as the sodium salts (EDTA as the tetra-salt). DTC, carboxymethyl dimethyldithiocarbamate; TBX, carboxymethyl O-*tert*-butylxanthate; EDTA, ethylenediaminetetraacetic acid; TCA, trichloroacetic acid; EtOH, ethyl alcohol

The first suggestion that chelating agents may show plant growth-regulating activity was made by Bennet-Clark at the Wye Symposium in 1955[5]. It was shown that ethylenediaminetetraacetic acid is capable of promoting slight extension growth both in oat and wheat coleoptile tissue, and this was attributed to a chelating mechanism whereby the calcium/pectin relationship in the cell wall was affected. The activity of ethylenediaminetetraacetic acid was independently observed by Heath and Clark[7], who also favour a chelation hypothesis. In support of this, they showed that whereas a number of other chelating agents possessed significant activity in the wheat cylinder test, various compounds not recognized as chelators possessed negligible activity. The suggestion was also made that highly active auxins such as 3-indolylacetic acid and 2 : 4-dichlorophenoxyacetic acid might owe their biological activity to chelating properties. In view of the limited capacity of these molecules to chelate with metals and their very high growth-regulating activity, this would appear unlikely. Furthermore, chelation cannot be a universal mechanism leading to all types of growth response, since in the pea curvature and tomato leaf epinasty tests, in which 3-indolylacetic acid and 2 : 4-dichlorophenoxyacetic acid are extremely active, ethylenediaminetetraacetic acid has been found to be completely inactive.

It is important that the activity of all these non-ring compounds should be seen in the right perspective. Heath and Clark[7] in one experiment with wheat coleoptile sections found ethylenediaminetetraacetic acid at 10^{-5} *M* gave practically the same increment of growth, compared with controls, as 3-indolylacetic acid at the same molar concentration. In a second experiment, the response to ethylenediaminetetraacetic acid was just significantly less than that shown by 3-indolylacetic acid. In the present work, using a different technique, ethylenediaminetetraacetic acid was found to be a much less active growth substance than 3-indolylacetic acid (Table 1, Fig. 1), a result previously found by Bennet-Clark using oat coleoptile segments[5].

It therefore became necessary to carry out further experiments in which the activities of ethylenediaminetetraacetic acid and 3-indolylacetic acid were compared after treatment periods of 24, 36 and 48 hr. The analytically pure compounds were tested both as the free acids and as their sodium salts, all four salts being included in the case of ethylenediaminetetraacetic acid. The results for the salts were similar to those obtained with the acids and, furthermore, no significant differences were observed

Table 1 THE ACTIVITY OF CERTAIN CARBOXYLIC ACIDS IN THE WHEAT CYLINDER ELONGATION TEST*

Formula of compound	Concentration in p.p.m. 0·1	1	10	100	500	1,000
CH_3COOH	100	104	101	102	100	99
CCl_3COOH	100	101	107	**117**	**125**	**119**
$C(CH_3)_3COOH$	101	102	102	102	104	101
$CHCl_2COOH$	99	100	**109**	**110**	**122**	**117**
$CH(CH_3)_2COOH$	103	102	106	105	105	100
$CH_2ClCOOH$	99	102	103	**112**	Toxic	Toxic
CH_3CH_2COOH	100	103	102	100	97	93
$CH_3CHClCOOH$	100	102	107	**113**	104	96
CH_3CCl_2COOH	99	102	102	**109**	106	100
$(CH_3)_2CClCOOH$	101	102	101	98	98	96
$CH_3OCSSCH_2COOH$	98	102	98	101	93	92
$C_2H_5OCSSCH_2COOH$	103	98	98	98	93	Toxic
$(CH_3)_2CHOCSSCH_2COOH$	100	98	96	94	Toxic	Toxic
$(CH_3)_3COCSSCH_2COOH$	102	100	103	**111**	Toxic	Toxic
$(CH_3)_2\overset{(+)}{S}(\overset{(-)}{Cl})CH_2COOH$	100	104	102	**115**	Toxic	Toxic
$(CH_3)_3\overset{(+)}{N}(\overset{(-)}{Cl})CH_2COOH$	100	97	105	93	Toxic	Toxic
$(CH_3)_2NCSSCH_2COOH$	101	98	**120**	**162**	**138**	**129**
$(C_2H_5)_2NCSSCH_2COOH$	98	100	**118**	**137**	**122**	**114**
$(CH_3)_2NCOSCH_2COOH$	96	98	99	103	**134**	**126**
$(CH_3)_2NCSOCH_2COOH$	**131**	**150**	**148**	**154**	**139**	**132**
$(CH_3)_2NCSSC(CH_3)_2COOH$	101	99	98	102	99	100
$(HOOCCH_2)_2N.CH_2CH_2.N(CH_2COOH)_2$†	98	99	101	110	118	Toxic
3-Indolylacetic acid	**143**	**165**	**158**	**153**	—	—
2 · 4-Dichlorophenoxyacetic acid	**125**	**154**	**160**	**132**	—	—

Figures in heavy type are significantly different from controls at the 0·1 per cent level

* All compounds were examined at stated concentration of the acid in the form of its sodium salt. Responses were measured after 24 hr. and activity expressed as percentage of final length of control segments.

† Tetra-sodium salt.

in the results obtained for the various treatment periods. It is apparent from Fig. 1 that ethylenediaminetetraacetic acid is very much less active for promoting extension growth in wheat coleoptiles than is 3-indolylacetic acid. Indeed, in these experiments ethylenediaminetetraacetic acid showed the same low order of activity as trichloroacetic acid and carboxymethyl O-*tert*-butylxanthate (Fig. 1). In view of the fact that these three non-ring compounds are completely inactive in the pea curvature test and that their capacity to induce slight growth responses in wheat coleoptile tissue is only revealed at near-toxic concentrations, it is possible that the compounds are not acting as true 'growth substances'. In agreement with this, the shape of the growth/time curves at optimum concentrations indicates that the pattern of growth is not typical of a normal auxin response. The action of these substances may well depend upon changes in membrane permeability and cell wall structure resulting from sub-acute toxicity.

To examine this possibility further, a study was made of the behaviour of ethyl alcohol in the wheat test. This compound showed the same low order of growth response (Fig. 1), and, furthermore, the highest activity was revealed at a concentration just below the level at which toxic symptoms were observed. Moreover, the type of elongation observed was typical of that shown by ethylenediaminetetraacetic acid, trichloroacetic acid and the xanthate and different from that induced by sugars and other respiratory substrates. This activity of ethyl alcohol has been confirmed a number of times, and it is suggested that this provides a further example of the 'non-typical' growth-regulating activity discussed above. On the other hand, certain dimethyldithiocarbamate derivatives (I), for example, can show appreciable activity in the wheat test (Table 1, Fig. 1), and since such compounds are also active in the pea and tomato-leaf epinasty tests it is probable that this type of non-ring structure is capable of inducing a true auxin response.

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INHIBITION OF PLANT CYTOCHROME OXIDASE BY BICARBONATE

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THE concentration of carbon dioxide in equilibrium with bicarbonate in the soil has been recognized as an important ecological factor for many years[1]. Recent experiments by Thorne *et al.*[2] have indicated that the level of bicarbonate in nutrient media is positively correlated with the incidence of lime-induced chlorosis. Bean plants grown in nutrient cultures in which *p*H and bicarbonate concentrations were varied by controlling the carbon dioxide pressure of the aeration stream developed chlorosis at the high bicarbonate levels regardless of the *p*H of the solutions. Further experiments[3] indicated that the inhibition by bicarbonate of the respiratory rates of roots from chlorosis-susceptible species was greater than that of the roots from chlorosis-resistant species. A study[3] of the carbon monoxide inhibition of oxygen uptake provided indirect evidence that cytochrome oxidase was the dominant terminal oxidase in the bicarbonate-susceptible plants, and possibly was the factor affected by bicarbonate salts.

The experiments reported herein provide direct evidence that bicarbonate is an inhibitor of cytochrome oxidase from certain higher plant species. These experiments were conducted in conjunction with a more detailed study of the stimulatory effects of various salts on cytochrome oxidase activity.

In the experiment illustrated in Fig. 1 the effect of sodium bicarbonate on the activity of cytochrome oxidase from two species was compared with that of sodium chloride on the activity of the enzyme. Particulate preparations containing cytochrome oxidase were made from the roots of spinach (*Spinacia*

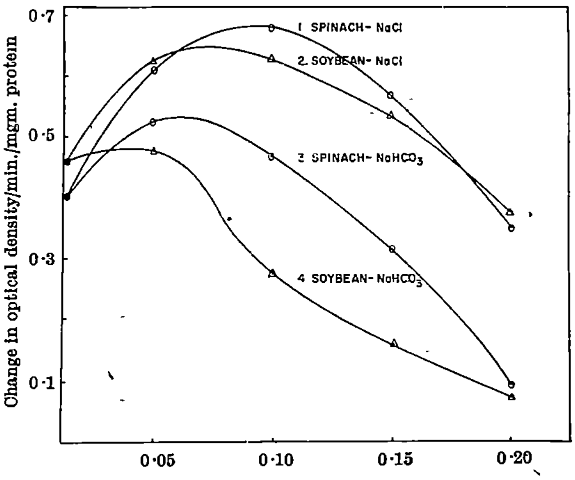

Fig. 1. The effect of sodium bicarbonate compared to sodium chloride on cytochrome oxidase activity of soybean and spinach roots. The complete system (curve 1) contained 50 μmoles tris buffer at *p*H of 8·8, 0 051 μmole reduced cytochrome *c*, extract of particulate material from spinach roots and concentrations of sodium chloride indicated in a final volume of 1 ml. Curve 2, identical reaction mixture with the exception that the extract was obtained from soybean roots. Curve 3, the assay mixture was identical to that for curve 1 with the exception that sodium bicarbonate was added instead of sodium chloride. Curve 4, the reaction mixture was identical with that for curve 2 with the exception that sodium bicarbonate replaced sodium chloride. Reactions were started by addition of extract containing 0·1–0 2 mgm. protein, and stirred prior to each reading to avoid errors due to the settling of particles in the cuvette

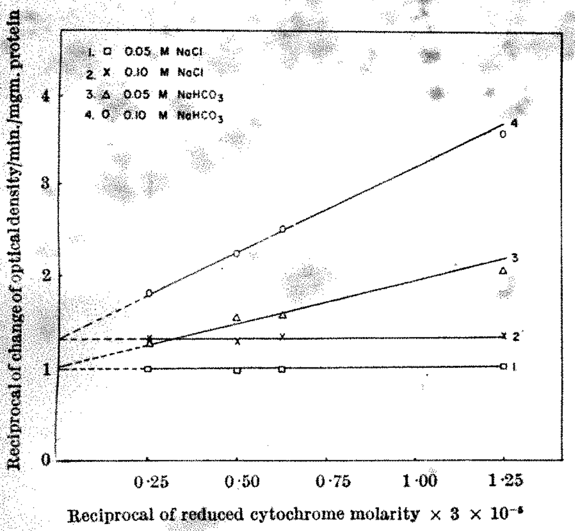

Fig. 2. Lineweaver–Burk plot of the inhibition of cytochrome oxidase activity of soybean roots by sodium bicarbonate. Assay mixtures in a final volume of 1 ml. contained 50 μmoles tris buffer at *p*H of 8·8, desired concentration of reduced cytochrome *c*, the indicated type and concentration of salt and extract containing 0·12 mgm. protein. Readings were taken every 10 sec. and enzyme activity calculated as the change in optical density per min. per mgm. protein using only the linear portion of optical density change per unit of time

oleracea L., variety Bloomsdale) or soybean (*Glycine max* Merr., variety Ogden) plants 6–30 days old as previously described[4], with the exception that the isolation medium contained 0·05 *M* tris-hydroxymethyl-aminomethane buffer at *p*H 7·5 instead of phosphate buffer. Reduced cytochrome *c* was prepared chemically by the use of sodium hydrosulphite[4] and the assays were determined spectrophotometrically at 550μ with a Beckman *DU* spectrophotometer[4]. The enzyme activity is indicated as the decrease in optical density between 15 and 75 sec. after the reaction was started by the addition of enzyme. Under the conditions of the experiments, the oxidation rates were linear for two minutes after the reactions had begun. The protein content of the extracts was determined by the use of Folin's phenol reagent[5].

The curves in Fig. 1 show that cytochrome oxidase from the roots of both spinach and soybean plants is stimulated by concentrations of sodium chloride up to 0·1 *N*; but concentrations greater than this resulted in decreases in activity. The influence of variable concentrations of sodium nitrate and sodium sulphate was practically identical to that of sodium chloride. It is apparent from Fig. 1 that various concentrations of bicarbonate at *p*H values comparable to those where chloride salts were used inhibited cytochrome oxidase activity from 20 to 75 per cent, depending on the bicarbonate concentration. This inhibitory effect also has been observed with cytochrome oxidase preparations from oat and tobacco plants and from pig heart. The inhibitory action of bicarbonate has been observed in assay mixtures adjusted to *p*H 7·8 by use of tris-hydroxyaminomethane buffer and carbon dioxide. The inhibition is not limited, therefore, to the high *p*H conditions used in the experiment shown in Fig. 1.

The influence of sodium bicarbonate on cytochrome oxidase activity of soybean root extracts at various reduced cytochrome *c* concentrations was determined, and the reciprocals of enzyme activities plotted against the reciprocals of reduced cytochrome *c* concentrations according to the method of Lineweaver and Burk[6] (Fig. 2). The results from assays containing concentrations of 0·05 *M* (curve 3) and 0·10 *M* (curve 4) sodium bicarbonate were compared with those from assays containing equivalent amounts of sodium chloride (curves 1 and 2). These results indicate that sodium bicarbonate is a competitive inhibitor of cytochrome oxidase.

Since it was apparent that bicarbonate inhibited cytochrome oxidase *in vitro* and since evidence in the literature indicated that excessive bicarbonate in culture media is detrimental to plant growth and is associated with chlorosis of leaves, it was deemed necessary to determine whether the addition of bicarbonate to culture solutions would influence the activity of cytochrome oxidase in tissues. To test this possibility, soybean plants of the Ogden variety were grown in pots of washed quartz sand in the greenhouse. Seven seven-day-old seedlings were transferred to each of twelve polyethylene pots of quartz sand. The pots held a volume of 6 litres and each was equipped with a drain hole in the bottom. Four treatments replicated three times were applied to the cultures in a randomized block experiment. The treatments indicated in Table 1 consisted of 0·008 *M* and 0·016 *M* sodium bicarbonate and 0·008 *M* and 0·016 *M* sodium chloride + sodium hydroxide. The variable culture treatments were added to a standard Hoagland nutrient solution, and the soybean cultures were flushed with the appropriate solutions three times daily. The *p*H of the effluent from cultures receiving sodium chloride + sodium hydroxide ranged between 7·5 and 7·7 and that of the effluent from cultures receiving sodium bicarbonate ranged between 7·6 and 7·9. After 25 days the plant receiving bicarbonate in solutions developed a chlorosis of leaves. At that time roots were harvested and extracts prepared from them by the method indicated in the experiment reported in Fig. 1. Results of assays presented in Table 1 show that the extracts from plants receiving the bicarbonate treatments were significantly lower in cytochrome oxidase activity than extracts from plants grown with comparable concentration of sodium added as the chloride and hydroxide. The inhibitory effect of the 0·008 *M* sodium bicarbonate treatment on the enzyme activity was significant at the 1 per cent level and the effect of the 0·016 *M* sodium bicarbonate

Table 1. THE EFFECT OF SODIUM BICARBONATE IN CULTURE SOLUTIONS ON THE CYTOCHROME OXIDASE ACTIVITY OF EXTRACTS FROM ROOTS OF SOYBEAN PLANTS

Culture treatment		*p*H of culture solution	Cytochrome oxidase activity†	Appearance of chlorosis
NaCl + NaOH*	$NaHCO_3$			
M	*M*			
0·008	0·000	7·7	1·13	–
0·000	0·008	7·7	0·67	+
0·016	0·000	7·8	0·92	–
0·000	0·016	7·8	0·60	+
L.S.D. (1 per cent			0·34	
L.S.D. (5 per cent)			0·23	

* Treatments containing no sodium bicarbonate were adjusted to the desired *p*H with sodium hydroxide, and sufficient sodium chloride was added to give a concentration of sodium comparable to the bicarbonate treatments.

† The reaction mixture in a final volume of 1 ml. contained 50 μmoles tris buffer at *p*H 7·5, 0·051 μmole reduced cytochrome *c* and extract prepared from roots of soybean plants grown with the various treatments and containing from 0·08 to 0·09 mgm. protein. Results are means of duplicate determinations from three replicate cultures and are expressed as optical density change at 550 mμ per minute per mgm. protein.

treatment approached this level of significance. As indicated in Table 1, the plants supplied with sodium bicarbonate developed a chlorosis of leaves; but this symptom was not apparent with plants grown without bicarbonate. There was no influence of treatment on the total growth of plants. Other treatments not reported indicated that extracts from plants grown with culture solutions with various *p*H values were not significantly different in cytochrome oxidase activity.

From the above results it seems clear that excessive concentrations either *in vitro* or *in vivo* inhibit cytochrome oxidase activity. Since the inhibition is competitive in respect to reduced cytochrome *c*, the inhibition in living tissues containing relatively low concentrations of cytochromes may be considerably greater than that indicated from assays conducted with relatively high cytochrome *c* concentrations. Further experimentation may prove that the inhibition of cytochrome oxidase by bicarbonate is related to the inhibition by this ion of respiration of plant tissues[3]. Also, these results may have a bearing on the observations that bicarbonate induces the accumulation of organic acids in excised barley roots[7] and on the observation that the tissues of plants affected by lime-induced chlorosis contain excessive concentrations of organic acids[8].

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A CYTOLOGICAL STUDY OF THE NEURONES OF *PATELLA VULGATA* BY LIGHT AND ELECTRON MICROSCOPY

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In view of various conflicting reports on the cytology of neurones of Mollusca[1-8] a study has been made of neurones from the pedal, pleural and visceral ganglia of the common limpet *Patella vulgata* by both light and electron microscopy.

Observations by Light Microscopy

When cells were treated by Kolatchev's method for the Golgi apparatus (post-osmification for 24 hr.) two types of inclusions were revealed: lipochondria (lipochrome granules, neutral-red bodies) and Golgi apparatus. The lipochondria were spheroidal in form, ranged in colour from light to dark brown, and varied greatly in number in different neurones. In large cells they typically clustered around a well-defined, and approximately central, region which, from evidence presented mainly by electron microscopy, was identified as an active secretory zone and will be termed the *S* region (Fig. 1). The Golgi apparatus nearly always appeared as a network of fine strands and only occasionally as apparently discrete curved dictyosomes. Both networks and dictyosomes were black in colour. Associated with some of the networks and dictyosomes was a weakly osmiophilic, diffuse material identified as archoplasm. In large neurones the Golgi apparatus ramified the *S* region and was therefore generally distinct topographically from the lipochondria. In small neurones the Golgi apparatus occupied a small juxta-nuclear region. The latter probably corresponds to the *S* region of larger cells.

It is generally accepted that iron haemotoxylin and acid fuchsin will stain mitochondria after appropriate fixation. Bleached Kolatchev preparations were stained, therefore, with iron haemotoxylin, and Helly post-chromed sections with acid fuchsin. The iron haemotoxylin stained small granules and rods which varied considerably in number from cell to cell and which were generally situated towards the periphery of the *S* region and among the lipochondria. By a study of individual cells both before bleaching

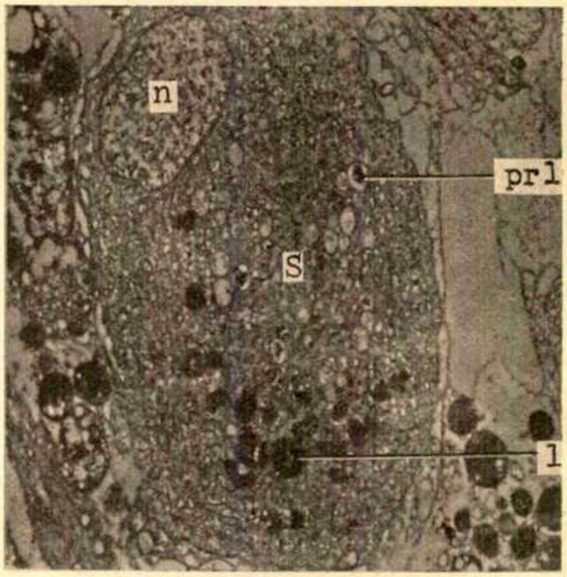

Fig. 1. Low-power micrograph showing the '*S*' region. Several pro-lipochondria (*prl*) and lipochondria (*l*) can also be seen. *n* = nucleus. (× 6,000)

and after staining with iron haemotoxylin, it was established that the Golgi apparatus is definitely not an artefact caused by the over-impregnation of mitochondria as maintained by Thomas[5].

In Helly preparations the acid fuchsin stained small granules and rods (similar to those revealed by iron haemotoxylin) and, to a less extent, the lipochondria. Some of the small granules were larger than others. Both in this respect and in their staining reaction they seemed to represent a stage in the formation of the lipochondria. Thus the acid fuchsin was apparently staining mitochondria, developing lipochondria, and mature lipochondria. (It is probable that the iron haemotoxylin also stained the mitochondria and developing lipochondria.) In cells containing many small fuchsinophil granules there were few lipochondria and vice versa.

Within the limits of resolution of the light microscope, the cell body of these neurones extended into a single nerve process. The position of the nucleus relative to the process was very variable. Often it lay either near the process or, on the other hand, at the extreme opposite end of the cell body. Rarely did we see a nucleus in the central position as so often depicted for cells of this kind[1-7]. Each nerve process passed from the outer (cortical) region of each ganglia into the central (medullary) part, where it met numerous other nerve fibres.

Each nucleus usually contained a single prominent nucleolus which was intensely osmiophilic and stained strongly with iron hæmotoxylin, acid fuchsin, and methylene blue. When Champy post-chromed preparations (gelatine embedded) were stained with acid fuchsin a few minute granules were seen in the nucleoplasm in addition to the nucleolus.

Kolatchev preparations not only revealed the lipochondria and Golgi apparatus but also fine fibrils within the nerve fibres.

Observations by Electron Microscopy

Studies on neurones treated by Kolatchev's method, or on those fixed in buffered osmium tetroxide and examined at high resolution with a Siemens Elmiskop 1, substantiated and extended the observations recorded above. The following account refers to material fixed in buffered osmium tetroxide except when stated otherwise.

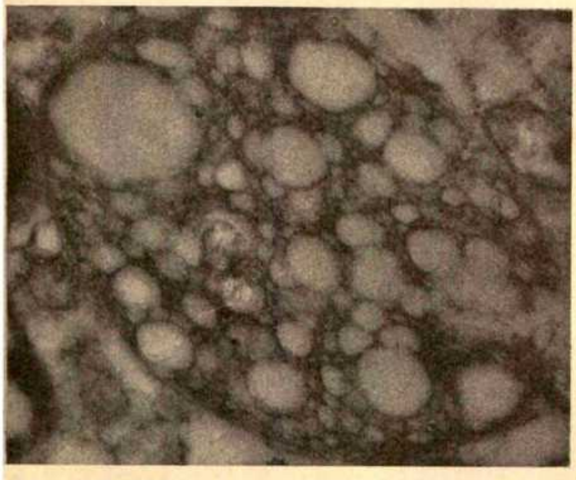

Fig. 2. Micrograph showing the ultrastructure of a lipochondrion. The internal network of membranes divides the inclusion into a number of osmiophobic compartments. (× 40,000)

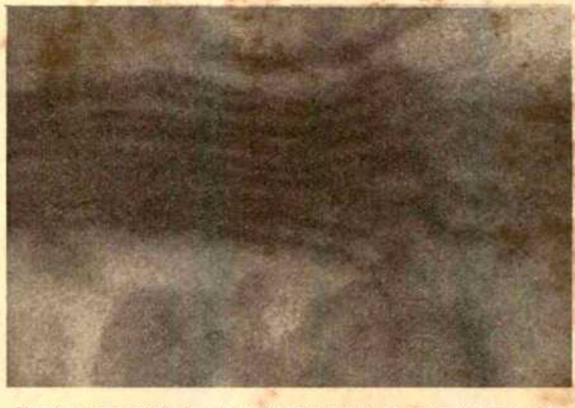

Fig. 3. Micrograph showing paired Golgi membranes. (× 120,000)

The lipochondria, which generally appeared homogeneous in light microscopical preparations, were either homogeneous or consisted of an elaborate internal network of membranes (Fig. 2). The Golgi apparatus had essentially the same ultra structure as in many kinds of vertebrate cells[9,10]. It consisted of paired anastomosing membranes which usually enclosed an inner dense (osmiophilic) substance, a vacuolar (osmiophobic) material lying within dilations of the paired membranes, discrete vacuoles, and small vesicles (Fig. 3). The networks and dictyosomes seen in light microscope preparations were due to the impregnation of the paired membranes and inner substance; the archoplasm probably resulted from the impregnation of the Golgi vesicles. The mitochondria were generally few in number and were either rod-like with numerous cristae[11] or spheroidal with few cristae (see below).

The *S* region was seen with great clarity (Fig. 1). Within this region was the Golgi apparatus, occasional rod-like mitochondria, and numerous spheroidal bodies. The last-named were generally smallest in the centre of the *S* region and largest towards its periphery, where they lay among the lipochondria. Some of the spheroids were identified as mitochondria although the limiting membrane was not always completely double. Cristae were few and small, and the matrix was osmiophobic. The majority of the spheroids possessed only a single external 'limiting' membrane, an internal coiled membrane, and an inner substance containing various amounts of a very dense (osmiophilic) material. The appearance of the last-named inclusions strongly suggested that they represented stages in the formation of the osmiophilic lipochondria. Provisionally they will be referred to as *pro-lipochondria* (Fig. 1). The evidence both from light microscopy (*vide* results with acid fuchsin above) and electron microscopy suggested that the pro-lipochondria were of mitochondrial origin. It may be emphasized here that lying between all the spheroids (mitochondria and pro-lipochondria) were masses of Golgi vesicles. This may suggest that the Golgi apparatus plays some part in the formation of the lipochondria.

Another kind of cell inclusion, lying below the limits of resolution of light microscopy, was revealed by the electron microscope. This inclusion consisted of a small vacuole with a dense granule embedded in its periphery. Such structures were observed generally towards the periphery of the cell body, although some were seen also in the *S* region.

The cells did not contain a highly developed system of ergastoplasmic membranes[12]. Typically they bordered lamelliform or large vesicular masses of ergastoplasm. Occasionally the membranes formed conspicuous whorl-like figures similar to those described by Palay and Palade[13] in vertebrate neurones. Some cytoplasmic particles[14] were in contact with one side of the ergastoplasmic membranes except when the latter were whorl-like in form. Numerous such particles lay free in the cytoplasmic matrix.

Each neurone was bounded by a single membrane. Frequently it appeared as if two membranes were present. However, in such cases the outer membrane belonged either to an adjacent cell body or nerve fibre. Each nerve fibre contained a variable number of neurofibrils (individually below the limits of resolution of the light microscope) and small mitochondria. In Kolatchev preparations studied by electron microscopy the osmium either was deposited heavily on single neurofibrils or, more usually, between them. In either way this accounted for the appearance under the light microscope of fine fibrils in nerve fibres treated by Kolatchev's technique. In material fixed in buffered osmium tetroxide, tangled masses of neurofibrils were observed passing around vacuolated bodies and small vesicles. It is possible that the vacuolated bodies and vesicles may serve as the nidus for the formation of the neurofibrils.

Both the lipochondria and the vacuole-granule inclusions described above were observed in nerve fibres. It appears, therefore, that each is a definite secretory product of the neurones. It is of particular interest that lipochondria appear to be formed in essentially the same way as are zymogen granules in exocrine cells of the pancreas[15,16]. Thus a common method of synthesizing secretion products apparently exists in such diverse types of cells as the neurones of a gastropod and pancreas cells of mammals.

We wish to express our appreciation to Drs. A. J. Marshall and V. E. Cosslett for their interest and encouragement in this work and to Mr. G. Rogers for his help in the cutting of ultra-thin sections. One of us (R. H.) is indebted to the Agricultural Research Council for financial support.

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ROLE OF OXYGEN IN MODIFYING THE RADIOSENSITIVITY OF *E. COLI* B.

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IN the course of X-ray experiments on *E. coli* B., it was found that the radiosensitivity of the bacteria was increased by oxygen concentrations as low as 1 μmole/l. This is very small compared with the concentration required to effect a similar change in other materials used in radiobiological experiments[1,2]. Oxygen concentration is measurable only in the fluids surrounding the cells or tissues concerned, and the assumption that it is the same within the cells seems best justified for micro-organisms, singly dispersed in a medium supplied with oxygen at a rate far exceeding that required for respiration. The effect of varying the oxygen concentration on the radiosensitivity of *E. coli* B. has therefore been investigated by irradiating very dilute suspensions while the required gas mixture was passed through the suspending medium in a vigorous stream of fine bubbles.

The bacteria were in the stationary phase, harvested 16–20 hr. after inoculation, from unaerated nutrient broth which then contained about 2×10^8 organisms/ml. The suspensions for irradiation were prepared by centrifuging the cultures, washing three times and resuspending in buffered saline (sodium chloride 0·13 *M*, phosphate buffer 0·02 *M*, *p*H 7·0); aliquots were then used for making up suspensions in buffered saline at the dilutions required. Irradiations were carried out at 20° C. with 200 kV. X-rays filtered by 2 mm. aluminium, at 2,000 rads/minute. 'Survivors' in the bacterial population were defined as those bacteria which retained the ability to form macrocolonies on nutrient agar plates incubated at 37° C. Survival curves were found to be exponential in all experiments. The radiosensitivity was defined as the slope of the line relating the logarithms of survivors to the dose. The radiosensitivity was found to be independent of the concentration of bacteria between 6×10^3 and 2×10^8 organisms/ml. and also independent of the respiration-rate. It appeared to depend only on the oxygen concentration at the time of irradiation. The survival curves were identical for bacteria which were held anaerobically from the time of harvesting until irradiation commenced, and for those which, in dilute substrate-free suspension, had been exhausted by oxygen bubbling at 30° C. for 1½ hr. Moreover, radiosensitivity was the same for suspensions which were free from substrate and those which contained potassium succinate at 0·01 *M*. The effect of the succinate on respiration-rate was demonstrated by measurements on a dense washed suspension of *E. coli* B. The rate of oxygen uptake was increased by a factor of 5 when succinate was added after 40 min. of endogenous respiration (we are indebted to Dr. F. A. Holton for making this measurement).

The relationship between radiosensitivity and oxygen concentration was determined by establishing survival curves under nitrogen, oxygen and a range of nitrogen – oxygen mixtures. A typical set of survival curves is shown in Fig. 1. The variation of radiosensitivity with oxygen concentration is shown in Fig. 2. The solid line (curve A) represents the equation

$$\frac{S}{S_N} = \frac{m[O_2]+K}{[O_2]+K} \qquad (1)$$

where S_N is radiosensitivity in the absence of oxygen; $[O_2]$ is oxygen concentration in micromoles of oxygen per litre; S is radiosensitivity at an oxygen concentration $[O_2]$; m and K are constants, respectively 2·9 and 7·2 micromoles/litre for curve A.

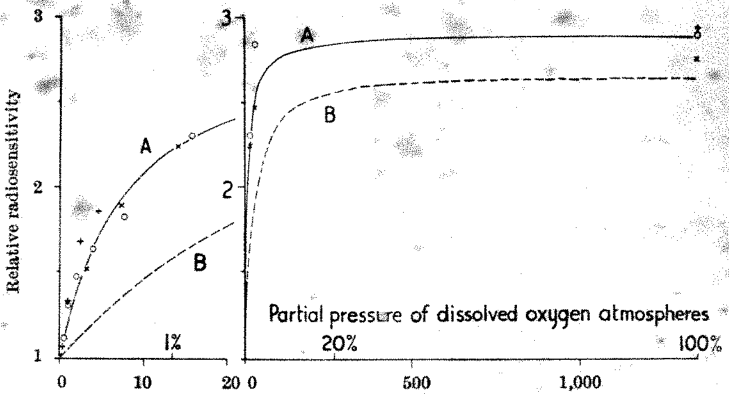

Fig. 2

The relationship between radiosensitivity and oxygen tension in other materials could also be described by an equation of the form given. In many cases the value of the constant m is close to 3 [1,2]. The value of K obtained for *E. coli* B. is, however, considerably lower than that obtained by fitting equation (1) to various sets of data in the literature: for example, Conger's data[2] on ascites tumour cells are fitted by $m = 3·6$, $K = 135$ μmoles/l. It remains to be determined whether K does in fact vary over a wide range, depending on the material and the test of damage, or whether the low value obtained in these experiments reflects the fact that oxygen pressure in the cells is more nearly the same as that measured than has been the case in the conditions of other experiments.

A relationship of the type expressed by equation (1) can be derived from various mechanisms which might be postulated to account for the oxygen effect.

HO_2 radical hypothesis. It has frequently been suggested that primary damage to biological targets may occur by a mechanism analogous with that which increases the yield of oxidation products in aqueous solutions irradiated in the presence of oxygen. This mechanism is believed to be the conversion of hydrogen to HO_2 radicals if oxygen is present. The oxidation of ferrous ions in 0·8 N sulphuric acid has been investigated by Ebert[2]. Equation (1) fits his data well with $m = 2·7$, $K = 22·4$ μmoles/l., and curve B of Fig. 2 represents the equation with these constants. In the chemical system, it can be presumed that there is far less competition for hydrogen radicals than in the living cell, where there must be a great number of competing molecules. For example, Alper (unpublished work) has found that herring sperm deoxyribonucleic acid in aqueous solution is an extremely efficient scavenger of hydrogen radicals. It is to be expected that, to bring about a given change in radiosensitivity by means of HO_2 radicals, a higher oxygen concentration is needed in the presence of a radical-acceptor. If the mechanism for the oxygen effect is the same, the constant K of equation (1) should be higher, or at least not lower, in the living cell than in solutions free from organic solutes. As the opposite was observed, it appears to us unlikely that the enhancing effect of oxygen can be accounted for by HO_2 radicals effecting primary damage.

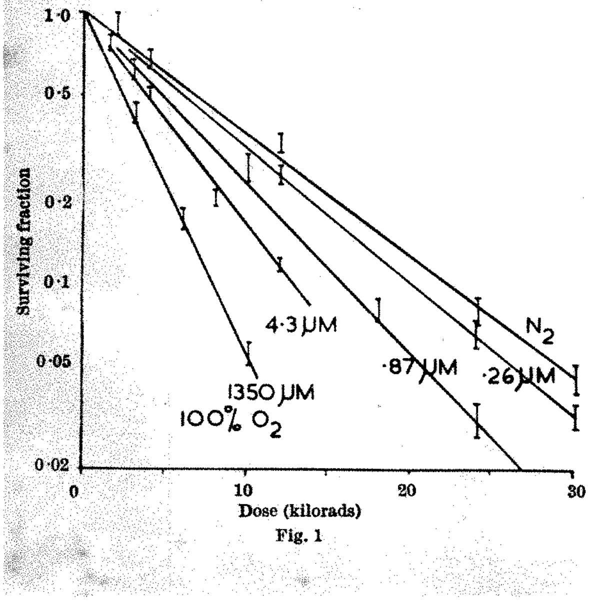

Fig. 1

Respiratory enzyme hypothesis. It is unlikely that radiosensitivity depends upon the state of the respiratory enzymes[3] as Longmuir[4] has shown that *E. coli* respire at half their full rate at an oxygen concentration of $2 \times 10^{-8} M$, whereas we found that more than 300 times as much oxygen was required to reach half the maximum radiosensitivity in *E. coli* B.

Direct effect hypothesis. In searching for an explanation of our observations on the oxygen effect on *E. coli* B., we have been led to postulate that the primary action of radiation in preventing cell multiplication is to ionize a vital target structure or molecule, which is then left in a highly reactive state, so that it will be involved in a chemical reaction within a very short time, probably less than a millisecond. The subsequent fate of the target molecule will depend on the nature of this reaction, which will affect the likelihood of its restoration to a functional state. If oxygen is present during irradiation, it will react with the ionized target and very much reduce the probability of restoration, so that a greater degree of damage will be apparent; but if it is admitted to the cell within a short time after the passage of the ionizing particle, it will be too late to take part in the reaction.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Output of Sympathin from the Spleen

Qualitative studies of the nature of 'sympathin', the vasopressor substance appearing in the venous blood after stimulating post-ganglionic adrenergic nerves, have shown that it consists of a mixture of adrenaline and noradrenaline. We have recently been investigating quantitative aspects of sympathin output from the spleen with particular attention to the effect of the frequency of stimulation.

The method used was to stimulate the splenic nerves of the chloralosed cat and to measure the sympathin, assayed as noradrenaline, appearing in the venous blood. Peart[1] and Mann and West[2] have shown that sympathin from the spleen is almost entirely noradrenaline. The spleen was isolated from the stomach, pancreas and omentum, but retained its own circulation. The venous blood from the organ could be temporarily diverted to a polythene cannula in the superior mesenteric vein by occluding the portal vein. The blood from the cannula was collected in chilled, silicone-coated centrifuge tubes containing solid heparin. These precautions prevented the formation of masking substances. The volume of the separated plasma was measured and its 'sympathin' content assayed on the pithed rat's B.P. The splenic nerves were stimulated with rectangular pulses known to be supramaximal. Since we were interested in the effect of the frequency of stimulation on the output, the total number of stimuli was kept constant at 200 stimuli irrespective of the frequency. Both adrenal glands were removed and both major splanchnic nerves cut.

The output of sympathin, expressed as output/stimulus, showed a remarkable variation with the frequency of stimulation. This is summarized in Fig. 1. At low frequencies, little sympathin appears in the venous blood; but the output rises sharply as the frequency increases, to reach a maximum at about 30 pulses per sec. In constructing this graph allowance must be made for variations in the plasma flow in the period of collection. The output of sympathin varies with flow, and if this is reduced the output falls. The figures used in this graph lie in the same range of plasma flow.

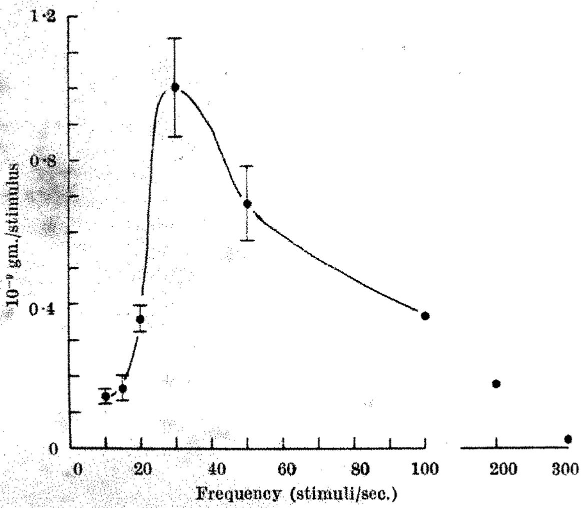

Fig. 1. Mean output/stimulus of 'sympathin' plotted against the frequency of stimulation. At all frequencies of stimulation the total number of pulses was 200. The vertical lines represent the standard errors of the means. Figures for 100, 200 and 300 pulses per sec. are single observations

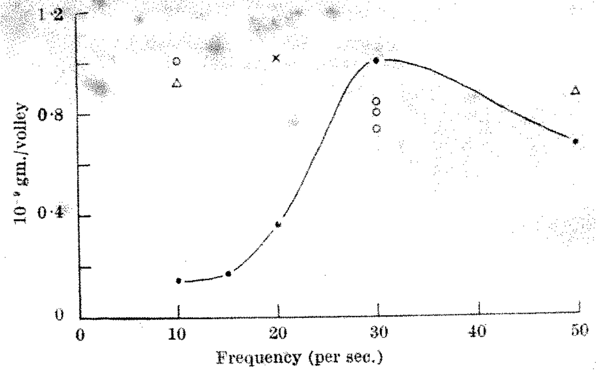

Fig. 2. First part of the graph in Fig. 1 with an extended scale for frequency. The individual results from three animals previously given 'Dibenamine' are shown. The output/stimulus at 10 pulses per sec. has increased and equals the maximum in the untreated animal. There is no obvious variation with frequency

Several explanations of this variation with frequency were possible. It might be that the more prolonged exposure to amine oxidase of the sympathin liberated at lower frequencies permitted a greater destruction of the active amine. This was tested by inhibiting the amine oxidase with isopropyl isonicotinyl hydrazine ('Marsilid'). The output before and after 'Marsilid' was the same.

Another possibility was that although the amount of sympathin released by each nerve volley was constant, the amount utilized by the tissue receptors was greater when the rate of release was slowed, that is, at low frequencies of stimulation. This was tested by blocking the tissue receptors with N.N. dibenzyl-β-chloroethylamine ('Dibenamine') and measuring the output/stimulus at varying frequencies. The results are shown in Fig. 2.

The first part of the previous graph has been drawn with an extended scale for frequency. Superimposed on it are the individual results for three experiments in which 'Dibenamine' had been given to the animal. The output at 10 pulses per sec. is increased some sevenfold and now equals the maximum output in the untreated animal. Furthermore the difference in output with frequency in this range has disappeared.

We suggest that the explanation of these observations is that the sympathin release per nerve volley is constant, and that the fraction utilized by the tissues is greater at the lower frequencies of stimulation.

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Autoradiography of End-plates with Carbon-14 – Calabash – Curarine I and Carbon-14 – Decamethonium

A HUNDRED years have passed since Claude Bernard's publication of his investigations on the action of curarine in "Leçons sur les effets des substances toxiques et médicamenteuses"[1]. He was able by indirect experiments to localize the curare-block in the end-plates of skeletal muscle. Some time ago when we investigated the metabolism of carbon-14 – curarine I in the cat[2], we tried to obtain autoradiographs of muscle, intending to show the fixation of this alkaloid directly at the neuro-muscular junctions.

For this purpose we had to synthesize carbon-14 – curarine of the highest possible radioactivity by methylation of 2·0 mgm. nor-curarine with an excess of 6·4 mgm. $^{14}CH_3I$, having the activity of 1 mc. After recrystallization we obtained 0·25 mgm. pure carbon-14 – curarine – iodide (biquaternary) with an activity of 24·2 μc./mgm. The minimal lethal dose of the water solution was injected into the veins of the tails of mice, which died of asphyxia within 40–120 sec. The diaphragms of these animals were stretched over steel rings of the same diameter (22 mm.) and dried in air. They were then brought into contact with X-ray film (Ilford X-ray PM_1) or mounted on microscope slides and covered by stripping film (Kodak). After developing the films the end-plates were stained by the Koelle method, in which acetylthiocholine is split by the cholinesterase, brown copper sulphide finally resulting[3].

After 60 days the resulting pictures on X-ray film showed a slight blackening in the region of the end-plates, which lie in a band of 260μ thickness around the centrum tendineum. In addition, there was blackening over the centrally situated vessels due to radioactivity in the blood. On microscopic examination of the stripping film a diffuse formation of silver grains over the end-plates was seen; but the crossfire over this region had been so heavy that only twice the grain density existed over each end-plate as compared to its immediate surroundings. The whole region had a 4–6 times higher density of grains compared with a corresponding region of muscle without end-plates.

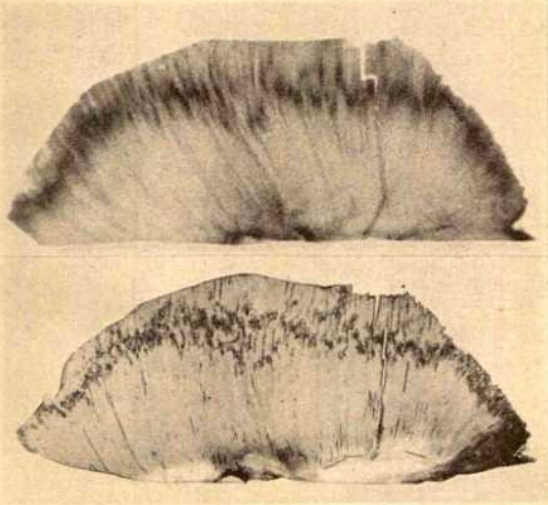

Fig. 1. Autoradiography of mouse diaphragm with carbon-14–decamethonium in comparison with staining of end-plates in the same diaphragm by the Koelle method (× c. 4)

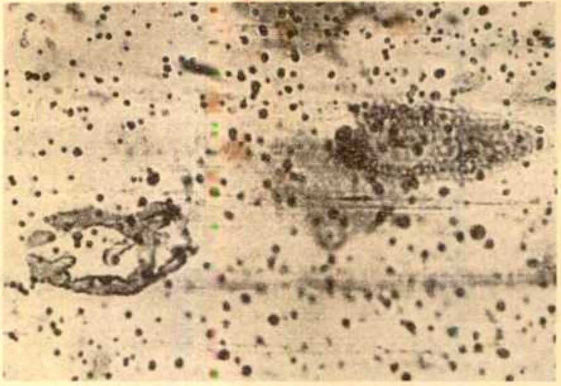

Fig. 2. Stained end-plates (Koelle method, × c. 700) and silver grains in stripping film by carbon-14–decamethonium

In order to obtain a much higher specific activity in a curarizing molecule we then methylated decamethylendiamine with $^{14}CH_3I$ and obtained 0·44 mgm. decamethonium with six carbon-14 atoms. The specific radioactivity was approximately five times larger than that of carbon-14 – curarine. After five days the resulting autoradiographs again showed clearly the localization over the end-plates, especially when compared with the stained diaphragms (Fig. 1). Over this region we counted four times more silver grains in the unit area of stripping film than in the muscle layer farther out (Fig. 2).

These pictures thus prove the fixation of 'curarizing' and 'depolarizing' drugs in the end-plate. They make possible the calculation of the number of molecules reacting with the receptor surface. We found 8 × 10^6 curarine molecules bound to one end-plate and 1·7 × 10^{12} molecules/cm.^{2} of apparent area of end-plate membrane, thus neglecting the possibility of a large increase in surface due to the palisade structure described by Couteaux[4]. The order of magnitude of apparent coverage of the end-plate surface is 5 per cent.

Details will be published in *Archives internationales de Pharmacodynamie et de Thérapie*.

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Globulins in the Chicken Egg-White

LONGSWORTH *et al.*[1] demonstrated, by electrophoresis in the Tiselius apparatus, three globulins in the white of an egg. These were labelled G_1, G_2, G_3. (G_1 was identified later with the lysozyme.)

The antigenic properties of egg-globulins were demonstrated first by Hektoen and Cole[2] and later by me[3].

In my studies on egg-white and its constituents[3-5], I have employed the methods which permit the analysis of complex mixtures, such as electrophoresis and immunochemical techniques in agar gel. Thus, for the demonstration and enumeration of egg-globulins, four methods were used: (1) zone electrophoresis on paper and in agar gel[6]; immunological techniques (in this communication we give only the qualitative ones); (2) specific precipitation by double diffusion in agar plates[3–5] and (3) immunoelectrophoresis[7]; and (4) ultracentrifugation.

In this work, I have always studied comparatively the entire egg-white and its fractions, prepared chiefly by salting out with ammonium sulphate between 25 and 50 per cent of saturation. These fractions were substantially enriched in globulins (about 75 per cent as determined by electrophoresis in the Tiselius apparatus); but they still contain variable amounts of egg albumin, conalbumin, ovomucoid and lysozyme.

In immunological experiments I employed two sorts of antisera: anti-egg-white and anti-egg-globulin preparations (fractions precipitated by ammonium sulphate at 50 per cent saturation). The latter reacts more strongly, quantitatively and qualitatively, than the former, with the globulins of egg-white[4,5].

The results obtained with different techniques are as follows:

By electrophoresis on filter-paper (barbiturate buffer μ 0·1, pH 8·2, 6 hr., 4 V./cm.) stained with bromphenol blue, the 'true' globulins are separated from the lysozyme. The latter forms an indefinite trail near the negative end of the paper strip. The egg-globulins give one intensively stained spot, situated between those of egg albumin and conalbumin. The total egg-white and the fractions poor in egg globulins give a faint spot at the same place; the analysis of the 'incomplete egg-white' (artificial preparation, deprived of globulins[3–5]) shows no colour in this position.

By electrophoresis in agar gel (barbiturate buffer, μ 0·05, pH 8·2, 5 hr., 4 V./cm.) a larger number of constituents is demonstrated, especially when stained with the 'Amidoschwartz' (black-blue naphthol B 'Geigy'). It is interesting to note that the natural egg-white does not give the same egg globulin spot as the fractionated preparations[5]. Thus, independent of the total protein concentration, the total egg-white analysis revealed only the spot which I have labelled β_2, while my globulin preparations never give this spot, but form the spots β_1 and β_3[6]. Other visible globulin spots are α_1 and α_2; the last correspond to constituents which do not migrate from the original reservoir and the 'tongue' due to lysozyme (an artefact caused by retention of lysozyme near the original reservoir by the agar[4]).

The other dyes employed react differently with the various globulins. For example, azocarmin reacts strongly with the β_1 but very weakly with the β_3. These facts suggest that the available terminal groupings of these two constituents are not the same.

Sudan black did not colour any of the globulins, indicating that they are not lipoproteins.

By specific precipitation by double diffusion in agar plates using the procedure described by me[4,5], numerous lines can be seen, which I attribute to the precipitating systems of egg globulins and their homologous antibodies. There are two kinds of lines: when the concentrations of the antibody and the antigen are near the point of equivalence or an excess of antigen, the first lines appear in 2–3 days near the serum reservoir; the second appears more slowly (6–10 days) and are always near the antigen reservoir. These two kinds of lines correspond to antigens with different diffusion constants, respectively high and low. I have observed one line of the first kind and up to five lines of the second kind. The first line is not apparent with anti-egg-white serum[5].

Table 1

Technique	No. of egg-globulins demonstrated in: Total egg-white	Preparations of egg globulin
Electrophoresis (Tiselius)	2 [1] ($G_2 + G_3$)	2
Zone electrophoresis:		
(*a*) Paper	1 [3]	1
(*b*) Agar gel	2 [5] (α_2, β_2)	4 [6] (α_1, α_2, β_1, β_3)
Specific precipitation	1 [2]	1 [2]
Specific precipitation in agar plates	4–5 [4,5]	6 [4,5]
Immunoelectrophoresis	3–4 [5]	9 [5]

N.B.—The lysozyme has not been included in this table.

By immunoelectrophoresis, the number of constituents is also dependent on the nature of the serum. Thus, with anti-egg-white serum, the line of β_3-globulin is absent, while it is the principal globulin line with anti-egg-globulin serum.

The number of globulin lines varies with the nature of the fraction studied, but the total number of different lines is at least nine.

The corresponding constituents are classified according to their mobility. I enumerated three α_2 (one of which corresponds to lysozyme), three β_1, two β_2 and one β_3. The lines of α_2 and β_1 are always formed near the antigen reservoir while that of β_3 corresponds to a protein of high diffusion constant.

Sedimentation studies have demonstrated that in my fractions there are constituents of high sedimentation constant ($S_{20} = 15$ and 18).

In conclusion, at east nine globulins have been demonstrated in the chicken egg-white by immunoelectrophoresis; but it is possible that there are more which might be demonstrated with different sera or methods.

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Coagulase Activity *in vivo*

COAGULASE production is a property of all pathogenic *Staphylococci* and is the most commonly accepted single criterion of pathogenicity. In addition it has been shown that coagulase plays a part in staphylococcal infections. Evidence for this is indirect: first, clottable plasma inhibits phagocytosis of *Staphylococci*[1]; secondly, rabbits can be protected from *Staph. aureus* infection by human coagulase-inhibiting serum[2], and, also, they receive a degree of immunity against such infection by active immunization with coagulase[3].

To our knowledge, however, there is no experimental evidence that coagulase does in fact exercise its clotting action *in vivo* except that in rabbits Tager[4] mentions the occasional fall in blood fibrinogen and death following the intravenous injection of very large doses of coagulase.

The present report presents what is considered to be evidence of *in vivo* clotting by coagulase. The preparation used was a purified coagulase supplied by Dr. E. S. Duthie; this preparation, at a dilution of 1 in 500,000, clotted an equal volume of 1 in 5 human plasma in 1 hr. and no alpha toxin was detected. Chinchilla rabbits (approximately 2 kgm.) were slowly injected intravenously (10–15 min.) with 2–10 mgm. coagulase in 6–8 ml. normal saline. The coagulase effect *in vivo* was assessed in two ways: by the estimation of fibrinogen-levels and histologically.

Fibrinogen was estimated both chemically and electrophoretically. Doses of 2–5 mgm. of coagulase produced a precipitous drop in the fibrinogen-level, the drop being roughly proportional to the amount of coagulase introduced, and the fibrinogen-level at 30 min. after injection ranged from 15 to 40 per cent of the original value. Blood shed at this stage failed to clot and puncture wounds bled freely. The fibrinogen was rapidly re-formed and by the second or third day was twice the initial value or more. Thereafter the level slowly dropped and had returned to the original level at the end of a week. A drop in all globulin fractions was observed simultaneously with the fall in fibrinogen.

Injection of large doses of coagulase (10 mgm.) led to the death of the animals in 10–20 min. Microscopic examination of the organs showed widespread intravascular deposits which gave the staining reactions of fibrin. These deposits were formed of multiple fibrin strands lying parallel to one another and to the long axis of the vessel in which they lay. The deposits were present in small or moderate numbers in the liver, kidneys and adrenals and they were exceedingly numerous in the lung, where they occluded the majority of capillaries and many of the small and large arteries. These findings and the manner in which the animals died suggested that death was due to blockage of the pulmonary vasculature.

The microscopic findings and changes in fibrinogen-level are similar to those observed after the intravenous injection in animals of thrombin or thromboplastin, and in some cases of accidental hæmorrhage in pregnancy.

In control experiments, autoclaved coagulase was used: no fall in fibrinogen-level was observed. Full details of these experiments will be published later.

It appears from these experiments that coagulase, admittedly in high doses, has a potent action *in vivo*. Since purified, but not pure, coagulase was used, it cannot be entirely ruled out that accompanying impurities may be responsible for the changes described above. However, since coagulase is a clotting agent, it seems logical to assume that the disappearance of fibrinogen from the blood and the formation of fibrin deposits in the vessels are due to the action of coagulase itself.

We wish to thank Dr. E. S. Duthie for the generous supply of purified coagulase and Dr. E. B. Hendry and his staff for fibrinogen estimations.

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Anaerobic Uptake of Glucose *in vitro* by the Isolated Rat Diaphragm

THE uptake of glucose *in vitro* by the isolated rat diaphragm has been reported to be the same under both aerobic and anaerobic conditions[1,2]. In these experiments the medium used for incubation was a balanced salt solution buffered with phosphate, and phosphate buffers are known to be inadequate for tissues exhibiting a high rate of glycolysis[3]. The uptake of glucose *in vitro* by the isolated rat diaphragm under aerobic and anaerobic conditions has therefore been re-investigated using as supporting medium a balanced salt solution buffered with bicarbonate.

The diaphragms were obtained from normal, hypophysectomized or adrenalectomized male albino Wistar rats of 100–150 gm. Normal animals were fasted for 20–24 hr. before use, and hypophysectomized or adrenalectomized animals were fasted for 6 hr. After excision the diaphragms were bisected along the central tendon and one half-diaphragm from each animal was prepared and incubated anaerobically, and the other prepared and incubated aerobically. The incubation media used were Geys' bicarbonate-buffered medium[4] and Krebs–Ringer phosphate solution (phosphate-buffered medium)[5]. (The Krebs–Ringer phosphate solution was modified by reducing the calcium content to approximately one-half. The calcium contents of the modified Krebs–Ringer phosphate and Geys' bicarbonate medium were then identical.) The bicarbonate-buffered medium was gassed either with 95 per cent nitrogen, 5 per cent carbon dioxide (anaerobic preparation and incubation) or 95 per cent oxygen, 5 per cent carbon dioxide (aerobic preparation and incubation). Phosphate-buffered medium was gassed either with nitrogen or oxygen. The glucose concentration of the medium was 2·5 mgm./ml. in all instances.

After excision the hemidiaphragms were washed for five minutes in the appropriate medium. The hemidiaphragms were then lightly blotted, transferred to small conical flasks containing 1 ml. of medium, the flasks gassed and sealed, and incubated for 1 hr. at 37° C. in a Dubnoff shaker. After incubation the hemidiaphragms were blotted and weighed and the residual glucose in the medium determined colorimetrically by Somogyi's modification of Nelson's method[6]. In some experiments the residual glucose was additionally determined manometrically using glucose oxidase, after the method of Keilin and Hartree[7]. Uptake of glucose by diaphragm was calculated as mgm. glucose disappearing

Table 1. Uptake of Glucose *in vitro* by the Isolated Rat Diaphragm under Aerobic and Anaerobic Conditions in Media buffered with Bicarbonate or Phosphate

State of rat	Incubation medium	Glucose uptake. Mean ± S.E. of mean (mgm. glucose/gm. of wet diaphragm/hr. of incubation)				
		Anaerobic	Aerobic	Difference (anaerobic–aerobic)	*t*	*P*
Intact	Bicarbonate-buffered medium	5·68 ± 0·11 (23)	3·03 ± 0·13 (23)	2·65 ± 0·17	15·6	< 0·001
Hypophysectomized		4·96 ± 0·22 (19)	3·54 ± 0·14 (19)	1·42 ± 0·25	5·61	< 0·001
Adrenalectomized		4·52 ± 0·25 (5)	3·04 ± 0·33 (5)	1·48 ± 0·41	3·70	< 0·01 > 0 001
Intact	Phosphate-buffered medium	3·23 ± 0·22 (12)	3·00 ± 0·22 (12)	0·23 ± 0·31	—	—

Figures in parentheses are number of observations from which the mean is derived.

Table 2. Comparison of Glucose Uptakes based on Glucose Values obtained by Copper Reduction (Somogyi, ref. 6) and by Glucose Oxidase (Keilin and Hartree, ref. 7)

Experiment No.	Glucose uptake (mgm. glucose/gm. of wet diaphragm/hr. of incubation)					
	Anaerobic		Aerobic		Difference (anaerobic–aerobic)	
	Copper reduction	Glucose oxidase	Copper reduction	Glucose oxidase	Copper reduction	Glucose oxidase
1	4·15	4·72	2·24	2·87	1·91	1·59
	4·85	5·53	3·26	3·80	1·85	1·53
2	4·38	5·82	1·92	3·36	2·46	2·46
	5·64	6·42	2·38	2·74	3·26	3·68

Each value represents the combined uptake of glucose by five hemidiaphragms incubated together in 3 ml. of bicarbonate-buffered medium.

from the medium/gm. of wet diaphragm/hour of incubation.

The uptake of glucose by the isolated rat diaphragm incubated in bicarbonate-buffered medium was found to be substantially greater under anaerobic conditions than under aerobic conditions (Table 1). The increase in glucose uptake under anaerobic conditions which was seen with diaphragms from normal, hypophysectomized or adrenalectomized rats was highly significant. Since this difference had not been reported by other workers who have studied the uptake of glucose by the isolated rat diaphragm under anaerobic conditions in phosphate-buffered media[1,2] the studies were repeated with a phosphate-buffered medium. In the phosphate-buffered medium the uptakes of glucose under aerobic and anaerobic conditions did not differ significantly—an observation in agreement with those of earlier studies by other workers[1,2], and in clear contrast to the results obtained in a bicarbonate-buffered medium. Measurements of *p*H before and after incubation showed that the *p*H of phosphate-buffered medium fell markedly during incubation under anaerobic conditions (*c.* 0·6 unit) whereas the *p*H of bicarbonate-buffered medium suffered little change (*c.* 0·1 unit).

Anaerobic incubation in a bicarbonate-buffered medium was associated with a significant fall in the level of glycogen in the diaphragm despite the high rate of glucose uptake, whereas aerobic incubation was associated with a significant increase in the level of glycogen. Lactic acid production was significantly increased under anaerobic conditions. Similar changes in the level of glycogen in diaphragm and of production of lactic acid by diaphragm have been noted previously, in phosphate-buffered medium, by Walaas and Walaas[1].

Chain, Catamzaro, Chain, Masi, Pocchiari and Rossi[8] have suggested that reducing substances other than glucose may be added to the medium by diaphragm during incubation and so lead to false values for uptake of glucose when glucose is estimated in the medium by methods based on reduction. In two experiments, therefore, glucose was estimated in the medium both by the copper reduction method of Somogyi[6] and by means of the specific glucose oxidase[7]. The uptakes of glucose, based on glucose values obtained with glucose oxidase, were higher than those obtained by the Somogyi method of glucose estimation. This observation would be in keeping with the suggestion of Chain *et al.* The increase in glucose uptake under anaerobic conditions in the bicarbonate-buffered medium was, however, still evident when glucose uptakes were calculated from glucose values obtained by the glucose oxidase method (Table 2).

These studies indicate that the uptake of glucose by the isolated rat diaphragm is increased under anaerobic conditions in a medium buffered with bicarbonate. The significance of these results in relation to the mode of uptake of glucose by the isolated rat diaphragm will not be discussed here. In a phosphate-buffered medium, anaerobic incubation does not lead to any alteration in the uptake of glucose by the isolated rat diaphragm. Media buffered with phosphate would appear to be unsuitable for *in vitro* studies with the isolated rat diaphragm, because of their poor buffering power. Estimations of glucose by both copper reduction (Somogyi) and by glucose oxidase have supported the suggestion of Chain *et al.*[8] that reducing substances other than glucose are added to the medium during incubation of the isolated rat diaphragm and that these are estimated together with glucose when copper reduction methods are used.

I wish to thank Prof. F. G. Young for helpful advice and criticism; Miss N. Savage for the gift of a preparation of glucose oxidase; and Mrs. J. C. D. Coe for technical assistance. The cost of this work was largely defrayed by a grant from the Medical Research Council.

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Heat Changes during the Clotting of Fibrinogen

In order to get a better insight into the energetics of the clotting of fibrinogen, we conducted heat measurements using the Benzinger[1,2] microcalorimeter.

The heat change during clotting of fibrinogen comes essentially from three sources: (1) the splitting of peptide bonds by thrombin, (2) the neutralization by the buffer system of the charged groups created, and (3) polymerization of the fibrin molecules to a network.

The polymerization involves the formation of 19 hydrogen bonds[3] where the histidine groups appear to be the acceptors[4,5]. In order that the histidines may serve as acceptors at pH 6, protons have to be removed. According to Mihalyi[4], at pH 6 three protons are removed from histidine residues.

In these experiments bovine fibrinogen, purified according to the method of Laki[6], and Parke–Davis thrombin were used. Usually, the thrombin solution and the fibrinogen solution were dialysed against the same buffer salt solution. About 5 mgm. fibrinogen per ml. was suitable for the measurements. Thrombin was added in an amount sufficient to make the clotting complete in 20–25 min. The experiments were performed in phosphate, tris (hydroxymethyl) amino methane (*tris*) and borate buffers. The results of the experiments are summarized in Fig. 1.

It is seen that in phosphate and borate buffers the heat evolved amounts to about 44 kcal. in a fairly wide pH range. In *tris* buffer the heat evolved is higher.

The 44 kcal. of heat evolution found in phosphate buffer at pH 7 is practically the same as found by Sturtevant *et al.*[3] for the heat of the polymerization reaction only. From this it follows that the heat of the splitting which is included in our experiments is very small and thus negligible.

At lower pH's Mihalyi finds that, as a result of the polymerizations, protons appear to originate from the histidine residues. This process absorbs about 6–7 kcal. of heat per proton. At pH 6, where three protons (per mole of fibrinogen, mol.wt. = 330,000) appear, this heat absorption is about 20 kcal. This means that at this pH instead of 44 kcal. we would measure 20 kcal. less in the polymerization reaction.

In the total reaction this heat absorption will be compensated by the neutralization heat of the amino-groups generated by the removal of the peptides. In phosphate buffer, therefore, we obtain a line which runs from pH 8·5 to 6 at a level of approximately 44 kcal. (Fig. 1).

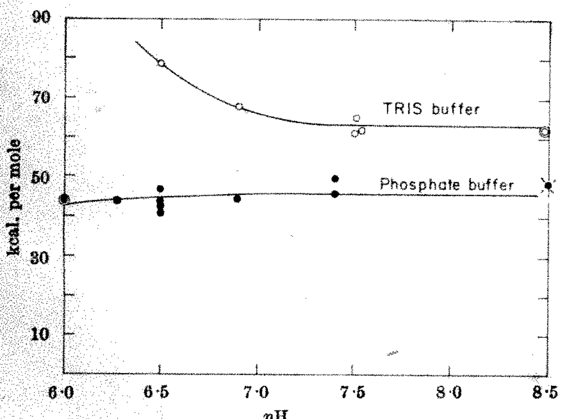

Fig. 1. The heat (in kcal.) liberated during clotting the fibrinogen plotted against pH of various buffers at which the clotting was performed. ●, Phosphate buffer; ○, *tris* buffer; ×, borate buffer

In *tris* buffer the situation is different so far as the neutralization of the liberated charged groups is concerned. From pH 8 down to pH 6 we find that the heat of neutralization of the two carboxyl groups is uniformly about 20 kcal., since *tris* involves about 11 kcal.[2,7] for the neutralization of a proton. The polymerization heat again can be expected to be 44 kcal.; but now as we approach pH 6, the three protons removed from the histidine residues are neutralized by the buffer, which involves considerable heat (in contrast to phosphate buffer[2,7]), thus overcompensating the heat consumption needed to remove these protons. We expect the curve, therefore, to bend upward, but to run about 20 kcal. higher (between pH 7–8·5) than the results obtained in phosphate buffer. The 20 kcal. difference is the result of the neutralization of the two protons of the carboxyl groups which are liberated during the enzymatic phase.

These experiments definitely indicate, then, that two (but not more) peptide groups are split during the clotting of fibrinogen. It is expected, therefore, that the peptides split from fibrinogen should contain C-terminal groups. This is in agreement with recent experiments of Gladner and Laki (unpublished work) showing that carboxypeptidase brings about a considerable degradation of both of these peptides. A detailed account of the work will be submitted for publication elsewhere.

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Cell Membranes and Morphogenesis

Cell membranes can be readily visualized in the electron microscope; but a rather special cell system is needed if one wishes to study their supposed role[1,2] in morphogenesis. In the hair follicle we have been able to examine at high resolution a system which fulfils most of the electron microscopist's demands. It is small enough not to make the task of surveying it at high magnification too formidable and, in a geometrical sense, simple, in that the differentiating cells move away from the papilla in almost linear streams, preserving the order of their formation.

In normal growth a steady stream of cells, maintained by division in the neighbourhood of the papilla at the base of the follicle, passes up the tube formed by the outer root sheath and differentiates to form as many as six concentric cylinders; the three outer cylinders constitute the inner root sheath and the three central, the hair proper. The cells of these layers are differentiated in their shape and in the different intracellular materials which they make.

In the mid bulb immediately above the zone of cell division the plasma membrane, seen in material fixed in osmium tetroxide solution and embedded by standard electron microscopical procedures, consists of a single thin (<50 A.) dense line bounding the cytoplasm. The cell surfaces are extremely convoluted and long finger-like pseudopods may penetrate far into neighbouring cells. These fixed appearances probably record momentary aspects of the restless membrane activity often noted in films of cultured cells. One gains the impression that adhesion between cells is slight. The intercellular space often dilates into wide empty openings (up to 2–3μ wide); where the membranes are closer it is evident (Fig. 1) that the gap is actually filled by a material of lower electron absorption than that of the membranes. Over certain small areas the separation is more constant (125–150 A.), and these seem to correspond to areas of true adhesion with the intercellular material acting as a cement. Such localized contacts also characterize the epidermis[3,4] and outer root sheath.

The first signs of differentiation appear in the presumptive cuticle cells and are shown by a spread of the 'adhesive contacts' leading to a closing of the gaps, a smoothing out of the cell surfaces and the progressive assumption of a columnar habit by the cells. This development also occurs later and to a lesser degree in the sheath cells. In the cortex, however, contact areas remain small and local, membrane activity persists and the intercellular gaps afford pathways for melanocyte processes bearing pigment. The fully established contacts between the cuticle cells seem, however, to bar further peripheral penetration by the pigmented processes, and the cuticle and sheaths thus remain unpigmented.

At about the level of the tip of the papilla all the cells (except those of the cuticle) have begun the synthesis of their characteristic products: fibrils of keratin in the cortex and droplets of amorphous trichohyaline in the inner root sheath. Trichohyaline synthesis commences first and proceeds farthest in the Henle cells nearest the outer root sheath; it is delayed and less marked in the two inner layers of the sheath. In each of these three cell layers, and with a time-lag between each, the amorphous trichohyaline droplets suddenly transform into a birefringent fibrous modification, a change well shown electron microscopically, and at the same time the cell membranes separate to about 250–300 A. with the deposition between them of a dense central layer. This type of membrane modification occurs also in the cuticle cells and leads to the deposition of a most elaborate succession of coats between the cells (Fig. 2). Proceeding from one cell to the other (and counting the 'white' lines which represent material of low electron density) we have here certainly seven layers and perhaps even nine.

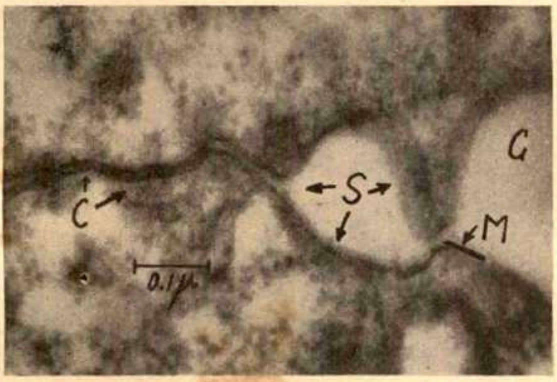

Fig. 1. Portions of two cells in the mid bulb of the hair follicle showing the nature of the areas of contact *C*. *G*, an intercellular gap; *S*, intercellular cement; *M*, the plasma membrane. (× 116,000)

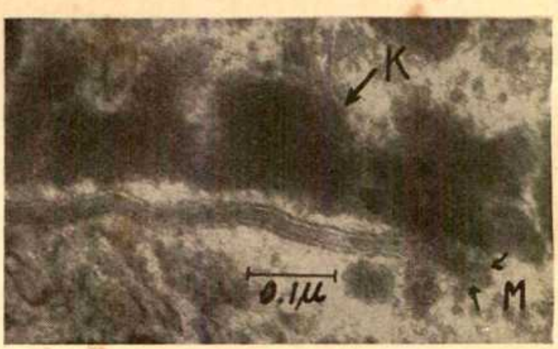

Fig. 2. Membrane complex developed between two cuticle cells at the level of keratin formation. *K*, keratin droplets; *M*, plasma membranes. (× 120,000)

In the central fibrous cortex of the hair the membranes, which have persisted in their surface activity longer than elsewhere, finally dilate and become cemented together as the cells fill with fibrous keratin, but do not develop a complex layered structure.

Surveying the whole process, it is seen that everywhere changes in cell contacts accompany differentiation. In the bulb localized adhesion, spread of contacts and suppression of membrane activity (contact inhibition[5]) seem early formative events in the causal chain; the later more elaborate development of the membranes seems part of the process of consolidating the tissue.

This investigation has been supported by grants to the Chester Beatty Research Institute (Institute of Cancer Research: Royal Cancer Hospital) from the British Empire Cancer Campaign, Jane Coffin Childs Memorial Fund for Medical Research, the Anna Fuller Fund and the National Cancer Institute of the National Institutes of Health, U.S. Public Health Service.

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A New Method for the Identification of Biochemical Mutants of Micro-organisms

A RAPID method for the identification of biochemical mutants of *Ustilago maydis* has been devised. The method is suitable for sporing or non-mycelial micro-organisms which form discrete colonies on agar.

Thirty-six possible requirements for single growth-factors are tested. Twelve plates of minimal medium are each supplemented with different combinations of six growth-factors with the arrangement shown in Table 1. A mutant strain with a single biochemical requirement when inoculated on all twelve plates will grow on two of them, one of plates 1–6 and one of plates 7–12. Thirty-six combinations are possible ; each combination indicates a different requirement. The number of requirements tested can be varied by altering the number of plates and the arrangement of growth-factors among them.

Table 1

	Plates 1	2	3	4	5	6
Plates 7	adenine	biotin	phenylalanine	alanine	arginine	leucine
8	hypoxanthine	folic acid	serine	cysteine	ornithine	glycine
9	cytosine	pantothenic acid	tryptophan	threonine	aspartic acid	*iso*leucine
10	guanine	pyridoxin	tyrosine	thiosulphate	proline	histidine
11	thymine	thiamin	*p*-amino benzoic acid	methionine	glutamic acid	lysine
12	uracil	riboflavin	nicotinic acid	choline	inositol	valine

An inoculating instrument with twenty-five points is used for transferring cells from each of twenty-five different mutant colonies growing on complete agar medium to each of the twelve plates. The multiple inoculator consists of twenty-five bolts (½ in., 10 *BA*) fitted to double-thickness zinc gauze. A short handle allows the instrument to be sterilized by dipping in methylated spirit and flaming. In preparing the master plate of complete medium the mutants are inoculated in positions corresponding to the points of the inoculating instrument and then incubated until a suitable growth has occurred. The Lederbergs' technique of replicating colonies with velvet or damp filter paper would be an equally suitable method for carrying out the inoculations[1].

So far as possible the arrangement of growth-factors allows for the detection of likely double or alternative requirements. Mutants requiring, for example, both *iso*leucine and valine for growth will only grow on plate 6, and the precise requirement must be tested with different combinations of the six growth-factors in that plate. Mutants with alternative requirements will grow on more than two plates. For example, those using methionine or cysteine will grow on plates 4, 8 and 11, and their requirements can be detected at once.

When large numbers of mutants are to be identified, this technique is more efficient than previous methods in which the field of search is progressively reduced[2,3]. With one or a few mutants auxanographic techniques are preferable[4,5].

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The Snail's Foot as a Langmuir Trough

THE importance of the surface film of protein on stationary or slowly moving bodies of water as a food for small aquatic animals had apparently not been realized until the recent work of Goldacre[1], who made film-pressure measurements on ponds, lakes and rivers and found on all of them unimolecular layers of protein in higher or lower states of compression. A concomitant study of the behaviour of small aquatic animals led him to the conclusion that they ate this protein in large amounts. Observations of the movements of dust particles in a film during its ingurgitation by a tadpole indicated that this animal might well eat its own dry weight of protein, spread as a monolayer at the air–water interface, in one day.

I have recently acquired, through the courtesy of Mr. G. Ashby of the Zoological Society of London, some water snails of the South American species *Pomacea canaliculata* Studies of the behaviour of these animals, of which my largest specimen weighs 52 gm., have shown that they not only eat surface films of protein, but also have the technique of compressing them to fibrous masses which are then eaten without a disproportionately high intake of water.

The phenomenon is manifested in the following manner. A snail in the usual resting position, adhering to the wall of the tank or to a floating plant just below the water surface, detaches the anterior portion of its foot and extends and curves it in such a manner as to form, either alone or with the tank wall, a funnel with its rim in the surface. Rapid undulatory movements are then seen to pass posteriorly from the periphery of the foot, while from the motion of particles in the adjacent water surface it is clear that the material constituting the surface film is being drawn towards the mouth of the funnel. Within a few seconds the presence of a collapsed protein film is evident at the water surface within the funnel. As the protein accumulates, the water-level is forced down and after, say 10 sec., the funnel is almost empty, with denatured protein tightly packed in the narrow end. After a short period of further accumulation, the animal brings its mouth forward and downward and eats the protein.

The funnel is not refilled from above during compression of the film since the foot is rendered hydrophobic by the protein and the contact angle between foot and water is hence increased. The protein is probably anchored to the mucin layer of the foot by its polar side-chains, the hydrophobic, non-polar groups being directed predominantly towards the air. The strongly anionic character of the mucin is shown by the avidity with which, *in situ*, it takes up basic dyes such as methylene blue.

This behaviour is very much more frequent in young snails than in adults. With the latter, film compression sometimes occurs, as it were, absent-mindedly, while the animal is engaged in a clearly more rewarding pursuit such as the consumption of a lettuce leaf. In such an event the protein mass is abandoned.

It may be pointed out that proteins are the only quantitatively important biological materials that yield surface films capable of pedipulation in the fashion here manifested.

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Influence of Freezing-rate on the Denaturation of Cold-stored Fish

It is commonly held that the major factor governing the changes which gradually take place in frozen muscle is the temperature of storage, and that the speed at which the tissue was originally frozen is of relatively small importance. Though storage temperature is undoubtedly the biggest single factor, it now appears that freezing-rate is more important than was formerly supposed.

Examination of published work relating to the effect of freezing-rate on fish after cold storage shows that in most cases this rate is very arbitrarily defined. At the worst, the only information given is the temperature of the medium in which material to be frozen is placed. A better concept is the 'freezing-time' defined as the time taken for a certain part of the muscle to pass through two fixed temperatures as measured by thermocouples. However, the tendency is still to relate observations to a simple numerical value, without intimate knowledge of corresponding disposition of the ice crystals or any cell damage for which they may be responsible.

It was the aim of the present work to investigate denaturation in relation to the disposition of the ice in fillets of North Sea cod (*Gadus callarias*). The type of ice distribution was indicated indirectly by a recent technique, which utilizes the amount of deoxyribose nucleic acid in the intercellular fluid as a measure of the amount of cell damage[1,2]. Denaturation was assessed from the percentage of muscle proteins that would dissolve in neutral 5 per cent sodium chloride. The reproducibility and accuracy of this method was much enhanced by taking account of most of the biological variation which normally destroys much of its usefulness. The technique by which this was done has recently been described[3]. Fillets were frozen at different speeds by stacking them in vertical piles on an aluminium plate maintained at —78° C. by solid carbon dioxide. It had previously been found[4] that such an arrangement yielded fillets frozen over a suitable range of conditions, those in contact with the plate freezing most quickly, and those at the top of the stack most slowly. Observations at the time of writing have been limited to fillets afterwards stored at —14° C. for 86, 108, 148 and 162 days, and at —30° C. for 328 and 390 days.

While the overall extent of denaturation depended on the length of storage, the results showed clearly that large differences in denaturation existed between fish frozen at different rates. Denaturation was relatively low where high-speed freezing produced small intracellular ice columns. It increased steadily with slower freezing to a maximum value at the point where the largest possible intracellular ice columns were produced, the proteins being then compressed into narrow strips along the margins of the cells (*see* Love[1], picture *E*). As freezing became slower still, cells were burst open, denaturation decreased, and decreased still more when the ice commenced to form in the intercellular spaces, until at freezing-times of 200–250 min. (time to cool from 0° to —5° C.), where all ice was intercellular and fibres no longer ruptured, denaturation was at a minimum. There was a gradual increase in denaturation after very slow freezing (500 min. and upwards), probably the result of dehydration, the ice front moving so slowly that osmosis was occurring from the cells outwards. An important factor affecting denaturation seems, therefore, to be the mode of ice formation and distribution and the resulting concentration patterns of tissue salts, rather than actual mechanical damage to the cell walls.

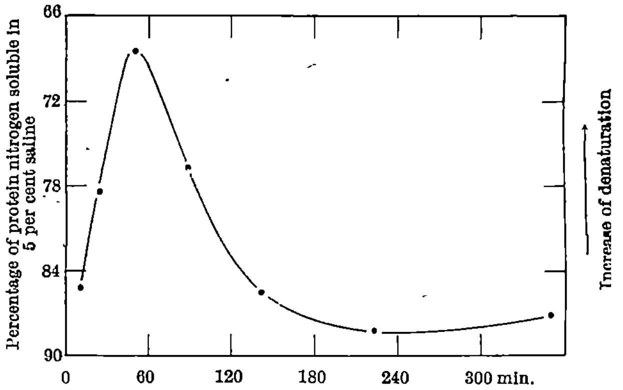

Fig. 1. Percentage of cod muscle proteins which can be dissolved in 5 per cent sodium chloride after freezing fillets at different rates and storing them at —30° C. for 390 days

The results from storage at —30° C. for 390 days are shown in Fig. 1, which illustrates the considerable difference in denaturation between fish frozen in 70 and 220 minutes. By deoxyribonucleic acid measurements the change-over from intra- to intercellular freezing was shown to have commenced in fillets with a freezing time of 60 min. and to have been complete in those of 130 min. freezing time in this experiment. The smoothness of the curve underlines the accuracy of the denaturation measurements. This pattern was not shown by fillets that had been stored at —14° C. for 162 days, since denaturation was almost complete at all rates of freezing. It is significant that the quantity of expressible fluid obtained under standard conditions from these fillets was almost the same at each rate of freezing, suggesting that the usefulness of such determinations is limited.

An indication of relative toughness can be obtained from a taste panel, and preliminary data obtained in this way suggest that the relation between toughness and denaturation is not a simple one, at any rate at low storage temperatures. For example, in Fig. 1, at a freezing-time of 220 min., 88·2 per cent of the proteins are soluble—a value but little below that of fresh fish (95–96 per cent)—but the muscle is undoubtedly tough to eat. This finding is in accord with the work of van Mameren[5], who detected no reduction in protein solubility at this temperature, in spite of increased toughness. Toughness and solubility appear to be more closely related at about —10° C.[5,6].

It would appear that these phenomena have previously been overlooked on account of the relatively narrow range of conditions under which they occur.

A full account of the completed work will be published elsewhere.

Protein solubilities were determined by Mr. J. I. M. Ironside and Mr. I. Robertson. Nucleic acids were determined by Miss Eleanor Brown. The work described in this communication is part of the programme of the Food Investigation Organization of the Department of Scientific and Industrial Research.

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Protective Action of Vitamin B_{12} in Experimental Liver Injury

THERE are several reports concerning the biochemical changes accompanying experimental liver damage by administration of carbon tetrachloride and other steatogenic poisons. However, the fundamental metabolic deviation causing fatty degeneration has not been well understood. Patwardhan *et al.*[1] have demonstrated that marked changes in the distribution and quantity of several constituents of the liver cells occur before structural damage to the organ. In the present communication, it is shown that a rapid rate of depletion of soluble sulphydryl compounds is among the major derangements in liver injury by carbon tetrachloride. The possibility has been indicated that the protection afforded by prior administration of vitamin B_{12} may be due to its known influence on sulphydryl metabolism[2].

Adult male rats (Wistar strain), 100–150 gm. in weight, reared on the laboratory stock diet, were given, intraperitoneally, vitamin B_{12} (10 μgm./animal) 3 hr. prior to carbon tetrachloride administration (2 c.c. per kgm. body-weight). It was ascertained from preliminary experiments that protection by the vitamin was best under these conditions and that animals not receiving the vitamin showed maximum liver fat accumulation at the end of about 48 hr., after which there was regeneration. Animals were killed at intervals after carbon tetrachloride injection and the livers quickly excised, chilled and homogenized in cold isotonic sucrose to a 20 per cent suspension. Determinations were made on aliquots of the whole liver and on centrifugally separated fractions. The values reported (Table 1) are averages for four animals from each group and are for the whole liver only, sampled at the end of 6 and 48 hr. after carbon tetrachloride poisoning and employing the analytical procedures cited.

It is seen that liver fat accumulation proceeds even after restoration of glutathione to normal levels and that vitamin B_{12} protects against rapid depletion of glutathione. A study of the distribution of glutathione in cell fractions has shown that while the mitochondrial fraction is completely devoid of it, nearly 80 per cent is present in the supernatant, the remainder being accounted for in the nuclei. Nuclear bound glutathione does not become depleted as a result of carbon tetrachloride injury. Mitochondrial damage in carbon tetrachloride injury can be inferred from alterations in pyridino-protein nucleotides[8] and lability of other acid-soluble nucleotides[9].

The protective action of vitamin B_{12} is more marked with respect to changes in ribonucleic acid and in phospholipids than in neutral lipids. It has apparently no effect on glycogen losses in the prenecrotic and necrotic stages. Deoxyribonucleic acid and methionine values remain unchanged throughout.

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Table 1. CHANGES IN LIVER CONSTITUENTS IN INJURY BY CARBON TETRACHLORIDE

	Untreated control	Hours after administration of carbon tetrachloride			
		6		48	
		Without vitamin B_{12}	Vitamin B_{12}-protected	Without vitamin B_{12}	Vitamin B_{12}-protected
		(mgm./gm. fresh weight)			
Total lipids (ref. 3)	23·6 ± 1·5	29 1 ± 1 2	28 2 ± 1·1	48·8 ± 2·5	34·9 ± 1·5
Phospholipids (ref. 3)	15·1 ± 0·2	15 1 ± 0·3	15·5 ± 0·2	10 6 ± 0 2	14·6 ± 0·2
Ribonucleic acid (ref. 4)	10·6 ± 0·6	8·8 ± 0 6	9·4 ± 0·6	6·9 ± 0·9	10·3 ± 0·3
Deoxyribonucleic acid (ref. 4)	3 8 ± 0·3	3·6 ± 0·3	3·7 ± 0·3	3·6 ± 0·3	3·6 ± 0·3
Glutathione (ref. 5)	1 4 ± 0·2	0·4 ± 0·2	1 3 ± 0·2	1·2 ± 0·1	1 7 ± 0·1
Glycogen (ref. 6)	3·3 ± 0 5	1·0 ± 0·2	1·5 ± 0·3	0 7 ± 0·2	0·6 ± 0·4
Methionine (ref. 7)	5·0 ± 0·5	4·9 ± 0·5	5·0 ± 0·3	4·9 ± 0·3	5·0 ± 1·0

Lability of Intramitochondrial Components in Experimental Liver Injury

THE mitochondrial membrane has a limited ability to retain nucleotides and other co-factors like Mg^{++} which are essential for maintaining normal respiration and efficient coupled phosphorylation[1]. Exposure to hypotonic conditions, ageing, other environmental alterations and physiological states cause swelling of the mitochondria accompanied by biochemical modi-

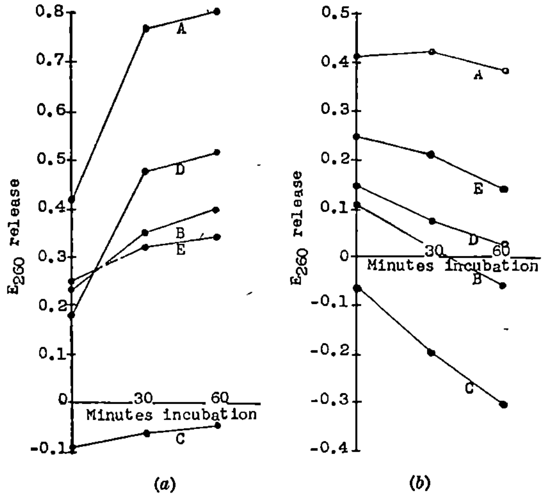

Fig. 1. (*a*) Release of acid-soluble nucleotides from mitochondria incubated in phosphate buffer; (*b*) effect of oxidative phosphorylation on E_{260} release.
A, Normal mitochondria; *B*, mitochondria from livers 6 hr. after injury by carbon tetrachloride; *C*, mitochondria from livers 48 hr. after injury by carbon tetrachloride; *D*, as in *B*, vitamin B_{12}-protected; *E*, as in *C*, vitamin B_{12}-protected

fications, such as loss of Mg^{++} and of acid-soluble nucleotides with absorption maximum at 260 mμ, increase in adenosine triphosphatase activity and dissociation of phosphorylation from oxidation[1-3]. Conditions favourable to oxidative phosphorylation or the presence of adenosine monophosphate apparently protect the mitochondria against this damage[1,4].

Uncoupling of oxidative phosphorylation has been reported in thyrotoxicosis[5], dietary necrotic liver degeneration[6] and experimental liver injury[2]. Mitochondrial preparations from such liver tissues show lowered oxygen consumption and decreased levels of pyridine nucleotides[2,5]. It was of interest to study their behaviour with respect to release of nucleotides and to ascertain the influence of prior administration of vitamin B_{12}, which protects against thyrotoxicosis[7] and injury by carbon tetrachloride[8]. This report relates to observations with the steatotic poison.

Well-fed adult rats (Wistar strain), 150–200 gm. in weight, were used for the different groups (Figs. 1*a* and *b*). Carbon tetrachloride was administered intraperitoneally at 2 ml. per kgm. body-weight, and control animals were similarly given corresponding amounts of distilled water. Vitamin B_{12} was also given intraperitoneally at 10 μgm. per animal, 3 hr. before carbon tetrachloride injection. The animals were killed by decapitation, 6 and 48 hr. after injury by carbon tetrachloride[8]. Mitochondria from the livers were prepared by the procedure of Schneider and Hogeboom[9]. The mitochondrial pellet was taken up in cold isotonic sucrose and aliquots equivalent to 500 mgm. wet weight of liver were incubated in the presence of 0·01 *M* phosphate buffer, *p*H 7·2, either alone or, to maintain conditions for oxidative phosphorylation[1], with additions of 3 μmol. each of magnesium chloride and adenosine monophosphate and 30 μmol. of glutamate in a final volume of 4·0 ml.; powdered sucrose was added to give isotonic conditions. At commencement, as well as at the end of 30- and 60-min. intervals, the suspensions were spun at 7,500 × *g*. The supernatant was deproteinized with 2 ml. of 1·5 *N* perchloric acid and the optical density at 260 mμ of the resulting solution was read in a Beckman *DU* spectrophotometer (Figs. 1*a* and *b*). Results are averages of at least quadruplicate determinations in each group.

As may be expected, incubation of mitochondria from normal livers in phosphate buffer results in a loss of intramitochondrial nucleotides which is checked in the presence of the oxidizable substrate. In mitochondria from steatotic livers the initial release of E_{260} material is very low and points to damage to mitochondrial morphology *in vivo*. There is a non-specific interference from absorption due to Mg^{++} and PO_4''', the influence of which are apparently more pronounced with mitochondrial preparations from livers 48 hr. after administration of carbon tetrachloride.

The uptake of adenosine monophosphate from the medium in presence of glutamate could be due to the action of surface-adenylate kinase and is consistent with the suggestion[2] that steatotic poisons interfere with the mechanism whereby inorganic phosphate is transferred to adenosine diphosphate to form adenosine triphosphate coincident with oxidation rather than with adenylate kinase action.

The protective action of vitamin B_{12} against poisoning by carbon tetrachloride[8] is reflected in the initially higher release of E_{260} material of mitochondrial preparations, as well as in its more normal increased release with time to the surrounding medium. This protection may not be specific and could arise from the general lipotropic action of the vitamin and from its known influence on sulphydryl conservation and nucleotide metabolism.

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Diphenylhydantoin and Brain-Levels of 5-Hydroxytryptamine

It has been demonstrated that the anti-epileptic drug, diphenylhydantoin ('Phenytoin'), in rats is capable of inhibiting the pituitary–adrenal system, preventing the usual depletion of adrenal ascorbic acid by such stresses as unilateral adrenalectomy, intravenous vasopressin and subcutaneous epinephrine[1].

There is evidence to suggest that 5-hydroxytryptamine might be an important neuroregulatory amine, perhaps playing a part in the transmission of impulses in the brain. It has been established that 5-hydroxytryptamine is present in certain areas of the brain[2,3], and that many of these regions are capable of synthesizing 5-hydroxytryptamine[4]. The hypothalamus, an area of extreme importance in autonomic and possibly hormonal homeostasis in the organism, is one region with high levels of 5-hydroxytryptamine and the enzyme responsible for its formation.

It seemed of some interest to determine the effect of diphenylhydantoin upon brain-levels of 5-hydroxytryptamine, since to date the only substances reported to alter brain-levels of 5-hydroxytryptamine have been, on one hand, the monoamine oxidase inhibitor, iproniazid[5], and the immediate precursor of 5-hydroxytryptamine, 5-hydroxytryptophan[6], which lead to an increase, and, on the other hand, reserpine, rescinnamine and 11-demethoxyreserpine, which lead to a decrease, in brain 5-hydroxytryptamine[7,8].

In preliminary experiments it was found that rats treated with diphenylhydantoin (100 mgm./kgm. B.I.D., intraperitoneally for two days) had twice the normal brain-level of 5-hydroxytryptamine (see Table 1). A further increase in the elevation occurred after the administration of 5-hydroxytryptophan (100 mgm./kgm. intraperitoneally given to diphenylhydantoin-treated rats). These animals were killed 1 hr. after receiving 5-hydroxytryptophan, and the adrenal ascorbic acid level was found to be lowered (no such result was obtained in control animals treated with the slightly alkaline medium in which 5-hydroxytryptophan was dissolved).

Table 1

Primary* treatment	Secondary treatment	Adrenal ascorbic acid† (μgm./100 mgm. adrenal)	5-Hydroxytryptamine† in brain, (mμgm./gm.)
None	None	460 (25)‡	330 (25)
Diphenylhydantoin	None	426 (12)	682 (6)
Diphenylhydantoin	One adrenal removed, and 1 hr. later the second taken for analysis	426 (10)	—
None	5-HTP 100 mgm./kgm. i.p. 1 hr. previously	—	879 (5)
Diphenylhydantoin	5-HTP 100 mgm./kgm. i.p 1 hr. previously	374 (9)	1,290 (6)
None	Reserpine 2·5 mgm./kgm s.c. 6 hr. previously	364 (5)	100 (3)
Diphenylhydantoin	Reserpine 2·5 mgm./kgm. s.c. 6 hr. previously	413 (2)	245 (2)

* In these experiments, male rats 150–225 gm. were used. The diphenylhydantoin was administered intraperitoneally 100 mgm./kgm. twice daily for four doses.

† Bioassay of 5-hydroxytryptamine was on hearts of *Venus mercenaria*: acetone extracts of whole brain (excluding cerebellum) made by procedure of Amin, Crawford and Gaddum (ref. 2). Ascorbic acid was determined by method of Roe and Kuether (ref. 9).

‡ Figures in parentheses indicate the number of rats.

Reserpine (2·5 mgm./kgm. subcutaneously) caused the same degree of depletion of brain 5-hydroxytryptamine in diphenylhydantoin-treated rats as in untreated animals when examined at 6 hr. after administering reserpine. However, there was no apparent depletion of adrenal ascorbic acid in the diphenylhydantoin-treated animals, in contrast to the regularly observed decrease seen in normal control animals. In control animals reserpine caused a more marked depletion of adrenal ascorbic acid at 2 and 4 hr., whereas in a small group of diphenylhydantoin-treated animals no significant changes were determined at these times.

Further examination of these interesting relationships are being undertaken; but it is clear that in the rat diphenylhydantoin causes an increase in the level of 5-hydroxytryptamine in the brain.

This investigation was supported, in part, by a grant from the Fluid Research Fund, Yale University, and a grant from the National Institutes of Health, Public Health Service.

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Shikimic Acid in Apple Fruits

FOLLOWING the discovery of quinic acid in apple fruits[1] it has been found in other fruits[2,3] and in grass[4]. It was originally suggested that quinic acid might provide a link between aliphatic and aromatic metabolism in plants and that shikimic acid might be the first stage from quinic acid in the 'disaturation' of the six-membered carbon ring[1]. However, shikimic acid could not at that time be found in apples. It was, however, isolated later from grass[5] and has recently been detected in small amounts in the juice of cider apples by Phillips, Pollard and Whiting[6], who used paper chromatography and a specific colour reaction. The development of the technique of gradient elution of organic acids from anion exchange resins[7,8] has greatly facilitated the separation and isolation in the pure state of organic acids present in very small amount from solutions which also contain other acids in much larger quantity; by using this technique, an acid has now been found in very small amount on paper chromatograms prepared from extracts of the peel of Bramley's Seedling apples which gave a yellow to orange colour with Cartwright and Roberts reagent[9] (specific for quinic, shikimic and dihydroshikimic acids[6]) and corresponded in R_{Malic} values with shikimic acid. About 20 mgm. of this acid was obtained in the pure form from an extract of 300 gm. of the peel of the same apples using gradient elution (acetic acid) from 'Dowex 1' columns in the acetate form. The acid had a specific rotation of $[\alpha]_D^{20} = -177\cdot5^\circ$ (an authentic sample, measured at the same concentration, of shikimic acid kindly supplied by Dr. Wayne Umbreit of the Merck Institute, gave $[\alpha]_D^{20} = -177\cdot1^\circ$). The elementary analysis gave, C, 46·9; H, 5·8 per cent; calculated for shikimic acid C, 43·3; H, 5·79 per cent. The specimen had a melting point of 182·5° C. (corrected); mixed melting point with the Merck sample of shikimic acid, 183·5° C. (corrected). It was undoubtedly shikimic acid.

The acid is barely detectable in the peel of unripe apples; but it increases in amount as the fruit ripens and becomes senescent. The amount of shikimic acid in pulp tissue even from senescent fruit is extremely small. It is interesting that there is also much less quinic acid in the pulp than in the peel of comparable apples[10]. If quinic and shikimic acids are indeed concerned in a chain of reactions leading to full aromatization of the six-carbon ring, it is possible that the rate of conversion of shikimic acid to the next member of the sequence is greater than the rate of production of quinic acid, so that shikimic acid appears in detectable amounts only during the general slowing down of metabolic activity associated with the senescence of the fruit.

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Physiological Control of Population Growth

Mouse ova collected from the Fallopian tubes at the eight-cell stage have been consistently shown to develop to blastulæ when cultivated in a purified medium[1]. It has now been observed that if progesterone is added to this medium, all ova die when the concentration is 8 μgm./ml. or more. A proportion survive at 4 μgm./ml., while a concentration of 2 μgm./ml. is without apparent effect. Since Forbes[2] found a level of 5·2 μgm./ml. in human plasma it seemed possible that this action of progesterone, together with those described by Pincus[3] and Ishikawa[4], might provide a method of fertility control. However, when recently inseminated mice were injected with 10 mgm. of progesterone intraperitoneally on two successive days, there was no reduction in the number of free blastulæ or of implantation sites.

The development of blastulæ from tubal ova *in vitro* was also prevented by low concentrations (10 μgm./ml.) of 'Triton' *W.R.* 1339 and other surface-active agents. In the presence of these substances the blastomeres, which normally fuse to form a compact spheroidal mass, failed to do so and remained discrete and rounded. The concentration required to produce this change was considerably less than that maintained in the blood by Cornforth *et al.*[5], or used in cultures of monocytes by Mackaness[6], which indicates that ova are more sensitive than other tissues to the action of 'Triton'. None the less, normal blastulæ could be recovered from the Fallopian tubes of mice injected intraperitoneally with 25 mgm. of 'Triton' on two successive days shortly after mating. In these animals, however, implantation did not occur, and if the injections were delayed until it had taken place the embryos were aborted or resorbed. A single intraperitoneal dose (10 mgm.) of suramin prevented or interrupted pregnancy in a similar way.

It is possible that this action of 'Triton' is related to the depletion of lipoids of the corpus luteum described by Rees[7]; however, such depletion did not occur in the animals injected with suramin. Nevertheless, both these substances are active in the systems described by Lovelock and Rees[8], so that their action in this case may also be related.

The absence of any action of 'Triton' or progesterone on ova *in vivo* may be due to a failure of the substances to reach the lumen of the Fallopian tubes. If this can be overcome, it may be possible to interrupt the course of pregnancy at the stage of oval cleavage.

The finding of an undescribed pharmacological action of suramin after years of clinical use is disquieting, and suggests the need to test new drugs on pregnant animals.

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Influence of Light on Sporulation of Brewing Yeast

It is well known that bottom yeast as used in the brewing industry can scarcely be made to sporulate. Only a few strains produce some spores. This is a handicap in experiments devised to obtain improved yeast by crossing suitable strains.

In this laboratory many of the presporulating and sporulating media described in the literature were tried with rather poor results. On the other hand, the influence of the season was observed: as a rule, more spores were formed in winter and spring.

Winge has shown that the formation of spores indicates a change from the vegetative generation to the generative generation of the life-cycle of the yeast. Now in the higher plants light has a considerable influence on this transformation. There are plants which only flower when exposed to a long period of light, others are short-day plants. Finally, there is a group which is indifferent to light. Influence of light on the sporulation of yeast was therefore investigated.

Several bottom yeasts, which are still in use in breweries, were inoculated in tubes with about 20 ml. of sterilized wort. After 7 days, when fermentation had ceased, the yeasts were transferred to new tubes. After 2 days, when fermentation was vigorous, 1–2 ml. of the wort was transferred to gypsum blocks.

After the wort had penetrated into the gypsum blocks the Petri dishes were provided with sterile tap-water. After 5 days, preparations of the yeasts on a slide stained with malachite green and safranin were examined microscopically.

One set of cultures (the dark set) had been kept in a dark thermostat at 20° C. all the time.

The second set (the long-day set) had been kept in the window. The third set (the short-day set) had been placed in the window from 9 until 17 hr. and for the rest of the time stored in the dark thermostat at 20° C. The dark set was not exposed to light except when being inoculated in normal daylight. The short-day set was subjected to 8 hr. daylight, the long-day set to about 16 hr., as the experiments were performed in May and June.

The culture tubes as well as the gypsum blocks of one set were kept under the same conditions.

Table 1

Yeast	Exposure time (hr.)	No. of cells counted	Percentage vegetative cells	Percentage asci with				Total asci (per cent)
				1 sp.	2 sp.	3 sp.	4 sp.	
G_{2a}	0	566	98·0	0·2	0·9	0·9	0	2·0
	8	605	96·4	0·8	1·0	1·5	0·3	3·6
	16	323	54·5	9·3	13·0	16·4	6·8	45·5
G_5	0	489	57·1	2·0	18·6	9·6	12·7	42·9
	8	610	75·9	2·1	7·0	9·7	5·3	24·1
	16	615	89·5	1·3	3·1	4·3	1·8	10·5
G_{27}	0	601	97·2	1·5	0·7	0·5	0·1	2·8
	8	620	97·7	1·0	1·1	0·2	0	2·3
	16	633	96·6	2·3	0·9	0·2	0	3·4

Three typical examples of the results are given in Table 1.

Sometimes when the experiments were repeated several times the results were identical; although at other times the results were different. Perhaps there is a certain period of sensitivity to light that may have a conclusive influence; but this has not yet been investigated. No doubt there exists an influence of light in inducing sporulation in the yeast strain G_{2a}. In other strains the sporulation is inhibited as shown in the case of strain G_5. The third type is indifferent towards light, as the latter neither stimulates nor inhibits sporulation (G_{27}). This was, however, only found with badly sporulating yeasts. On the other hand, no abundantly sporulating bottom yeast is known.

When the water of the 5-day-old cultures on gypsum blocks was replaced by a 0·1 per cent glucose solution, the sporulation sometimes could be improved without altering the proportion of the results. In one experiment 0·5 per cent sodium acetate produced no improvement.

The experiments will be extended with more exposure times. Where there is a sensitivity towards light, a substance, presumably a pigment, is probably responsible. This is to be investigated. With regard to this substance, the effectiveness of different wavelengths will be also examined.

Some strains show an influence of light on the rate of fermentation. When the cultures of these yeasts are exposed to artificial light during 24 hr. the rate of fermentation is decreased. This inhibition may explain the irregular results which are sometimes obtained.

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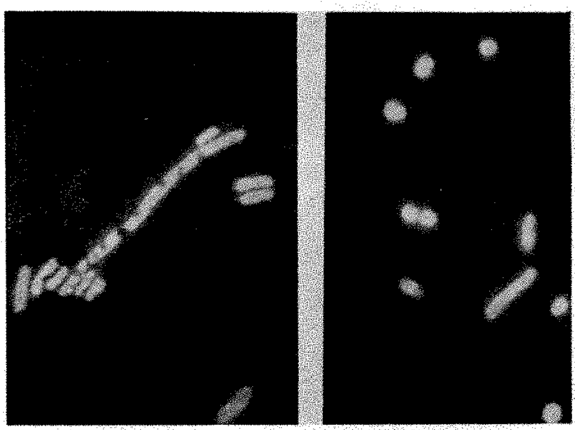
Autolytic 'Protoplast' Release in *Bacterium coli*

We recently discovered accidentally that controlled autolysis of certain Gram-positive bacteria in concentrated sucrose solutions adjusted to a critical ionic strength at *p*H 6 results in the release of the internal protoplasts from the mechanical protection of the cell-wall[1,2]. These 'protoplasts' are stable in suspension media of osmotic pressure above 20 atm., but lyse in more dilute media. The observations of Alfred Fischer[3] and Garbowski[4] on plasmoptysis of certain Gram-negative bacteria in media of low salinity suggested that autolytic release of stable protoplasts might also be possible in these organisms. We have therefore made a preliminary investigation of the conditions required to release the protoplasts of *Bacterium coli* (American strain *B*).



(*a*) (*b*)

Fig. 1. Anoptral contrast micrographs of *Bacterium coli* (*a*) at commencement of incubation and (*b*) after 12 hr. incubation in the controlled autolysis medium (× 4,000)

The development of osmotic fragility—representing loss of tensile strength of the cell-wall—was measured by the degree of lysis of the organisms (depression of light scattering) when pipetted into a buffered medium of low osmotic pressure (0·01 *M* phosphate buffer *p*H 5·8) compared with equivalent samples pipetted into *M* sodium chloride containing the same buffer. Rapid development of osmotic fragility without appreciable lysis of the 'protoplasts' occurs at 25° in 0·3 *M* sodium malonate in 0·5 molal L-arabinose at neutral *p*H. The rate of 'protoplast' release is greater the faster the growth of the organisms at harvesting; and, for exponential phase growth in an aerated 2 per cent tryptone, 1 per cent glucose, 0·1 per cent 'Marmite' medium at 25°, half the organisms become osmotically fragile in less than 60 min.

Anoptral contrast microscopy (Messrs. Reichert, Austria) shows that the organisms are initially strongly plasmolysed in the autolysis medium (Fig. 1*a*). The chains of organisms become shorter as autolysis proceeds; but when complete osmotic fragility is achieved the organisms are still cylindrical. Transformation to spheres commences some hours later (Fig. 1*b*) and nears completion in about 12 hr. Similar results have been obtained with *Aerobacter aerogenes* although sphering is much more sluggish in this organism. It is possible that the plasma-membrane and/or protoplasm of these organisms normally possess enough mechanical rigidity to resist the tendency to assume a spherical shape even when the cell-wall has been lost or has ceased to possess mechanical rigidity.

We are indebted to Mr. R. A. Fox for photography, and to the Scottish Hospital Endowments Research Trust for grants in aid of this work.

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Application of Large Volumes in Small Spots on Paper Chromatogram Strips

SEVERAL devices have been designed for continuous application of large volumes up to 5 ml. on chromatogram strips[1,2]. The diameter of the spots thus obtained is usually 1 cm. or more, and considerable time is needed.

In order to apply relatively large volumes in very small spots on narrow paper strips in a reasonably short time, the following apparatus was constructed, in which a strong centripetal stream of warm air is concentrated around the place of application on both sides of the paper.

The apparatus is made of glass and consists of two parts (Fig. 1).

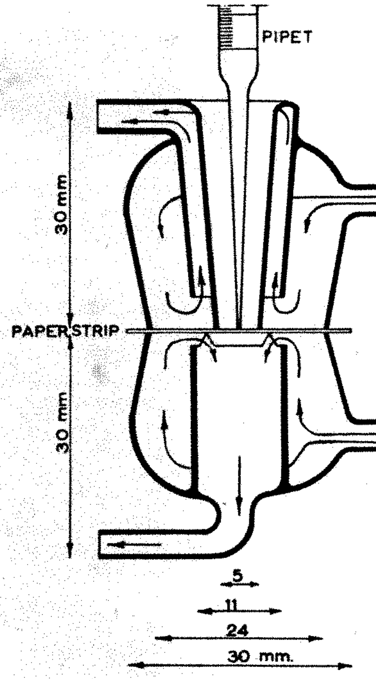

Fig. 1

The upper part is made of three concentric tubes, of diameters as indicated, fused together at the top. The middle tube is 2 mm. shorter than the other two, which have been ground down afterwards so as to end at exactly the same level. An air inlet is fused to the outer tube, the outlet is between the middle and the innermost tube.

The lower part is made symmetrical with the upper part, but without the innermost tube. The inner tube is again shorter than the outer one by 2 mm. and provided with four small points, the ends of which have been made level with the rim of the outer tube by grinding.

The paper is firmly held in its place by the rims of the two outer tubes of the innermost tube of the upper part, and the points of the inner tube of the lower part. The two parts are held together by slightly flexible rubber joints on the air inlet.

In this way even very narrow chromatogram strips 6 mm. wide can be used, when a paper mask is inserted. The tip of the applying burette or pipette is put on to the paper by entering it into the innermost tube of the upper part, and is protected by it from the air stream.

Air is blown through the apparatus from the compressed-air main after passing a filter and a heated copper spiral. A thermometer permits control of temperature.

The solution can be applied by means of a microburette of the Scholander or Rehberg–Kirk[3] type or by means of an Agla microsyringe. Thus outflow of solution, air stream and air temperature can all be controlled.

The time needed for application depends on the paper, the temperature used, and the volatility of the solvent. With various sorts of paper and solvents very small spots can be obtained in a reasonably short time: dilute solutions can be applied in a spot of 4–5 mm. diameter at a rate of 0·1 ml. in less than 10 min. for water, and less than 5 min. for butanol at 50° C. It is more convenient to condense volumes larger than 1 ml. by evaporation before application.

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Chromatography of Insulin on Calcium Phosphate Columns

Swingle and Tiselius[1] investigated the behaviour of the protein phycoerythrin when subjected to chromatography on columns packed with hydrated tricalcium phosphate supported on kieselguhr. It was found that the protein could be displaced by low concentrations of phosphate buffer. In a further study by Tiselius[2] it was found that other proteins could be displaced to give sharp elution zones when using aqueous solutions containing sodium phosphate.

The purpose of this communication is to record some results obtained when solutions of insulin stored under various conditions were subjected to chromatography on calcium phosphate–kieselguhr filled columns, eluting with sodium phosphate buffer of linearly increasing concentration.

The method used for the preparation of the calcium phosphate gel was essentially that of Keilin and Hartree[3], and each column contained 40 ml. gel supported on 26 gm. kieselguhr. The insulin was adsorbed at low ionic strength and eluted with the phosphate gradient increasing from zero to 0·05 *M* (*p*H 7·3) over a volume of 150 ml.; the concentration was then maintained at 0·05 *M*. The eluting solvent contained 0·5 per cent sodium chloride. Fractions of 3·5 ml. volume were collected and the optical density of each fraction at 276 mμ determined on a Unicam *SP* 500 instrument.

When the insulin solution was freshly prepared, the protein was eluted as a reasonably sharp peak (insulin 1) showing evidence of tailing. Any preservative such as phenol was only slightly, if at all, adsorbed and was eluted as a band ahead of the insulin. When the insulin solution was stored for a period of time in acid solution before subjecting to chromatography, it was found that a fraction of the insulin was transformed to a modification (insulin 2) which was eluted behind the band originally observed. On increasing the period of storage, the fraction of insulin changed increased still further. This effect is illustrated by

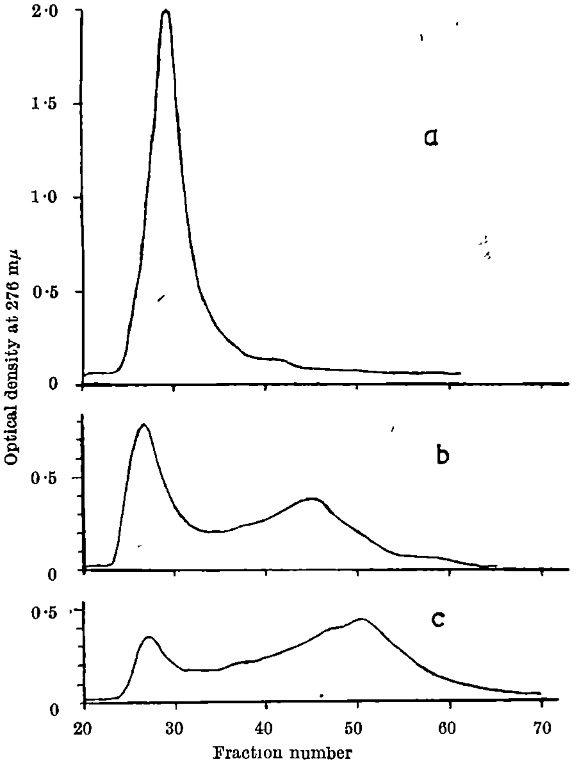

Fig. 1

the accompanying elution curves (Fig. 1), for insulin solution freshly prepared (*a*), and when stored for four days (*b*) and eight days (*c*), at 40° C. and *p*H 3·0.

Insulins 1 and 2 were isolated after elution and subjected again to chromatography, when it was found that each gave its appropriate peak on the elution curves. Bio-assay of materials isolated from the two peaks indicated that insulin 2 retained most, if not all, of the original potency in spite of the marked difference in chromatographic behaviour. A mouse assay gave the ratio of the potency of insulin 2 to insulin 1 as 0·92 ($p = 0·95$, limits 0·827 and 1·03).

It was found that the decrease in concentration of unchanged insulin, as represented by the area under the first insulin peak of the elution curve, followed first-order kinetics, at least for the early stages. Experimental values obtained for the half-life for the transformation of insulin 1 to insulin 2 at *p*H 3·0 and various temperatures are given in Table 1.

These values correspond to an energy of activation of 25,000 cal./mole. The rate of reaction is increased by lowering the *p*H and decreased by increasing the *p*H of the solution for storage. It appears to be affected only slightly, if at all, by sodium chloride concentration, by increasing the zinc concentration, or by removing the zinc from the insulin.

Preliminary results from Dr. Johnson and Mr. Rowe, of the Department of Colloid Science, Cambridge, who are investigating the two fractions, have indicated that a molecular-weight change may be associated with the transformation of insulin 1 to insulin 2.

Table 1

Storage temperature (° C.)	Half-life
0–4	3 0 years
30	14 8 days
40	3 84 days
50	1 11 days
60	10 6 hours

Further work is in progress on this effect, and it is hoped to publish detailed results in due course. I wish to thank Mr. W. Brown for assistance with the experimental work, Mr. K. L. Smith for the bio-assay, and the directors of Boots Pure Drug Co., Ltd., for permission to publish this communication.

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An Improved Method for the Preparation of Sialic Acid or Acetylneuraminic Acid

Although two decades have passed since the discovery of sialic acid by Blix[1], few investigations on this acid have been reported, due possibly to the difficulty of the preparation of the acid and the small yield. Recently Odin[2] reported a modified method for the preparation of sialic acid by mild acid hydrolysis in good yield instead of the old method, in which 'water hydrolysis' was employed. I have found that sialic acid is almost quantitatively adsorbed on activated charcoal, and this provides a convenient method for its preparation in good yield.

30 gm. of bovine submaxillary mucin were heated in 30 ml. of distilled water in a sealed tube for 2 hr. at 100° C. After cooling, the solution was dialysed against distilled water for 20–24 hr., changing the water three times during dialysis. The dialysate showed not only a positive direct Ehrlich reaction and Fehling test, but also the biuret reaction. However, the Molisch reaction was negative. The combined dialysate was concentrated *in vacuo* to about 50 ml. The solution became slightly pink during the concentration. The concentrated solution was then passed through an activated charcoal (about 150 mesh) column (2 cm. × 10 cm.). The effluent solution was colourless and was negative in the direct Ehrlich reaction. Thus sialic acid had been quantitatively adsorbed on charcoal. The column was washed with 100–150 ml. of water, and no sialic acid was lost from the column. After removal of the washing water, sialic acid was eluted with 180 ml. of 98–99 per cent methanol. Sialic acid was scarcely eluted at all with ethanol. The effluent solution was evaporated *in vacuo* to dryness. The residue, which did not show the biuret reaction, was dissolved in dry methanol and filtered into a centrifuging tube, and dry ether was carefully added to the filtrate, producing a flocculent precipitate. When no more flocculent precipitate occurred on adding ether, the precipitate was centrifuged off. The volume of ether needed did not exceed that of the methanol solution. Dry petroleum ether (about 5 ml.) was added dropwise to the clear colourless supernatant solution, whereupon the solution became turbid. On allowing to stand in an ice-box, crystalline sialic acid appeared on the glass wall. The form of the crystal was similar to that reported by Blix[1], and the yield was about 350 mgm. from 30 gm. of the mucin. The nitrogen

content was 4·1 per cent; the same value was obtained for every preparation. Other chemical properties of the crystal were identical with those of bovine sialic acid described by Blix. The specific rotation of the crystal, however, was different from that of bovine sialic acid reported by Blix: according to Blix[3] bovine sialic acid has the value of $[\alpha]^{23}_{D} = +8 \pm 2°$; whereas my sample showed $[\alpha]^{20}_{D} = -42 \cdot 0°$ (in water) after 10 min. and $-32 \cdot 8°$ after 30 min. The value of the specific rotation extrapolated to zero time was $-50°$. Thus mutarotation was observed with the substance. This evidence accords with the assumption of the presence of a potential aldehyde group in sialic acid[4,5].

From the optical rotation and nitrogen content of the product I have obtained it seems to be identical with Klenk's acetylneuraminic acid[6] and sheep sialic acid[3]. Recently, Klenk *et al.*[7] stated that acetylneuraminic acid should be identical with sheep sialic acid. Whether the product I have obtained is natural bovine sialic acid or not is not yet certain. It may be a slightly decomposed bovine sialic acid. Although bovine sialic acid was distinguished from neuraminic acid by the aid of colour reaction[5], Blix's authentic bovine sialic acid (kindly provided by Prof. Blix) could not be distinguished from my product by colour reaction.

The details of this investigation will appear elsewhere; further experiments are now in progress.

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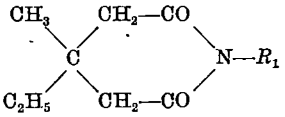
New Analeptics and Hypnotics related to the Barbiturate Antagonist, 'Bemegride'

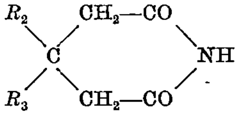
THE preparation of various glutarimides in these laboratories for testing as possible analgesics led to the discovery[1] in the Department of Pharmacology and Physiology, University of Melbourne, of the antibarbiturate activity of ββ methyl ethyl glutarimide ('Bemegride', 'Megimide'), from which a new method of treatment for barbiturate intoxication has been developed[2]. This prompted the investigation of related β-substituted glutarimides and derivatives of 'Bemegride' for similar activity. A series of compounds was therefore synthesized for examination, and the results of preliminary pharmacological trials are reported here.

The effects of the test compounds on the sleeping times induced by pentobarbital sodium in mice were compared with that of 'Bemegride', using groups of ten mice. The control group received 60 mgm./kgm. pentobarbital sodium. The test group received pentobarbital sodium (60 mgm./kgm.) and the test compound (25 or 50 mgm./kgm.), followed by further injections of the test compound at the same dosage at 15 min. intervals. The third group received pentobarbital sodium (60 mgm./kgm.) and 'Bemegride' (25 mgm./kgm.), followed by further injections of 'Bemegride' as for the test group. The control group received injections of distilled water at similar intervals. All injections were intraperitoneal. Where the compounds were too insoluble for administration in aqueous solution, suspensions in 1 per cent gum tragacanth were used. The sleeping time was the time elapsing between loss and recovery of the righting reflex. Where any appreciable reduction (50 per cent or more) in mean sleeping time was observed, a *t*-test was applied.

The two hydrolysis products of 'Bemegride', ββ methyl ethyl glutaramic acid and ββ methyl ethyl glutaric acid, were found to be ineffective as barbiturate antagonists. Three N-substituted derivatives of 'Bemegride' (I where R_1 = Me, Et and Ph) were also found to be inactive.



(I)



(II)

Fourteen other β-substituted glutarimides of type (II), where R_2, R_3 = H, H; Me, H; Me, Ph; Et, H; Ph, H; Et, Et; Pr, Pr, and the series of ββ methyl alkyl glutarimides, where R_2 = Me and R_3 = Me, *n*-Pr, *n*-butyl, *i*-butyl, *n*-amyl, *n*-hexyl and *n*-heptyl, together with the β spiro cyclopentane, cyclohexane and cycloheptane glutarimides, were then examined for analeptic activity.

Three compounds, the β spiro cyclopentane, ββ methyl *n*-propyl and ββ diethyl glutarimides, were found to have similar analeptic effect to that of 'Bemegride', the relative activities being in the order named. The cyclopentane compound was almost as effective as 'Bemegride' at the same dose-level (25 mgm./kgm.) in producing a 50 per cent reduction in sleeping time, while the other two produced the same result when administered at 50 mgm./kgm. (*t*-tests gave $P < 0 \cdot 01$ in all cases). Like 'Bemegride', all three caused convulsions in mice when injected alone at doses of 15–50 mgm./kgm., the cyclopentane and diethyl compounds being lethal at 20 and 75 mgm./kgm. respectively. The methyl *n*-propyl compound is less toxic and at doses up to 400 mgm./kgm., induced periodic convulsions for upwards of one hour, when the animals usually recovered.

The β ethyl, ββ methyl *iso*butyl and the other two β spiro cycloalkane glutarimides were also convulsants when administered alone at 20–50 mgm./kgm. Treatment of the animals with pentobarbital before injection of any of these compounds prevented convulsions in all cases; but the sleeping times were not affected.

ββ Methyl *n*-butyl glutarimide was found to have hypnotic effects in mice, its action being opposite to that of the convulsant methyl *iso*butyl compound. The methyl *n*-amyl and methyl *n*-hexyl glutarimides were also found to have hypnotic activities, while the methyl *n*-heptyl compound had no apparent pharmacological action.

These three hypnotic glutarimides, being rather insoluble in water, were administered as suspensions in 1 per cent gum tragacanth. For all three compounds, the minimum hypnotic dose is 150–200 mgm./kgm. and the approximate *LD*50 is 600 mgm./kgm. Using groups of ten female albino mice, the mean sleeping times induced by each compound at a dose

Table 1

-glutarimide	Dose level (mgm./kgm.)	No. losing righting reflex	Mean induction time (min.)	Sleeping time (min.) Mean ± S.E.
ββ Methyl *n*-butyl-	200	7	7	3·5 ± 1·23
	300	10	6	23 1 ± 2·75
ββ Methyl *n*-amyl-	200	10	5	42·3 ± 6·02
ββ Methyl *n*-hexyl-	200	10	9	17 0 ± 2 62

of 200 mgm./kgm. were obtained, and are listed in Table 1.

The methyl *n*-amyl compound thus appears to be the most effective of the three. No signs of toxic effects were observed at these doses. Sleeping times up to 5 hr. were induced with all three hypnotics at doses of 400–500 mgm./kgm.

Finally, it has been shown, by the procedure used for screening the other test compounds, that the hypnotic action of these three glutarimides is very effectively antagonized by the methyl ethyl glutarimide, 'Bemegride'. Of a group of ten mice injected with 200 mgm./kgm. of the methyl *n*-amyl compound followed by a single injection of 20 mgm./kgm. 'Bemegride', five did not lose the righting reflex at all, and the mean sleeping time of the remaining five was reduced to less than one-third the control value. No convulsions were observed, indicating a swift antagonism between the two glutarimides in the animals.

From the pharmacological results so far obtained the following conclusions regarding the activity of 'Bemegride' as a barbiturate antagonist are evident. (1) The intact glutarimide ring is essential for analeptic effect, as the two hydrolysis products have no activity. (2) The inactivities of the *N*-substituted derivatives of 'Bemegride' demonstrate the importance of the imido hydrogen atom. (3) 'Bemegride' is not unique among β-substituted glutarimides as a barbiturate antagonist, as three closely related compounds have been shown to have similar activities.

In the series of β methyl β *n*-alkyl glutarimides, which contains two analeptic compounds, 'Bemegride' and ββ methyl *n*-propyl glutarimide, further extension of the *n*-alkyl substituent to butyl, amyl and hexyl results in hypnotic activities in these three compounds. 'Bemegride' effectively antagonizes the hypnotic effect in mice of these glutarimides. The methyl *n*-heptyl glutarimide, however, has no particular activity.

Work is continuing on compounds of the glutarimide type, and further pharmacological results, together with complete chemical information, will be published shortly.

I should like to thank Prof. F. H. Shaw, of the Pharmacology Department, University of Melbourne, who allowed me to use the facilities of that Department for some of the earlier testing, and also the directors of Nicholas Proprietary, Ltd., for permission to publish this communication.

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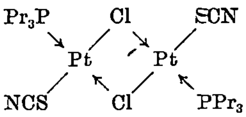
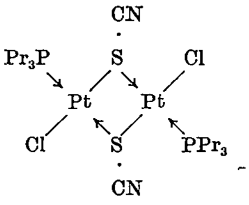
Use of the Infra-Red Spectrum to distinguish Bridging from Terminal Thiocyanato-S-Groups in Co-ordination Compounds

In 1952 the existence of two thiocyanato-complexes of composition $(PPr^n_3)_2Pt_2Cl_2(SCN)_2$ was reported[1]. The labile α-isomer had m.p. 144°–152° and the stable β-isomer, m.p. 173°–174·5°. These isomers have dipole moments of less than 2 Debye units and so must have the tri-*n*-propylphosphine groups in *trans*-positions to each other. Possible structures are (I), (II) and (III).



(I)



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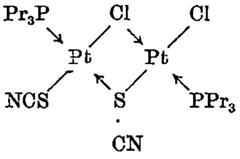

(III)

A substance of structure (II) might also exist in two geometrically isomeric forms, according to whether the CN groups are in *cis* or in *trans* relationship to each other about the planar PtS_2Pt ring. Since such geometrical isomerism, arising from the aplanarity of the valencies from the 3-covalent sulphur atoms, was then unknown, it was considered that the α- and β-isomers would most probably be structural isomers, and from general considerations of their relative stabilities they were assigned structures (I) and (II) respectively. At that time no means of confirming or disproving that assignment of structures was available to us; but now using infra-red methods we conclude that both isomers have their SCN groups in bridging positions, and so cannot be the structural isomers at first postulated.

We find that the infra-red spectrum affords an excellent method of determining whether thiocyanato-S groups are in terminal or in bridging positions. This conclusion is based on the examination of a number of thiocyanato-complexes of platinum (II) and of palladium (II). The spectra were obtained from paraffin oil mulls of the powdered crystalline complexes using a Grubb-Parsons *S3A* spectrometer fitted with a lithium fluoride prism. The observed frequencies (to the nearest cm.$^{-1}$) are listed in Table 1. All the thiocyanato-complexes which we have studied exhibit at least one strong absorption band in the region of 2,100–2,170 cm.$^{-1}$, and this can be unequivocally assigned to the SCN stretching modes. The particular modes are presumably derived[2] from ν_3 of SCN^-, which has[3] a frequency of 2,066 cm.$^{-1}$. All the mononuclear complexes have an absorption band in the range 2,100–2,120 cm.$^{-1}$, and those binuclear complexes which from their composition must contain both bridging and terminal SCN groups have additional bands in the range 2,150–2,182 cm.$^{-1}$. It is evident that bridging SCN groups give rise to

Table 1. STRONG ABSORPTION BANDS IN THE 4μ REGION OF THE SPECTRA OF SOME THIOCYANATO-COMPLEXES OF PLATINUM AND PALLADIUM

Compound	Bridging SCN	Terminal SCN
$(AsPr^n{}_3)_2Pd(SCN)_2$	—	2,115
$(AsBu^n{}_3)_2Pd(SCN)_2$	—	2,113
$dipyPd(SCN)_2$*	—	2,100
$(PBu^n{}_3)_2Pd(SCN)_2$	—	2,110
$(PPr^n{}_3)_2Pt(SCN)_2$	—	2,120
$(AsPr^n{}_3)_2Pd_2(SCN)_4$	2,154	2,120
$(PBu^n{}_3)_2Pd_2(SCN)_4$	2,162	2,120
$(AsBu^n{}_3)_2Pd_2(SCN)_4$	2,153	2,120
$(PPr^n{}_3)_2Pt_2(SCN)_4$	2,182, 2,166	2,105
$(AsPr^n{}_3)_2Pd_2(SCN)_2Cl_2$	2,154	—
$(AsBu^n{}_3)_2Pd_2(SCN)_2Cl_2$	2,154	—
$(PBu^n{}_3)_2Pd_2(SCN)_2Cl_2$	2,159	—
α-$(PPr^n{}_3)_2Pt_2(SCN)_2Cl_2$	2,162	—
β-$(PPr^n{}_3)_2Pt_2(SCN)_2Cl_2$	2,169	—

* Dipy = 2 : 2′-dipyridyl

stretching frequencies about 30–80 cm.$^{-1}$ higher than the corresponding frequencies originating from terminal SCN groups, and that all the complexes of the type $L_2M_2(SCN)_2Cl_2$ (L = $AsAlk_3$ or $PAlk_3$; M = Pd or Pt) which we have investigated have both their thiocyanato-groups bridging the two metal atoms.

This conclusion rules out the original proposal that the α- and β-forms of $(PPr^n{}_3)_2Pt_2Cl_2(SCN)_2$ are the structural isomers (I) and (II) and points to both having the structure (II). On this basis the two isomers can only be accommodated if they are the geometrical isomers discussed above, and would provide the first example of such isomerism. Against this it can be argued that all SCN stretching modes of the *cis*-form of (II) should be infra-red active and hence its spectrum should have two bands in the neighbourhood of 2,160 cm.$^{-1}$, whereas we observe only one. However, in complexes containing heavy metal atoms accidental degeneracies may easily occur and prediction from group theory concerning the numbers of bands which should occur in the infra-red spectrum can be misleading. As evidence for this we have the single absorption band in the spectrum of the dipyridyl complex which cannot be centrosymmetrical. It is proposed to investigate these points more fully.

The difference between the SCN stretching frequencies of the bridging and terminal groups is in the sense to be expected if it were caused by electronic effects. The valence force treatment of the SCN^- ion given by Penney and Sutherland[2] indicates that the frequency of the 4μ band is determined to a large extent by the CN bond-stretching force constant. The CN bond order will increase with increasing positive charge on the sulphur atom, and so the frequency of the 4μ band should be greater when the sulphur atom is co-ordinated to two metal atoms than when it is only co-ordinated to one, as we observe.

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Vapour Pressures of Some Disperse Dyes

THE vapour pressure, heat and standard entropy of sublimation of two disperse dyes, 1-methylaminoanthraquinone and 1-(β-hydroxyethyl)aminoanthraquinone, have been determined.

Vapour pressures of the former were determined over the temperature range 110°–130° C., and of the latter over the range 150°–165° C., by a modification[1,2] of Knudsen's effusion method. The vapour effused through a hole of known area into a hard vacuum and was condensed on a cold finger. The rate of effusion was measured by observing, by means of a cathetometer, the deflexion of a silica spring from which was suspended the effusion vessel. This vessel had been previously calibrated at approximately 40° C. by using benzophenone, the vapour pressure of which has been accurately determined by Neumann[3]. As a check, a second vessel containing a hole of smaller area was also used, and the results agreed within the experimental error. The method assumes that the effusing vapour is monomolecular.

The dyes were purified by chromatography and sublimation *in vacuo*. Spectrographic analysis of material sublimed in the temperature ranges, as above, shows that no decomposition of the material takes place under these conditions.

On plotting $\log_{10}p$ (cm. of mercury) against $10^3/T$, where T is the absolute temperature, the results were found to fit the equation

$$\log_{10}p = \frac{a}{T} + b$$

Data for the two dyes are given in Tables 1 and 2.

Table 1

	a	b
1-Methylaminoanthraquinone	−6,740	13·435 (±0·036)
1-(β-Hydroxyethyl)aminoanthraquinone	−7,973	14 819 (±0·005)

Table 2

	1-Methylaminoanthraquinone	1-(β-Hydroxyethyl)aminoanthraquinone
Heat of sublimation (kcal. mole^{-1})	30·85	36·50
Standard entropy of vaporization for vapour at one atmosphere (cal. mole^{-1} deg.$^{-1}$)	52 87 (±0·30)	59·24 (±0 01)

Majury[4] has shown that, in the case of five 'model' dyes, namely, *p*-nitroaniline, NN-dimethyl-*p*-nitroaniline, azobenzene, *p*-aminoazobenzene, and NN-dimethyl-*p*-aminoazobenzene, from a knowledge of vapour pressures and dyeing adsorption isotherms from the vapour phase, the absolute heat of association of the model compound with the substrate can be found.

In the present work, the compounds used are actual dyestuffs with much smaller vapour pressures, and it is hoped, eventually, to correlate these results with data on the energy and entropy of adsorption of the dye vapour on suitable substrates, and with data on the diffusion of dyes in such media.

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Oxidation-Reduction Reactions of Metal Salts in Non-aqueous Solvents

THE recent exploitation of electron exchange reactions in aqueous solutions[1] has provided valuable information on oxidation-reduction reactions in general and stimulated their study. The situation for the latter reactions in non-aqueous solvents is completely different, little being known about them despite their importance in trace-metal catalysed autoxidations[2]. Collinson and Dainton[3] have pointed out that radicals produced during polymerization will react with a variety of metal salts in a number of media. Useful comparative data can also be obtained by studying the reactions of metal salts with a stable free radical. In this instance the reactions between metal acetates and the radical αα′-diphenyl-β-picrylhydrazil have been investigated. First-order kinetics for each reactant were observed; below are listed specific rate constants for reactions in anhydrous acetic acid at 25° C.

Metal acetate	Specific rate constant (M^{-1} sec.$^{-1}$)
Lead (IV)	35
Cobalt (III)	22
Cerium (IV)	55
Iron (III)	88

Other acetates, namely, those of chromium (III), copper (II) and manganese (III), also react with the free radical, but kinetic data are not available yet. In all these reactions the rate was reduced by the addition of methyl alcohol or benzene but increased markedly by the addition of water.

Further interesting reactions were found to occur between valence states of metal acetates; again, anhydrous acetic acid was the main solvent used. The systems which were examined in detail are lead (IV)–cobalt (II), lead (IV)–cerium (III) and lead (IV)–manganese (II); first-order dependence on all the reactants except manganous acetate was observed. Below is a table of apparent activation energies and specific rate constants for these systems.

	Specific rate constants (M^{-1} sec.$^{-1}$)	Activation energies (kcal./mole)
Lead (IV) + cobalt (II)	0·56	14 ± 1
Lead (IV) + cerium (III)	0·24	21 ± 1
Lead (IV) + manganese (II)	0·43	14 ± 1

Attempts are being made to identify the reacting species by noting the effect of the addition of other solvents and unreactive salts on the reaction-rates, absorption spectra and ion migrations with an applied potential. For example, in the lead (IV)–cobalt (II) reaction addition of water retarded the reaction-rate whereas sodium acetate accelerated it; both these additives affected the absorption spectrum of cobaltous acetate markedly; with added water, migration to the cathode only was observed, but when sodium acetate was present instead, migration to both anode and cathode occurred.

Preliminary work has shown that reactions between the valence states of the acetates of chromium, copper, mercury and iron also take place in dry acetic acid. In addition, chromous acetate may be oxidized to the chromic state in methyl alcohol by some metal acetates.

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Crystal Structure of 1 : 2-Benzanthracene

As part of an investigation into Daudel and Pullman's theory[1,2] concerning the connexion between carcinogenic activity and the chemical structure of benzanthracene derivatives, we have made a detailed study of the crystal structure of 1 : 2-benzanthracene.

Crystal studies of this substance have been reported previously by Iball[3], who, however, appears to have obtained a *c*-crystal axis dimension which is twice the length we have found.

As already reported by Iball, 1 : 2-benzanthracene is very difficult to obtain in crystals suitable for single-crystal analysis. We have found that a dilute solution of benzanthracene in a mixture of 1/3 methanol to 2/3 ethanol, which is allowed to evaporate slowly (24 hr.) at room temperature, will deposit perfect, but very small, crystals (0·1 mm. × 0·3 mm. × 0·5 mm.). Slowing down the rate of evaporation did indeed enable one to obtain larger crystals, but single-crystal photographs of these invariably showed them to be twins.

We have carried out a three-dimensional Fourier analysis of 1 : 2-benzanthracene in order to measure

Table 1. OLD AND NEW CRYSTAL DATA OF 1 2-BENZANTHRACENE

Monoclinic (A)	*a*	*b*	*c*	*β*	*Z*	Space group
Iball	7·91	6·43	23·96	99°	4	C^2_{2h}–$P2_{1/m}$ or C^2_2–$P2_1$
	7·95	6·50	12·12	100·5°	2	C^2_2–$P2_1$

Table 2. ATOMIC CO-ORDINATES OF THE 18 CARBON ATOMS IN THOUSANDTHS OF A UNIT-CELL EDGE

Atom	*x*	*y*	*z*
A	119·0	−53·3	370·1
B	188·5	7·3	489·2
C	164·7	−134·4	576·0
D	214·1	−70·2	681·6
E	287·3	111·8	720·9
F	327·5	130·7	845·0
G	414·7	324·0	876·1
H	451·2	467·2	796·2
I	409·1	432·0	680·7
J	328·8	261·7	643·4
K	279·2	208·0	512·6
L	302·5	338·9	436·2
M	234·9	292·5	324·9
N	263·6	462·6	241·2
O	195·1	414·3	131·8
P	115·7	232·6	105·7
Q	90·1	98·8	176·1
R	153·8	104·9	287·6

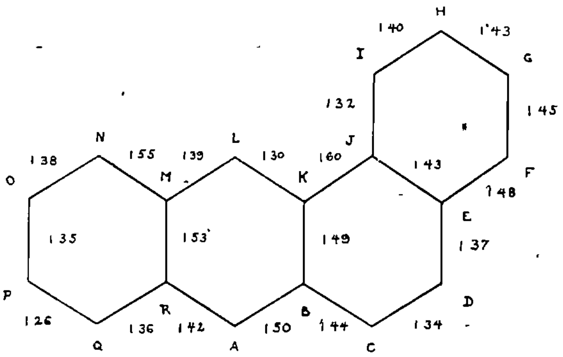

Fig. 1

the bond-lengths and electron densities of the *K*-region, so named by Daudel and Pullman[1].

Because of the lack of a centre of symmetry in three dimensions, the total absence of atomic resolution in the only centrosymmetric projection (*h0l*), and the low percentage of measured reflexions (518 out of a permitted total of 1,658), the refinement of the structure has been difficult and is not yet complete. For this reason the bond-lengths (in A.) shown in Fig. 1 are only tentative. To date, the refinement has consisted of three rounds of three-dimensional Fourier refinement (for which our thanks are due to Prof. R. Pepinsky, who very kindly allowed us to use *X-RAC*) and nine rounds of three-dimensional least-squares refinement carried out on the *IBM* 701 computer and Remington Rand's *UNIVAC*. The structure now has a discrepancy *R* of 21·5 per cent over the 518 planes. The molecule is planar within experimental error. Further work is in progress to improve the discrepancy, and full details will be reported later.

We are grateful for a U.S. Public Health Service grant.

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Absorption of Oxygen and Carbon Monoxide by Barium Alloy Getters

WAGENER[1] has described a novel method of finding both the pumping speed and capacity of getters, and has made measurements[2,3] with common gases and barium alloy getters of the type used in radio valves. The results obtained were conflicting. In the earlier paper[2] it was reported that the speed of pumping depended upon the amount of ionizing electron current in a nearby diode or ionization gauge. Wagener's measurements were made in a range of electron current from 5 m.amp. to 20 m.amp. If these measurements are extrapolated to zero current they show that the speed of pumping is not then zero, contrary to the hypothesis suggested in the paper. In the later publication[3] it was reported that the speed of pumping was about the same without, as with, an ionizing electron discharge. The present work was undertaken to decide between these contrary findings. It was decided to study the pumping of oxygen, because the chemical affinity of barium for this gas would make more remarkable any necessity for electron current.

The apparatus used here was similar to that described by Wagener[1-3], except that, for measuring pressures without using any ionizing electron current, a Pirani gauge was fitted. In addition, pressure measurements could be made with the ionization gauge over a range of electron current, from less than 1 microamp. to more than 1 milliamp. During most of the present experiments, the pressure above the getter was of the order 10^{-6} mm. mercury. The barium alloy getters used were of the *KIC* type, 20 mgm. size, with a non-magnetic stirrup, as in television tubes.

It was found that the speed of pumping of oxygen by a barium getter film was very little changed when an ionizing (180 V.) electron current was run nearby. A typical set of values of speed and current was as follows:

Electron current (μamp.)	0	1	5	10	50	100	500	1,000
Speed of pumping (l.sec.$^{-1}$)	1 50	1·50	1·50	1·50	1·52	1·54	1·67	1·85

The slight variation of speed with current was linear. Thus barium getters pump oxygen in the absence of any ionization.

The speed of pumping of the getters was found to vary with time, as had already been reported by Wagener[2]. The variation of the speed of pumping with time and temperature is shown in Fig. 1. The increase of speed with temperature should be noted. Moreover, the amount of oxygen taken up by the getter (capacity) increased with temperature. At room temperature the capacity was independent of the thickness of the getter film deposited, so that thick films were still opaque and metallic-looking when pumping ceased. At higher temperatures the capacity increased with the thickness of the film, and the deposit became translucent at the end of pumping. These results show that the mechanism of gettering involves diffusion.

In spite of ionization not being necessary for the pumping of oxygen by barium, it was suspected that the hot filament in an ionization gauge might influence the speed of pumping. The measurements of the variation of the speed of pumping of oxygen, with electron current, were made with the getter film at room temperature, while the speed was not changing with time. However, it was found, from Pirani gauge measurements, that during the falling-speed period, towards the end of the life of a getter film, all pumping ceased if an incandescent tungsten filament near the getter was switched off. The tungsten filament became effective when its temperature was raised above 1,800° K.; but increasing the temperature to 2,100° K. did not increase the speed further. Moreover, the speed was not raised further by increasing the number of filaments that were heated. Thus, some product of the interaction of oxygen molecules with an incandescent tungsten filament, probably atomic oxygen, has a catalytic effect upon the taking up of oxygen by a failing barium getter film.

A considerable increase of speed of pumping and of capacity with temperature was also found in experi-

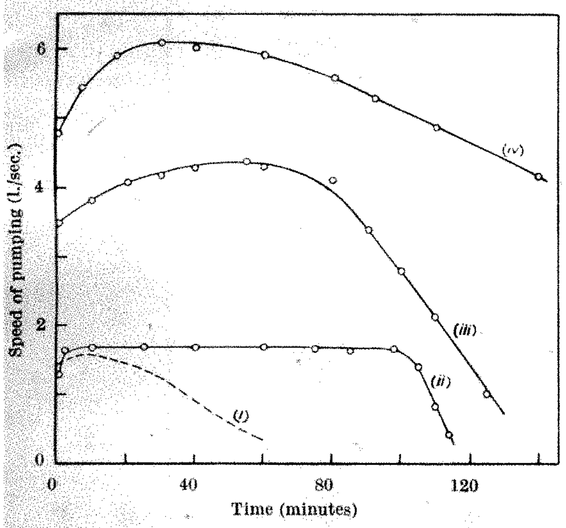

Fig. 1. Variation with time and temperature of the speed of pumping of oxygen by barium. Curve (i) represents Wagener's work, with an area of 12 sq. cm. at an unknown temperature. The present work is with an area of 8 sq. cm. at the following temperatures: (ii) room temperature; (iii) 40° C.; (iv) 70° C.

ments with carbon monoxide. This result contrasts with the small increase reported by Morrison and Zetterstrom[4]. The increased capacity was marked by the getter film becoming translucent, although stained brown.

I wish to thank Mr. M. E. Haine and Mr. B. M. Cox for much help, and Dr. T. E. Allibone, director of this laboratory, for permission to publish this communication.

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Change in Surface Area of Anthracite on Heat Treatment

Maggs[1] and Malherbe[2], among others, have shown that coal behaves as a molecular sieve material. That is, the adsorption of nitrogen and argon at 77° K. is restricted because of activated diffusion into pores of molecular dimensions and gives data only on the readily accessible macropore area of coal. From heats of wetting and gas-adsorption data at higher temperatures, the macropore area is shown to represent an insignificant part of the total surface area of most coals.

The presence of a large micropore area in coal affects many of its properties. One property which is thought to be markedly affected is the thermal stability of anthracite on pyrolysis. Raw anthracite when used as a metallurgical fuel is susceptible to thermal shock, usually resulting in the lowering of its physical strength and subsequent size degradation. This phenomenon is thought to be primarily caused by the large increase in gas pressure in the micropores produced by the difficulty of releasing volatile matter from these pores upon heat treatment. It is with this thought in mind that a comprehensive programme has been initiated to study the nature of the micropore surface area in anthracites, its change with heat treatment, and its relation to decrepitation. An initial result of interest is being reported at this time.

The anthracite studied has the following proximate analysis on the as-received basis: water, 3·4 per cent; volatile material, 2·9 per cent; ash, 7·1 per cent; free carbon, 86·6 per cent; and sulphur, 0·54 per cent. Adsorption studies were performed on minus-60 mesh samples (Tyler series) of raw and calcined anthracite. Calcination was conducted in a reducing atmosphere with samples heated to 1,200° C. in two hours and maintained at this temperature for two additional hours. Surface areas of the anthracite were determined from nitrogen adsorption at 77·2° K. and carbon dioxide adsorption at 194·6° K. using the procedure and Brunauer–Emmett–Teller equation discussed by Emmett[3]. Final adsorption pressures were read after 30 min. even though equilibrium was not completely attained.

Table 1 presents the surface area data. The nitrogen value can be considered essentially the macropore area, whereas the carbon dioxide value can be considered essentially the total area. The nitrogen value would be expected to consist of some micropore area, and the carbon dioxide value would be expected to be somewhat less than the total area since equilibrium was not reached. Naturally, any arbitrary adsorption time of reasonable duration has the above limitations, and this fact must be kept in mind when interpreting the data. It should also be pointed out that good agreement of surface areas from nitrogen and carbon dioxide adsorption on carbons known to have an insignificant microporosity has been obtained[4].

Table 1. SURFACE AREA OF RAW AND CALCINED ANTHRACITE

Treatment	N_2 area, m.²/gm.	CO_2 area, m.²/gm.
Raw	11·2	175
Calcined	0·78	2·8

It is seen that for the raw anthracite the micropore area represents at least 93 per cent of the total area, whereas for the calcined material only somewhat more than 72 per cent need be in micropores. Of greater significance is the marked decrease in the magnitude of micropore area upon calcination. At least 98 per cent of the micropore area has been destroyed or blocked from access to the exterior surface on calcination at 1,200° C.

Calcination of the anthracite produced approximately a 15 per cent volume-shrinkage. In the light of the area results, it appears that this shrinkage parallels the removal of the majority of micropore area from the anthracite. Indeed, anthracite which has been calcined at a very low heating rate[5] shows good thermal stability when afterwards plunged rapidly into a hot zone, which is to be expected if the microporosity and occluded gases have been removed.

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The Golgi Apparatus and Secretion of Enzymes in Peptic Cells of Rabbit

IN rabbits starved for 48 hr. with free access to water, the Golgi apparatus as shown by the Aoyama technique, as modified by me, is in the form of a compact reticulum lying close to the luminal pole of the nucleus (Fig. 1.1). After feeding, the Golgi reticulum expands and increases gradually in volume until it occupies the luminal part of the cytoplasm (Fig. 1.2–4). During increased secretory activity, the power of the Golgi substance to reduce silver nitrate or osmium tetroxide gradually increases ; this suggests that besides the morphological changes, chemical changes occur in the Golgi substance. In the fed rabbits, argentophile secretory granules appear in the field of the Golgi apparatus, and as the latter hypertrophies the secretory granules increase in number (Fig. 1.2–3).

Most of the secretory granules are seen in close association with the Golgi substance ; those which have moved away from the Golgi apparatus field are present above it in the supranuclear region which is usually free from mitochondria. The granules when secreted are argentophile ; then they increase in size and loose their argentophily. Some of these argentophobic granules run together, forming larger spheres which ultimately accumulate at the luminal part of the cytoplasm.

It is worth mentioning that subsequent to feeding, the argentophile granules were observed in the cells ; but after approximately two hours they were less frequently seen, and instead of them non-argentophile larger granules were observed. Some of these argentophobic granules were seen to be encircled either partly or completely by the Golgi substance (Fig. 1.4) ; this is well illustrated in the photomicrograph (Fig. 2), where argentophobic spheres (*Z*) lie in the claw-like prolongations of the Golgi substance ; this indicates that the argentophile material represents an early stage in the formation of the non-argentophile secretion granules, and that the process of transformation of young secretory granules to mature zymogen takes place in contact with the apparatus of Golgi.

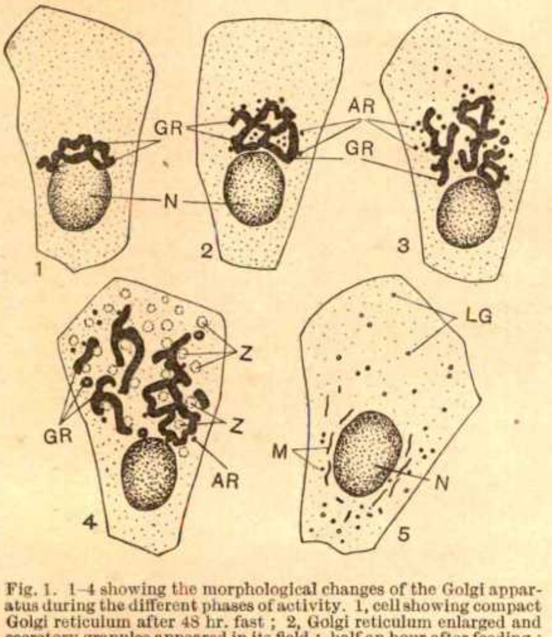

Fig. 1. 1–4 showing the morphological changes of the Golgi apparatus during the different phases of activity. 1, cell showing compact Golgi reticulum after 48 hr. fast ; 2, Golgi reticulum enlarged and secretory granules appeared in its field ; half an hour after feeding ; 3, cell in an advanced stage of secretion ; one hour after feeding ; 4, cell showing the transformation of some of the argentophile secretory granules (propepsinogen) into non-argentophile pepsinogen spheres ; 5, a composite cell showing lipid granules (drawn here as spheres) and mitochondria

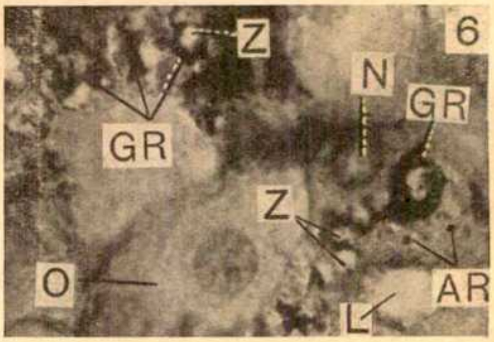

Fig. 2. A photomicrograph showing argentophile propepsinogen granules and non-argentophile pepsinogen globules which are encircled either partly or completely by the Golgi substance ; two hours after feeding. *AR*, argentophile secretory granules (propepsinogen) ; *GR*, Golgi reticulum ; *L*, lumen of gastric gland ; *LG*, lipid granule ; *M*, mitochondria ; *N*, nucleus ; *O*, oxyntic cell ; *Z*, non-argentophile pepsinogen globules

In rabbits which had constant access to food the Golgi apparatus presents great variations in appearance, which indicate that the cells are in different phases of activity and that each cell appears to act as an independent unit.

I consider the argentophile granules, which appear after the intake of food, as the young or prozymogen (propepsinogen) granules ; these are transformed into mature secretory granules (zymogen or pepsinogen) which are non-argentophile. None of the prozymogen or zymogen granules appears to stain vitally in neutral red, methylene blue or janus green. They have also no marked affinity for sudan dyes, and in sections prepared for the study of the mitochondria, unstained vacuoles are seen in the place of zymogen granules. The earliest secretory granules (prozymogen) are lightly stained in mitochondrial preparations ; they are larger than the granular mitochondria and are restricted to the field of the Golgi apparatus.

The mitochondria are shown most clearly in material fixed in Champy's fluid and stained with Heidenhain's iron-alum hæmatoxylin or better by treating post-osmicated material for mitochondrial staining. They are present as granules, rods and filaments scattered through the cytoplasm, especially around the nucleus (Fig. 1.5). Fasting and feeding do not induce any noticeable change in the size, shape, distribution or in the number of the mitochondria.

No evidence was obtained suggesting that the mitochondria of peptic cells change into the Golgi material, secretion granules, or that they take any part in cellular secretions as claimed by some authors. On the contrary, the location of the earliest secretory granules in the Golgi apparatus field and in intimate connexion with the Golgi substance, the difference in position between the mitochondria and secretory granules, and the changes in the morphology of the Golgi apparatus during the different phases of activity seem to point to the Golgi apparatus as being the centre of enzyme formation in peptic cells. The Golgi apparatus reticulum is argentophile and osmiophile but does not stain with sudan black, neutral red or methylene blue. The apparatus seen in living unstained or supravitally stained cells, under the phase-contrast microscope, is comparable with the Golgi apparatus picture given by silver or osmic methods.

A further account of the material is being published elsewhere.

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Relationship between Blood Concentration and Environmental Salinity in *Palaemonetes varians* (Leach)

IN Britain *Palaemonetes varians*, variety *microgenitor*, commonly inhabits only saline water around the coastline and has never been recorded in fresh water. The prawn is, however, very abundant in water of extremely low salinity in the Cardiff area, where it occurs in the drainage ditches of farm-land adjacent to an area of salt-marsh[1]. In the summer months both the salt-marsh and the farm-land waterways swarm with larval prawns. The *P. varians* of these two regions are morphologically identical but differ physiologically, those from the latter habitat being in some way better suited for life in a low salinity environment. When in water of low salinity (such as that contained in the ditches traversing the cultivated area) they show a much smaller expenditure of metabolic energy (as measured by the respiratory rate) than those from the neighbouring, highly saline marsh pools[2].

Estimations of the osmotic pressure of blood taken from specimens of both habitats kept in different concentrations of sea-water have been measured by Baldes's modification of Hill's thermo-electric technique[3,4], in order to determine whether a difference in blood concentration exists in these two physiological races. A reduced blood concentration in a low-salinity medium would diminish the osmotic gradient and, as a consequence, decrease the amount of energy the animal would have to expend on osmoregulatory work.

The results are shown in Fig. 1. Both groups of prawns are isotonic at a salinity of about $20^{0}/_{00}$ sodium chloride in the external medium, which is in agreement with the figures given by Panikkar[5]. The blood concentrations vary slightly as the external medium changes in salinity; but these are comparatively minor fluctuations, being only about $5^{0}/_{00}$ sodium chloride over a range of $30^{0}/_{00}$ sodium chloride in the external environment. Both populations show a slight fall in the value for blood when the medium becomes diluted to a salinity below $10^{0}/_{00}$ sodium chloride. The small differences of values between the two sets of results are well within the range of fluctuations due to experimental error incurred by the use of this thermo-electric technique, and shows no significant difference in their concentrations. Thus the marked difference in energy consumption in media of very low salinity, displayed by these two populations of *P. varians*, is not due to one of the groups becoming subjected to a reduction in the osmotic gradient between external environment and internal body fluid. The blood concentration is the same in both cases and both are typically homoiosmotic.

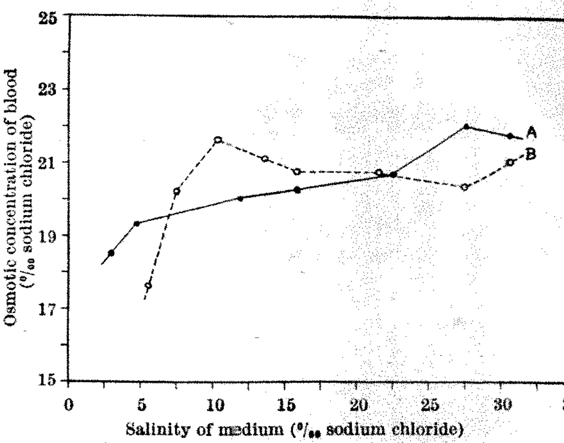

Fig. 1. Blood concentration of *Palaemonetes varians* at different environmental salinities (*A*) salt-marsh prawns; (*B*) low-salinity prawns

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A Spiral 'Valve' in the Hepatic Portal Vein

THE occurrence of laminar flow in the hepatic portal vein is acceptable on hydrodynamic grounds[1]. In any consideration of the probable distribution within the liver of blood from a particular tributary of the portal vein the anatomy of the vein is important. Drs. C. H. Barnett and W. Cochrane[2] suggest that the relative diameters of tributary and main vein and the angle of union are the important factors in determining the path of the streams. I have recently observed an anatomical structure in the portal vein which on theoretical grounds would appear to be more important than either of these factors.

In neoprene latex casts of the portal vein of rabbits there is a constant spiral groove, starting below the junction of the splenic with the mesenteric vein and ending above it, making two complete clockwise turns. In life this can be seen as a band of thickening in the vein wall, the wall bulging between the turns of the spiral. Within the vein the band of thickening corresponds to a flap or ridge projecting from the vein wall, composed of a fold in the intima and media, bridged by a continuous adventitial coat.

This structure was present in all of twelve rabbits examined. Its occurrence in other species is being investigated. Preliminary observations suggest that it is present in other small rodents but not in dogs or man.

If, as seems likely, this structure rotates the portal blood stream within the vein, then the speed of rotation will vary with flow-rate and the distribution of the different components of the portal blood to the efferent branches of the vein will vary. Since minor fluctuations in flow-rate probably occur with the respiratory changes in intra-abdominal pressure, the final result may be randomization of the distribution within the liver of the blood from any given tributary.

The presence or absence of such a spiral fold within the portal vein of any species is clearly of great importance in assessing the probability of selective distribution of the portal blood within the liver of that species.

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Life-History of *Phyllodistomum simile* Nybelin

It is of interest to note that although sixty-one species of *Phyllodistomum* have been described, the life-cycles of only four have been determined experimentally and recorded. All four are American species. In Europe, however, no successful experimental work has been undertaken, although several early workers including Sinitsin[1], Reuss[2], Odhner[3], and Nybelin[4] have postulated, on the basis of morphological similarities, certain relationships between cercariæ, metacercariæ and sexually mature phyllodistomes. Many of the suggestions made in this connexion were contradictory.

The purpose of this communication is to place on record that the life-history of *P. simile*, a European species, has been elucidated by me under experimental conditions. The trematode was found in the urinary bladder of brown trout, *Salmo trutta* L., taken from the River Teify in mid-Wales. This appears to be the first record of *P. simile* in Britain. The tubular, motionless, sporocyst stages occurred in the epibranchial cavity and between the gill lamellæ of *Sphaerium corneum* L. The cercariæ are liberated from the daughter sporocysts through the birth pores and, after entering the epibranchial cavity of the clam, emerge to the outside through the exhalent siphon. The cercaria is of the macrocercous type, with a cercarial chamber in the tail, into which the body of the cercaria is completely retracted. It possesses a stylet, six pairs of penetration gland cells and a flame-cell formula of $2(4+4)+(4+4+4+4)$. There is no pharynx.

Attempts to infect aquatic insects and minnows, *Phoxinus phoxinus* L., were unsuccessful. Brown trout, *Salmo trutta* L., known to be free from infection, were, on the other hand, successfully infected in the laboratory with metacercariæ which had encysted precociously in the daughter sporocysts. Sexually mature worms were recovered three months after the initial infection. It is noteworthy that while the cercaria and certain aspects of the life-history differ from those described by the European workers, they bear many resemblances to those of the American species described by Beilfuss[5]. A detailed description of the cercaria and the life-history will be published elsewhere.

I am indebted to the Department of Scientific and Industrial Research for financial help, and also to Mr. L. E. Hughes, of the Veterinary Investigation Laboratories, Aberystwyth, for undertaking the experimental infection of the trout.

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July 26.

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Meiosis without Chiasmata in *Periplaneta americana*

That meiosis in *Periplaneta americana* is characterized by the absence of any visible chiasma has already been reported by Morse[1] and Suomalainen[2]. However, this absence of visible chiasmata with the consequent parallel disposition of the homologues in the bivalents from the zygotene to the pro-metaphase I, in this species, differs from that in coccids[3] and dragon-flies[4], but resembles *Callimantis*[5] inasmuch as the meiosis is pre-reductional. A thorough examination of the chromosomes during the prophase of the first meiotic division reveals that this anomalous type of meiosis is closely related to the persistence of the single thread of each homologue right from the leptotene to the pro-metaphase, and it is only during the pro-metaphase stage, which is of a little longer duration than usual, that the latter is duplicated. In fact there is very little difference between the bivalents at the late zygotene and those at the early pro-metaphase, and it is the orientation of the bivalents at the metaphase plate which results in the regular segregation (pre-reduction) during anaphase of the first division. Thus, like *Callimantis*, the diplotene and diakinesis which are of practically universal occurrence in the typical pre-reduction meiosis are altogether absent in this species.

This anomaly of meiosis in *P. americana* does not, however, go in any way against the precocity theory of Darlington[6]. The homologous chromosomes in each bivalent are held together by the force of attraction due to the singleness of each homologue, even in the absence of any chiasma, throughout the prophase of the first meiotic division. The regular disposition of the bivalents at the metaphase is, however, partly due to the repulsion of the homologues, because of their duplication and partly by their orientation, which is, perhaps, accompanied by some sort of poleward pull of the homologous centromeres towards the opposite centrosomes. Unlike *Callimantis*, therefore, where according to Hughes-Schrader[5] the two pairs of chromatids show no repulsion except at the kinetochores, the repulsion of mainly the homologues, in this species, appears to play the major part in the formation of metaphase bivalents, as is evident by the ring-like configurations at this stage. The kinetochores do not appear to show any repulsion whatever, at least in some of the bivalents. In fact the homologues of each bivalent appear to be held together, at the metaphase, by the residual affinity or the terminal attraction even in the absence of any chiasma.

A detailed account of the structure and behaviour of the chromosomes in *P. americana* will shortly be published elsewhere.

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Crossing-over in *Drosophila willistoni*

In the course of analysing the frequency of chromosomal inversions in 292 adult females of *Drosophila willistoni*, we have recorded for the first time evidence of crossing-over between two non-overlapping inversions in the same chromosome arm of this species. These findings are of some general interest since, as Dobzhansky and Epling[1] have said: "The biological function of inversions in natural populations of *Drosophila* and their principal role in the evolution of these insects might be conceived to be the suppression of crossing over between gene complexes which have reached an adaptive equilibrium. Crossing over would destroy these complexes and would result in gene combinations of different adaptive values, but would be prevented by the binding effect of the inversions".

In *D. pseudo-obscura* Dobzhansky and Epling found a strong suppression of crossing-over in the third chromosome due to inversion heterozygosis. Such suppression of crossing-over is adaptive, for the reasons Dobzhansky and Epling give. At the same time suppression of crossing-over reduces one source of genetic plasticity. However, there is gain in plasticity in other ways since crossing-over appears to be intensified on those chromosomes without inversions in individuals heterozygous for inversions on a given chromosome. This is true of *D. pseudo-obscura* as well as of other species[2]. In *D. willistoni* the inversions occur on all chromosomes. Suppression of crossing-over on all chromosomes would then cause a great reduction in genetic plasticity. But this does not seem to occur, as the following results indicate.

We have examined the frequency of inversion heterozygotes of six offspring of each of 292 crosses of wild virgin females with males of a strain homozygous for its gene arrangements. Table 1 shows the minimal frequency with which crossing-over occurred between inversions *B* and *J* on the third chromosome and between inversions *E* and *F* on the left arm of the second chromosome. These are minimal frequencies since not all crossing-over will be recorded in this way. There were insufficient numbers of pairs of heterozygous inversions on the other chromosomes for us to obtain estimates for these chromosomes. The flies were bred from three different wild fruits. There are no significant differences between the fruits, so the samples may be regarded as replicates. For chromosome *IIL* the minimal mean frequency of crossing-over between inversions *E* and *F* was 19·7. This is remarkably high as these two inversions are quite close to one another on the chromosome. For chromosome *III* the mean frequency of crossing-over between inversions *B* and *J* was 11·7. This is less remarkable as the distance between these two inversions is quite large, *B* being at the base of the chromosomes and *J* near the tip.

Table 1. Minimal estimates for the frequency (per cent) of crossing-over between inversions *E* and *F* in the left arm of the second chromosome and between inversions *B* and *J* in the third chromosome of *Drosophila willistoni*. Flies were bred from three different fruits

Fruit	Chromosome and inversion		No. of flies
	IIL *E* and *F*	*III* *B* and *J*	
Philodendron sp.	23	9	100
Psidium araça	20	11	100
Arecastrum romanzofianum	16	15	92
Mean	19·7	11·7	

These high frequencies of crossing-over in *D. willistoni* are quite in conformity with the principle formulated by Dobzhansky and Epling[1] to which we have already referred. It is what might be expected to happen in a species in which inversions are spread through all the chromosomes. The inversions maintain the integrity of blocks of genes within the inversions but do not inhibit recombination as between inversions.

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Chromosomes of the Cultivated Mushroom

Since the original work by Maire[1], the attention of a number of cytologists[2-4] has been attracted to the study of nuclear behaviour and basidiospore formation in the two-spored cultivated mushroom, *Agaricus campestris* Fr. var. *bisporus*[5]. Sass[2] first published a full account of meiosis in the basidium, and although in one of his diagrams eight bivalents are clearly figured he reported a diploid chromosome number of approximately eight, a determination which was later confirmed[4]. In the interim, however, Colson[3], after a most comprehensive study, reported a chromosome number of $n = 9$.

The results of an investigation using a variety of mushroom grown on a commercial scale in Great Britain have proved of considerable interest, and a chromosome number differing from the two earlier recorded numbers has been found. In this material,

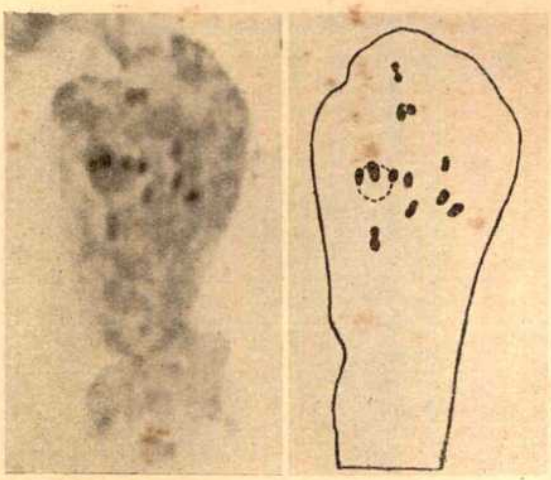

Fig. 1. Metaphase I showing twelve bivalents and a persistent nucleolus. Note the small bivalent in the 11 o'clock position (× 2,860)

twelve chromosomes have been observed at mitosis, and twelve bivalents are regularly formed at meiosis (Fig. 1). The chromosomes are extremely small and at metaphase I of meiosis the largest bivalent is slightly more than 1μ long.

Possible explanations for the reported differences in chromosome number are: (1) that different strains of the fungus having different chromosome numbers have been studied (the two haploid numbers of four were determined from American and French material, whereas the two higher counts were found in British material); or (2) that differences in chromosome number are due to limitations of technique.

In the Autobasidiomycetes, haploid chromosome numbers of $n = 4$ are most common[6], the haploid number of twelve for the mushroom being the highest reported in this group. The possibility that the variety studied is triploid has been investigated, but evidence indicative of a polyploid origin has not been found; meiotic pairing is complete and no multivalent associations have been observed.

The second possibility, that differences in chromosome number are due to inadequacy of techniques, is suggested because all earlier work was carried out using sectioned material. In the present work, considerable use was made of sectioning techniques; but it was found that reliable chromosome counts could not be obtained with such methods. The chromosomes contain considerable amounts of heterochromatin, and in many of the preparations studied there was a tendency for secondary association of bivalents. Associations of bivalent chromosomes are difficult to resolve in sectioned material, and consistently accurate counts were only achieved through the use of squash techniques. For this purpose, material was fixed in a mixture of chloroform, ethanol and glacial acetic acid (7 : 5 : 2) and stained in aceto-carmine or acetic orcein.

Although the possibility of the existence of different chromosome races cannot be ruled out, the minuteness of the chromosomes, together with the inadequacy of sectioning methods for accurate chromosome analysis, lend support to the suggestion that previous counts may have erred on the low side.

This work was conducted in the Department of Agricultural Botany, Aberystwyth, under the direction of Prof. P. T. Thomas, whose help and encouragement are gratefully acknowledged: a more detailed account will be published later.

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Dormancy of Seeds of *Phalaris arundinacea* and *Phalaris tuberosa*

DORMANCY, giving rise to irregular and poor germination, is a characteristic of certain strains of *Phalaris arundinacea* and *P. tuberosa*.

Seeds of the Welsh Plant Breeding Station strain *S*.230, a hexaploid hybrid derived from *P. tuberosa* × *P. arundinacea*, were subjected to thirteen treatments, as in Table 1, and incubated on a Jacobsen apparatus at 25° C. with access to light. Seeds of a commercial strain of *Lolium perenne* were used as a check.

The treatments involving dehulling, scarifying and pricking show a significant increase in germination compared with the control. The causal factor of dormancy remains unknown; but the following points are indicative: (1) The caryopses swell, therefore water is not limiting. (2) Pricking the palea with a pin and scarifying are partially effective, therefore a chemical inhibitor within the palea is unlikely, and this is borne out by the ineffectiveness of the soil and water treatments designed to reduce the concentration of a possible inhibitor. (3) Pricking can be effective, so mechanical impedance of the coleorhiza by the palea is unlikely, particularly as seeds dehulled after twenty-one days incubation showed no signs of rupture of the integument. (4) Treatments designed to remove epidermal secretions of wax, fat, etc., failed to have any significant effect on germination, though possibly they were not sufficiently drastic. (5) After twenty-one days incubation the palea were removed from a number of seeds within each treatment which had failed to germinate, and within 48 hr. a high percentage (30–100 per cent) had emerged.

Table 1. THE GERMINATION PERCENTAGE OF *S*.230 WHEN SUBJECTED TO VARIOUS TREATMENTS

Time / Treatment	No. of days				
	3	5	7	14	21
Acetone for 15 sec.	0	0·41	0·41	0·82	1·23
Acetone for 3 min.	0	0·79	0·79	1·2	1·2
50° C. water for 5 min.	0	0	2·9	3·9	4·5
50° C. water for 20 min.	0	0	1·6	2·8	3·6
4*N* sulphuric acid for 60 sec.	0	0·4	1·2	2·2	3·2
Ether for 15 sec.	0	2·2	2·4	4·4	5·2
70 per cent ethyl alcohol for 15 sec.	0	0·4	1·6	2·6	2·8
Germinated in 4 mm. deep tap water	0	0·4	1·2	1·4	1·6
Germinated on moist garden soil	0	0	1·2	1·2	3·6
Germinated on washed soil	0	0	1·2	2·4	2·8
Pricked with a pin	11·1	19·7	26·7	32·7	37·4
Scarified with sand paper	14·8	35·4	42·5	48·3	50·9
Dehulled	41·9	63·4	70·9	73·1	73·1
Control	0	1·2	2·8	3·4	4·8
Commercial *Lolium perenne*	36·3	84·8	88·8	90·8	90·8

A gaseous inhibitor is not inconsistent with the above facts, and it is suggested that failure to germinate is due either to a lack of oxygen, or to a build-up of carbon dioxide concentration having a narcotic effect, within the immediate region of the germinating embryo.

A more detailed report of this and other experiments will appear elsewhere.

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Differences in Social Aggregation in Two Species of Locust

Natural populations of locusts are characterized by large fluctuations in numbers, accompanied by changes in morphology, colour and behaviour in both the nymphs (hoppers) and the adults. When numbers are high, the hoppers aggregate into bands containing from a few hundred to several thousand individuals. Similar gregarious hoppers can be produced in the laboratory by rearing several together in one cage[1]. There is much circumstantial evidence to suggest that, provided the total numbers are sufficient, the formation of hopper bands depends partly on a patchy physical environment, especially a vegetation mosaic, and partly on strong attractions between hoppers[2,3].

In the laboratory, the hopper inter-attractions leading to aggregation have been studied in cages that provide a physically uniform environment[4]. In recent experiments, groups of ten hoppers were tested in an evenly lighted and heated, ring-shaped cage, the floor of which was marked radially into twenty equal divisions. When first placed in the cage, the ten hoppers moved about; but later they settled down, those in the same division generally touching one another. After 30 min. the number in each division was noted. The hoppers were then disturbed so that the groups were broken up, and after another 30-min. period the number in each division was again noted. Four such readings constituted a test. No hopper group was subjected to more than one test per day.

If the hoppers settled at random, the number of cage divisions containing 0, 1, 2, 3, and so on, would follow a binomial distribution given by the formula $(19/20 \times 1/20)^{10}$. The percentage of hoppers grouped (that is, in groups of two or more) would be 37·5, and in each test of four readings, involving 80 divisions, 48 divisions would be empty, 25 would contain one hopper and 7 would contain two or more. If more hoppers were grouped than one would expect for random distribution, then the grouping was due to the hoppers being attracted to one another, since the cage provided a physically uniform environment and the hoppers moved actively before coming to rest. Such grouping has been called social aggregation[4]. In successive tests, any differences in the amount of grouping was a measure of the difference in strength of hopper inter-attractions.

Two locust species, *Locusta migratoria migratorioides* (R. and F.) and *Schistocerca gregaria* (Forsk.), were compared. They came from the routine stocks of the Anti-Locust Research Centre that have been kept crowded in cages for many generations. Small batches of hoppers (six batches of *Locusta* and seven of *Schistocerca*) were tested soon after hatching and at intervals of one or two days afterwards until the end of the first instar. The tests were carried out at an air temperature of 28° C. and the hoppers were well fed before each test, these physical conditions having been found to be optimal for social aggregation in both species[4,5].

Table 1. The Average Number of Divisions containing 0, 1, 2, 3 or more Hoppers

(The figures are based on 3–5 separate tests, each test consisting of four readings)

Age from hatching	*Locusta*					*Schistocerca*				
	No. of hoppers per division				P*	No. of hoppers per division				P*
	0	1	2	3 or more		0	1	2	3 or more	
Up to 3 hr.	47	27	5	1	>0·8	52	21	4	3	>0·5
6–12 hr.	53	19	6	2	>0·3	55	15	6	4	<0·05
1 day	52	20	6	2	>0·3	58	13	4	5	<0·02
2 days	55	16	4	5	>0·05	58	12	6	4	<0·01
3 days	58	12	5	5	<0·01	59	13	2	6	<0·02
4 days	58	13	5	4	<0·02	58	13	4	5	<0·02
5 days (near to moulting)	55	15	6	4	<0·05	55	15	6	4	<0·05

* Probability of distribution being random

Soon after hatching and the intermediate moult, when the cuticle was still a little soft, the hoppers of both species distributed themselves at random within the cage (Table 1). About six hours after hatching, the *Schistocerca* hoppers showed strong attractions for one another and their distribution was probably not a chance one. One day after hatching, *Schistocerca* showed maximum social aggregation and the hopper distribution differed significantly from chance. This contrasted strongly with the behaviour of the *Locusta* hoppers, which continued to settle at random until they were two or three days old, maximum aggregation not occurring until they were three or more days old.

The hatching of hoppers of swarming populations of *Schistocerca* has often been observed in the field. The hoppers of each egg pod usually hatch within a few minutes of one another[2] and the number from a single pod is generally between 40 and 90. Consequently, the hoppers begin their life by being grouped. For the first five or six hours after hatching they are very inactive and remain grouped around the egg-pod holes. If they are undisturbed, very little movement takes place during the first day. The laboratory experiments suggest that one day of grouping is sufficient for the hoppers to learn to aggregate and so to resist factors leading to dispersal. No corresponding field observations have yet been made with hatchlings of swarming populations of *Locusta*, but the specific difference in social aggregation demonstrated in the laboratory suggests that under natural conditions hatchlings of *Locusta* are more easily dispersed than those of *Schistocerca*. It also seems likely that a patchy physical environment is of greater importance in the retention of groups and the formation of new ones in *Locusta* than in *Schistocerca*.

I wish to thank Prof. G. C. Varley for laboratory facilities in the Hope Department, Oxford.

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Aug. 17.

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"Lucubratory Biochemistry"

Under this title a review of my biochemistry text-book was published in *Nature* of March 24, p. 544. The reviewer criticizes many of my statements by expressions such as "astonishing dictum", "Paradox indeed", or by other ironical remarks. A reply to each of the numerous comments would occupy much space. Therefore, only a few of them can be answered here.

The reviewer quotes as "interesting" the statement that natural isotopes are stable, and asks: "Has Dr. Haurowitz never heard of naturally occurring radioactive isotopes, for example of potassium or of carbon ?" It is not evident from the review that the statement criticized is made in a section on "Methods", in which only those isotopes are treated which are used as tracers in biochemical research. Obviously, the statement on the stability of natural isotopes applies only to isotopes of this type. Natural radioactive potassium and carbon, mentioned in the question of the reviewer, are not used as tracers. Potassium-42 and carbon-14, used in tracer work, are produced artificially. The obvious answer to the first part of the question asked by the reviewer is that every high-school boy knows about the occurrence of uranium and of other radioactive isotopes in Nature. One may wonder why the question was asked.

The review contains the following comment: "On p. 132 the statement is made, 'The amino acids are colorless substances that are soluble in water', although later the insolubility of cystine in water is mentioned (p. 156)". On p. 156 I wrote: "Cystine, in contrast to cysteine, is almost insoluble in water". Omission of the word "almost" creates here a contradiction.

Another comment refers to the following words of my book: "Attempts to prepare estrogenic hormones synthetically, led to the unexpected result that certain *stilbene derivatives*, such as dihydroxydiethylstilbene, are just as active as estradiol". This statement is criticized as "historically incorrect, as can be seen by consulting the early papers of Dodds and his collaborators". Dodds and his co-workers, in their paper on the œstrogenic activity of stilbene derivatives (*Proc. Roy. Soc.*, 127, p. 140), wrote: ". . . in view of the difficulties presented by the total synthesis of the naturally occurring œstrogenic hormones, attempts were made to prepare more accessible substances the molecules of which would be similar to œstradiol in shape, weight and in the situation of the hydroxyl groups". Readers of *Nature* will now be able to judge whether my presentation was "historically incorrect".

More than a dozen examples of a similar type could be added. They would not show more than the three examples given above, namely, that most of the comments of the reviewer are hypercritical and that the text of my book is not so inadequate as it may appear to those who read only the review in *Nature*.

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Since my review was critical, I attempted to be as fair as possible by quoting at length some of the extracts with which I did not agree. I do not believe that any useful purpose can be served by arguing about individual points, although I could take up each of the comments which Prof. Haurowitz has made. I am content to leave those who wish to judge whether my review was fair or not to read it in relation to the book itself.

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A Word Common to the Natives of Alaska, Canada, Greenland and Brazil

Dr. Nicholas Polunin has suggested that I should direct the attention of botanists and others to the ancient provenance of a word which appears to mean fundamentally 'the juice of a plant that is used for chewing', as a chewing gum.

Not being English or French, but of speech a mid-west American from Manitoba and Dakota, it did not mean anything to me when in 1906 I heard the Eskimos of the Mackenzie Delta and north-eastern Alaska speaking of spruce gum as 'kutsuk'. They used to fetch this themselves from the evergreen forest to the south or buy it from the forest Indians; more recently, they had been buying flavoured chewing gum from the whalers, which they also spoke of as 'kutsuk', as they did of a substitute of their own, dried seal blood, which they said they "always" used in the pre-white days if they ran out of spruce gum for their children to chew.

Years later, perhaps in 1912, I learned that the word for the gum of a Brazilian plant, and of other South American plants, is 'caoutchouc', and the Oxford Dictionary defines it as "a milky resinous juice of certain trees in S. America . . .". The Oxford Dictionary goes on to connect the derivation of this word for rubber with a French expedition to the Amazon country in 1739. 'Webster' has the same tale, more briefly, and gives varied spellings, among them 'caucho' and 'gutteux'. I like the last best, for it is nearest to what I have heard among the Eskimos from Bering Strait to Coronation Gulf. They said 'gutsuk', the *s* as always in their tongue with an *sh-* sound.

Turning now to Greenland, in Sam. Kleinschmidt: "Den Grønlandske Ordbog" (Copenhagen, 1871), I find "kutsuk. (1) Harpix (det almindelege, af Naaletraeer; (2) hvad der paa samme Maade udsondrer sig i andre Traeer: Gummi, Campher og lignende producter". Schultz-Lorentsen's "Dictionary of the West Greenland Eskimo Language" (Copenhagen, 1927) has only: "kutsuk, resin, gum".

So we appear to have in the New World a term for the gum of a plant which people use for chewing and call by the same name from Greenland to Alaska to Brazil. When I first began to talk about this, I was told it was coincidence. But the intellectual climate is changing, among other things in linguistics, and now the disciples of men like Uhlenbeck and Hammerich think 'connexion' a likelier word than 'coincidence'. Incidentally, I found the Eskimos saying 'ignirk' for fire and I knew that the Romans said 'ignis'; but again my linguist friends said 'coincidence'; now I believe the followers of Uhlenbeck think we have in this a connexion from the Sanskrit to the Latin to the Eskimo.

Vilhjalmur Stefansson

Dartmouth College,
Baker Library,
Hanover, New Hampshire.

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, November 5

Society of Engineers (in the Apartments of the Geological Society, Burlington House, Piccadilly, London, W 1), at 5 30 p.m.—Mr. D. F. Collins: "Gas Turbines in Theory and Practice".

Society of Chemical Industry (at 14 Belgrave Square, London, S.W.1), at 6.30 p.m.—Dr. T. V. Arden: "Recovery of Uranium from Low-grade Ores".

Royal Institute of Chemistry (at Norwood Technical College, Knights Hill, West Norwood), at 7 p.m —Mr. E N. Jenkins: "Laboratory Techniques in Radiochemistry".

Tuesday, November 6

Royal Geographical Society (at 1 Kensington Gore, London, S.W.7), at 5 p m.—Prof. M E. L. Mallowan: "Twenty-five Years of Mesopotamian Discovery".

Institution of Civil Engineers (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. H. J. F. Gourley . Presidential Address.

Institution of Electrical Engineers, Measurement and Control Section (at Savoy Place, London, W.C.2), at 5 30 p.m.—Dr. E. H. Holt: "Electric Strength of Highly Compressed Gases"; Dr. P. R. Howard: "Insulation Properties of Compressed Electro-Negative Gases".

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. W. A. Robson: "The Welfare State".* (Hobhouse Memorial Lecture.)

University of London (in the Gustave Tuck Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m —Mr J. A. Ratcliffe: "The Ionosphere".* (Further lectures on November 13, 20 and 27)

Wednesday, November 7

Institute of Petroleum (at 26 Portland Place, London, W.1), at 3 p.m.—Symposium on "Digital Computers in the Petroleum Industry".

Institution of Chemical Engineers (at the Royal Institution, Albemarle Street, London, W.1), at 3 p m.—Symposium on "Grinding".

Royal Statistical Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p m —Symposium on "The Spectral Approach to Time Series". Papers by Mr. A. M. Walker, Mr. S. K. Zaremba and Mr. Z. A. Lomnicki and Dr. P. Whittle.

Society for Analytical Chemistry (in the Meeting Room of the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p m.—Dr. H. M. N. H. Irving: "The Structure of Dithizone and its Metal Complexes".

Thursday, November 8

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. M. Blackman and Mr. N. D. Lisgarten: "The Cubic and other Structural Forms of Ice at Low Temperature and Pressure"; Mr. J. F. Nye: "The Distribution of Stress and Velocity in Glaciers and Ice Sheets".

Institution of Electrical Engineers (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. J Eccles: Lecture on the Visit of the British Electricity Supply Delegation to the Soviet Union.

Society of Chemical Industry, Road and Building Materials Group (at 14 Belgrave Square, London, S.W 1), at 6 p.m —Mr. D. C. Broome and Mr. A. Please: "The Use of Mechanical Tests in the Design of Bituminous Road Surfacing Mixtures, Part 2—Stability Tests on Rolled Asphalt".

Institution of Mechanical Engineers, Lubrication and Education Groups (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p.m.—Discussion on "The Extent to which Lubrication should enter into First Degree and H.N.C Courses".

Royal Institute of Chemistry (joint meeting with the Acton Technical College Scientific Society, at Acton Technical College, High Street, Acton, London, W.3), at 7 p m.—Prof. M. J. S. Dewar: Some Aspects of Modern Theoretical Chemistry".

Friday, November 9

Institution of Mechanical Engineers, Hydraulics Group (at Birdcage Walk, Westminster, London, S.W 1), at 6 p.m —Mr. [illegible] H. Lever, Dr H. Ritter, Mr. M. Woolfson and Mr. C. T. Wright: Rotating Beam Channel and 30-in. Water Tunnel at the Admiralty Research Laboratory".

University of London (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at .30 p.m.—Mr. A Renfrew: "Plastics in Perspective".* (Fifth of en University Extension Lectures on "Technology and Industry". Further lectures on November 16, 23, 30, December 7 and 14.)

Society of Chemical Industry, Fine Chemicals Group (in the Chemistry Lecture Theatre, King's College, Strand, London, W.C.2), at 7 p.m.—Dr. F. Sanger . "The Chemistry of Insulin".

Royal Institution (at 21 Albermarle Street, London, W.1), at p.m.—Prof. Sir Charles Dodds, F.R.S. . "The Chemical Substances influencing Mental and Physical Development".

Friday, November 9—Saturday, November 10

British Society for Immunology (at the Wellcome Foundation, 183 Euston Road, London. N.W.1), at 10 a.m.—Scientific Papers. Friday afternoon—Symposium on "Complement".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned

Biologist (with a degree in biochemistry or physiology) to the Hospital and Medical School—The Secretary, King's College Hospital Medical School, Denmark Hill, London, S.E.5 (November 9).

Assistant, Grade B, in Physics—The Clerk to the Governors, Woolwich Polytechnic, London, S.E.18 (November 10).

Scientist (with a good degree (preferably in chemistry) or equivalent qualification, and preferably previous editorial experience), for duties which include the progressing of research programmes, editing research reports, etc.—The National Coal Board, Coal Research Establishment, Stoke Orchard, near Cheltenham, Glos, quoting X.450 (November 12).

Pasture Research Officers (3) (either with a degree in the natural sciences, with botany as a major subject, and postgraduate training in ecology and pasture research, or a degree in agriculture with training in pasture research, and preferably with experience in the establishment and management of pastures and in the management of dairy cattle and sheep) in the Department of Research and Specialist Services, Federal Ministry of Agriculture, Federation of Rhodesia and Nyasaland—The Public Service Attaché, Rhodesia House, 429 Strand, London, W.C.2 (November 15).

Hospital Biochemist, Senior or Principal Grade (with a university degree in science or equivalent qualification, and preferably with a higher qualification or good research experience), in the routine Biochemical Laboratory—The House Governor and Secretary, Royal Victoria Infirmary, Newcastle-upon-Tyne 1 (November 17).

Lecturer in Psychology in St. Salvator's College—Joint Clerk to the University Court, College Gate, St. Andrews (November 17).

Physical Chemists and Chemical Engineers (with a good honours degree or equivalent, and preferably experience), for important technical research into developing new processes for making smokeless fuels—The National Coal Board, Coal Research Establishment, Stoke Orchard, near Cheltenham, Glos, marking envelope "X/447" (November 19).

Assistant Lecturer in Zoology—The Secretary, The Queen's University, Belfast (November 20).

Senior Lecturer, Lecturer or Assistant Lecturer in Botany at the University, Khartoum—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (November 20).

Lecturer (British subject, with a first- or second-class honours degree in mathematics, and preferably teaching experience) in the Department of Mathematics—The Director of Studies, Royal Naval College, Greenwich, London, S.E.10 (November 24).

Lecturer (with special qualifications in palæontology) in Geology—The Registrar, King's College, Strand, London, W.C.2 (November 24).

Assistant in Inorganic or Physical Chemistry—Joint Clerk to the University Court, Queen's College, Dundee (November 30).

Chair of Geology in the University of Khartoum—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (November 30).

Lecturer or Assistant Lecturer in Mathematics at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, November 30).

Lecturer (with a degree or diploma and preferably research, teaching and industrial experience) in General Chemistry for Engineering Students in the School of Applied Chemistry, New South Wales University of Technology, Sydney, Australia—The Agent-General for New South Wales, 56 Strand, London, W.C.2 (Australia, November 30).

University Lecturer in Mathematics—The Secretary, Appointments Committee of the Faculty of Mathematics, The Arts School, Bene't Street, Cambridge (November 30).

X-Ray Crystallographer (preferably with some experience of powder methods and work on metals), for special investigation sponsored by the Central Electricity Authority—The Secretary, Birkbeck College (University of London), Malet Street, London, W C.1 (December 1).

Chair of Chemistry—The Secretary and Registrar, The University, Southampton (December 15).

Senior Physicist (with a B.Sc. degree, preferably with honours in physics, and an extensive knowledge of electronics) with the Auckland Hospital Board, New Zealand, for duties which include responsibility for a 4 MeV. linear accelerator—Office of the High Commissioner for New Zealand, 415 Strand, London, W.C.2 (New Zealand, December 31).

Biologist (with a biological degree with emphasis on botanical and biochemical subjects) to carry out an investigation into the nature of the food of British wildfowl and into the nutritional requirements of wildfowl in captivity—The Assistant Director (Research), The Wildfowl Trust, Slimbridge, Gloucestershire.

Chemist (with an honours degree or A.R.I.C. or F R.I.C., and at least three years post-qualification experience) in the Medical Department, Government of Hong Kong—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.117/51/018.

Engineer or Physicist (young graduate, preferably with some mathematical ability and experience in the use of electronic instruments) at Sheffield, for work on the problems of file testing and manufacture—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W 1, quoting "F 2".

Experimental Officer/Assistant Experimental Officer (with at least H.N.C. chemistry or equivalent), to assist in fundamental and applied investigations relating to radioisotopes and surfaces—The

Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting Ref. A 1154/34.

EXPERIMENTAL OFFICER (at least 26 years of age, with higher school certificate, or equivalent qualification, in science subjects) WITH THE TECHNOLOGICAL IRRADIATION GROUP of the Isotope Division, to be responsible for the operation of a number of kilocurie radiation sources, and projects associated with the investigation of the effects of radiation on chemical reactions, foods and other materials—The Establishment Officer, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting 661/34

LABORATORY TECHNICIAN (qualified in biochemistry or chemical pathology) IN THE DEPARTMENT OF CHEMICAL PATHOLOGY—The Finance Officer, St. Thomas's Hospital Medical School, London, S.E.1.

METEOROLOGIST (well qualified and experienced) with the Government of Cyprus, to investigate meteorological stations and the needs of technical departments concerned for climatological research; to advise on measures needed for reorganization, and to train a suitable Cypriot officer as his successor—The Director of Recruitment, Colonial Office, London, S W.1, quoting BCD.57/17/01.

PHYSICIST/CHEMIST (male or female, M.Sc. or B.Sc. (Hons.) with majors in chemistry and physics, and a knowledge of microscopy) IN THE MINES DEPARTMENT, Government of Northern Rhodesia, to undertake research into the problems of silicosis, particularly in connexion with analysis of mine-dust samples by X-ray diffraction and by chemical methods, and to set up and equip a laboratory at the Headquarters of the Mines Department in Northern Nigeria—The Director of Recruitment, Colonial Office, London, S W.1, quoting BCD.99/3/04.

RESEARCH FELLOW (with a degree in either physics, chemistry or metallurgy) IN THE FIELD OF THE VISCOSITY OF MOLTEN METALS—The Department of Industrial Metallurgy, The University, Edgbaston, Birmingham 15.

SCIENCE GRADUATE (preferably with experience in clinical biochemistry), to work on metabolic studies at the Institute of Orthopædics, Royal National Orthopædic Hospital, Stanmore, Middlesex—The Dean, Institute of Orthopædics, 234 Great Portland Street, London, W 1.

SCIENTIFIC OFFICER (with a good honours degree and an interest in biological problems, and preferably some research experience) IN THE CHEMISTRY DEPARTMENT to take part initially in researches on the chemistry of the milk proteins and enzymes—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, quoting Ref. 56/12.

SENIOR LECTURER or LECTURER IN MATHEMATICS; SENIOR LECTURERS or LECTURERS IN RADAR AND TELECOMMUNICATIONS; and a SENIOR LECTURER or LECTURER IN ENGINEERING PHYSICS at the Royal Military College of Science, Shrivenham—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.361/6A.

SENIOR LECTURER (with a higher degree or considerable practical or research experience) IN CIVIL ENGINEERING with either hydraulics, hydrology or public health engineering—The Secretary, Royal College of Science and Technology, Glasgow, C.1.

SOIL ANALYST (with a good honours degree in chemistry and not less than three years postgraduate experience in soil or agricultural chemistry) IN THE DEPARTMENT OF SOIL AND LAND-USE SURVEY, Gold Coast Local Civil Service, to supervise routine analysis of soil samples, to carry out special soil analysis and laboratory investigations relating particularly to the nutrient status of soils used for cocoa production, and to undertake the training of junior analytical assistants—The Director of Recruitment, Colonial Office, London, S.W 1, quoting BCD.79/13/06.

SOIL SCIENTIST (with an honours degree in natural science, chemistry and/or botany) in Gambia (H.M. Oversea Civil Service), to undertake research into soil deficiencies—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.63/12/010.

TECHNICIAN (male or female, preferably with research experience) IN THE DEPARTMENT OF PHARMACOLOGY—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2.

ZOOLOGIST (with a good honours degree in zoology and preferably the ability to pilot light aircraft) to assist in the study of the populations and ecology of wildfowl—The Assistant Director (Research), The Wildfowl Trust, Slimbridge, Gloucestershire.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Department of Scientific and Industrial Research: Road Research Laboratory. Road Research Technical Paper No. 36: The Sampling and Analysis of Rolled Asphalt and Coated Macadam. By C M. Hongh. Pp vi+30+3 plates. (London: H.M. Stationery Office, 1956.) 3*s.* net [238

1956 Supplement to *British Chemicals and their Manufacturers.* (The Directory of the Association of British Chemical Manufacturers.) Pp. 35 (London: Association of British Chemical Manufacturers, 1956.) [238

Ministry of Housing and Local Government and Scottish Office. The Surface Water Year-Book of Great Britain, 1953–54: Hydraulic Statistics for British Rivers together with related Rainfalls, for the year ended 30th September, 1954. Pp. xiii+117. (London: H.M. Stationery Office, 1956.) 30*s.* net. [238

Ministry of Agriculture, Fisheries and Food. Domestic Food Consumption and Expenditure, 1954: Annual Report of the National Food Survey Committee. Pp. v+89. (London: H.M. Stationery Office, 1956.) 5*s* net [238

National Union of Journalists. Freelance Directory, 1956 Pp. i+66. (London: National Union of Journalists, 1956.) [238

Department of Scientific and Industrial Research. Report of the Building Research Board with the Report of the Director of Building Research for the year 1955. Pp. iv+72+16 plates. (London: H.M. Stationery Office, 1956.) 5*s.* net. [238

Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences. No. 668, Vol. 240 (23 August 1956): The Layered Ultrabasic Rocks of Rhum, Inner Hebrides. By G. M. Brown. Pp. 1–53+5 plates. 27*s.* No. 669, Vol. 240 (23 August 1956): Properties of a Mass of Cells Capable of Regenerating Pulses. By R. L. Beurle. Pp. 55–94. 12*s.* 6*d.* (London: Royal Society, 1956.) [238

Land Utilization Map of Cyprus. (Bude and London: Geographical Publications, Ltd., 1956. Published for the World Land Use Survey.) 3*s.* [119

Single Story Industrial Buildings. Pp. 44. (London: Cement and Concrete Association, 1956.) [189

The Renaissance of Inorganic Chemistry. By Prof. R. S. Nyholm (An Inaugural Lecture delivered at University College, London 1 March 1956.) Pp. 24. (London: H. K. Lewis and Co., Ltd., 1956. 2*s.* 6*d.* net. [189

Other Countries

The Written Word in Agricultural Advisory Work. Pp. 78. (Paris Organisation for European Economic Co-operation; London: H M Stationery Office, 1956.) 450 francs; 9*s.*; 1.50 dollars. [238

Acta Universitatis Debreceniensis de Ludovico Kossuth Nominatae Tom. 1, 1954. Pp. 206. (Budapest · Tankonyvkiadó, 1954.) [238

Bibliographie des Articles Parus dans les Périodiques Turcs, 1953 Index des noms d'Auteurs. Pp. 53. (Publication de l'Institut Nationa Turc de Bibliographie.) (Istanbul: Maarid Basimevi, 1956.) [23

Atvinnudeild Háskólans: Fiskideild. Fjölrit Fiskideildar Nr. 6 Astand Sjávar á Sildeveidisvaedinu Nordanlands Sumarid 1955 By Unnsteinn Stefánsson. (Hydrographic Conditions on the North Icelandic Herring Grounds during the Summer, 1955. With an English Summary.) Pp. ii+23. Fjölrit Fiskideildar, Nr 7: Rannsoknir á Atu, Hitastigi og Dreifingu Sildar Gerdar á Rannsóknaskipinu "Aegi" Sumarid 1955. By Hermann Einarsson. (Observations o Plankton, Temperature and the Distribution of Herring, made from th research vessel "Aegir", during the Summer of 1955. With an Englis Summary.) Pp. ii+21+7 plates. (Reykjavik: Atvinnudeild Háskólans: Fiskideild, 1956.) [23

Australian Map of Antarctica. Second edition, revised. (Canberra Antarctic Division, Department of External Affairs, 1956.) [23

The Carlsberg Foundation's Oceanographical Expedition Round th World, 1928–30, and previous "Dana" Expeditions. Dana Report No 42: The Miripinnati—a New Order of Teleost Fishes. By E. Bertelse and N. B. Marshall. Pp. 34+1 plate. (Copenhagen: Andr. Fred Høst and Son, 1956.) 10 Kr. [23

East Africa High Commission. Annual Report of the East Africa Council for Medical Research, 1954–1955. Pp. ii+40. (Nairobi East African Council of Medical Research, 1956.) [23

National Academy of Sciences—National Research Council. Nint Annual Report of the Pacific Science Board, 1955. Pp. 58 (Washington, D.C.: National Academy of Sciences—National Research Council, 1956.) [18

Fiskeridirektoratets Skrifter. Serie Havundersøkelser. Vol. 1 No. 5: Theragra Finnmarchica N.SP. Gadus Poutassou, Risso Rala Spinicauda, Jensen. Eumicrotremus Spinosus Subspec. No Eggvinii Av Einar Koefoed. Pp. 24+3 plates. Vol. 11, No. 6 Cod Populations Identified by a Chemical Method. By Eva Hen Dannevig. Pp. 13. (Bergen · A/S John Griegs Boktrykkeri, 1956.) [18

Biologische Bundesanstalt fur Land- und Forstwirtschaft in Berli Dahlem. Bibliographie der Pflanzenschutz-Literatur (Bibliograph of Plant Protection), 1950. Bearbeitet von Dr. J. Bärner. Pp. xlii+438. (Berlin: Biologische Bundesanstalt fur Land- und Forstwirtschaft, 1956.) [18

Bulletin of the Museum of Comparative Zoology at Harvard Colleg Vol. 114, No. 7: Post-Triassic Nautiloid Genera. By Bernhar Kummel. Pp. 321–494+28 plates. (Cambridge, Mass.: Museum o Comparative Zoology at Harvard College, 1956.) [18

World Health Organization. Venereal Diseases: a Survey of Existing Legislation. Pp. 44. (Originally published in the Internation Digest of Health Legislation, 1956, 7, 155–198.) 2 Swiss francs 3*s.* 6*d.*; 0.70 dollars. The Training of Sanitary Engineers: Schoo and Programmes in Europe and in the United States. By Milivo Petrik. (World Health Organization Monograph Series, No. 32 Pp. 151. 12 Swiss francs; 20*s.*; 4 dollars. (Geneva: World Healt Organization; London: H M. Stationery Office, 1956.) [18

World Health Organization. Technical Report Series. No. 105 Expert Committee on Psychiatric Nursing—First Report. Pp. 4 1 Swiss franc; 1*s.* 9*d.*; 0.30 dollars. No. 107: Joint FAO/WH Conference on Food Additives, Geneva, 19–22 September 1955—Repor Pp. 14. 1 Swiss franc; 1*s.* 9*d.*; 0.30 dollars. No. 108: Expe Committee on Biological Standardization—Ninth Report. Pp. 2 1 Swiss franc; 1*s.* 9*d.*; 0.30 dollars (Geneva · World Health Organization; London: H.M. Stationery Office, 1956.) [18

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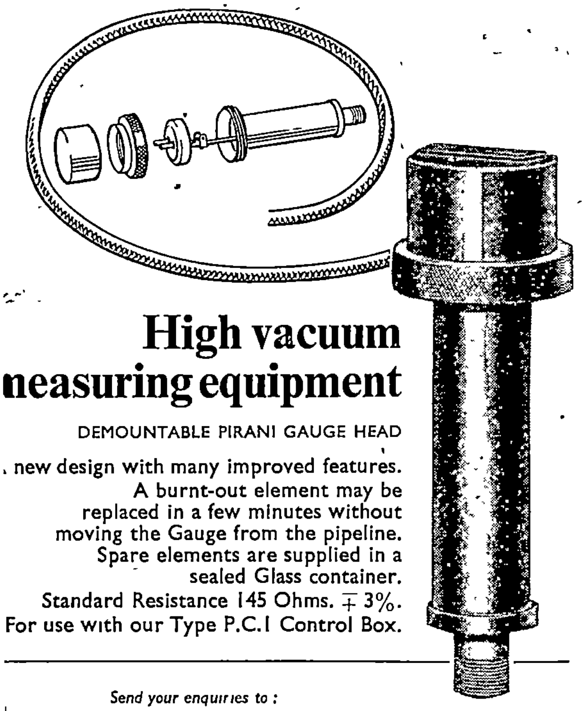

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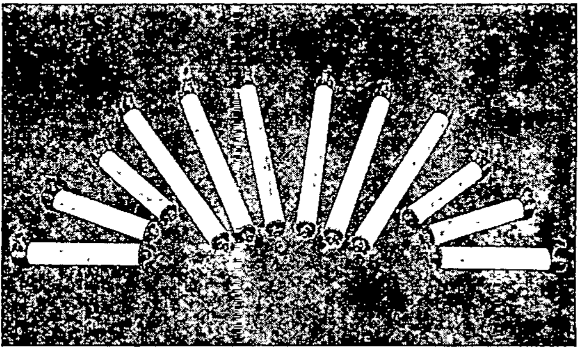

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LECTURES AND COURSES

UNIVERSITY OF BIRMINGHAM

A summer course on "Oilfield Reservoir Engineering" will be held in the University of Birmingham during July 1-26, 1957. The course, which will be residential, will comprise lectures by members of the Petroleum Production Department of the university and specialist lectures from industry, including, in particular, the British Petroleum Company Limited.

Further information can be obtained from H. Gilmour, Petroleum Production Department, University, Edgbaston, Birmingham, 15.

G L. BARNES,
Secretary.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

LONDON, S W.7

TECHNICAL OPTICS SECTION

A course of six lectures on "Microwave Optics" will be given by Dr. J Brown (University College, London) on Tuesdays and Thursdays at 4.30 p m., commencing Tuesday, November 27, 1956, but omitting November 29. The lectures will be held in the Physics Department, Royal College of Science, Imperial Institute Road, South Kensington. The fee for the course is £2 2s Students of the College and Inter-Collegiate students will be admitted free.

Copies of the syllabus and application forms may be obtained from the Registrar of the Imperial College, Prince Consort Road, S.W.7.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

(TECHNICAL OPTICS DEPARTMENT)

A Course of eight lectures
on
MICROSCOPY
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Tuesdays and Thursdays at 4 p.m., commencing Tuesday, January 29, 1957.

A course of practical work will also be given from February 25 to March 22, 1957. This will consist of 8 periods of 3 hours each.

Application for admission should be made to the Registrar of the Imperial College, Prince Consort Road, London, S.W.7.

The fee is two guineas for the lectures, and four guineas for the practical work.

UNIVERSITY COLLEGE LONDON

FREE PUBLIC LECTURES, AUTUMN TERM, 1956

Thursdays, November 15, 22, at 5 p m; Dr. Dorothy Needham, "The Biochemistry of Muscular Action."

Thursday, November 29, at 5 p m, Professor G. F. Marrian, "Some Recent Progress in the Biochemistry of the Oestrogenic Hormones."

Complete list of public lectures (including lunch-hour lectures), from Publications Officer, University College, Gower Street, W.C 1. (Stamped addressed envelope required.)

THE POLYTECHNIC

REGENT STREET, W 1

DEPARTMENT OF CHEMISTRY AND BIOLOGY

Six lectures on "Ionic Reactions in Organic Chemistry" will be given on Friday evenings at 7 p.m. commencing November 2, 1956.

Lecturers: Professors E. D. Hughes, C A Vernon, Drs. V. Gold, P. B. D. de la Mare, W Davey, R. J. Gillespie.

Fee for the course: 11s.

Enrolment forms may be obtained on application to the Director of Education.

OFFICIAL APPOINTMENTS

AUDIO-VISUAL AIDS OFFICER

Applications for the above appointment for an initial term of three years are invited from suitably qualified and experienced persons. The appointee will be required to live in Sydney, Australia, but must be prepared to travel on duty within the South Pacific area in order to promote the development of the audio-visual aids project. Initial salary in range £stg.1,000 to £stg.1,300, plus special allowances.

For further particulars, including outline of duties and details of allowances, apply by airmail to South Pacific Commission, Box 5254, G.P.O., Sydney, Australia.

Applications should be sent by airmail to Secretary-General, South Pacific Commission, Noumea, New Caledonia, and postmarked not later than December 15, 1956.

TOBACCO RESEARCH BOARD OF RHODESIA AND NYASALAND

APPOINTMENT OF BIOCHEMIST

The appointment of Biochemist to the Board is open to applicants with suitable training and experience in biochemical work Physiology training will be considered an advantage. Investigational work would include biochemical, chemical and physical analyses of tobacco from fertilizer, rotation, variety, breeding and other experiments now in progress at the Board's Headquarters in the Federation. Commencing salary would be at the rate of £2,050 per annum, any higher offer being subject to negotiation dependent on qualifications and experience.

Application, nominating two referees, should be made in the first instance to the Director, Tobacco Research Board of Rhodesia and Nyasaland. P O. Box 1909, Salisbury, Southern Rhodesia, by November 30, 1956. Consequent on the initial consideration of applicants, further information would be forwarded concerning conditions of service, etc.

PHYSICIST

(SENIOR GRADE)

Applications, with the names of two referees, are invited for the above post in the Radiotherapy Department, Charing Cross Hospital, London, W C 2 Hospital experience is not essential but a knowledge of X-rays, radium and radioactive isotopes is required. Duties concern routine Radiotherapy Physics, and the applications o' radioactive substances in other branches of medicine Salary scale £950 per annum to £1,280 per annum.

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GOVERNMENT ORGANIZATION OF RESEARCH

IN view of the attempts which are frequently made to compare both the magnitude and the organizaion of the research effort in Great Britain with that in the United States, the report "Organization of the Federal Government for Scientific Activities" which has recently been issued by the National Science Foundation in its National Science Studies series is of considerable interest*. It is one of a series of publications which set forth the basic facts concerning he scientific research effort of the United States, and is the outcome of a study made by the National Science Foundation in 1954 and 1955. It covers not only the conduct of research and development but also their planning and administration and the expansion of facilities for this purpose, the training of scientific man-power and the dissemination of cientific information, as well as the collection of tatistics in the natural and social sciences and such matters as testing, evaluation and standardization.

The report is in two parts, the first being a direct sequence to the Steelman Report of 1947, and giving pecial attention to subsequent developments. The econd, which occupies more than three hundred of he 340 pages, describes the organization for scientific activities of each department and agency of the Federal Government. It does not attempt to give more than a summary of the scientific effort of the Government as a whole, though the nature of the scientific programme of the thirty-eight departments and agencies is briefly indicated.

This second part of the report should serve as a reference work on the scientific activities of the Federal Government, to which there is nothing parallel in Great Britain either in scope or scale. Thus in Britain the account of "Government Scientific Organization in the Civilian Field" which the Advisory Council on Scientific Policy produced in uly 1951 does not deal with the defence departments, nor does it indicate the man-power employed by the various departments and agencies on scientific ctivities, excluding grants to the universities through the Universities Grants Committee. Without fuller nowledge of the man-power and resources involved —as is provided in the American report for the United States—effective discussion of the scale and irection of the scientific effort of Britain is hamstrung, as was evident in the recent discussions on the Department of Scientific and Industrial Research Bill. Mr. James Callaghan, for example, in urging n July 16 in the House of Commons the need for more effective co-ordination in research, particularly between the Service Departments and the Civil Departments, put the present expenditure on research at £235 million, of which the Department of Scientific and Industrial Research was responsible only for some £10 million. He could, however, only add that, or the rest, the great bulk of the expenditure was n the research side.

The National Science Foundation does not in this report give the total Federal expenditure on research, though it points out that in 1954 defence research accounted for 86 per cent of the Federal expenditure on research, as compared with an estimated 20 per cent in 1938. Figures given in the report put the total expenditure on defence at little short of 19,000 million dollars out of 23,500 million and the scientific staff at some 23,000, of whom all but 191 are in one or other of the three Services, out of a total of 45,000 scientists in Government service. The analysis is made by departments and agencies but gives the expenditure and personnel devoted to scientific activities as compared with that devoted to the total activities of the department or agency and not necessarily that given to research alone. Even so, we are left with a much clearer picture of the scientific effort of the Federal Government, in which the magnitude of its research effort can be fairly clearly discerned.

This is assisted by the way in which the report directs attention to the major developments in the Federal Organization for Scientific Activities since 1947. In 1953, for example, the research functions of the Department of Agriculture were reorganized, the Bureau of Agricultural Economics being abolished and its functions distributed between the Agricultural Research Service, to which was assigned all the production and utilization research of the Department, except forestry research, and the Agricultural Marketing Service, which was made responsible for marketing research and related statistical and economic research. The Agricultural Research Service was also made responsible for the conduct of the soil conservation research, previously carried out by the Soil Conservation Service, for certain grass and range-management research, formerly done by the Forest Service, and for some of the research and development work from the Foreign Agricultural Service. The Department's expenditure in 1954 totalled 750 million dollars, of which just over 76 million went on scientific activities, in which 3,848 out of its scientific staff of 16,123 (out of a man-power force of 77,405) were engaged.

Nuclear research and production was transferred from military to civilian control in January 1947; but it was more than a year later that the Manhattan Engineer District transferred the last of its contracts to the Atomic Energy Commission, the expenditure of which in 1954 totalled just over 1,417 million dollars; of this total 266 million dollars was on scientific activities, in which 99 out of its 1,009 scientific staff were engaged. The staff of the Commission totals 6,029, but about two-thirds of the research and development programme is conducted in Government-owned facilities operated under contract by industrial and institutional contractors, and of these the Ames Laboratory, Bettis Plant and the Brookhaven National Laboratory have been established since 1947. In its early years, the Commission's research and development programme was organized in five divisions: production, research and development, engineering, military application, and biology and medicine. In 1949 the Division of Engineering was placed within a new Division of Reactor Development, the Division of Research participating in advanced reactor work and supporting research, while in 1954 an assistant general manager of research and development was appointed. It is emphasized that scientists have consistently occupied key roles in the formulation of policy, and close working relations have been maintained between the Division of Military Application and the Armed Forces Special Weapons Project, the Military Liaison Committee serving as the major means of interchange of advice and information with the Department of Defence at the policy level.

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* National Science Foundation. Organization of the Federal Government for Scientific Activities. Pp. vii+349. (Washington, D.C.: overnment Printing Office, 1956.) 1.75 dollars.

The Department of Commerce, with a total expenditure of nearly 990,000,000 dollars and a staff of 41,539, employs a staff of 6,486 scientists, of whom 2,679 are engaged in scientific activities on which 65,804,000 dollars were expended. Its research activities are on quite disparate subjects and the National Bureau of Standards, the Bureau of the Census, the Weather Bureau and the Coast and Geodetic Survey have a relatively high degree of autonomy. From 1947, increasing use was made of the National Bureau of Standards as a general purpose physical laboratory for defence research; but in 1954 staff and facilities engaged in ordnance work for the Army were reconstituted as an activity of the Army Ordnance Corps and a group engaged on naval missile development was transferred to the Bureau of Ordnance of the Navy Department. A third group, the Institute for Numerical Analysis, was transferred to the administrative control of the University of California at Los Angeles.

The Department of Defense, with a total expenditure of 553,000,000 dollars, of which some 21,675,000 dollars is on scientific activities, employed 191 scientists, excluding all military personnel, in 1954, of whom 89 were engaged in scientific activities. The situation in each of the military departments, in spite of the major changes in the organization for military research and development since 1947, is regarded as still in flux. Under the National Security Act of 1947, the Secretary of Defense has broad responsibilities for unifying the activities of the three military departments and specifically for eliminating unnecessary duplication in research; but in 1953 the President's Advisory Committee on Government Organization recommended abolition of the Research and Development Board which had been established to assist the Secretary of Defense in this task. This Board was responsible for the preparation of an integrated military research and development programme, and for advising on trends in scientific research relevant to national defence as well as for recommending measures of inter-service co-ordination and allocation of responsibilities. The Board was assisted by a staff of several hundred, both civil and military, and by more than two thousand consultants, as well as by a network of committees and panels. The latter, generally consisting of scientists outside the Government, advised on work undertaken in the major scientific disciplines. Besides considering the major programmes and the research and development budget, the Board was concerned with such problems as the assignment of responsibilities, the common use of facilities and the recruitment of scientific manpower, and it developed a system for classifying the research and development effort into categories and programmes, and for relating these to the operational needs of the military services.

The functions of the Board were thus much wider than those of the Defence Research Policy Committee in Great Britain, and its resources were obviously much greater. It is considered that the Board was particularly useful in providing a forum for reconciling the diverse points of view of the three Services and for the exchange of information on activities of common concern. The plan which abolished thi Board in 1953 assigned the responsibility for research and development to a new Assistant Secretary o Defense (Research and Development), assisted by a Research and Development Policy Council. Retaining part of the Board's staff and some of the panel and committees, this Assistant Secretary of Defens has broad powers of formulating and co-ordinatin policy over military research and developmen programmes and exercises other functions for whic the Board was previously responsible.

In June 1955, the Commission on Organization o the Executive Branch of the Government furthe recommended (see *Nature*, 176, 1012; 1955) the re grouping of the functions of the Office of the Secretary of Defense in the four management fields of logistics research and development, personnel and finance each under an assistant secretary. Under thi arrangement the assistant secretary (research an development) would assume responsibilities no divided between him and the assistant secretar (applications engineering). It was also recommende that supervisory duties in each military departmen be divided among those same few assistant secretarie and that each departmental assistant secretar (research and development) should be a person wit a technical background and should co-ordinat research and development within his department This latter recommendation was included in th Reorganization Plan submitted to Congress o May 15, 1956. There is also an Assistant to th Secretary of Defense (Atomic Energy), who is chairman of the Military Liaison Committee, which is th focal point for liaison of policy between the Atomi Energy Commission and the Department of Defense while besides the Weapons System Evaluation Grou there also reports to the Assistant Secretary o Defense (Research and Development), and to each Chief of Staff, the Armed Forces Special Weapon Project, established in 1946.

Organization for research and development differ somewhat in the three Services in the United States In August 1955 the Secretary of the Army establishe the new post of Director of Research and Develop ment, and in September 1955 the post of militar chief of research and development was raised t deputy chief of staff level. Like the other militar services, the Army has established a committee o outstanding scientists and industrialists to advise on its research and development programmes; but besides its responsibility, since June 1954, for co-ordinating the Navy's research and development programmes, the Office of Naval Research has since 1947 been one of the main sources of Government financial support of basic scientific research. The Department of the Air Force was the first of the military departments to establish a higher research and development post (at Secretary level), and in August 1955 appointed a former director of the Bell Laboratories to the post of Secretary of the Air Force. In 1955 about two dozen research centres were engaged almost entirely on contracts for the three military departments.

The Department of Defense in the United States is thus concerned with research, including fundamental research, to a far greater extent than obtains in Great Britain, and the picture of the distribution of man-power given by the recent Zuckerman report (see *Nature*, Oct. 27, p. 887) does not suggest that the nation's research effort is widely different in pattern from that indicated by Mr. Callaghan last July. The 13,900 scientists and engineers in Government service in 1956 represent some 10 per cent of the total employed, and about 7,600 of them are employed in the defence departments. There is, however, no estimate of the proportion engaged on research and development, and the figures for the Ministry of Supply may well include many who in the United States would appear under the Department of Defense.

So far as the United States is concerned, the Department of Defense seems to reflect faithfully, in staff and expenditure, the magnitude of the national pre-occupation with defence, and there appears to be a continuing concern that that effort shall be expended as efficiently and fruitfully as possible from the point of view of the general national interest. There is less apparent evidence of such concern in Britain; and the recent report of the Select Committee on Estimates suggests that, at least in regard to the Navy's expenditure on research and development, there is need for a continuing review by some body with stronger authority than the Defence Research Policy Committee in order to avoid waste and duplication. The very magnitude of the effort in defence research and development in Britain, even when all allowance is made for possible benefit and repercussions in other fields, makes it imperative that there should be continuous co-ordination and upervision to prevent unbalanced development and the expenditure of resources unwisely in too limited a field.

Of the other major changes in the Government rganization for research in the United States since 1947 emphasized in this report, the establishment in 953 of the Department of Health, Education and Welfare must be mentioned. This Department xpended in 1954 some 78 million dollars out of ,000 million dollars on scientific activities; and of ts 35,730 employees, 3,790 were scientists and 1,886 were engaged in scientific activities. Most of the esearch done in the Department is carried out by the Public Health Service, and since 1948 has been largely guided by the Research Planning Council, while at the same time an Office of Research Planning was established to maintain information on current research projects, compile data and develop methods of appraising fields in which research should be expanded or contracted. Most public health research is carried out at the Institutes of Health or under contracts or grants. Some other research in the Department in the biological and physical and social sciences is in support of the Food and Drug Administration, the Office of Vocational Rehabilitation or the Office of Education, and in 1955 the educational research activities of the latter were placed under an assistant commissioner for co-ordination of educational research activities.

The organization for scientific work within the Bureaux of the Department of the Interior, which expended in 1954 some 83 million dollars on scientific activities out of 527 million dollars, has not greatly changed since 1947. It employed 9,307 scientists in a staff of 55,279, and of these 4,725 were engaged in scientific work. The Bureau of Mines was reorganized on a regional basis in 1949 and in January 1955 the number of regional offices was reduced from nine to five. In 1954 the Fish and Wildlife Service extended its activities in fishery technology, market development and fishery biology, and like the Geological Survey, the National Parks Service and the Bureaux of Mines and Reclamation, carries on scientific work in the biological, physical and social sciences. In 1953 the programme staff of the Department was replaced by a technical review staff.

The whole of the National Advisory Committee for Aeronautics, with an expenditure of 57 million dollars, which has doubled its programme since 1947, carries on scientific activities and 2,279 of its staff of 7,150 are scientists. Under the Unitary Wind Tunnel Plan, the Committee is responsible for constructing and operating certain facilities primarily to meet the needs of the Department of Defense and the aircraft industry for the development and testing of aircraft, missiles and propulsion systems.

Of the National Science Foundation itself, it will suffice to add here that its expenditure in 1954 was 7,913,000 dollars, and its scientific staff numbered 37 out of 151. One of the latest of the Federal Government's research programmes is that begun early in 1947 and known as Veterans' Administration. It arose out of the recognition that the demand for medical care by eligible veterans of the Second World War would increase greatly. Since 1947 its support of research has shifted from that by outside investigators on contract to intramural research, and the policy has been increasingly followed of maintaining many small laboratories dispersed among the Administration's hospitals. Of its expenditure of 4,400 million dollars in 1954, 5,343,000 dollars was on scientific activities in which, however, only 334 out of its scientific staff of 10,253 were engaged.

The report directs special attention to two science committees: the Interdepartmental Committee on Scientific Research and the Science Advisory Committee of the Office of Defense Mobilization. The latter was set up in 1951 to direct attention to new developments of science of significance for the national security, and to advise on the effective utilization of scientific resources so as to assure their availability in mobilization. The former, the need for which was emphasized both by Dr. Vannevar Bush's report in 1945 and by the Steelman report in 1947, was established in 1947 to study and make recommendations in relation to the research and development programmes of the Government and the promotion of national welfare; increasing the administrative efficiency of Federal research and development programmes; and Federal policies and practices in support of research.

PROF. NORBERT WIENER: AN AUTOBIOGRAPHY

I Am a Mathematician

By Prof. Norbert Wiener. Pp. 380. (London: Victor Gollancz, Ltd., 1956.) 21*s*. net.

AUTOBIOGRAPHIES of mathematicians are not common; a book, therefore, by Prof. Norbert Wiener dealing with his adult life and mathematical development is of special interest. It can scarcely be said that mathematics ordinarily leads to the kind of life which would interest the general reader, but Prof. Wiener is no ordinary mathematician; his interests are far wider than the title of this book might suggest. They embrace, in addition to most branches of mathematics itself, electrical engineering, aspects of mathematical physics, neurophysiology, statistics and, to use a word which he himself invented, cybernetics. Moreover, Prof. Wiener has travelled extensively in the course of his life. A resident of Cambridge, Massachusetts, he has spent long periods in Cambridge, England, and is familiar with most European countries; of his travels farther afield, he has much to say of interest about Japan, China, India and, in his own hemisphere, Mexico.

The volume under review is not a complete autobiography; it is a companion to an earlier book entitled "Ex Prodigy", and deals with the author's life from the time of his first appointment, at the age of twenty, to the Department of Mathematics in the Massachusetts Institute of Technology, where he is now professor. It is throughout an interesting book, frankly written in a free and readable style. In the preface the author analyses the motives which led him to undertake this work. "Why did I assume this uninviting labour, which at best can add little to my stature as a working scientist and at worst must offer new opportunities for those who may be inclined to criticise me? All in all, I don't know. There have certainly been motives of literary vanity and the desire to show that, both as an individual and as a scientist I have been able to accomplish a task off my regular beat." Further on, other and less subjective reasons are given to which those acquainted with the author and his work will give greater weight.

Part of the book is, of course, taken up with accounts of the author's mathematical researches. These are numerous and varied; even mathematicians may be surprised at the number and scope of the researches which he has inspired. It is characteristic of the man that much of his work has been done in collaboration with others. Attempts to explain mathematical researches in everyday language to non-mathematicians almost always fail, and even Prof. Wiener is not really successful in passages of this kind. These sections of the book—happily short—are the least interesting. Many readers, particularly students of the subject, will enjoy most of all the stories of his contacts with well-known mathematicians of the past and the present. The book abounds with these, all quite short, but often illuminating. Such a one, taken from his account of the mathematical congress at Strasbourg in 1920, may be quoted: "Camille Jordan, who for all his ninety years accompanied us on our pedestrian excursions, was like a memory from the days of Louis Philippe. His recollections dated back to the great days when Cauchy was lording it over French mathematics and forcing all the younger men to pay tribute."

Readers of this book who do not know Prof. Wiener personally will be surprised and pleased to learn that, in spite of his many achievements, he is still only just past sixty years of age. His concluding remarks are: "How many years may be granted me—I do not know; but even now I can feel reasonably sure that my scientific career, though it began early, is lasting late." All readers of this book will sincerely hope that this proves to be so, and that we may, perhaps, have in due course the pleasure of reading a third instalment of this fascinating autobiography.

H. JONES

EXPERIMENTAL DESIGN AND STATISTICS FOR BIOLOGICAL WORKERS

Experimental Design and Its Statistical Basis

By Dr. D. J. Finney. (The Scientist's Library: Biology and Medicine.) Pp. xi+169. (Chicago: University of Chicago Press; London: Cambridge University Press, 1955.) 30*s*. net.

MANY text-books on experimental design tend to concentrate on the combinatorial aspects of the subject and on methods of analysis. (The notable exception is, of course, Sir Ronald Fisher's original treatise.) As a result, many biological research workers and students are discouraged in their efforts to appreciate the subject, while others, more persistent or perhaps more mathematically minded, have their attention directed from the ideas on which theory and practice are based to questions of technical detail.

Dr. D. J. Finney has written his book especially for these workers and students. They should find it a valuable and well-written account of the principles of a difficult subject. The basic ideas are clearly stated, and examples drawn from many fields of biological work are given at each stage of development. The most important experimental arrangements or plans are surveyed, including randomized blocks, Latin squares and incomplete blocks. An excellent short account of factorial experiments is also included. Here rather more prominence is given to fractional replication than to confounding, although the latter is, in practice, the more useful device. There is also a useful chapter on the various types of sequential experiment now under development. This is followed by a discussion of biological assay which serves to show how the principles of experimental design have been applied in a particular field. The last chapter is of special interest, as it deals with topics which are sometimes thought to be outside the province of statistics. Here the author briefly discusses the ways in which statistics can help decisions to be reached on questions relating to the choice of treatments and experimental units, and to the type and number of experiments which should be undertaken.

Technical detail has been kept to a minimum throughout the book; but some discussion of methods of analysis has been considered necessary. The sections including these discussions, particularly those connected with tests of significance, are among the most difficult in the book. Those who are uninitiated in the mysteries surrounding tests of significance may take heart from Dr. Finney's remark on p. 41 that "emphasis has been placed on the making of tests of significance, but more often the real purpose of an experiment is to estimate one or more treatment effects". Indeed, readers would do well to underline these words, for the point they express is all too often overlooked.

Altogether this book contains a considerable amount of advice which biological research workers should find of great value. H. D. PATTERSON

WAR-TIME FOOD RATIONING IN BRITAIN

Food, Vol. 2: Studies in Administration and Control

By R. J. Hammond. Pp. xiii+835. (History of the Second World War: United Kingdom Civil Series. Edited by Sir Keith Hancock.) (London: H.M. Stationery Office and Longmans, Green and Co., Ltd, 1956.) 50s. net.

IN this, the second of three volumes about food control in Britain during the Second World War, Mr. R. J. Hammond provides a number of studies of the methods used for controlling such commodities as fish, milk, eggs and potatoes, which (since they were wholly or mainly home-produced and did not have to pass through a manufacturing process on their way to the consumer) were particularly difficult to regulate. He also deals in some detail with the emergency services which the Ministry of Food devised in case the normal system of distribution should break down under air attack or invasion—the arrangements for supplying bread and milk to bombed cities, the meals provided for air-raid victims and shelterers, the 'iron-ration' dumps, etc. But the part of the book most likely to be of interest to students of administrative techniques is the section which deals, diffusely—and yet here and there with a tantalizing incompleteness—with the numerous inter-related problems connected with consumer rationing.

It would not perhaps be entirely fair to blame Mr. Hammond for the diffuseness. The system which grew up was bewilderingly complex, and its roots, which he examines with some care, were more than a little tangled. Less fortunate than those concerned with rationing in the First World War, the administrators and politicians concerned with such problems in the Second had before them a large body of imposing but, as it proved, largely misleading precedent, handed down by their predecessors, who had dealt very successfully with other, and less exigent, problems some twenty years earlier. "Precedent", says Mr. Hammond justly, "is the uncritical recourse to history"; and he attributes many of the difficulties which the rationers experienced in the Second World War to the *catalogue non-raisonné* officially handed down to them from the First. This indeed, with the important lesson it holds for the future, not only of this but of other large-scale operations, is the central theme of his brief and comparatively crisp concluding chapter. In his view—and having seen the evidence, it is impossible not to agree with him—"It would certainly be a cardinal error to base any future scheme on the forms and documents that were eventually achieved in the Second World War, without regard to the circumstances they were designed to serve, or the processes by which they came into being. This account of those processes will be justified, practically speaking, only if it drives home the warning that the most dangerous legacy a rationing scheme can leave behind is a collection of its forms and instructions."

Mr. Hammond's second main point is that the Ministry was fortunate in having to deal with a war of attrition, a long-drawn-out struggle of a kind to which its rationing system, "dogged, painstaking, a trifle slow in its movements', was eminently suited. He points out that the continuous refashioning it underwent, from 1941 onwards, was untroubled by massive air attacks, heavy movements of population, or frequent and violent changes of ration-levels; and he concludes that "there must remain some doubt whether, even discarding such things, the system would work at all in a war of a different kind".

The feature of the British rationing system which, above all others, made it difficult to work and impossible to introduce quickly, was the tie between the retailer and the consumer. When tea rationing was introduced late in the War, the tie was dispensed with, and despite what had come to be the traditional prejudices of the officials, the simpler system was seen to be quite workable. Mr. Hammond suggests that in this particular connexion Lord Woolton, bringing a fresher mind to the problem, was able to teach officials a useful lesson in method. "The contrast between their freshness in device", he adds, "and their reluctance to bring sustained criticism to bear on basic notions, is a striking feature of British food control."

Mr. Hammond permits himself one or two other significant asides upon various aspects of the official psychology. He mentions in a footnote that the clothing ration book had at first an impressive series of panels inside the front cover, with figures and letters labelled "for official use only". When this disappeared, the Ministry of Food's Rationing Division, says Mr. Hammond, 'asked respectfully and with professional interest, what the change betokened". The reply was that it had been put there to fill up space and make the book appear more official! He quotes, too, in an appendix, the *cri de cœur* of a Stationery Office official charged with the duty of obtaining accurate estimates of the number of ration books that would be needed: ". . . after three and a half years your local people can, if they will use the brains God gave them and the tax-payer is paying for, make far closer estimates than they have yet done".

The iron men of the Stationery Office—with their back-breaking requirement of six months for printing a new ration book—and the registrar-general, perennially preoccupied with the needs of the National Register, emerge indeed from Mr. Hammond's narrative as firmer and somehow more professional figures than the somewhat shadowy officials in the fluctuating divisions of the Ministry itself. Sir Sylvanus Vivian, director of registration in the First World War and registrar-general in the Second, was, in any event, one suspects, too big a man altogether to have been kept out of the centre of this picture either by Mr. Hammond or by successive generations of food rationers. His brief but compelling memorandum on a unit system of general rationing, which is printed here as an appendix and appears in essence to have anticipated the 'points' rationing system by something like a quarter of a century, reveals an imaginative grasp and a generalizing ability which, for one reason or another, were not often apparent in the schemes that followed. Those concerned with the thankless task of drawing lessons for use in the hypothetical next war might do worse than take a glance at it, if not for its matter, then for its manner. It is scarcely longer than this review. FRANK DUNNILL

NUCLEAR MOMENTS

Kernmomente

Von Dr. Hans Kopfermann. Zweite, neubearbeitete Auflage. Pp. xvi+463. (Frankfurt am Main: Akademische Verlagsgesellschaft M.B.H., 1956.) 54 D. marks.

IN this second edition Dr. Hans Kopfermann has completely rewritten and greatly expanded his original book, which for fifteen years stood as a standard work in the field of optical hyperfine structure. During that time the moments of atomic nuclei in the ground state have been studied in many laboratories by the methods of high-frequency spectroscopy, which are here described in addition to the optical methods.

The first three sections of the book deal with the investigation of nuclear moments through their interactions in free atoms, free molecules and condensed phases, respectively. The fourth section gives an account of various nuclear models and compares the moments which they predict with experimental values.

The book is essentially a manual for experimenters. Thus, accounts are given of techniques in high-resolution optical spectroscopy, and in work on atomic- and molecular-beam magnetic and electric resonance, nuclear magnetic and electric quadrupole resonance, and paramagnetic resonance. The methods are well illustrated with examples. The theory is given in detail, both of the various techniques and of the relations between the observed quantities and the nuclear moments themselves. References to original papers number about four hundred. Tables are given of various correction factors, and of the moments of nuclei, their structure according to the shell model, etc.

The contents of this book reflect the wide range of activities in the laboratory which Dr. Kopfermann directs. His experience in these diverse fields enables him to give a first-hand and a balanced account of these branches of nuclear physics. Specialists will welcome the new edition as a reference book for use in their particular fields and as a text-book for instruction in kindred topics.

A consequence of the close association in the text of basic theory with the technique in which it is applied is a certain lack of continuity in the theoretical sections. I would have preferred to find the theory of the hyperfine structure of free atoms in one place, for example, rather than distributed between an introduction, a section on optical hyperfine structure and a section on atomic beam investigations. A further minor criticism is that references are not given to the sources of some of the reported measurements. These are small matters weighed against the vast amount of organized material in this book. Readers who have difficulty with the German text will welcome the English translation which is shortly to be published. G. W. SERIES

MAGIC OF THE EAST

Oriental Magic

By Sayed Idries Shah. Pp. xviii+206+5 plates. (London: Rider and Company, 1956.) 25*s.* net.

IN this work the author has attempted to correlate the magical traditions of the East with those current in the West and to show how oriental influence was potent in moulding not only the lore of Western sorcerers but also the technique through which they claimed to produce their results. Possessed, as he is, with some ethnological training, Idries Shah is naturally interested in the similarities between beliefs and practices in different parts of the world; and thus he has made a special study of the evidence for the diffusion of culture, paying particular attention, as Blau had previously done, to the history of Egyptian magic and to that of Babylonia and Assyria. This book, therefore, supplies the general reader with a useful guide to the magic of the East and the importance that it must have in any appraisal of occidental sorcery.

For the purposes of the scholar, however, the book is somewhat disappointing. The author has tried to do too much in too little space, and thus much of the material is badly co-ordinated and ill-digested. In many passages he shows that he is fully aware of the difficulty of knowing what value can be placed on literary accounts of oriental miracles; yet when he has established contact with a Hindu magician who shows him striking phenomena, he does not attempt any serious investigation but takes refuge in vague suggestions of 'snap-hypnosis'. Anecdote takes the place of the kind of record we should expect from a trained ethnologist, and this is all the more regrettable since Idries Shah appears to have enjoyed opportunities for inquiry which are far from common. Nevertheless, the author stresses a point of view of which too little has been heard in the past. He points out how parapsychology, and, above all, the modern work on extra-sensory perception, are throwing fresh light into the dim recesses of the sorcerer's cave. Amid all the charms, the mumbo-jumbo and the hocus-pocus there may sometimes have emerged flashes of paranormal perception or even strange things. It is here that, as the author says, the true link can be found which connects the sorcery of all ages and peoples, be they oriental or occidental.

The book is well produced and the list of authorities convenient for reference. It is surprising, however, that, although there are two references to the famous "Book of Changes", there is no discussion of the modern use of the technique in its relation to theories of psycho-kinesis. E. J. DINGWALL

Manual of Elementary Practical Chemistry

By Dr. R. D. Brown and Dr. T. A. O'Donnell. Pp. x+185. (Melbourne: Melbourne University Press; London: Cambridge University Press, 1955.) 30*s*. net.

THE practical work dealt with in this book is that arranged for first-year students at the University of Melbourne. The syllabus consists of familiar gravimetric and volumetric determinations, qualitative analysis, including the identification of cations occurring in the same group, the purification of substances, and the preparation and analysis of some typical organic compounds. In both the organic and inorganic analysis semi-micro methods are exclusively used. There are no inorganic preparations and no exercises in physical chemistry. The scheme of work, therefore, does not quite meet the requirements of Intermediate examinations in Britain. The syllabus is intended to be worked in conjunction with a course of lectures on the relevant physical chemistry.

An uncommon feature is the singular use of the Bronsted–Lowry concept of acid throughout the book. This theory is first clearly expounded and then, in due course, applied to the work in hand: that is, to neutralization and redox reactions, solvated and complex ions, the calculation of *p*H, the construction of titration curves, indicator action and solubility-product phenomena. The scope of the practical work is not extensive, but what is done is ntegrated with the theory and done thoroughly. Thus preparations and determinations are limited to typical examples, and mixtures for analysis are deliberately restricted in difficulty. The idea, a sound one, is to avoid confusing a student with overmuch technical detail, so that he may be encouraged to devote his energy to the mastery of the underlying principles.

Students using this book on such a course should emerge with an understanding of elementary analysis well calculated to help them make rapid progress with more advanced work. G. FOWLES

Treatise on Inorganic Chemistry

By Prof. H. Remy. Vol. 1: Introduction and Main Groups of the Periodic Table. (Translated by Prof. J. S. Anderson. Edited by Prof. J. Kleinberg.) Pp. xxi+866. (Amsterdam: Elsevier Publishing Company; London: Cleaver-Hume Press, Ltd., 1956.) 105*s*.

THIS English version of a successful German work, with modifications and improvements by the translator, has many good features. It is based on the periodic system and has chapters on many aspects of theoretical and physical chemistry which are essential in a proper understanding of inorganic chemistry. These include valency, crystal structure, bond types and resonance, co-ordination, and the modern theory of acids and bases. Industrial methods and uses are given. Physical properties and mineral compositions are tabulated.

The straightforward treatment of inorganic chemistry is generally good, but is uneven: some topics (for example, the peroxycarbonates) are dealt with superficially and not always in accord with modern knowledge, while others (for example, the lower oxides of iodine) are not even mentioned. Perhaps these latter will be included in the second volume. The modern view of the composition of bleaching powder is not given. A few minor errors were noticed: for example, S_2O_3 is green, not blue, and the melting point of ClO_2 is −59°, not −76°. References to literature are given in the text and short bibliographies at the ends of chapters.

This is a valuable and important book, which can be recommended for study and reference.

Topological Dynamics

By Prof. Walter Helbig Gottschalk and Prof. Gustav Arnold Hedlund. (American Mathematical Society Colloquium Publications, Vol. 36.) Pp. vii+151. (Providence, R.I.: American Mathematical Society, 1955.) 5.10 dollars.

TOPOLOGICAL dynamics might claim to have its roots in the dynamical astronomy of the late eighteenth century; but its present developments spring from the qualitative, topological methods introduced by Poincaré to replace quantitative methods of tackling some of the intractable problems of celestial mechanics. A further major contribution was made by G. D. Birkhoff in his systematic study of topological methods in dynamics. The subject has now become a branch of topology, wherein are studied those topological properties of transformation groups which can trace their origin back to problems in classical dynamics. References to orbits, periodicity, flows, all used in highly technical senses, only faintly recall the dynamical origins.

Profs. W. H. Gottschalk and G. A. Hedlund have organized their material admirably, so that definitions, axioms, notations and proofs are clearly identifiable, and arguments are efficient and precise. But so concise a treatment of so austerely abstract a topic has made the book difficult to read, and in order to keep the volume within reasonable compass, some knowledge of set theory and of topological groups is assumed; in fact, the relevant parts of Bourbaki should first be mastered. It is thus a book for the expert, not the novice. T. A. A. BROADBENT

What Flowering Tree Is That?

A Handbook for the Tropics. By Edwin A. Menninger. Pp. 110+4 plates. (Stuart, Florida: Edwin A. Menninger, 1956.) Cloth, 3 dollars; Paper (without colour plates), 1.50 dollars.

FLORIDA has the good fortune to possess a climate and a variety of soils ideally suited for the cultivation of flowering tropical trees. She has also produced a refreshingly original and enterprising person in the author and publisher of this little book, which describes a thousand such trees now growing in his garden at Stuart, where he keeps open house on Sunday afternoons. For many years he has imported seed of unusual and showy trees and shrubs from every tropical country in the world, and now 'The Flowering Tree Man', as he is called, hopes that other residents of Florida, the 'State of Flowers', will follow the example set by his initiative.

The trees are arranged by families in alphabetical sequence, and the common name is given precedence, followed by the Latin name and a short informal description. A few spectacular vines are listed separately at the end of the book, which is illustrated by many small black-and-white photographs and a few full-page plates in 'Kodachrome'. The botanical names are not of importance to the author, though he claims they are correct: "I don't care what you call these trees; my sole interest lies in the beauty they can produce". His enthusiasm is infectious, and the Sunday callers may be envied their unique experience with the author and his book as their guide. N. Y. SANDWITH

GENERAL ASPECTS OF AUTOMATION

A JOINT meeting at Sheffield of Sections F (Economics) and G (Engineering) of the British Association, held on September 3 and 4, discussed various aspects of automation. Under the chairmanship of Mr. A. C. Hartley, president of Section G, Lord Halsbury introduced the subject by saying that the public is substantially misinformed about it. He emphasized that it is virtually impossible to define automation and that different people define it in quite different ways. In discussion at the end of the meeting, he pointed out that in the three papers by Mr. J. F. Coales, Prof. H. D. Dickinson and Mr. George Doughty, the word 'automation' could have been substituted, without affecting the meaning, if it had been replaced respectively by some such term as increased mechanization, improved productivity or production engineering. He pointed out that the advent of automation as some new technical invention is in effect a rumour which has been taken up by the Press and become emotional rather than factual. "The automatic factory and the automatic office," he said, "have arrived, but they are no more than the development of improvements in production that have been going on for many years. The only really new technique which has been injected into industry is the digital computer." He said that automation is most likely to affect the section of industry which produces what are called consumer durables, that is, motor-cars, radio, television, washing machines, etc. It is very unlikely to be widely used in heavy engineering, shipbuilding, agriculture, mining, textiles and highly mechanized industries. Unfortunately, consumer durables are the first to be hit when there is any form of financial stringency, since when times are bad it is these goods which families first go without, making the motor-car or radio or washing machine do another few years, rather than spending less on food or on amusement. He believes that although automation will cause men and women to change their jobs and perhaps move to new areas, widespread unemployment is not a danger because in any event changes are unlikely to come about quickly.

Lord Halsbury was followed by Mr. J. F. Coales, of the Engineering Laboratory, University of Cambridge, who read a paper entitled "The Historic and Scientific Background of Automation".

"Automation", he said, "is no more than the evolution of improved methods of replacing human and animal labour by energy from natural sources and the development of tools to control these processes in order to relieve the operators of the burden of watching them or of making calculations and adjustments." This process, stimulated by man's inherent laziness, has been going on for at least two thousand years, first by the use of gravity, water- and wind-power, and later by the use of solid fuels, and now by the use of nuclear power. This has resulted in electrical energy now costing only about one five-hundredth of that of human labour, so that there is an enormous incentive to replace human labour by natural energy wherever possible; this has resulted in very rapid advances during the past few years. Water trip-hammers are known to have been in use in 350 B.C., and water-wheels existed in China, Persia and the West in the first century B.C. The prototype of the automatic factory is undoubtedly the windmill, since by the end of the eighteenth century there were many thousands in Britain, incorporating automatic controls so that they could be completely operated and controlled by one man, who could leave the mill to run untended while he dressed the stones not in use, tested the quality of the meal, or hoisted sacks to fill the automatic hoppers in just the same way as maintenance, quality control and transport have to be carried out to-day.

Mr. Coales then recounted the developments which took place in the textile industry during the eighteenth century and the development of calculating machines which started with that of Blaise Pascal in 1642. Pascal was followed by Liebniz, who designed what was the precursor of the modern desk calculator, while Charles Babbage proposed a 'difference engine' in 1822 which was the precursor of the modern digital computer. These developments led up to the automatic office, which is now an accepted fact.

Automatic production-methods were then discussed, and Mr. Coales outlined the development of automatic transfer machines for the motor industry. This led on to the organization of the automatic factory of the future and developments which will be necessary to bring such a project to a successful conclusion. Most of the operations required can now be carried out automatically, although automatic assembly and automatic inspection and test present considerable difficulties. There is still, however, a long way to go from having the techniques available to being able to set up such a factory as an economic success.

Mr. Coales then discussed the effect of automation on labour; for this purpose he classified human activity under the following eight headings: (1) manual labour; (2) watching and controlling; (3) memory; (4) calculation and correlation; (5) writing and giving orders; (6) decision making; (7) research and invention; (8) design of product and plant.

Of these, the first five, it has been shown, can be replaced by machines already existing or under development; but at present it is not envisaged that there is any possibility of machines usurping the higher attributes of man inherent in the last three categories, although computing machines are making it easier for him to marshal the facts on which to make decisions and to carry out the calculations required in research and invention and in the design of product and plant. He is, therefore, being released by automation from the part he has played as a beast of burden. The challenge of automation is for us to show that by education we can train a large proportion of our manual workers to take their place in the army of skilled maintenance engineers that will be required, and eventually to swell the ranks of qualified engineers and managers who must provide the creative thought. Experience shows that the more a factory becomes automatic, the more the labour has to be transferred from the unskilled to the skilled classes, and that also there is an ever-increasing demand for the professional engineers to design new products and plant. In considering whether the automatic factory is likely to bring serious unemployment, it is important to remember that the capital expenditure involved in setting up any automatic factory is enormous—many times that for a conventional factory—and it is quite impossible that the change-over in industry as a whole can be rapid. It is also worth noting that in the United States, manufacturing industry employs only 25 per cent of the total labour force, and clearly, not all industries are suitable for automation. Some redundancy may occur in other industries, such as banks and insurance offices, where clerks may be replaced by computing machines; but on the other hand, increased production due to automatic factories will inevitably increase the numbers required in the distributive trades.

In the second session of the morning, under the chairmanship of Prof. Gilbert Walker, president of Section F, Prof. H. D. Dickinson, of the University of Bristol, read a paper on the "Economic Effects of Automation". He said that long-period results of automation may be expected to be almost wholly for the benefit of mankind, since it will in the long run enable the joint efforts of human beings to produce more material goods with less expenditure of time and effort than before. Certain very long-term considerations do, however, obtrude themselves, namely, problems arising out of the use of leisure, the sufficiency of supplies of natural raw materials and very long-run consequences of population growth; but these he is confident can be solved by a robust application of scientific technique and a rational attitude towards problems of human ecology. He believes that the best way of ensuring the good effect of automation is by price reduction; but unfortunately, in Britain, both management and labour seem to be averse to this method. Organized labour thinks first of obtaining as much benefit as possible for the workers in the form of higher wages and shorter hours, or both, and management seems to think of price reduction as something almost indecent. To obtain the full advantages of automation, workers must be willing to change jobs and re-train for new jobs. Emphasis on traditional demarcations and rules must go. We must avoid a situation, too, where the benefits are monopolized by a small rich class giving Babylonian luxury to the few, which would give rise to a politically irresistible demand for higher taxation and nationalization of industries subject to automation. If this can be avoided, the benefits would be widely spread and there would be a big increase in services rendered to the community generally, such as those of teachers, medical men, dentists and nurses. "Automation", he said, "involves changes in the relative intensity of demand for the various agents of production. As between capital and labour, it is likely to increase the demand for capital relative to that for labour, and as between the different grades of labour it is likely to increase the demand for the highest grades of skill and reduce the demand relatively for practically all other grades. This raises an important political and social question, since in the biggest Trade Unions the numerical strength is now in the unskilled and semi-skilled grades, which are therefore likely to react violently against any tendency to put into reverse the egalitarian tendency in the movement of earned income that has shown itself so strongly during the last fifteen years. There is a danger in the tendency towards increased inequality between workers in different industries or between employees of different firms, which would be intensified by any general introduction of profit-sharing or co-partnership schemes, or even of a guaranteed annual wage on the model now popular in the U.S.A."

Following Prof. Dickinson, the large audience was delighted by a short, but excellent, contribution from Mr. George Doughty, general secretary of the Association of Engineering and Ship-Building Draughtsmen. He said that among skilled workers, automation is generally understood to offer no immediate threat to security, and is a challenge which leads to new opportunities; but he said many unskilled workers are not happy about it. "British workers," he said, "do not resist technological advances, but they resist being fired without reasonable alternative employment." He urged managements to consult work-people about changes in methods of production and to seek their co-operation. This would involve receiving suggestions, intelligently discussing alternative jobs, formally assessing compensation and discussing plans for re-training displaced workers for whom new jobs cannot be created. Some redundancy would be inevitable and planning is essential to retain maximum employment. The workers would argue vigorously for this to be tackled by shorter working hours, longer holidays and earlier retirement. "Consultations," he said, "should not be merely a formal intimation by the management of the dismissal of large numbers of work-people."

The meeting was then thrown open to general discussion, and one speaker raised the question of the possible shortage of raw materials if automation became general. He was followed by Mr. E. A. Watson, chief engineer of Joseph Lucas, Ltd., who referred to the common belief that mass-production and automation result in a product of poorer quality He said that in every case with which he had been associated, increased mechanization or automation had resulted in a marked improvement in the quality of the finished product.

On the following morning, September 4, a number of specialist papers on automation were presented to Section G, under the chairmanship of Prof. A. L. Cullen, of the Electrical Engineering Department, University of Sheffield In the first of these, Mr. A. J. Young, of Imperial Chemical Industries, Ltd., discussed the importance of automatic control in the process industries and gave a general description of the methods used at present. He gave a discourse on the fundamental principles underlying process control and indicated what would probably be the future developments.

Mr. D. T. N. Williamson, of Ferranti, Ltd., then presented a paper entitled "Computer-controlled Machine Tools". He said that the concept of high-speed digital computers allied to servo-mechanisms with accurate feed-back systems offers tremendous possibilities for improvement in the field of industrial controls. Although automatic machine tools have been in use for at least thirty years, they have not been applicable to the production of small quantities of complicated parts, owing to the length of time required to design, make and instal the necessary cams. However, the application of digital computer and feed-back servo-mechanism techniques to machine tools have enabled universal machine tools to be created which give fully automatic production with the equivalent of setting time, now called programming time, reduced on the average to less than one-fifth of the time necessary to make one component by hand. The computer can, at very high speed, accept basic dimensional and machining information in numerical form which often allows much of the detailed drawing procedure to be omitted. The computer then calculates the movement of the cutting tool to machine the component and records the information on magnetic tape. A control unit associated with the machine tool into the reader of which this tape is placed controls servo-mechanisms, which move the slides in accordance with the instructions on the tape. Dr. Williamson said that the possible uses of a control system of this type go far beyond the limited field of machine tools, and the principle is applicable to all industrial processes.

The next paper, presented by Dr. Denis Taylor, of the Atomic Energy Research Establishment, Harwell, was entitled "Atomic Energy and Automation". Dr. Taylor said that automation has a large part to play in the development of atomic energy for two reasons. First, there are those processes which arise in any industry which, although they can be carried out manually, can be carried out on a large scale more satisfactorily by automatic machinery; and secondly, there are processes peculiar to atomic energy which, because of the radiation hazards, are difficult or impossible to carry out manually. Dr. Taylor described various automatic equipments used in the laboratories for reducing the amount of assistant labour that would otherwise be required for carrying out routine measurements. Such machines are capable of working night and day with very little attention and quickly pay for themselves. Automation also finds application in the atomic-energy field in the processing of experimental data, such as in the study of cosmic-ray showers. A common experiment is the observation of the coincidence-rate of two counters as a function of their separation, and this may be extended to include the coincidence-rate of three or more counters as a function of the size of the geometrical configuration, triangle or square, etc. An enormous amount of data will be obtained in quite a short time, and some form of automatic processing of the data becomes essential. In the atomic-energy field, as in the chemical industry, there has been a change-over from batch processing to continuous flow techniques, and automatic control for plants processing radioactive materials is particularly attractive because of the health hazard. Another problem which arises is that of handling the reactor fuel elements. After a nuclear reactor has been in operation for some time, re-cycling of active fuel elements may be required in order to re-use the elements. These elements will be highly radioactive and could not be handled directly. Here, therefore, there is an important problem in the field of automation.

The next and last paper, "Conscious Machines", was presented by Mr. J. Sargrove, who, as early as 1948, set up an automatic line in Britain for making radio receivers. Mr. Sargrove spoke mainly of automatic machines for inspecting and controlling the production of a number of small and common commodities. He showed a film to illustrate different types of electronic problems which occur in industry, starting with a very simple application and leading up to more complex ones, as follows: (1) automatic electronic stock-keeping; (2) automatic printing of calendars; (3) automatic production of continuous stationery; (4) automatic processing of knitted 'Nylon'; (5) automatic extrusion of plastic rods, such as knitting needles; (6) high-speed weighing of pieces of dough, and automatic control of a dough divider in a bakery; (7) high-speed counting, batching and packaging of tablets in the pharmaceutical industry.

Having given these examples, Mr. Sargrove went on to say that if we are genuinely to increase our standard of living with full employment, this can only happen by an increase in the total production of goods and commodities. If all human beings are fully employed, this extra output, which we all desire, can only come from the more intensive use of automation. In his experience, no employee has ever been discharged from a firm due directly to the introduction of automatic machines.

THE CHROMOSOMES OF MAN

By Dr. C. E. FORD and J. L. HAMERTON

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ACCURATE knowledge of the number of chromosomes and of their behaviour in mitosis and meiosis has illuminated the genetic analysis of many species. The outstanding example, of course, is *Drosophila melanogaster*[1]. *Zea mais*[2] and *Oenothera lamarckiana*[3] are notable examples from the plant kingdom. Chromosome observations have been of some value even in the fungus *Neurospora crassa*[4], and recent work[5] has given promise that the genetics of the house mouse may benefit in the same way. There is therefore good reason for supposing that the genetic study of man himself may be advanced by reliable information about his chromosomes. The unique features of the human genetic milieu—the alterations in breeding structure[6], the changing selection pressures[7], and the possible influence upon mutation-rates of the environmental changes of the past two or three centuries—are all in great need of study and measurement in order to be able to estimate their effect upon the genetic structure of future human populations, and it is possible that a thorough examination of the chromosomes in a range of human groups would make a useful contribution. The rapid and economical technical methods now available would enable relatively large numbers of individuals to be examined and should make a new approach to human cytogenetics both possible and rewarding. Nor is this the only field in which chromosome observations may be of value to human biology. The rapid pace at which knowledge of the chromosomes in tumours of experimental animals[8] is advancing suggests that the chromosomes may have an increased part to play in the investigation of human neoplastic conditions; and they may also be able to assist in the causal analysis of infertility, at least in the male[9].

The first attempt to determine the number of chromosomes in human cells would appear to have

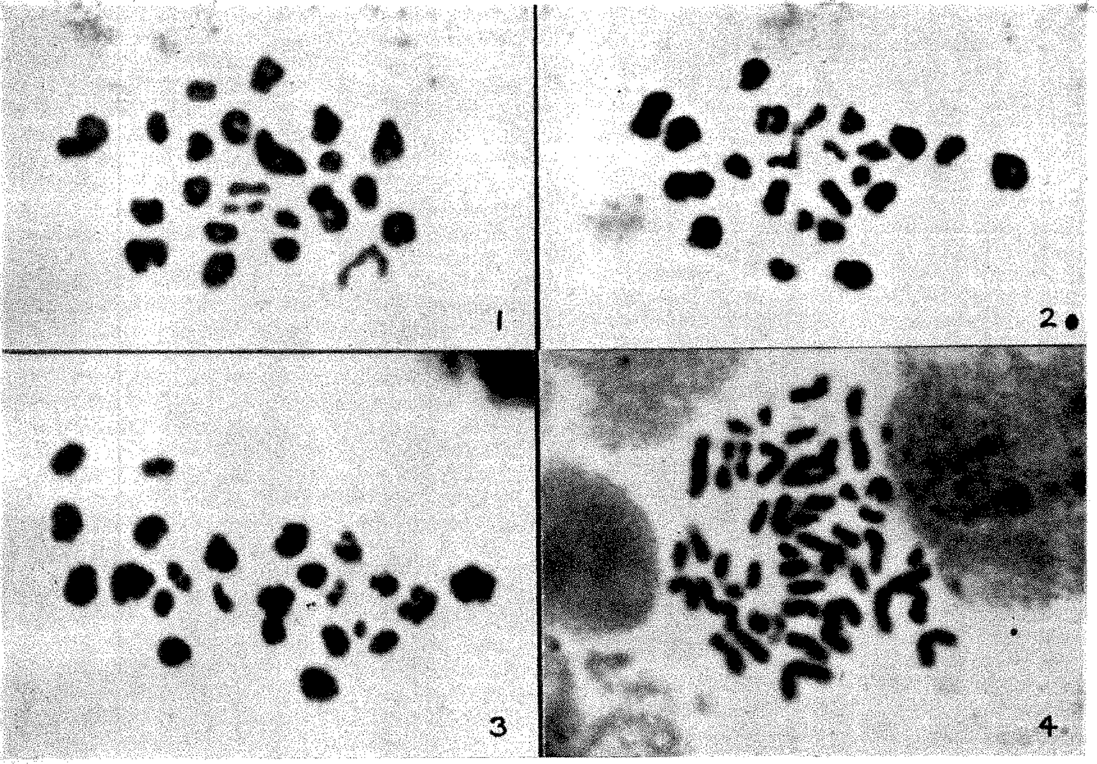

Fig. 1. First spermatocyte of patient 1 at diakinesis, 23 bivalents
Fig. 2. First spermatocyte of patient 3 at diakinesis, 23 bivalents
Fig. 3. First spermatocyte of patient 2, 22 bivalents plus univalent *X*- and *Y*-chromosomes
Fig. 4. Spermatogonial metaphase of patient 1, 46 chromosomes
All × 2,800

been made by Hansemann, who in 1891 reported three cells from 'normal human tissues' with 18, 24, and more than 40 chromosomes, respectively[10]. From then until the appearance of de Winiwarter's classical paper[11] in 1912, diploid numbers ranging from 16 to 36 were reported, the balance of opinion being in favour of 24. De Winiwarter claimed that there were 47 chromosomes at metaphase in spermatogonia, and 23 autosomal bivalents plus an unpaired *X* in primary spermatocytes. Painter[12] in 1921 reported the presence of a small *Y* chromosome in males and was the first to assert that the correct diploid number was 48 in both sexes[13]. In the following two decades most authors[14] supported Painter's position; but de Winiwarter and his associates[15] adhered to the opinion that there was only a single sex-chromosome at meiosis in the male and 47 chromosomes in spermatogonia. Koller's account[16] of the behaviour of the sex-chromosomes in spermatocyte meiosis brought this period to an end just before the outbreak of the Second World War. From then on, the value of $2n = 48$ in both male and female remained unchallenged for nearly twenty years, and it seemed that the chromosome number of man had finally been established. However, in a very recent paper[17], Tjio and Levan report consistent counts of $2n = 46$ in cultures of lung tissue taken from four aborted embryos, and refer to further counts of $2n = 46$ obtained by Hansen–Melander, Melander and Kullander in preparations of liver, also from aborted embryos. The regular loss of two chromosomes during development of the organs or growth of the cultures would seem to be most unlikely, and the implication was clear that the generally accepted figure of $2n = 48$ might, after all, have been in error.

A re-examination of spermatocyte and spermatogonial chromosomes was obviously desirable, and we have been fortunate in securing testis tissue from three males, aged forty-seven, fifty-three, and sixty-three years respectively. The material was obtained at the Churchill Hospital, Oxford, from fresh operative specimens at the moment of removal from the body. The tubules were teased out in hypotonic fluid, allowed to remain in the fluid for 30 min. at room temperature, fixed in acetic alcohol and stained by the Feulgen procedure. Squash preparations were made in the usual way. Many of them contained one or more small clusters of spermatocytes in the most suitable stages for counting, namely, diakinesis and first metaphase. Obviously broken cells with scattered chromosomes, and cells in which the chromosomes were clumped or badly fixed, were rejected. Counts were made on all the remainder and are summarized in Table 1. It will be seen that the great majority contained 23 bivalents, and that our results therefore complement those of Tjio and Levan. Examples of these cells are shown in Figs. 1 and 2. In a few cells at late diakinesis and first metaphase, the *X*- and *Y*-chromosomes were unpaired and usually well separated from each other, so that 24 bodies were counted (Fig. 3). Precocious disjunction (already reported by Koller[16] in sectioned material) would seem to be the most likely explanation of the non-association of *X* and *Y* in these exceptional cells, although some cases may have been due to the rupture of the terminal connexion between them during the making of the preparations. The

Table 1. COUNTS OF NUMBERS OF BODIES PRESENT IN FIRST SPERMATOCYTES AT STAGES FROM LATE DIPLOTENE TO METAPHASE

Patient	Age	First spermatocytes containing : 22 bivalents or fewer	23 bivalents	22 bivalents $+ X + Y$
1	63	9	81	11
2	53	3	39	11
3	47	2	29	3
Total		14	149	25

few cells recorded as containing fewer than 23 bivalents, although apparently intact, may have been damaged and we attach no significance to them.

Relatively few spermatogonia were observed in mitosis and, in contrast to the spermatocytes, most of them were broken and their chromosomes scattered. We have noticed similar fragility of spermatogonia in several other species of mammals. Nevertheless, a few clear counts of 46 chromosomes were obtained in apparently intact cells, one of which is shown in Fig. 4. It is noteworthy that the centric constrictions are sometimes greatly elongated in from one to four chromosomes.

In the great majority of first spermatocytes examined, the sex chromosomes were associated terminally, the attachment varying from a relatively long thin thread to a condition in which only a slight narrowing indicated where X ended and Y began. All these associations could be interpreted as terminal chiasmata, although Sachs[18] denies that true chiasmata occur in the sex-bivalent of man. The few cells in which the sex-chromosomes were present as univalents have been mentioned. In one cell only the X- and Y-chromosomes appeared to be associated in a different manner. The structure of this bivalent was not resolved with certainty; but its appearance strongly suggested the presence of a sub-terminal chiasma, or possibly that it was a 'symmetrical' sex-bivalent as described by Koller[16]. This single observation can scarcely be construed as support for the possibility of crossing over between X and Y: on the other hand, the observations as a whole are certainly not inconsistent with the occurrence of partial sex-linkage[19].

Koller[16] figured diplotene bivalents with many chiasmata. This observation we confirm. The largest autosomal bivalent frequently has five chiasmata; and some of the others may have four. In well-fixed cells the successive loops can be clearly seen in planes at right angles to each other, as in the classical plant and orthopteran species. In cells where the bivalents are rather crowded, it would not be difficult to mistake a terminal loop for an additional small bivalent. The numbers of chiasmata were counted in some of the clearest cells at stages from late diplotene to mid-diakinesis, and the results are given in Table 2.

Since the hypothesis that each cytological chiasma represents a single genetic cross-over was first put forward, evidence in its favour has been steadily accumulated, although its general validity has been questioned[20]. Assuming it to be true in man, the counts of chiasmata can be used for making an estimate of the total genetic length of the human chromosome set, on the basis that one chiasma is equivalent to 50 centimorgans. The over-all mean number of chiasmata per cell is 55·9 and the estimate of genetic length is, therefore, 27·9 morgans. However, should there have been any reduction of chiasmata by terminalization, the observed frequencies will have been somewhat less than the original frequencies, with the result that the estimate of genetic length will be a minimum one. So far as we are aware, the only other mammalian species in which estimates of total genetic length of chromosomes have been obtained is the house mouse, and it is satisfactory to note that the estimates obtained from Slizynski's chiasma counts[21] and by Carter's linkage-data method are in reasonable agreement. The two methods yield values of 19·2 and 16·2 morgans respectively[22]. It would appear that, genetically, the chromosomes of man are at least half as long again as the chromosomes of the mouse.

Table 2. COUNTS OF CHIASMATA AT STAGES FROM LATE DIPLOTENE TO MID-DIAKINESIS

Patient	Age	Cells counted	Chiasmata per cell: Range	Mean
1	63	11	50–62	54·4
2	53	6	52–62	57·1
3	47	6	50–63	57·1
Total		23	50–63	55·9

The reservation should be made that the estimate of 27·9 morgans strictly applies to middle-aged and elderly males only. However, in the mammalian species studied genetically, recombination fractions do not in general differ much with age or sex. As a rule the values are slightly higher in the female sex, although there are some exceptions. There is therefore no reason for supposing that genetic lengths will be greatly different in the two human sexes, and until direct estimates have been obtained at oogenesis the value of 27·9 morgans derived from chiasma counts at male meiosis may be regarded as an approximate minimum estimate for the female also.

Two comments in connexion with the high frequency of occurrence of chiasmata are relevant: it reflects the rarity with which autosomal linkages have been detected in man; and it implies a genetic system in which there is a rapid re-assortment of the genotypic variability, which, according to Darlington[23], is the mark of a plastic species able to adapt itself readily to diverse environmental circumstances.

Returning to the question of the chromosome number of man, how should the discrepancy between the recent counts and the older ones be explained? Although the occurrence of numerical chromosomal polymorphism has now been established within populations of one mammalian species[24] and may exist in a second[25], it is most unlikely that the occurrence of a similar situation in the human species could provide the whole answer—the probability of drawing by chance from such a polymorphic population seven successive individuals (four of Tjio and Levan, three recorded here) with 46 somatic chromosomes after an even larger series all with 47 or 48 would be altogether too low. Nevertheless, the rare occurrence of individuals with the latter numbers is not excluded. The alternative is to assume a persistent error, and this we consider to be the more likely explanation. (It is of interest to note that in his preliminary communication on the subject, Painter was uncertain whether the diploid number was 46 or 48.) Three features of the behaviour of human chromosomes which have already been mentioned may have contributed to erroneous counting. In somatic cells and spermatogonia, one or more of the exceptionally long centric constrictions seen in some chromosomes may have been overlooked, with the result that each arm was counted as a separate chromosome; and in spermatocytes, counts of 24 bodies could have arisen as a consequence of precocious disjunction of X- and Y-chromosomes, or from mistaking an end loop of one of the larger elements for a separate bivalent. In view of the much closer packing of the chromosomes in the cells, these difficulties would have been much more serious with the older sectioning technique. Undoubtedly the adoption of the squash method[26] and ancillary treatments for dispersing the chromosomes within the cells[27] is bringing about a great change in mammalian chromosomal cytology, and it is to this technical improvement that the rectification of the error—if such it be—must primarily be attributed. The crux lies no longer in the microscopy but in the preparative technique. The weary hours of toil which the pioneers must have spent at the microscope is reflected in de Winiwarter's *cri de coeur,* "J'ai perdu un temps énorme à répéter des numérations fatigantes et j'avoue aussi, très fastidieuses". The wonder is that there is so little to alter.

We acknowledge gratefully the help and interest of Mr. G. E. Maloney, who provided us with the material upon which the study was based. The efficient technical assistance of Mr. G. Breckon is also acknowledged.

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PROPERTIES OF MAGNETIC MATERIALS

THE final session of Section A (Physics) of the British Association was held on September 5, and appropriately for a Sheffield meeting was devoted to three papers dealing with various aspects of magnetism.

Prof. W. Sucksmith, of the Department of Physics, University of Sheffield, gave an outline of the developments leading to present-day production of magnetically hard materials for permanent magnets and magnetically soft materials for use in dynamos, transformers and other electromagnetic devices. The desirable characteristics of the two types of material are respectively high coercivity and high permeability. Until the early years of the twentieth century, tool steel was used in the manufacture of permanent magnets and no special materials were produced for the purpose. Subsequent empirical development culminated in the production of oxide magnets (cobalt ferrite, $CoO.Fe_2O_3$) by Kato and the iron–aluminium–nickel magnet steel, the parent of many present-day magnet steels, by Mishima.

A number of interesting problems of fundamental importance have arisen from considerations of the magnetization processes responsible for the high coercivity of permanent-magnet materials. Modern theories of magnetization processes are based on refinements of the theory of magnetic domains originally proposed by Weiss. In general, it is supposed that ferromagnetics are subdivided into domains in each of which the elementary magnetization vectors lie along one of two or more preferred directions; domains characterized by different preferred directions are separated by domain boundary walls. In the demagnetized state the domain arrangement is such as to produce zero external magnetization. However, when a magnetic field is applied the domain walls move, domain magnetization vectors rotate from the preferred directions and the specimen becomes magnetized. Materials in which domain boundary movements are greatly impeded by structural and other imperfections are magnetically hard and have applications as permanent magnets. Néel, in his theory of 'disperse fields', has considered these aspects in detail. High coercivities may also be obtained in materials in which magnetization cannot occur by boundary movement but by rotation of domain magnetization vectors from one preferred axis to another. Thus if the dimensions of an isolated ferromagnetic particle are sufficiently small ($\sim$ 300 A.), it is energetically unfavourable for boundary walls to be created and the particle is a single magnetic domain. No boundary movements are involved in the magnetization of an assembly of single-domain particles; only rotations of the magnetization vectors may occur against anisotropy forces arising from the shape of the particles, crystalline anisotropy or strain anisotropy. It follows, as Néel in France and Stoner in Britain have shown, that prolate ellipsoidal particles departing by relatively small amounts from a spherical form will possess high coercivity. This work has stimulated the production of compacts of oriented single-domain particles of acicular shape for use as permanent magnets and also for magnetic recording tape.

In this connexion work on single-domain assemblies which is being carried out at Sheffield was also mentioned. Copper–iron alloys containing about 1 per cent of iron may be rapidly quenched from high temperatures and preserve the iron in solid solution. Precipitation of the iron in fine particle form can be induced by heat treatment at lower temperatures and may be interrupted at various stages to investigate the magnetic properties. Alloys of coercivity 500 oe., but with low remanent intensity of magnetization, have been produced in this way. It has also been found possible, by cold drawing the alloys, to orient the precipitate. In this way cold-drawn alloys with precipitated iron and nickel have been prepared with coercivities of greater than 1,500 oe. and 670 oe., respectively.

The necessary characteristics of magnetically soft materials of high permeability were then considered as the converse of those possessed by permanent magnet materials. For high permeability the material must have low magneto-crystalline anisotropy and low magnetostrictive deformation in order to minimize the effect of internal strains. For example, the composition of the alloy of iron–silicon–aluminium of the highest permeability is 84 Fe, 10 Si, 6 Al; for which the values of magnetocrystalline anisotropy and magnetostrictive deformation are least.

Prof. Sucksmith's conclusions were that, so far as the conducting magnetic materials are concerned, both soft and hard materials appear to be within sight of a stage where the relevant quantities are only reached under exacting laboratory conditions. The practical applications are becoming more and more controlled by manufacturing expediency. It also appears that the rapid extension of the alternating current applications of the non-conducting magnetic materials, particularly to high frequencies, gives a promise of a greatly expanded future.

In a paper by Dr. E. W. Gorter, of the Philips Research Laboratory, Holland, some aspects of the properties and underlying theory of non-conducting magnetic materials, the ferrites, were discussed. The unit cell of a ferrite may be represented by the formula $M_8Fe_{16}O_{32}$, where M is a divalent metal; the crystal structure is cubic spinel. The metallic ions occupy two types of site in the lattice: A-sites for which there is tetrahedral co-ordination with oxygen ions, and B-sites having octahedral co-ordination. Dr. Gorter exhibited a model of part of the unit cell which convincingly illustrated the possible magnetic couplings between the ionic moments of metallic ions occupying A and B sites. In general, the ionic moments are aligned mutually parallel or antiparallel.

The characteristics usually required of ferrites in alternating-current applications are high permeability and low loss. In turn, these characteristics depend on the spontaneous magnetization of the material, I_S, the magneto-crystalline anisotropy, K, the magnetostrictive deformation, λ, and the internal stresses and defects. The latter are inevitably introduced during the sintering processes used in the manufacture of ferrites and can never be entirely eliminated by annealing. Systematic investigations of the factors which influence I_S, K and λ (chiefly by Dr. Gorter and his colleagues) now make it possible for ferrites to be 'tailor-made' and suitable for a wide variety of applications. Thus, it follows from the theory of ferrites, originally developed by Néel, that the addition of zinc leads to an increase of spontaneous magnetization. Gorter has shown that this increase is limited by the fact that, when the zinc content exceeds a certain limit, the ionic moments are no longer mutually parallel or antiparallel. This leads to a reduction of spontaneous magnetization. The total magnetic moment of a magnetic ion is the resultant of two components, one due to electron spin and the other arising from the orbital motion of the electrons. There is a direct connexion between the magnitudes of the magnetocrystalline anisotropy and the orbital contribution to the ionic moment. Thus the orbital contributions to the moments of cobalt and nickel ions are 0·3 and 0·7 Bohr magneton, respectively, and cobalt and nickel ferrites are characterized by large magnetocrystalline anisotropy. However, the magnetocrystalline anisotropy coefficients of cobalt and nickel ferrites are of opposite sign; in cobalt ferrite the directions of easy magnetization are along cube edges, whereas for nickel ferrite cube diagonals are easy directions. Thus by sintering nickel ferrite with a small quantity of cobalt ferrite, it is possible to prepare materials in which there are only small magnetocrystalline anisotropy forces impeding rotation of the magnetization vectors and the permeability is high. Materials of this type purposely made with defects and air pores are found to have a low-temperature coefficient of permeability over a range of 60° C. The magnetostriction of ferrites can also be controlled by preparing mixed ferrites. The majority of ferrites have positive magnetostrictive deformation, that is, they expand on magnetization in a direction along the applied field. However, ferrous ferrite, $FeO.Fe_2O_3$, contracts on magnetization and has a negative magnetostriction. The magnetostriction of a mixed ferrite can thus be made zero if it contains the correct proportion of ferrous ferrite.

The concluding section of Dr. Gorter's paper dealt briefly with some of his recent work on dipole–dipole interactions in ferrites. In both manganese and lithium ferrites the orbital electron contributions to the ionic moments are small, and it follows from the above that the magnetocrystalline anisotropy energies are small in both cases. At first sight it would therefore appear that the permeabilities of both lithium and manganese ferrites should be comparable. However, it is observed that the permeability of manganese ferrite (μ approximately 400) is about ten times that of lithium ferrite (μ approximately 40). The reason for this difference is revealed by studying the influence of a magnetic field applied to lithium ferrite during its cooling from high temperature; the permeability measured along the field direction drops to a value of 9. The interpretation is that in lithium ferrite there are additional forces, inhibiting the rotation of the ionic magnetization vectors, which arise from dipole–dipole interaction. When the field is applied during cooling, the interaction is between lithium ion pairs aligned along the field direction.

In sum, the paper fully justified Dr. Gorter's claim that by adopting careful manufacturing techniques and applying sound theoretical principles, it is now possible to produce ferrite materials of predictable properties and suitable for a wide range of applications.

The final paper of the session was presented by Dr. A. Edwards, of James Neill and Co. (Sheffield), Ltd. Dr. Edwards first dealt with the historical development of the Sheffield magnet steel industry. The most modern and most efficient product of this industry is an alloy prepared by special cooling techniques to have a columnar structure with crystallites having axes of easy magnetization lying along a common direction. The composition of this alloy, known as 'Columnar', is adjusted so that valuable anisotropic magnetic properties are obtained by cooling the completed magnet in a magnetic field. It was pointed out that although the Sheffield permanent magnet tradition is based on alloy steels, it is realized by some manufacturers that future development may well be into the field of ferrite or shaped micropowder magnets. As an example of this trend in Sheffield, brief reference was made to the progress which has been made in the preparation of the anisotropic material $BaO.(Fe_2O_3)_6$; although it has been found difficult to obtain consistently high values of stored magnetic energy with this material, many production problems have recently been solved.

The second part of Dr. Edwards's paper was devoted to an account of some of the very many practical applications of permanent magnets. This was illustrated by a number of well-chosen and most efficiently presented demonstrations, all of which were greatly appreciated by the audience. Outstanding among the applications considered were the automatic train control system using permanent magnets, now installed on the King's Cross–Grantham line, and the hysteresis motors with very small permanent magnet rotors for operation at speeds of 10,000 rev./min. and above.

R. Street

PLASTIC THEORY OF STRUCTURES

CAMBRIDGE SYMPOSIUM

A RECENT book review ("Plastic Behaviour and Design of Steel Frame Buildings", *Nature*, August 4, p. 227) gave some account of the advances which have been made since the War in the theory of structures, particularly in the plastic design of steel structures. Much of this work has been carried out in the Cambridge Engineering Laboratory. It was fitting, therefore, that the first symposium on the subject in Britain should be held there. One hundred and ten engineers and applied mathematicians, nine from the United States, five from Holland and representatives from the U.S.S.R., Belgium, India and Italy watched, in the introductory session, after dinner in the hall of Clare College on September 18, experiments carried out by Prof. J. F. Baker on three steel structures loaded to collapse. These experiments showed some of the advantages of basing design on plastic behaviour.

During the next three days, eight working sessions were held. The first paper, introduced by Dr. J. Heyman, dealt with the plastic design of single-story portal frames. These have been of particular importance in the development of plastic theory, and a consideration of their behaviour forms a useful introduction to the subject. After dealing with some simple cases, Dr. Heyman turned to the multi-bay frame in which collapse is usually confined to the end bay only. If a horizontal tie is introduced at eaves-level, or the end stanchions are made so stiff that horizontal 'sway' movement is prevented, other interesting modes of collapse under unsymmetrical load and an instability mode may be introduced. Though a separate session had been set aside for the discussion of instability, the subject loomed large in this first session and not unnaturally became the recurring theme of the whole symposium. Mr. A. Bolton complained that the effect of axial load in the rafters was usually neglected and presented calculations showing that considerable reduction in load-carrying capacity would result if the rafter carried an axial load as low as one-tenth its Euler crippling load. This led to a discussion of the effect of cladding on the behaviour of shed buildings. Mr. R. L. Ketter, of Lehigh University, where a research team is working on plastic design, showed a series of curves from which could be read the sizes of members required for a wide variety of shed buildings. This approach appealed to some of the consulting engineers present.

The second paper, introduced by Dr. M. R. Horne, dealt with multi-story frames, in particular with that most complex problem, the behaviour and design of continuous stanchions. The paper considered only those frames where horizontal sway is prevented by the cladding, and showed the state of knowledge of stanchion behaviour and the resulting methods of design available at the moment: namely, to design the beams of the structure to remain elastic, allowing the stanchions to enter the plastic range, or to design the beams plastically while the stanchions are so proportioned as to remain elastic at the collapse of the beams. The discussion began with the description by a practising engineer of a method of analysis based on an assumed initial curvature which he had found confirmed by the early Cambridge tests on stanchions. This was an attempt at an empirical solution, following the kind of reasoning used to-day in elastic design; but it was decided that there is, as yet, insufficient justification for its acceptance. The discussion then turned to the dangers of sway instability, that is, the possibility of the frame as a whole becoming unstable even though the individual members had not reached full plasticity. It seemed to most of the members of the symposium that this was not a real danger for buildings of the type and height usual in Britain, but would become important if brick panel walls were replaced by the metal cladding which is becoming common in America. More attention must clearly be given to the problem as the plastic method is developed for multi-story structures. Attention was directed to the four-story wing of the Engineering Department at Cambridge now under construction and visible from the symposium room, which had been designed plastically—sway collapse fortunately being prevented by its attachment to the main building.

The third session was devoted to the subject of foundation design, with an introductory paper by K. H. Roscoe and A. N. Schofield. One of the attractions of the plastic method of designing a steel frame is that it allows a rational approach to be made also to the design of foundations. It is usually desirable, so far as the superstructure is concerned, to fix the feet of the stanchions. Orthodox elastic design virtually demands the assumption, in such a case, that the feet are completely encastré, so that no rotation or sinking can occur. It is, of course, impossible to build foundations which satisfy this assumption. The plastic design of the framework is unaffected, however, by sensibly large rotations or sinking of the foundations, so long as the full plastic moment of the steel stanchion can be developed. The Cambridge team has carried out full-scale tests on steel shed buildings with real, and most economical, foundations which confirm this. Plastic theory can also be applied to the design of the foundations themselves, and it is common to assume the soil to be a dilatant perfectly plastic material. It is interesting, as indicating how far the principle of plastic design for the steelwork had been accepted by the audience, that the lively discussion was centred almost entirely on the design of the foundations. The merits of pad and pier foundations for eccentric loads were compared, together with the advantages of tieing the latter and the practical difficulties of so doing. It was remarked that when excavating the soil after failure around the pier foundations, in the tests mentioned above, a layer of loosened soil into which the fingers could be inserted was evident to a depth of 2 ft. between the moving soil wedge and the surrounding soil. The thickness of these dilatant layers was so small in any form of laboratory or model test that they could not easily be measured or even observed.

The fourth session was opened with an elegant paper by Prof. W. Prager, of Brown University, on plastic design and thermal stresses. The work was based on an idealized moment curvature relationship applied to a propped cantilever introducing also the concept of standard states of bending moments. This particular problem allows of graphical representation but leads to general theories which can be proved rigorously. It was found that shakedown would occur if, and only if, a state of self-stress could be found such that superposition of the elastic response to the prescribed cycles of load and temperature on this state of self-stress nowhere led to a violation of the yield condition. It was suggested in the paper that alternating plastic deformation must be avoided at all costs. Discussion revealed evidence that in many steels tens of thousands of cycles are necessary to produce failure under this condition, so that in many practical cases it may be unobjectionable. An incremental collapse mechanism involving large changes of geometry might, on the other hand, be objectionable. The discussion turned again to problems of instability. Attention was directed to the case of a plate subjected to lateral load where compressive stresses led to buckling. Prof. Prager remarked that compressive stresses in themselves did not upset the plastic theory, but that if buckling occurs then some modification has to be made. It was pointed out that buckling due to heating and due to loading are quite different effects and that incremental collapse cannot be produced by thermal cycles alone. Some loading of the structure is necessary for this mode of collapse, but thermal stresses alone can produce incremental buckling.

The session dealing with impact was introduced by two very different papers, "Dynamic Loading and Impact", by Prof. Paul S. Symonds, of Brown University, and "Simple Experiments on the Dynamic Plastic Behaviour of Mild Steel Beams", by Dr. E. W. Parkes, of Cambridge. Prof. Symonds has attempted to replace the structure, subjected to such impact loading as a severe blast pressure, by a model of one degree of freedom, when the structure in fact would undergo a highly complicated series of shape changes that would require many degrees of freedom in an accurate description. Dr. Parkes described experiments he has carried out to find how structures behave when struck by moving masses. He found that, except at the point of impact of a high-velocity projectile, their deformations could be predicted by analysis based on the concept of a constant dynamic plastic moment. There was much discussion on how far the elastic response of a structure could be neglected and on the influence of high rates of straining on the yield. It was pointed out that the simple plastic theory leads to a simple and most reliable design method for structures under impact when the rates of straining are not excessively high. A demonstration showed how the once familiar 'Morrison table shelter' behaved, and a film illustrated the success of an even earlier war-time application of the plastic method to the design of reinforced surface shelters. The hope was expressed that the results of the vast amount of experience obtained in Britain during the War had been made available to American workers.

While discussion on various aspects of instability kept recurring throughout the Symposium, one session was devoted entirely to the subject. W. Merchant, of the Manchester College of Technology, had provided in an introductory paper a study of the behaviour of a structure which fails by a combination of plasticity and instability, using some of the early Cambridge strut tests as an illustration; but in opening the discussion he turned immediately to the possibility of overall instability in a multi-story frame in which sway bracing of one form or another was not present. As in the second session, this gave rise to much discussion and a certain feeling of pessimism. Accounts were given by Dr. R. H. Wood of the Building Research Station and others of particular problems which have been solved exactly, the labour involved being excessive; but though Mr. Merchant suggested some interesting empirical approaches, it became clear that this is a branch of the subject which requires more study. Among other problems discussed was the lateral instability of I-beams. It appeared from Prof. B. Thurlimann's account of work at Lehigh that the broad-flanged beam is not as satisfactory in this respect as the British Standard section. Dr. M. R. Horne gave an account of how design rules have been evolved to guard against the danger of lateral instability in plastic designs using British Standard sections.

The seventh session was devoted to design problems and was opened by Dr. M. R. Horne and Dr. J. Heyman with a paper raising some of the practical problems encountered by the Cambridge team in producing the first plastically designed structures. Slides were shown of a number of these buildings, including a seventeen-bay factory building, an unusual monitor-type portal frame workshop and the British Welding Research Association's fatigue laboratory, which was the first plastic building. This encouraged others to show their designs. Mr. R. T. Cole, who has used the plastic method for some hundreds of structures, claimed that bolted connexions can be satisfactorily introduced, are attractive architecturally and are cheaper than site-welded connexions. He was challenged on this last point, as certain firms insisted on the site-welding of their structures because it gave the lowest erection costs. There was much discussion on the problem of deflexion in plastically designed structures. Engineers were urged to publish accounts of the structures they designed plastically, as only in this way can experience be passed on quickly and the more timid encouraged to use rational methods.

The final session dealt with the teaching of the plastic theory of structures and its place in the university curriculum. Prof. J. F. Baker made it clear that, while he is enthusiastic about the subject, particularly as it is the only satisfactory way structural design can be taught in a university, he would not introduce it into the engineering syllabus unless something else could be left out. This naturally led, in the vigorous discussion which always arises when teaching problems are ventilated, to the question of what can be left out of to-day's crowded syllabus. The conclusion reached was that in an undergraduate course on theory of structures, a sound grounding in the fundamentals makes it possible to omit many of the specialist methods of elastic stress analysis. Stability again came to the fore; one experienced teacher, putting in a plea for its consideration, pointed out that he was not committed to any particular theory. He regarded all theories as tools of analysis, so that a student should be capable of dealing with problems of elasticity, plasticity and stability. Other topics discussed were the possible use of models in teaching and the behaviour of flat plates, the last arising from an illustration used by Prof. Prager to show there is no satisfactory method of elastic design.

At the end of the session Prof. Symonds, after dealing with the teaching at Brown University, remarked on the high level of interest and the high standard of discussion which had persisted throughout the three days of the symposium. Mr. T. R. Higgins, secretary of the American Society of Steel Construction, who had presided over this last session, expressed surprise at the level of familiarity with the subject shown by such a large group of practising engineers, He said that it is a new subject for American engineers, who are not so far ahead with it as are designers, in Britain.

There is no doubt of the unusual interest throughout the symposium. Plastic design, which enables so many of the unsatisfactory assumptions of elastic theory to be swept aside, has captured the imagination of most teachers and of many practising engineers. While there is little evidence that the great body of structural designers are aware of the revolution in their art, plastic design is clearly spreading fast.

OBITUARIES

Dr. J. W. Trevan, F.R.S

Dr. J. W. Trevan was well known as a pharmacologist and as a pioneer of the biological testing of drugs. He died on October 13 last at the age of sixty-nine. He was born in Bodmin and after education in Plymouth he gained scholarships to St. Bartholomew's Hospital, London, where he obtained several prizes and graduated in physiology in 1908 and in medicine in 1911. After undertaking resident appointments, he obtained the Fishmongers' Research Scholarship and carried out research on respiration. In 1914, he qualified as M.R.C.P. and served in the First World War as a pathologist.

Trevan joined the Wellcome Physiological Research Laboratories at Beckenham in 1920; later he became a member of the Standards Commission of the League of Nations, and was elected president of the Section of Therapeutics of the Royal Society of Medicine. In 1940 he became director of the Wellcome Physiological Research Laboratories and a director of the Wellcome Foundation, Ltd. In 1942 he became a Fellow of the Royal College of Physicians and in 1946 a Fellow of the Royal Society.

At Beckenham Trevan worked at first on local anæsthetics and analeptics, and on chemotherapy. He had great ability in the design of apparatus, and the simple and useful microbalance and microsyringe which are now very commonly employed were his inventions. Soon his attention was attracted to the difficulty of biological standardization of digitalis, and later of insulin. Up to that time, no one had realized that one animal differed very greatly from another similar animal of the same species in its response to drugs. Trevan's work emphasized the necessity for the use of a large number of animals for the standardization of drugs and he introduced the term *LD*50 for the dose of drug which would kill 50 per cent of the animals under test. Much of his work was directed to the standardization of insulin; there were great difficulties in this matter as the early batches of insulin varied considerably from one to another and clinicians were unable to depend on a constant preparation. His work resulted in the development of a very satisfactory method of standardization using a quantal method depending on the convulsions induced in batches of mice. This work provided for a test for insulin which enabled the clinician to rely on every batch being of the same potency, and it was a considerable contribution towards the solution of the problem of the treatment of diabetes.

His work on the bioassay of drugs was published in the *Proceedings of the Royal Society* in 1927; it was the forerunner of the statistical methods of drug standardization which are in common use to-day, enabling us to make an accurate assessment of the error of a particular test. These assays are of fundamental importance, both to the manufacturer of therapeutic substances and to the physician who is making use of the preparations.

Trevan was one of the most friendly and helpful of colleagues, and his great scientific ability was devoted as much to helping his associates and subordinates as to his own research. While he was a great enthusiast in all scientific matters, he was much more critical of his own work than that of his colleagues, and his notebooks contained great numbers of records of carefully controlled experiments which he did not feel were sufficiently significant for publication. He had a great sense of humour and delighted in telling stories against himself; the many honours he received he always felt were quite undeserved.

While so many workers in the field of pharmacology have gained much of his advice and foresight, such was his modesty that he usually managed to make them feel that they had thought of the ideas themselves. He was a pioneer in pharmacology, especially in the field of the standardization of drugs, and there are many who will miss his friendly advice and help.

He was a deacon and member of the choir at St. Aubyn's Congregational Church at Upper Norwood. His first wife, daughter of the Rev. J. L. Keyes, died in 1937. Of this marriage there were three sons and two daughters. His second wife, by whom he had three children, is the daughter of Sir Hubert Llewellyn Smith.

G. A. H. Buttle

Prof. Arthur Rohn

A year ago mention was made in these pages of the first centenary of 'ETH', as it has come to be internationally known, namely, the Eidgenössische Technische Hochschule, Zurich, or the Swiss Federal Institute of Technology. Now we have to record the death on October 3 of the man who more than any other in his generation helped to give the Institute the position it holds as a centre of teaching and research in the field of technology in the widest sense of the term: Prof. Arthur Rohn, former president of the Institute's board and rector as well as a member of the professorial staff during eighteen years.

In the twenty-two years from 1926, when he was appointed head of the Institute, until 1948, when, greatly admired and respected as one of the country's élite, he gave his farewell address, Prof. Rohn had determined the policy and guided the development of the Institute in a way that earned him the gratitude of scholars, students and industrialists all over the world. His greatest achievement is the creation of more than two dozen specialized research centres in the form of institutes, which he helped to provide with sufficient grants, libraries, staff and special buildings. In addition to this, he persuaded the Swiss Government to create forty new professorial chairs in the field of pure and applied science. If the research institutes, for example, of aerodynamics, town and country planning, industrial accountancy, bear witness to his far-sighted vision, other innovations, like the new chairs for theoretical physics and mathematics, show his insistence on solid basic research in fundamentals.

Before he was called to the post of president of the Institute's Board, Prof. Rohn had held for nearly twenty years (1908–26) one of the most important chairs of civil engineering, that of structural engineering and bridge-building. Early and extensive experience in bridge-building in Switzerland and the Ruhr district had introduced him to this, his favourite field, in which he soon rose to be a master.

It was not only the eminence of the specialist nor the long experience as an academic teacher that enabled Arthur Rohn to exercise his brilliant leadership in higher professional education and industrial development, nor were these the only qualities that earned him the high respect—the veneration even—that was felt for him in later years. He combined qualities that are not often found together in such fullness: breadth of vision with practical executive power and great firmness of will, a profound belief in the capacity of men to improve things, with a clear notion of what was possible, aristocratic aloofness with kindness and generosity and a sense of justice. It was this largeness of his mind and the impressive stature of his moral character that won him the admiration of his students and that inspired the Institute of which he was for so many years the head.

Max Wildi

V. A. Obruchev

Vladimir Afanasievich Obruchev, the premier geologist in Russia, died in Moscow on June 19, at the age of ninety-three. He was born on September 28 (Old Style), 1863, in Klepinino, Tver district, in the family of an army officer. He was educated in Vilna, and went to the St. Petersburg Mining Institute. After graduating as a mining engineer in 1886, he went to Central Asia where, following the lead of his teacher, Prof. I. V. Mushketov, he spent two years in the study of aeolian deposits. In 1888 he was attached to the Mining Department in Irkutsk.

This was the beginning of Obruchev's work on the geology of Siberia, to which he devoted the rest of his life. At first he worked on the stratigraphy and tectonics of the Palæozoic and Pre-Cambrian rocks of the Transbaikal and Lena region, and studied the geology of the gold fields. In 1892 he started on a series of travels to Central Asia, Dzungaria, Mongolia, China and various parts of Siberia. For a time he taught geology in Tomsk Polytechnical Institute (1901–12) and later in Taurida University at Simpheropol (1918–22) and in the newly founded Moscow Mining Academy (1922–28). In 1929 he was elected to the Academy of Sciences and during 1929–34 he was the director of the Geological Institute of the Academy. There are many other administrative and editorial posts which he filled at different times in his career.

Obruchev's publications are very numerous and they range over a wide field. His most important work deals with the geology of Siberia, on which he was a recognized authority. The three fundamental works on this subject are: "The Geology of Siberia", in one volume (1926), published both in Russian and German ("Geologie von Siberien"); "The Geology of Siberia", in three volumes (1935–38); and "The History of the Geological Explorations of Siberia", in five volumes (1931–42). The two best-known text-books written by Obruchev are: "Ore Deposits" and "Field Geology". His travel books include: "Central Asia, Northern China and Nan-Shan", "From Kyakhta to Kuldzha", "In the Mountains and Deserts of Central Asia", and "My Travels in Siberia". But even more popular were Obruchev's novels, all of them provided with a vivid geological setting, such as "The Land of Sannikov", "Gold-seekers in the Desert", and "Plutonia".

Obruchev, in the eyes of his contemporaries, was not only a great geologist, a great traveller and a great writer; he was also a man of striking personal charm, a remarkable organizer and a great character. He was very popular, especially with the young readers of his popular books and novels; it was said of him that he used to receive thousands of letters, and that none was left unanswered when an answer was asked for.

S. I. Tomkeieff

Mr. D. L. Edwards

With the death on September 23, after a brief illness, of Mr. D. L. Edwards, director of the Norman Lockyer Observatory of the University of Exeter for nearly twenty years, another link with Sir Norman Lockyer, eminent astronomer and founder and editor for many years of *Nature*, has been severed all too soon.

Donald Luther Edwards was born at Peterborough on January 11, 1894, into a family whose scientific attainments were later to receive distinguished recognition in the fields of entomology and geology. He was educated at Cambridge County School, and the Royal College of Science, London, whence he graduated with the associateship, and a diploma in astronomy.

On the outbreak of the First World War he joined the Signals section of the Royal Engineers, serving in France with a sound-ranging unit. After demobilization early in 1919, Edwards went to Sidmouth as assistant to Lockyer, and commenced his duties at the Hill Observatory (as it was then called) in May of that year. Sir Norman died in 1920; and with the appointment of his son, Dr. W. J. S. Lockyer, as director in February 1921, Edwards became chief assistant, which post he held until December 1936, when he, in turn, was made director following the death of Dr. Lockyer.

During the period of his association with the Lockyers, Edwards's main interest lay in the determination of stellar parallaxes by a spectroscopic method first suggested by Adams in 1920. At Sidmouth, the technique was successfully applied to objective-prism spectra; and between 1922 and 1930 six papers were published by him, summarizing the results for two hundred B-type stars.

Later researches continued the study of the irregular variable, γ Cassiopiae, begun in 1923 by W. J. S. Lockyer. Quite recently, he had contributed an essay on this star to the second of the commemorative volumes, "Vistas in Astronomy", presented to Prof. F. J. M. Stratton on his seventieth birthday.

As director, he had the future development of the Observatory always at heart, while preserving the best of the Lockyer tradition. It was due largely to his untiring efforts that the Observatory Corporation was transferred to the University of Exeter (then the University College of the South-West) in May 1948.

Edwards was elected a Fellow of the Royal Astronomical Society in 1921 and served on its Council during 1946–50; he was also a member (from 1915) of the British Astronomical Association.

In all that he undertook he was conscientious and meticulously careful in every detail. Outside his professional work, his interests were wide, embracing such diverse subjects as music, ornithology, Egyptology and philately. For almost forty years he had known the encouragement and support of a serenely happy domestic life, having married in 1919 Elsie, daughter of the late Thomas Stanley, of Wednesbury, who survives him.

D. R. BARBER

NEWS and VIEWS

Chemical Engineering at the Imperial College, London: Prof. P. V. Danckwerts

A CHAIR of chemical engineering science has been established in the Department of Chemical Engineering at the Imperial College of Science and Technology, London, and Mr. P. V. Danckwerts has been recently appointed to it. Mr. Danckwerts studied chemistry at Balliol College, Oxford, under Mr. R. P. Bell. Graduating in 1939, he spent a year as a research chemist with the Fullers' Earth Union before joining the Navy. He served for six years, first as a bomb-disposal officer in various parts of the world, then, after being wounded during the invasion of Sicily, at Combined Operations Headquarters. At the end of the War he went as a Commonwealth Fund Fellow to study chemical engineering at the Massachusetts Institute of Technology, and received a master's degree in chemical engineering practice in 1948. He then joined the staff of the newly formed Department of Chemical Engineering at Cambridge, where he spent the next six years as a demonstrator and lecturer, helping to establish the curriculum and set the standards for the Chemical Engineering Tripos course. He also made a number of theoretical contributions to chemical engineering science in the fields of diffusional processes, mixing and continuous-flow systems. For the past two years he has been deputy-director of the Research and Development Branch of the Industrial Group, Atomic Energy Authority, where his duties have included the direction of the Group's extensive development work in chemistry and chemical engineering.

Senior Appointments at the Royal Aircraft Establishment: Mr. E. C. Cornford

MR. E. C. CORNFORD has been appointed head of the Guided Weapons Department of the Royal Aircraft Establishment. He was educated at Kimbolton School and Jesus College, Cambridge, where he read mathematics, graduating in 1938. He entered government service at the Royal Aircraft Establishment, where he was concerned with research on armament problems. During most of the war years he worked with the late Dr. L. B. C. Cunningham in the Air Warfare Analysis Section of the Air Ministry at Harrow. His work covered a wide range of theoretical investigations in the growing field of operational research, the application of mathematical probability methods to problems of air combat, and the introduction of the new radar blind-bombing devices which were so successfully used by Bomber Command. In 1946 he was transferred to the newly formed Controlled Weapons Department at Farnborough. After attending the Joint Services Staff College in 1950 he was seconded as senior principal scientific officer to the Scientific Adviser's Staff, Air Ministry. He returned to the Royal Aircraft Establishment as superintendent of the Guided Weapons Assessment Division in 1954 and has since been responsible for advanced work in the study of new weapon systems and air defence problems.

Mr. D. J. Lyons

MR. D. J. LYONS has been promoted deputy chief scientific officer to fill the post of senior superintendent, Ballistic Missile Division, in the Guided Weapons Department at the Royal Aircraft Establishment. He is a graduate of the University of London (Queen Mary College), where he obtained his degree in engineering in 1937. Following this, he joined the Aerodynamics Department at Farnborough, where he worked on wind-tunnel and full-scale stability and control problems. He had an interval of two years on flying duties in the R.A.F. before returning to Farnborough in 1941. Afterwards his work covered full-scale investigation of stability problems in new aircraft, particularly on spinning and autostabilization, followed by a move to the Guided Weapons Department, where he took charge of the Division responsible for experimental projects, control physics and missile aerodynamics. He has for several years specialized in problems relating to ballistic missiles.

Mr. P. A. Hufton

MR. P. A. HUFTON has been appointed senior superintendent of the Supersonics Division of the Aerodynamics Department, Royal Aircraft Establishment. He was educated at the University of Manchester, graduating in 1933 in engineering. After obtaining his M.Sc. for postgraduate research on flow through labyrinth packing, he joined the Royal Aircraft Establishment in 1934. A period on wind-tunnels was followed by some years on aerodynamic research in flight. He built up and led a strong team dealing with the handling and performance aspects of take-off and landing and low-speed flight. He moved to the Aircraft and Armament Experimental Establishment at Boscombe Down in 1946, as one of the superintendents, and did much to establish revised methods of performance testing and handling assessment for the new types of aeroplane then emerging, his knowledge being used extensively both by the civil and military authorities. Returning to the Royal Aircraft Establishment in 1953, he took charge of the supersonic aerodynamics group at Farnborough, at a time when supersonic flight was rapidly mounting in importance, and this has now been followed by his new appointment as head of an expanded Supersonics Division of the Aerodynamics Department.

Automation and Technical Education

A DEBATE on automation in the House of Lords on October 23 was opened by Lord Macdonald of Gwaenysgor, who emphasized the importance of research and of technical training, as also did Lord Crook; Lord Hall suggested that overhaul of training systems in Britain is urgently required. Lord Hailsham replied to the debate on behalf of the Government. He emphasized that clear-sighted planning, in direct consultation with the workers, is essential if automation is to avoid creating hardship; this is primarily the responsibility of management. He sees no reason why the consequences of the introduction of automatic machinery cannot be forecast far enough ahead for the individual employer to make his plans for recruitment and re-training his labour force, and to discuss well in advance with representatives of the workers how they will be affected. The Minister of Labour intends to discuss with representatives of employers and trade unions the period of notice in the contract of service and its relation to the length of service previously enjoyed, and has powers to assist transfers and training. In regard to education, Lord Hailsham strongly emphasized the impact which will be made upon the whole educational system of Britain, particularly on general education. It is still insufficiently appreciated that this is the real basis. Parents still do not realize the value of a technical secondary education, although there is increasing need for more craftsmen and technicians of all kinds and for new and modified types of training, and—most important of all—for more technologists and managers. Of non-recurrent grants of more than £25 million allocated by the University Grants Committee since the War, about one-third has gone to general university buildings of interest to all faculties, and 84 per cent of the remainder has gone to laboratories and other buildings for research and teaching in science and technology, including medicine. In regard to research, Lord Hailsham said that while the money provided under Conditional Aid Funds has come to an end, the continuation of the studies scheduled in the report on automation is receiving close attention, and it should not be assumed the work will come to an end.

Replying to a question in the House of Commons regarding progress in the extension of facilities for technical education since the publication of the White Paper, Sir David Eccles said on October 25 that the 1957–58 and 1958–59 building programmes have been approved and local education authorities know that they can start more than £40 millions worth of the five-year programme of capital investment. Eight colleges have been provisionally designated colleges of advanced technology and two designations confirmed. The National Council for Technological Awards has published its conditions for awarding the diploma in technology. The number of sandwich courses has risen from 103 to 168, and substantial increases of salary, recommended by the Burnham Committee for technical college teachers, have been approved. A committee, drawn from the National Advisory Councils on Education for Industry and Commerce, under the chairmanship of Dr. Willis Jackson, has been set up to report on the supply and training of teachers for technical colleges. The Minister has met representatives of local education authorities about regional co-ordination and inter-authority payments.

Awards for Postgraduate Study in Britain

NEW arrangements for awards for postgraduate study have been announced by the Ministry of Education and the Department of Scientific and Industrial Research, which have recently concluded in consultation with the Committee of Vice-Chancellors and Principals of Universities of the United Kingdom a full review of the present system. From 1957–58, the Department of Scientific and Industrial Research will offer a considerably increased number of competitive postgraduate awards in science and technology. These awards will be of two kinds: (1) *Research Studentships*, for postgraduate students seeking two or three years of supervised training in research, leading in most cases to a doctorate of philosophy; and (2) *Advanced Course Studentships*, for postgraduate students wishing to attend courses of advanced instruction in science and technology of not less than six months duration. The awards will be tenable at technical colleges as well as at universities. Their increased number has been so calculated that it will not normally be necessary for the Ministry of Education nor for local education authorities to make awards for postgraduate study in science or technology. Full details of these awards are being issued by the Department of Scientific and Industrial Research. Present arrangements for awards to students in medicine, dentistry, agriculture and veterinary science are not affected, nor are those for aiding graduates to train as teachers. Applications for the Department of Scientific and Industrial Research awards must be made through university or college authorities, and must reach the Department by March 1, 1957. The Ministry of Education is offering about 250 similar postgraduate awards, to be known as 'State studentships', for postgraduate study in arts subjects.

Chemical Industry in Britain

In his Messel Memorial Lecture to the Society of Chemical Industry on October 12, Sir Alexander Fleck, in reviewing some achievements and problems of the chemical industry, referred briefly to the life and work of Messel himself, particularly to his emphasis on the co-operation of science and industry, his insistence that specialization should be based on general education capable of stimulating the imagination and promoting independent thinking, and on the way he spent his working life at Silvertown living among the people who were employed by him. Sir Alexander suggested that if more employers and leaders had done this, the centres of chemical industry might have been made desirable residential neighbourhoods. He laid some stress in conclusion on this aspect of industry, urging that we cannot afford to make our surroundings either a geographical or a cultural desert, and that there must be sociological advance on many fronts, including a general advance in the educational level and a spirit of sincere service to the community. Sir Alexander also emphasized the need both on the management side and on the trade union side for a more flexible organization, capable of understanding current and impending changes; and while such an organization is being built up, the more intimate partnership of the works councils has an important part to play.

Looking at the achievements of the industry, Sir Alexander put the output of sulphuric acid at 2,095,000 tons in 1955 compared with 800,000–900,000 tons in 1881, and that of soda ash, soda crystals, caustic soda and sodium bicarbonate, which in 1881 was nearly 600,000 tons, probably exceeded 2 million tons in 1951. The output of dyestuffs had grown from 6,950 tons in 1907 to 42,900 tons in 1951. The average five-and-a-half-fold increase in the real value of production over a large section of the chemical industry in Britain between 1907 and 1951 can be compared with a three-fold increase for manufacturing industry as a whole; over the past five to ten years, the expansion for the whole industry was 9 per cent per annum, compared with 5 per cent for manufacturing industry as a whole.

Finance for the Department of Scientific and Industrial Research

Replying to a Parliamentary question in the House of Commons on October 23, Mr. J. R. Bevins, Parliamentary Secretary to the Minister of Works, as representing the Lord President of the Council, said that the five-year plan for the expansion of the activities of the Department of Scientific and Industrial Research provides for a financial review in the event of major variations in prices. This review has now taken place, and, subject to annual votes, additional resources will be made available up to March 1959 for grants to research associations and for other purposes. As the Department's receipts for paid services exceed estimates, it will be possible to maintain the number of awards to postgraduate students and other scientific grants during 1956–57.

University of Oxford

The issue of the *Oxford University Gazette* for October 16 gives some interesting statistics on the numbers in residence in the University and their various lines of study. There were 2,463 matriculations in 1954–55, an increase of nearly 3·7 per cent on the previous year, and for 1955–56 there were 6,207 men and 1,139 women in residence, making a total of 159 more than last year. The distribution of students under the six headings distinguished by the University Grants Committee is as follows, the first figures referring to men and the second to women: arts, 4,501 and 918; science, 1,139 and 163; medicine, 282 and 45; technology, 101 and 1; agriculture, 98 and 4; oversea services probationers, 52 and 1. The numbers of those taking honours schools in scientific or technical subjects in 1956 are as follows: mathematics, 68; physics, 74; physiology, 69; chemistry, 115 (part I) and 77 (part II); zoology, 23; botany, 12; geology, 5; engineering science, 29; geography, 57; agriculture, 9; forestry, 19; psychology, philosophy and physiology, 14; and biochemistry, 5 (part I) and 8 (part II). At Oxford, research students working for either the D.Phil. or B.Sc. in 1956 numbered 218 and 802, respectively. Though the University population is nearly 50 per cent greater than in 1938, the research side has obviously increased to a very much greater extent since then, for the comparable pre-war figures are: D.Phil., 67; and B.Sc., 78.

Statistics in the University of Sheffield

Through the generosity of the United Steel Companies, the University of Sheffield has been able to create an independent Department of Statistics, which began work as such at the beginning of this session. Provision for the teaching of statistics and for research in this field has hitherto been made within the Departments of Mathematics; but the growth of the subject and the very great increase in its use in wide fields of scientific and medical work—which in turn have meant many calls on the University staff in statistics—have rendered it desirable that a separate department should be established. This was already projected as a future development: the action of the United Steel Companies has made it possible to realize it at once. The head of the new Department, a post which carries the rank of senior lecturer in the University, is Dr. G. H. Jowett, hitherto lecturer in statistics in the University, whose post will be entitled "The United Steel Lectureship".

British Museum (Natural History): Recent Gifts

The British Museum (Natural History) has recently received a number of gifts, among which are the following. The Royal College of Surgeons has presented three sub-fossil human skulls from East Africa, thirty-five miscellaneous human skeletal fragments (mainly limb bones), eight models illustrating eruption of human teeth, and one primate brain-cast. Mr. Angus Booth (University College, Achimota, Gold Coast) has presented a large collection (114 specimens) of monkeys from the Ivory Coast, Gold Coast and Togoland, and four schoolboys have presented the considerable part of a skeleton of the rather rare narrow-nosed rhinoceros, *Dicerorhinus hemitoechus* Falconer, which they found in a peat deposit on the foreshore at Selsey, Sussex; further bones have been recovered by officers sent from the Museum, where the remains are being hardened and repaired. The cast of a skull of a child of the Old Stone Age, found with Mousterian flint implements in a cave of Teshik-Tash in Uzbekistan in 1938, has been received in exchange with the Museum of Anthropology, Moscow State University, and casts of the hand and foot bones of an early Neandertal man from Kiik-Koba, Crimea, have been received in exchange from the Institute of Anthropology, Leningrad, and the Museum of Anthropology, Moscow State University. The skull of an early Inca or Pre-Inca individual showing seven trephinations which the owner survived, collected at Pachacamae, in the Department of Lima, Peru, by the late Dr. D. S. Matthews, has been presented by the British Andean Expedition to Mount Huageruncho (1956). An exchange has been arranged with the Meteorite Committee, Academy of Sciences of the U.S.S.R., Moscow, through Prof. E. L. Krinov, by which specimens of ten meteorites hitherto unrepresented in the Museum's collection at South Kensington have been acquired.

Supplies of Anterior Pituitary Hormones

Five of the individual Institutes of the National Institutes of Health, Bethesda, Maryland, are jointly providing the funds for the purchase or production of large uniform lots of anterior pituitary hormones, other than adrenocorticotropic hormone, purified to meet exacting specifications set by the Endocrinology Study Section both for potency and for low limits of contamination with other activities. The first lots of bovine growth hormone and of ovine prolactin have been approved by the Study Section and are ready for distribution. The growth hormone and prolactin are packed as sterile, lyophilized powders in vials of 50 mgm. and 25 mgm. respectively. Data on the estimated potency and degree of contamination, and instructions for dissolving the materials, are issued with each package. A pilot plant at Emory University is being set up under the direction of Drs. Stanley Ellis and Alfred E. Wilhelmi for the production of follicle-stimulating, luteinizing and thyrotrophic hormones. These materials will not be ready for some months. Grants of the hormones will be made to qualified investigators who apply to the Endocrinology Study Section, c/o National Institutes of Health, Bethesda 14, Maryland. Application may be made by letter giving a brief description of the proposed work, together with an estimate of the amount of hormones required. It is hoped that by this service both clinical and fundamental studies on the anterior pituitary hormones will be stimulated.

The Mond Magazine: a Journal on Products from Nickel-containing Ores

For a quarter of a century the *Nickel Bulletin*, published by the Mond Nickel Co., Ltd., has provided a monthly summary of the world's literature relating to nickel and nickel-containing materials. The Company has now instituted the publication of *The Mond Magazine*, which is intended to have a wider scope and different functions, though it will not, fortunately, supersede the *Bulletin* itself. The object of the new publication is to provide articles and notes on a wide variety of subjects related to all the products extracted from the Sudbury ores, which, in addition to the nickel, contain copper, cobalt, gold, silver, the platinum metals, selenium, tellurium, sulphur and iron ore. In the first issue (No. 1, July 1956; pp. 24) are articles on terramycin, the plant for which is constructed of a nickel–chromium corrosion-resisting steel; a short note on palladium in relation to its use in jewellery; stained-glass windows, in which cobalt, selenium and nickel, etc., are used as colouring matters; nickel–chromium steels in steering-rod assemblies; high-nickel cast iron; the use of nickel–chromium–molybdenum steel in the oxygen equipment for the 1955 Kangchenjunga expedition; the resistance of platinum to molten glass; and mechanical excavators. It is clear that this new publication, which can be obtained free of charge from the Publicity Department, Mond Nickel Co., Ltd., Thames House, Millbank, London, S.W.1, should interest a very wide variety of new readers.

Prehistoric Wooden Implements from Africa

Besides a note by Dr. A. S. Brink on some Thecodonts, Part 6, Vol. 1, "Researches of the National Museum, Bloemfontein", contains an interesting article by Dr. Desmond Clark on a wooden implement from the level of Peat I at Florisbad, Orange Free State. Florisbad is not a very satisfactory site. There are peats of various ages at these fossil springs, and when, as in 1912, local upheavals occur, their contents all tend to get mixed up. However, all the levels seem to be referable to some time in the Gamblian period. It is rare for wooden objects to have survived from prehistoric times. Only in exceptional circumstances can this occur. Dr. Clark, however, has himself unearthed an even more interesting example at a site (Kalambo) near Abercorn in Northern Rhodesia. Here the date is definitely late Acheulean. In both cases the working is of a simple order and not in itself of much importance; but the use of wood by very early man for tool-making purposes is now definitely established.

Bassi's "Del Mal del Segno"

To mark the centenary of the death of Agostino Bassi (see *Nature*, 177, 255; 1956), the University of Pavia has issued an attractive photographic-offset facsimile of the two parts of Bassi's monograph, "Del Mal del Segno" (1835, 1836). Loosely inserted is a brochure in which a note on the commemorative edition by Antonio Pensa is followed by a reprint of the appreciation of Bassi by G. B. Grassi from the collected edition of Bassi's works published in 1925, a list of the changes Bassi made in the second edition (1837) of "Del Mal del Segno", and a catalogue of Bassi's writings. A limited number of these facsimiles are for sale. Inquiries should be made to the Rector of the University of Pavia, Italy.

Royal Society Antarctic Expedition

The main party of the Royal Society Antarctic Expedition for the International Geophysical Year (July 1957–December 1958) under the leadership of Colonel Robin Smart will leave London on November 15 for Royal Society Base, Halley Bay, in the M.S. *Magga Dan*, which is being shared with the Trans-Antarctic Expedition. The party will relieve the advance party of ten men under the leadership of Surgeon Lieut.-Commander D. Dalgliesh who sailed from Southampton in November 1955 in the M.V. *Tottan*, and most of them will remain at Halley Bay until January 1959.

Oversea Service Division, Colonial Office

The following appointments have recently been made in the Oversea Service Division, Colonial Office: J. M. Arthurs (rural education officer, Federation of Nigeria), principal of the Farm Institute, Arapai, Uganda; D. R. N. Brown (assistant director of agriculture, Uganda), deputy director of agriculture, Uganda; V. E. M. Burke (assistant agricultural officer, Kenya), agricultural officer, Kenya; L. F. Derraugh (senior agricultural officer, Gold Coast), commissioner for food products, Department of Agriculture, Gold Coast; E. W. Findlay (agricultural officer, Eastern Region, Nigeria), senior agricultural officer, Eastern Region, Nigeria; J. O. I. Longe (senior agricultural officer, Western Region, Nigeria), principal of School Agricultural Department, Western Region, Nigeria; R. F. A. L. Reed (principal of School Agricultural Department, Western Region, Nigeria), assistant director of agriculture, Western Region, Nigeria; E. Quist-Arcton (assistant conservator of forests, Gold Coast), senior assistant conservator of forests, Gold Coast; J. R. L. Bain (forest assistant Nyasaland), principal forest assistant, Nyasaland; K. H. Bryant (senior assistant conservator of forests, Federation of Malaya), conservator of forests, grade B, Federation of Malaya; C. Cairns (conservator of forests, grade B, Federation of Malaya), conservator of forests, grade A, Federation of Malaya; Foggie, A. (deputy chief conservator of forests, Gold Coast), chief conservator of forests, Gold Coast; J. M. Ramsay (senior assistant conservator of forests, Gold Coast), conservator of forests, Gold Coast; A. Ginsberg (veterinary officer, Kenya), senior veterinary officer, research officer (hygiene), Kenya; L. S. Pfob (veterinary officer, Uganda), senior veterinary officer, Uganda; P. T. Preston (veterinary officer, Kenya), provisional veterinary officer, Kenya; E. A. Wells (veterinary officer, Uganda), senior veterinary officer, Uganda.

Announcements

Prof. Charles Singer and Mrs. Singer have been awarded jointly the George Sarton Medal of the History of Science Society. The Medal was founded last year and the first award was to Sarton himself.

Robert Roesler de Villiers Awards of the Leukemia Society, Inc., have been made to Dr. L. O. Jacobson, professor of internal medicine in the University of Chicago, "in recognition of his pioneer experiments on the beneficial influence of local tissue shielding on general hematologic recovery after external irradiation—a fundamental discovery concerning a therapeutic weapon of continuing value in human leukemia"; and Dr. John F. Loutit, director of the Medical Research Council Radiobiological Research Unit at the Atomic Energy Research Establishment, Harwell, "in recognition of his elegant and conclusive demonstration that general hematologic recovery after total body irradiation is enhanced by bone marrow cell colonization, even from a different species—a discovery of potentially great significance in the therapy of human leukemia".

It is announced by the University of London that the title of reader in sociology has been conferred on Dr. R. T. McKenzie, and that of reader in industrial relations on Mr. B. C. Roberts, in respect of the posts held by them at the London School of Economics and Political Science.

The following have been elected officers of the Association of Clinical Biochemists: *President*, Prof. E. J. King; *Chairman*, Dr. R. Gaddie; *Treasurer*, Dr. I. MacIntyre; and *Secretary*, Dr. A. L. Tárnoky (Royal Berkshire Hospital, Reading).

Some time ago (*Nature*, 175, 1066; 1955) reference was made to the "Coffee Pot", a club for young university graduates and professional people founded by Mrs. H. D. R. P. Lindsay. To meet the many applications, Mrs. Lindsay has now started a second club, the "Samovar", which has the use of the restaurant of the "Coffee Pot". Inquiries about the club should be made to the Membership Secretary, The Samovar Club, 108 Baker Street, London, W.1.

The British Society of Rheology is organizing a conference on "Rheology of Elastomers" to be held at the Rubber Producers Research Association at Welwyn Garden City during May 30–31. Further information can be obtained from the Honorary Secretary of the Society, 52 Tavistock Road, Edgware, Middlesex.

The Metallurgical Engineering Committee of the Institute of Metals is arranging an all-day informal discussion on "Degreasing", which will be held in the University of Birmingham on February 27. Members and non-members who would like to be present should notify the Secretary of the Institute of Metals, 17 Belgrave Square, London, S.W.1.

The annual exhibition meeting of the Botanical Society of the British Isles will be held in the Lecture Hall, British Museum (Natural History), on November 24, from 2.30 until 5.30 p.m. Further information can be obtained from Dr. J. G. Dony, 41 Somerset Avenue, Luton, Beds.

A small exhibition is being held in the University of Cambridge Engineering Department and will be open until November 17 to commemorate the publication of Sir Henry Bessemer's paper to the British Association entitled "On the Manufacture of Malleable Iron and Steel without Fuel". Exhibits include a showcase of original Bessemer steel specimens made between 1856 and 1859, lent by the Iron and Steel Institute; modern examples of steel made by the Bessemer acid process given by the Workington Iron and Steel Co.; a model of a Bessemer plant lent by the director of the Science Museum; a film strip projector automatically showing diagrams of the Bessemer converter in action; and photographs, notes and diagrams.

The Foundations' Fund for Research in Psychiatry has been given a grant of 3,682,000 dollars by the Ford Foundation for the support of the development of research personnel in mental health. It is stipulated that the money be expended or committed within five years, and it will be used concurrently with the present programme of fellowships and research grants in the field of psychiatry and related sciences. A brochure describing such awards can be obtained from the Foundations' Fund for Research in Psychiatry, 251 Edwards Street, New Haven 11, Connecticut.

Full-time courses on "Radioisotopes and Their Uses" are being arranged in the Department of Chemistry, Sir John Cass College, Jewry Street, Aldgate, London, E.C.3. These courses, which begin on January 14, are each of four weeks duration, and are a development of evening courses in radioactivity and radiochemistry established at the College in 1949. Additional facilities have been provided, and a new instrument room has been equipped for measurements and counting. Entry is restricted to graduates or others possessing an equivalent professional qualification. The fee for each course is £30.

The Wellcome Trustees announce that the office of their chairman (Sir Henry Dale) and their scientific secretary (Dr. F. H. K. Green) has been transferred from 24 Harley Street, London, W.1, to 52 Queen Anne Street, London, W.1 (Tel. Welbeck 5721/2).

Dr. W. M. Cumming, technical director to the British Dyewood Co., Ltd., and formerly professor of technical chemistry in the Royal College of Science and Technology, Glasgow, has retired in order to take up work as a technical consultant.

SCIENTISTS IN GOVERNMENT SERVICE IN BRITAIN

SPECIAL PROMOTIONS

FURTHER special posts have been created in the Civil Service, under provisions included in the White Paper on the Scientific Civil Service (Cmd. 6679; 1945), to provide for the promotion of individual research workers of exceptional merit. They include the following:

Deputy Chief Scientific Officers

DR. R. D'E. ATKINSON. Dr. Atkinson was appointed chief assistant at the Royal Observatory, Greenwich, in 1937, and in 1940 was loaned for degaussing work under the Admiralty. He is now at the Royal Greenwich Observatory, Herstmonceux. Dr. Atkinson is well known for his pioneer work on the mechanism of generation of stellar energy, but has in recent years turned his attention to the problems of positional and meridian astronomy, and has devoted considerable attention to the problem of flexure in transit instruments, this being a recognized source of error in accurate meridian work. He has designed a mirror transit which it is proposed to make for the Royal Greenwich Observatory..

MR. H. B. HOWARD. Mr. Howard joined the Scientific Civil Service in 1916. He has had long and varied experience in aircraft research, and since 1945 he has been assistant director of research on aircraft structures at Ministry of Supply Headquarters, in which capacity he has personally planned and co-ordinated aircraft structural research sponsored by the Ministry of Supply at the universities and in the aircraft industry. He is particularly distinguished as originator of the 'Howard diagram', for his early and far-sighted organization of research on flutter and vibration at the Royal Aircraft Establishment and for many substantial personal contributions to modern aircraft structural research.

DR. G. H. METSON. Dr. Metson joined the Post Office in 1933. Since 1946 he has led a team developing long-life, high-slope, pentode valves for submerged repeaters. His studies of oxide-cathode valves have led to a proper understanding of the causes of failure and to a production line employing novel techniques and rigorous testing and selection. In particular, passive platinum replaces active nickel for the cathode core; the growth of interface impedance and the excessive production and evaporation of metallic barium are thereby avoided and the means for activating and retaining activation on the passive core have been successfully found and explained. Subsidiary studies of other necessary materials and vacua have been made. His valves are in use in the Newfoundland to Nova Scotia section of the Trans-Atlantic Telephone Cable.

Senior Principal Scientific Officers

MR. I. M. DAVIDSON. Mr. Davidson works at the National Gas Turbine Establishment, where he has been primarily concerned with research in the aerodynamics of engines and has made notable contributions to the theory of supersonic flow and supersonic compressors, his recent work on the use of the jet flap to improve aircraft performance being particularly outstanding.

DR. K. H. DOETSCH. Dr. Doetsch is at the Royal Aircraft Establishment. Since 1953 he has been in charge of research and development of auto-pilots, autostabilization gear and powered controls.

DR. L. ESSEN. Since Dr. L. Essen joined the National Physical Laboratory in 1929 he has been concerned with precise microwave measurements, in particular with the measurement of frequency and time. Recently he has developed a frequency standard, based on a resonance of the cæsium atom, which offers the possibility of a more permanent, convenient and accurate fundamental time-standard than the astronomical standards hitherto used.

DR. F. A. ISHERWOOD. Since joining the Low Temperature Research Station, Cambridge, Dr. Isherwood has investigated the chemistry and biochemistry of the cell wall of plants and the soluble constituents of the cytoplasm. Recently, he has been studying the contribution which lignin and other phenolic substances make to the physical properties of the cell wall.

DR. M. S. LONGUET-HIGGINS. Dr. Longuet-Higgins joined the National Institute of Oceanography in 1954. Hitherto noted primarily for his important theoretical studies, he is at present particularly concerned with allied experimental investigations on the generation and changes in the characteristics of ocean waves and with the propagation of storm surges.

DR. L. W. MAPSON. At the Low Temperature Research Station, Cambridge, Dr. Mapson and Dr. Isherwood have made notable contributions to the knowledge of the role of ascorbic acid in plants and animals. Dr. Mapson's studies have been particularly concerned with the biological synthesis of vitamin C in plants and animals, the conditions of its stability and its role as a component of the respiratory enzyme system.

DR. H. SMITH. Dr. Smith has worked at the Microbiological Research Establishment since 1947. He has done outstanding research on the virulence-enhancing action of mucin and on the chemical basis of the virulence of the anthrax bacillus.

MR. J. K. ZBROZEK. Mr. Zbrozek has been working at the Royal Aircraft Establishment on the influence of atmospheric gusts on the flight dynamics of aircraft, using the 'power spectrum' method.

MR. H. ZIEBLAND. Since 1946 Mr. Ziebland has worked at the Explosives Research and Development Establishment, where he has applied engineering skill and theoretical and experimental ability in physics to problems of heat transfer, low-temperature research and thermal conductivity.

Similar promotions have been made by the United Kingdom Atomic Energy Authority as follows:

Deputy Chief Scientific Officer

DR. B. B. KINSEY. Dr. Kinsey became associated with atomic energy in 1942 when he joined the research team working at the Cavendish Laboratory, Cambridge, under the Directorate of Tube Alloys. When part of this project was transferred to Montreal, he joined the group engaged in the determination of the basic data required for nuclear reactors, and then, a year later, moved to the newly founded laboratory at Chalk River, Ontario. There Dr. Kinsey did notable work on the gamma-rays produced by neutron capture. In 1954 he spent a year at the Radiation Laboratory of the University of California as a guest of the United States Atomic Energy Commission, studying the interactions of high-energy protons with nuclei. Since 1955 Dr. Kinsey has held a special research appointment at the Atomic Energy Research Establishment at Harwell.

Senior Principal Scientific Officers

Dr. G. C. Barker. Dr. Barker is in charge of a small electrochemistry section in the group under Dr. E. Glueckauf. He has been responsible for the development of the square-wave polarograph which represents a major advance in polarography. He has studied the electrochemistry of ion-exchange resins and has recently applied the square-wave polarograph to the determination of ions in molten salts.

Mr. W. B. Hall. Mr. W. B. Hall, of the Atomic Energy Authority Industrial Group, is in charge of experimental engineering in the Research and Development Laboratories at Windscale in Cumberland. He has worked on heat transfer and associated problems in reactors with both gaseous and liquid metal coolants.

Mr. J. D. Lawson. Mr. Lawson is distinguished for his work in electron physics. He has studied the behaviour of electron beams in accelerators and the radiation from targets bombarded by high-energy electrons, and has led a team in the development of new types of high-power klystron valves operating in the microwave region. He is at present head of a section of the Accelerator Group at Harwell, in charge of long-term research on particle dynamics in unusual configurations of electric and magnetic fields, with the help of electronic and mechanical analogues.

NEUROCHEMISTRY

INTERNATIONAL SYMPOSIUM IN AARHUS

THE word 'neurochemistry' is coming to mean something rather more than the bare chemistry of nervous tissues. At the second International Neurochemical Symposium recently held at Aarhus, Denmark, the discussion ranged freely from electron microscopy to problems of nervous transmission and drug action. While the metabolism of nervous tissues formed the central theme, the programme reflected a growing appreciation of the significance of biochemistry in relation to the morphology and function of the nervous system.

In the opening session, Prof. F. O. Schmitt, of the Massachusetts Institute of Technology, gave an admirably lucid account of the molecular structure and properties of the nerve cell membrane. He reported that isolated sections of nerve membrane obtained from squid giant axons show a relatively high metabolic activity *in vitro*, suggesting that the membrane may account for a large part of the metabolism of the whole cell. In a discussion of the nature and structure of the myelin sheath of medullated nerve fibres, it appeared that the new evidence obtained with the electron microscope agrees with that derived from X-ray studies in supporting the view that the myelin sheath is made up of concentric layers of a double membrane. According to the 'jelly-roll' hypothesis, the double membrane grows out from the point of contact of nerve axon and Schwann cell, and wraps itself around the axon; but it is difficult to apply this hypothesis to the myelin in the central nervous system. Mr. G. B. David (Cardiff) reviewed the structure of the synaptic terminations, of which some two thousand can be counted on the surface of the large ganglion cells of the brain. He presented evidence that some of the nerve endings terminate in fine filaments which enter the post-synaptic ganglion cells. Recent work on the mechanism of nervous conduction was described by Dr. R. D. Keynes (Cambridge), and the relation of phospholipids to the binding and transport of cations was discussed by Dr. J. Folch-Pi (Waverley). It appears that the phospholipids may be intimately concerned in the operation of the 'sodium pump'.

In a session devoted to the histochemistry and cytochemistry of nervous tissues, Prof. O. H. Lowry (St. Louis) described the spectacular work coming from his laboratory on the quantitative distribution of enzymes in individual ganglion cells, obtained by micromanipulation from different parts of the brain. Some enzymes are evenly distributed throughout the cytoplasm and others are located especially at the cell surface. Asked by Dr. M. G. Larrabee (Baltimore) if he had yet made measurements on individual mitochondria, Prof. Lowry replied: "No. But there is another Symposium in two years!". Cytological aspects of nucleic acid metabolism were reviewed by Prof. L. Einarson (Aarhus), who discussed in particular the changes associated with functional activity of the neurone. Dr. J. E. Edström (Gothenburg) reported a very outstanding piece of work on the purine – pyrimidine analysis of the ribonucleic acid in individual nerve cells of the hypoglossal nucleus, using a combination of chromatography on single cellulose fibres and ultra-violet microspectrophotometry.

Other sessions dealt with the general metabolism of the brain *in vivo* and of isolated ganglia, brain slices and peripheral nerve. The role of coenzymes in group activation was reviewed by Prof. F. Lipmann (Boston), and Prof. H. McIlwain (London) contributed a paper on the speed of chemical changes in the brain. Prof. H. Waelsch (New York) reviewed the nitrogen metabolism of the brain and described new results with radioactive lysine which confirm the earlier work with radioactive methionine in showing the high metabolic activity of the proteins. The rate of incorporation of labelled amino-acids is greatest in the microsomes, and Dr. D. Clouet (Cardiff) reported the isolation from the microsomes of a highly active nucleoprotein which accounts for a large part of the amino-acid turnover in the proteins of the brain. Lipid metabolism was discussed by Prof. R. J. Rossiter (Ontario) and Prof. E. Klenk (Cologne). Prof. F. Lynen (Munich) contributed a review of the role of acetyl–coenzyme A in the synthesis of fatty acids.

In the closing session, devoted mainly to the biochemistry and physiology of pharmacologically active compounds and drugs, Dr. W. Feldberg (London) gave an account of the role of acetylcholine in the central nervous system. Dr. M. Vogt (Edinburgh) described recent work on the distribution of adrenaline and noradrenaline in the brain, and concluded that the tranquillizing drug reserpine appears to act by restricting the retention of basic metabolites in the tissue. Serotonin metabolism was reviewed by Dr. S. Udenfriend (Bethesda) and histamine by Dr. G. B. West (London).

The proceedings of the Symposium will be appearing shortly under the title "Metabolism of Nervous Tissue", edited by Dr. D. Richter and published by the Pergamon Press, London.

SOCIETY OF LEATHER TRADES' CHEMISTS

ANNUAL CONFERENCE

THE annual conference of the Society of Leather Trades' Chemists was held in the University of Leeds during September 21–22, the chair being occupied by the president, Dr. R. G. Mitton. The morning session of the first day was opened with a paper by Dr. G. H. Green on the mechanism of liming and bating. The main object of bating is to prevent adherence of leather fibres on drying, and evidence was put forward which leads to the following scheme:

$$\text{intact collagen} \xrightarrow{\text{lime}} \text{progelatin} \xrightarrow{\text{heat}} \text{gelatin} \xrightarrow{\text{trypsin}} \text{peptides of low molecular weight}$$

Progelatin consists of filamented collagen fibres produced on the newly formed collagen fibre-surface after liming or other swelling treatment, which, by its polar nature, acts as a glue when the fibres are dried. Removal of this progelatin restores the isoelectric point of the collagen, previously lowered to about pH 5·0 by alkali hydrolysis, and progelatin causes what is technically termed 'falling' and develops air-permeability and some silkiness of the grain surface of the pelt. Re-liming a skin after bating causes a serious loss of substance by progelatin formation, due to the bating enzymes assisting the action of the lime.

The tanning characteristics of aliphatic aldehyde–ketone resins were then discussed by J. R. B. Hastings and Dr. T. White. A resin tannage was described in which the hide is first impregnated with a condensate prepared by the alkali-catalysed reaction between an aliphatic aldehyde and ketone, which is afterwards resinified *in situ* by further alkali treatment. The leather can contain up to 20 per cent of resin with an increase in shrinkage temperature of 14 deg. C. The condensates can be converted into water-soluble products by treatment with sulphites or bisulphites and employed by conventional tanning methods. The role of the sulphonate group in the solubilized products was discussed and further compared with analogous sulphonated tanning materials. The aldehyde–ketone condensates were thought to have potential value if used with other tanning materials.

The last contribution to the morning session was a paper by Prof. D. Burton and Dr. R. Reed on some further electron-microscope researches, in which the structural changes in tanned collagen fibrils during shrinkage in hot water were described. First, the fibrils swelled either at certain regions along their length or at their ends. The bands across the fibrils became fainter in the swollen regions and, significantly, became much closer together. At the same time the swollen portions flattened and assumed a peculiar spiral form. This initial swelling was usually observed at a temperature below that of macro-shrinkage—that is, below that of a strip of leather as determined in the usual apparatus. Moreover, the fibrils in any particular sample of leather did not all swell and shrink at the same rate. On raising the temperature, the swollen fibrils broke across to form short stubby structures, which on prolonged heating were reduced to ill-defined masses of glue-like material. These changes appeared to take place with all the leathers so far examined, but were best illustrated in the case of chrome and oil-tanned leathers where the fibrils were not obscured by the presence of amorphous material such as vegetable tannin. On the basis of these results, suggestions were put forward for the structure of the native collagen fibril, its stabilization by tannage and its shrinkage by hot water.

The afternoon session was devoted to the delivery of the seventh Procter Memorial Lecture by Dr. G. W. Kenner, who selected for his subject the present and future scope of peptide synthesis. During recent years, great advances have been made in the analytical and structural chemistry of proteins and the question must be asked whether synthesis will keep pace. No deep and rapid incursion into this field should be expected, but progress in two directions is discernible. Oligopeptides containing some ten amino-acid residues arranged in a definite sequence can now be constructed from most, if not all, of the amino-acids which occur in proteins; the chief interest in such compounds has lain in their relation to hormones and antibiotics, but they may also prove useful as models in studies of protein reactions. Many polypeptides have been synthesized from single amino-acids, and the possibility of repeating many times a given short sequence is now apparent.

For building oligopeptides of defined structure, one still relies fundamentally on the approach made by M. Bergmann—namely, protection of the terminal amino-group of an amino-acid or peptide, while the terminal carboxyl group is condensed with the amino-group of another section of the peptide chain. However, the actual range of methods is now much greater than that which was available to Bergmann. In addition to Bergmann's carbobenzoxy-protecting group, one now has the tosyl, phthaloyl and trityl groups—to name only the most important—and in addition to the azide method of condensation, there are those methods relying on various mixed anhydrides, cyanomethyl esters, thiolesters, derivatives of trivalent phosphorus, and carbodi-imides. The power of these methods has been amply demonstrated in the syntheses of oxytocin and related compounds by du Vigneaud and his colleagues as well as by other groups of workers.

Polypeptides have been synthesized from the N-carboxyanhydrides of amino-acids; but this method is not applicable to the production of material containing more than one amino-acid and having a defined structure. For this purpose some of the methods used in the synthesis of oligopeptides can be adapted; but there are many problems in securing reasonable yields of material with a high molecular weight. Nevertheless, progress along these lines can be confidently expected.

The remainder of the afternoon of the first day was occupied by the annual general meeting of the Society.

The morning of the second day of the conference was opened with a paper by N. L. Holmes and H. G. Wollenberg on investigations into the rate of tannage of sole leather. In this work, which was devoted to a study of the effect of temperature on the rate of tanning of sole leather, it was found generally that the total uptake of tannin increased with increase in temperature, as also did the rate of uptake, the temperature-levels used being 8°, 18°, 28° and 38° C. This was followed by the concluding paper of the meeting, by J. M. Harrison and T. Turner, on some experiments on the impregnation of sole leathers, in which were described some laboratory-scale experiments on the use of polymeric materials to improve abrasion resistance and water repellence of sole leather. The factors associated with emulsion impregnation and solvent impregnations were discussed. Many of the monomers, which on polymerization would give the type of elastomer required, are very volatile, and this has presented one of the difficulties. One method of *in situ* polymerization has been developed which gives a leather of improved properties.

LIBRARY PROBLEMS IN GREAT BRITAIN

IT is difficult to discern a common thread in the papers presented at this year's conference of the Library Association, held in Folkestone during September 18–21, though several of them stressed the importance of an adequate library system in relation to technological education and indeed to further education and the dissemination of information generally. In his paper on libraries in colleges of technology and further education, Mr. L. L. Ardern attacked the Government's failure to implement plans for an adequate national library service, at any rate for science and technology, and he was fully supported by Dr. G. Chandler and, at least by implication, by Mr. O. S. Tomlinson, who, reviewing post-war influences on librarianship, referred to the indifference of the teaching world, except in the universities and grammar schools, to the educational value of books.

Mr. Ardern began with a most interesting review of the early development of technical college libraries down to the official admission of their vital importance, which he welcomed, in the recent White Paper on Technical Education; but he showed convincingly how poor is the overall provision and how great is the need for some effective regional co-operation in each industrial area between the public libraries, the technical colleges and industrial libraries. Mr. Ardern remarked that we do not ask often enough how much duplication we can afford and suggested that this is a field where local co-operation would be particularly valuable, though the technical college library has to give priority to the subject fields of the departments it serves, and this limits the extent to which it can serve other fields.

Mr. Ardern fully recognized that the library is only a part of the technical college and that we cannot expect the part to be healthy, virile and progressive if the whole is not. He was clearly sceptical as to the Government's proposals for technical education providing us with colleges which are not overcrowded, under-staffed and under-equipped. Dr. G. Chandler, discussing present trends and future developments in large municipal libraries, did not mention the technical colleges, but in his reference to special libraries, to technical libraries and to patent libraries he was likewise concerned with the Government's failure to implement the recommendations of the Advisory Council on Scientific Policy. The rapid dissemination of scientific and technical information is probably, he said, from the national point of view the most vital library problem, and large public libraries will not be able to meet the varied specialist demands of to-day unless the Government gives them much greater preferential treatment than at the moment. The Government does not realize, he said, that large public libraries are, in effect, national institutions and that they serve an even more advanced section of society than either the technical colleges or universities.

Dr. Chandler urged that libraries have as large a part to play in education as have schools and colleges, and that education is more than ever a pre-requisite of our survival in a fiercely competitive world. In this he and Mr. Ardern were fully supported by Mr. E. R. Lake in a paper on reading in the television age, as well as by the president of the Association, Mr. Edward Sydney, who concluded his presidential address by remarking that the public library service in any really democratic society is, and always will be, an essential instrument in enabling its citizens to live wisely, agreeably and well. Mr. Sydney devoted his address mainly to developments during the decade since the Second World War, stressing, like Mr. Ardern, in his more limited field, the need for greater co-operation, for high standards in provision of books, of service and of staff; Mr. Sydney also gave a brief glance at the international field, which was surveyed in greater detail by Dr. H. Coblans in a paper entitled "International Librarianship—Some Problems and Implications". To the scientist the chief interest of Dr. Coblans's paper lies in his reference to the opportunities which bibliography, documentary reproduction and translation offer for international action. Commenting that, in spite of some improvement in co-operation between national services in certain subjects, the abstracting services as a whole deteriorate every year, becoming more expensive, less complete in coverage and more numerous, Dr. Coblans said that international agreement to co-operate along well-defined lines offers the only hope of solution. *Chemical Abstracts*, he remarked, in 1956 costs six times what it cost in 1955. During the past few months Unesco has accepted some responsibility for defining the problems presented by the automatic printing of large numbers of references or index entries and the solution of items of knowledge on a given subject, and also for stimulating research and study for centres at various stages of library development.

Mr. D. J. Foskett, in a paper entitled "Science, Humanism and Libraries", maintained that science is much more than the accumulation of masses of data and that the failure to realize this is a major cause of misunderstanding and of breakdown in the communication of science. In the course of his work the scientist gains new knowledge and new ideas which are capable of inspiring him with emotions akin to those felt by the poet and the artist, and these have to be communicated in such a way that others also can appreciate their significance. Mr. Foskett thought that it is important to get into our libraries those works which deal with the specifically human side of science, such as the histories and biographies, and that one reason why scientists become so specialized in outlook is the mere mass of publication, some of a very low standard and much of it repetitious. He suggested that libraries should attempt to discourage unnecessary publication and also that those possessing special knowledge should use their opportunities to produce works of wide interest, such as guides to the literature and bibliographies.

Mr. K. C. D. Vernon's admirable factual account of the libraries and work of some learned societies began, like Mr. Ardern's paper, with a historical review. Broadly speaking, he suggested, the strength of many of these libraries lies in their collection of periodicals, and he regretted that the holdings of many of these libraries are not recorded in publications such as the "World List of Scientific Periodicals". Some of these libraries have almost unknown riches on their bookshelves, and many have important collections of manuscripts. Many of them, however, are undeveloped and largely unknown except to small groups of people. Their resources could add much more to scholarship ; but although some, particularly those serving expanding professions, have been forging ahead, recataloguing and rearranging their books, binding old books and introducing more up-to-date methods, much remains to be done before these libraries are fully mobilized to serve their societies.

THE MELLON INSTITUTE

REPORT FOR 1955-56

THE annual report of the president, Dr. E. R. Weidlein, to the Board of Trustees of the Mellon Institute, Pittsburgh, for the year ended February 29, 1956*, records that expenditure on pure and applied research was 5,009,213 dollars, of which 1,125,213 dollars was in support of original investigations in pure science in the Institute's five research departments and conducted under the auspices of thirteen fellowships. The report traces the idea of setting up a partnership between American industry and science, which the Institute represents, to Dr. R. K. Duncan who, after attending the Sixth International Congress of Applied Chemistry, held in Rome in 1906, arranged for the first industrial fellowship at the University of Kansas on January 1, 1907. During the past year 160 members of the Institute were engaged in pure science research projects and 412 members on the applied science researches conducted under fifty-eight fellowships. Of these seventy-one fellowships, 44 were multiple and 27 individual; four had been proceeding for forty years, four more for thirty-five years and six for twenty-five years.

Investigations in the Department of Research in Chemical Physics have included a detailed study of sodium, potassium and calcium salts to determine the magnitude of the anion effects in flame photometry, the redetermination of the infra-red spectrum of heavy benzene in both gas and liquid phases, and studies of the effect of temperature on the infra-red spectra of cyclohexane and dioxan ; special equipment was assembled for measuring the intensity of X-ray scattering at very small angles. In the Department of Research in Physical Chemistry the study was completed of the effects of packing density and annular width on the separating efficiency of packed thermal diffusion columns, and work was considerably extended in chromatography. Three high-efficiency distilling units capable of handling charges up to 20 l. have been designed and installed, and a start made on the design of an automatic take-off system. Work on the determination and correlation of physico-chemical properties of hydrocarbons of high molecular weight continued, and the changes in pore-volume distribution of reactivated filtration clays are being followed in co-operation with the Multiple Petroleum Fellowship, and the absorption and desorption phenomena of porous glass in co-operation with the Glass Science Multiple Fellowship.

There is a continuing demand for workers in the Department of Instrumentation to construct instruments previously developed in it or by others, and also for training in the operation of instruments. In a basic study of the recording micro-balance and weighing techniques a procedure has been developed to adjust the instrument to be very insensitive to the tilt of the building and balance table. In the Department of Applied Mathematics a study has been made of the mathematical models used in predicting the concentration of atmospheric pollution ; work has also been begun in the Department on programming and coding a routine for calculating structure factors used in crystal-structure analysis by the Department of Research in Chemical Physics, and assistance has been given the Multiple Glass Science Fellowship in determining light scattering in glass as a function of fluctuations in anisotropy and density and to the Multiple Petroleum Fellowship on statistical analysis and experimental design in the engine testing of petrol and oils.

Following preliminary studies, in co-operation with the Multiple Fellowship on Petroleum, with a Lingane-type of potentiostat, the Department of Analytical Chemistry has provided a more widely adaptable instrument for coulometric analyses at controlled potentials and has expanded its microbiological and microscopical services during the year. A new microtome permits the preparation of cross-sections of biological and inanimate materials as thin as 0·05 μ, and a new stereoscopic microscope is an invaluable aid in selecting areas for photomicrography and for the examination of surfaces. A study of the effect of micro-organisms on petroleum and petroleum products was commenced, and procedures were formulated for cultivating and counting micro-organisms in aerosol dispersions. The expansion characteristics of starches and flours were studied in co-operation with the Food Varieties Multiple Fellowship, and the fundamental study of the chemo-synthetic autotrophic bacterium, which has been designated *Ferrobacillus ferroxidans*, isolated from bituminous coal-mines was continued.

Reviewing the work carried out under the Fellowships in Pure Science, the report stresses the work of the Industrial Hygiene Foundation, which has now completed twenty years of service to industry, including 380 companies in its membership, for which seven hundred special studies have been made as well as fifty basic research programmes in the Foundation's laboratories. Field investigations during the year included the determination of the magnitude of the in-plant contamination of the air with hexavalent chromium compounds, and the magnitude of fluoride exposures in specific areas of a chemical plant. A study was being made of the incidence of occupational dermatitis due to specific substances and the importance of these substances as causative agents in industrial dermatitis, and another of the effects of abrasive dust on normal lungs and on the evolution of pulmonary tuberculosis. Work under the Multiple Fellowship in Chemical Hygiene is being devoted mainly to the study of the safety of chemical residues remaining in food as a result of new developments in its production, processing and packaging, and the low level has been demonstrated of sensitizing ability of a new epoxy resin catalyst now being introduced. Under a fellowship in the effect of atmospheric moisture on air-borne bacteria a better understanding has been yielded of the water exchange between bacteria and their atmospheric environment and of the way in which certain chemicals alter this relation when bacteria are dispersed from suspensions of these substances. The Fellowship in Mine-Acid Control is now applying the accumulated information of nine years to a large complete watershed in a coal-mining area. The Multiple Fellowship in Glass Science has developed improved procedures for measuring the nuclear-spin relaxation-times of the silicon-29 atoms in glass, continued its study of irradiated glasses and commenced experimental studies on the surface of glass. The Multiple Fellowship in the Properties of Synthetic Rubber, now sponsored by the United States National Science Foundation, has scrutinized the determination of macromolecular sizes by methods of intrinsic viscosity and molecular weight and also the application of this technique to studies of branching in polymers. The degree of orientation caused by stretching the elastomer has also been investigated, and the response of solid rubber compounds to sinusoidal stresses. A filler has been developed that possesses a static buoyancy similar to that of buoyant glass fibres, in which the inherent strength, bulkiness and resiliency of a synthetic staple fibre of extremely small diameter are combined with the water repellency of a silicone polymer, and further tests are being made of the efficiency of this product. By combining xerography with electroluminescent powders, workers under the Multiple Fellowship on Carpenter Components have produced panels containing self-luminous information displays, which appear to be specially attractive for instrument panels.

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* Scientific Research Progress in Mellon Institute, 1955–1956. (Annual Report Series, No. 43.) Pp. vi+54. (Pittsburgh, Pa.: Mellon Institute, 1956.)

About 60 per cent of the report is concerned with the research programmes of the Fellowships in Applied Science, and among the points of more general interest which may be mentioned are the fundamental studies on the ageing of selenium rectifier plates made under the Multiple Fellowship in Power Rectifiers and the construction of a furnace to grow single crystals of silicon in a vacuum or in an inert atmosphere with independent pulling and rotation of the seed crystal. A study of the interaction of organic ammonium salts with bentonite has led to a stabler clay complex which is organophilic and hydrophobic and is used in gelling oils to greases and in controlling the thixotropy of oil-base paints. Considerable success has been achieved in determining the optimum water content for the proper extrusion of clay–water mixes by use of the 'Brabender plastograph', and an apparatus has been designed and constructed to measure the force-deformation characteristics of green clay bars under transverse sheer. Progress has been made in the development of cover-coat enamels with improved alkali resistance for use on sheet steel. Several interesting organic derivatives of zirconium have been prepared, and the production of a metal zirconium plate by electrolysis in non-aqueous media investigated. A comprehensive information-processing system, utilizing commercially available computers, communication systems and other devices, has been designed, and much basic research has been done on fundamental problems in the painting of steel structures, such as anchor-pattern profile, blast-cleaning inhibitors, and cleaning agents. An investigation of natural sediment in streams was commenced, and progress has been made with paper chromatography as a method for differentiating phenolic compounds and in a study of odour thresholds of pure phenolic compounds. Low-temperature crystallization techniques have been developed for the purification of organic compounds, and alloys of unusual characteristics have been developed by the electromelting of waste products from the recovery and utilization of anthracite.

Improved methods of synthesis have been devised for certain of the porphyrins and their metallic complexes, and the structure of the vanadium complexes determined. Volatility studies have been made on some of these metallic complexes, and studies initiated on the thermal stability of various sulphur concentrates from crude petroleums. A chemical shock tube has been designed and constructed for a fundamental study of combustion reactions, and a new micro-catalytic chromatographic technique developed for studying catalytic reactions, which promises to accelerate the accumulation of data on new catalysts. An extensive study was made of the chemisorption of nitrogen, carbon dioxide and carbon monoxide on nickel catalysts, prepared in the presence of alkali, and studies were continued on the composition and properties of fractions of high molecular weight from petroleum, while the use of calcium phosphates as a solid catalyst or catalyst carrier for various industrial reactions received detailed attention. Phase-contrast photomicrographs have been taken of a wide variety of plain and modified starches before and after heat treatment, and several modifications have been made in the method of synthesizing the bacterial starter from which salt-rising bread is manufactured.

A new dextrin has been developed for use as a high-performance size for filament acetate, and methyl glucoside has been used in the preparation of long oil-modified alkyl resins, oil derivatives and modified amino-formaldehyde resins. Compounds have been discovered with excellent detergency at low concentration in perchloroethylene, and the synthesis and evaluation of soluble linear polymers were continued; a comprehensive study of the autoxidation of polyalkylene oxide derivatives has revealed that carbon-to-carbon bonds along the whole length of the polyalkylene oxide chains, as well as terminal hydroxy-alkyl groups, are vulnerable to oxidative attack Considerable effort has been given to the synthesis of materials for use as, or in, high-temperature lubricating and hydraulic fluids, and more than fifty systems were examined for the stabilization of vinyl films to heat and light. The field of polyethylene/paraffin wax blends for coating paper-container stock was explored further, and methods were sought for determining the wettability of a metallic surface by a coating and the ability of a coating to flow on a metal surface. New techniques were developed for the preparation of functionally active siloxanes, and a special glow-proofed 'Neoprene' foam, which meets flame and smouldering-resistance requirements, was being developed. Besides the preparation of 6-diazo-5-oxo-L-norleucine, which is highly effective in inhibiting the growth of malignant tumours in mice and rats, studies of the mechanism by which the antibiotic, azaserine, inhibits the growth of malignant tumours showed that azaserine blocks at least one previously unknown enzyme from carrying out a key reaction involving L-glutamine and led to the identification of formylglycinamide ribotide as the reactant and formylglycinamidine ribotide as the product of the blocked reaction.

SPACE PERCEPTION IN CHICKS

ECKHARD H. HESS has carried out investigations to ascertain whether a chick's visual perception of space depends upon learning or upon the maturation of an innate ability (*Sci. Amer.*, July 1956).

Experiments were devised to prevent normal visual experience and which would not interfere with the normal physiological development of the eye. This was done by fitting the chicks' eyes with prismatic lenses which would displace the visual image to the right or to the left.

If the exact visual localization of objects in space is a totally learned ability, the chick's performance would be unaffected by the fact that it is wearing displacement prisms.

If, on the other hand, the chick is born with an innate ability to locate objects visually, the first pecks which such a chick directs toward objects seen through the displacement lenses would be about seven degrees to the right.

In experiments, twenty-eight Leghorn chicks were hatched in complete darkness and were immediately fitted with thin rubber hoods into which transparent plastic goggles had been inserted. The hoods were placed over their heads quickly in such a subdued light that the animals had essentially no normal light experience.

All the animals were returned to darkness for a period of about six hours so that they could become accustomed to the hoods. Then, when they were about one day old, all were tested for pecking accuracy. They were allowed to strike at small objects embedded in modelling clay. The targets were small brass nails, embedded so that they could not be dislodged by pecking.

There was a fundamental difference in the performance of control and experimental animals. In the control group the pecks were scattered about the target so that the target itself formed the centre of the distribution. For those chicks wearing lenses which displaced the visual field to the right, the pecks were similarly scattered; but they were centred about a point seven degrees to the right of the target. Similarly, the group the lenses of which displaced their visual images to the left showed a scattering of pecks to the left of the target.

Actual grain was now scattered and, when the chicks were between three and four days old, they were tested again. The results showed a great increase in accuracy on the part of the control chicks: now their pecks clustered quite closely about the target.

Among the animals wearing displacement prisms, improvement of a kind had also occurred. The pecks were clustered just as tightly as those of the controls, showing that increased accuracy had certainly been achieved.

It would appear that the chick's visual apparatus for locating objects in space is innate and not learned. This conclusion is based on the fact that the chick wearing displacement prisms clustered its pecks about the spot where the object was seen. It did not peck at random until it struck the target.

Moreover, the chick the visual field of which was displaced appeared unable to learn through experience to correct its aim. Its only improvement was to increase the consistency of the distance by which it missed the target. Apparently, the innate picture which the chick has of the location of objects in its visual world cannot be modified through learning if what is required is that the chick learns to perform a response which is antagonistic to its instinctive one.

Further experiments showed that adult chickens and newly hatched chicks used binocular cues for localizing objects in space. This innate organization for the perception of depth requires neither learning nor continued use for its presence in the adult animal.

HOME CARE AND NURSING

AN entire issue of *The Practitioner* is devoted to home care and nursing (179, No. 1057; July 1956). In an introductory article Dr. G. E. Godber notes two features of the National Health Service in Britain which have tended to be overlooked. One is that the Service depends primarily upon comprehensive home care, with hospitals and specialist services only for diagnosis and treatment of illness outside the scope of the family doctor and his supporting team. The other is that "the greatest innovations of the Service have been the domiciliary consultation with a consultant and the general provision of home helps". In other words, as Dr. Metcalfe Brown points out in his article on the domiciliary services available to the doctor, "The preventive services and the hospital service are there to help the family doctor, not to displace or replace him".

From the inception of the National Health Service the hospital service has absorbed a large proportion of the not inconsiderable sum which the nation spends upon the Service. Thus, during 1953–54, according to the Guillebaud Report, the hospitals absorbed more than 61 per cent of the £430 million spent on the Service that year, compared with only a little more than 12 per cent spent on the general medical service. Even if the cost of the pharmaceutical service is included in that of the general medical service, the proportion is still only a little more than 21 per cent.

There can be little doubt that if more attention were devoted to the development of the domiciliary services available to the general practitioner, the unnecessary load now carried by the hospitals would be radically reduced. Further, and equally important, the standard of general practice would be improved, to the greater benefit of the individual patient. The symposium provides an authoritative review of the services available to the general practitioner and of examples of how these services can be developed. The emphasis is upon the home care of children as these form such a vitally important part of the work of the family doctor; but all aspects of home care are integrated into the general picture. Three of the articles are written by medical officers of health. This is a sign of the increasing realization of the need for the closest possible co-operation between the medical officer of health, who is responsible for most of the domiciliary services, and the general practitioner, for whom these services are intended.

CASTE AND THE JAJMANI SYSTEM IN INDIA

IN works about caste it is rare to find an analysis of how the different groups interact with one another in the production and exchange of goods and services. William H. Wiser, in his book "The Hindu Jajmani System", described how goods and services are exchanged in a rural Indian village and analysed jajmani relations as a system. Knowledge of this jajmani system is essential for an understanding of the economic aspects of caste in rural India; its methods of working have been investigated and described by Prof. Oscar Lewis and Dr. V. Barnouw (*Sci. Mon.*, 83, No. 2; August 1956).

Under the system each caste group within a village is expected to give certain standardized services to the families of other castes. A khati (carpenter), for example, repairs tools, while a nai (barber) cuts hair; but they do not necessarily perform these services for everyone. Each man works for a particular family or group of families with which he has hereditary ties. His father worked for the same families before him, and his son will continue to work for them, the occupation or service being determined by caste. The family or family-head served by an individual is known as his jajman, while the man who performs service is known as the jajman's kamin or kam karne-wala (literally, worker). These are the terms used in north-western India; where the system prevails in other parts of India other terms may be used.

It is a characteristic of the jajmani system to operate without much exchange of money. For it is not an open-market economy, and the ties between jajman and kamin are not like those of employer and employee in a capitalistic system. The jajman compensates his kamins for their work through periodic payments in cash or grain, made throughout the year on a daily, monthly or bi-yearly basis. Kamins may also receive benefits such as free food, clothing, and residence site, and the use of certain tools and raw materials. These concessions represent the strength of the system and are more important than the monetary payments. Despite the increased use of money in recent years, the peasants tend to prefer grain payments to cash, since grain prices have risen so enormously in the past decade.

There is evidence that the jajmani system exists in eastern Uttar Pradesh, parts of Malabar and Cochin, the Mysore District, Tanjore, Hyderabad, Gujarat and the Punjab.

A major function of the jajmani system is to assure a stable labour supply for the dominant agricultural caste in a particular region by limiting the mobility of the lower castes, especially those who assist in agricultural work. If a kamin leaves the village, he must get someone to take his place, usually a member of the same joint family. This does not usually involve sale, and the jajman is not likely to object, as long as the position is filled. Such transfers are rare, the kamins having valued rights and advantages which make them hesitate to move. Moreover, the community may put pressure on an individual to make him stay.

Jajmani rights, however, which link an individual to certain families, may be regarded as a form of property passing from father to son. Like land property, it is equally apportioned among brothers when they separate.

The widely held view that the caste system is crumbling rapidly in India is not borne out by examination. Although the jajmani system is tending to decline, this will not necessarily be followed by an automatic or speedy disintegration of the caste system. Instead, caste may continue to take on new functions and manifestations.

CAPILLARY FILTERS OF KNOWN AND ADJUSTABLE PORE-SIZE

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RODS of even thickness, when closely packed in parallel arrangement, produce a bundle of straight capillaries, with lumen corresponding approximately to one-sixth of the rod diameter. A possible use of such capillaries is in filtration, for example, by connecting an element of the kind shown in Fig. 1 to a syphon or some other suction system. Capillary filters of such structure are characterized by pores, which are (1) uniform, (2) of known size, (3) adjustable by more or less tightening the outer press. These three features have not been realized hitherto in any type of filter, in spite of considerable efforts in many instances[1]. Besides filtration, they open possibilities in other fractionations by size, for example, in sieving, diffusion, etc.

Among the materials which can be used in manufacturing capillary systems of the above kind, artificial textile fibres are of importance. Table 1 gives some characteristics of a few synthetic fibrillæ.

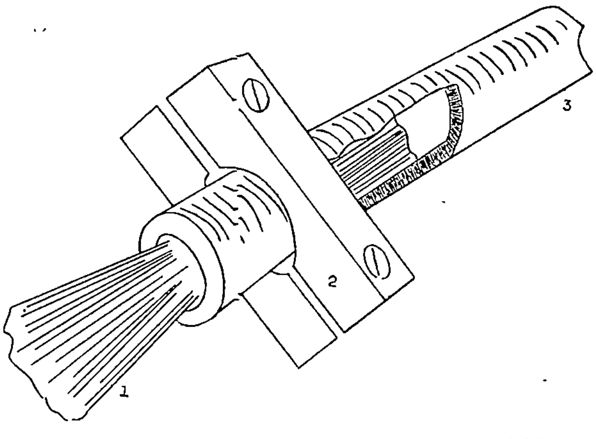

Fig. 1. (1) Rods and capillaries; (2) press; (3) plastic tubing

Table 1

Fibrilla	Composition	Cross-section (ref. 2)	Thickness (microns) (ref. 3)	Per cent swelling in water (ref. 3)
Acetate rayon	Cell. acetate	Crenulated	11 ± 30%	6–30
Casein	Protein	Circular	20 ± 13%	Very large
'Dacron'	Polyester	Circular	11 ± ?	0
Glass	Silicate	Circular	2·5 ± 20%	0
'Nylon'	Polyamide	Circular	11 ± 6%	2
'Orlon'	Acrylonitrile	'Dog-bone' shaped	18 ± ?	Very slight
Rayon	Cellulose	Crenulated	10 ± ?	'Viscose: 45–82 'Cu-NH$_3$': 99–134

The logical way of obtaining regularly packed rods from fibres is, of course, by reeling continuous filaments, for example, from commercially available bobbins. A procedure of this kind has been used by Hopkins and Kopany, who, however, were not interested in capillaries, but manufactured bundles of transparent fibres for the conveying of optical images[6]. For our purposes, the reeling is done on wheels the circumference of which is 2^n times the desired rod-length (n is any whole number), taking no particular care to deposit the fibres strictly parallel, because capillary forces arrange this automatically later, when the filter is wet.

Having deposited a counted number of turns, the pad obtained is cut open, taken off the wheel, and plied n times. Using a 'fish-wire', the 'tuft' is pulled into the tubing. If desired during this operation, the bundle can be given a precise length by neat cuts at both ends. A sharp knife is sufficient for cutting organic material. Glass can be sheared by scissors or cutting pliers (sawing by a 'Carborundum' disk—even water-lubricated—seems to produce sintering and plugging). As regards fibre length, I have observed that the rate of fluid transfer through the filters depends primarily on the zone of compression, being, for example, the same for filters cut flush with the faces of the clamp and others which extended in loose 'brushes' of irregular fibre length as far as 5 cm. beyond one or both sides of the restriction.

However, in filtration proper, these two types of capillary filters, the loose-end 'brush' and the clean-cut 'slice', may cause specific fractionation effects. The brush-filter and the slice (if at the end of the tube) are easily manufactured by the method described above. A filter-slice with free ends of tubing on both sides can be made by first cutting out a disk from a bundle of fibres packed within plastic tubing and then by pushing it into a larger tube, or by press-moulding or cementing it between two ends of tubing.

For a tube of 6·25 mm. inner diameter the following numbers of filaments can be used: 'Dacron' (DuPont 70-34-0-5,600-semi-dull), 20,000; glass (Owens–Corning *ECD*-900-1/0-'Fiberglass'), 8,000; 'Nylon' (DuPont 7-1-0-0-200-semi-dull), 40,000; 'Orlon' (DuPont 75-30-0-7281-semi-dull), 16,000; 'Rayon' (American Bemberg 50-36-44-*HH*-cupro ammonium), 4,000. These numbers of filaments and the press, the bore of which was ⅜ in. (= outer diameter of the tube) with ⅛ in. clearance for compression, allow of regulating aqueous flow (in ml. per hr.), through a syphon of 10-in. head, between 6·5 and 0·3 for 'Dacron'; 3 and 0·2 for glass; 7 and 0·05 for 'Nylon'; 4 and 0·5 for 'Orlon'; 3 and 0 for 'Rayon'.

Unfortunately, many fibrillæ (among them almost all natural and the thinnest artificial) are not available in continuous fibres. In this case, roughly parallel packing can be obtained by cutting staple fibres somewhat longer than twice the desired tuft length and then combing out the shorter fibrillæ. Weighing allows the estimation of the number of fibres per cross-section. For a tube of 6·25 mm. inner diameter, the weight in gm. per cm. length may be: for 'Rayons' and wool, 0·26; 'Nylon' and cotton, 0·35; for glass, 0·8. Otherwise, the procedure of manufacturing follows the pattern outlined above, the final packing and orientation by capillary forces being even more important here.

For various fluids specific interactions with the rod-materials can be expected. Water, for example, swells many fibres, as shown in Table 1. I have measured the decrease of water transfer (in ml. per 24 hr.) during consecutive days through capillary filters of cupro-ammonium 'Rayon' as follows: 11, 10, 9·5, 9, 8, 9, 8, 7·5, 5, 5, 5, 4, 4, 4, 3, 3, 3. Since the available space is limited by the outer press, expansion of the swelling fibres occurs into the capillary ducts, decreasing the lumen of pores. This can be used in constructing a capillary filter, with an outer metallic ring in place of a clamp, variable compressions and pore sizes being obtained by varying the number of fibres. For example, in the lumen of a 6·25-mm. tubing with an outer diameter of 9·375 mm., tightly fitted into a brass ferrule of 1 cm. in length, the following numbers of filaments (American Bemberg 50-36-44-*HH*-cupro ammonium) 3,800, 3,700, 3,600, 3,500, 3,400, 3,300, 3,200, 3,100, 3,000 gave, after two weeks of stabilization, flows of 0·0089, 0·024, 0·0328, 0·037, 0·0685, 0·089, 0·104, 0·1425, 0·226 ml. per hr., respectively, the head being 75 cm.

When using a water-resistant material like glass, several molecular layers of water are adsorbed by the surface of the rods[4], also producing clogging. Correspondingly, the flow of water through a capillary filter of glass decreases as follows under the same conditions as above: 11, 10, 9, 8, 7, 8, 7·5, 7. Obviously, the 'known' size of the capillaries cannot be calculated simply from the rod thickness in the 'dry' condition. It will vary and will have to be determined for each filtering medium. Presumably hydrodynamic methods will give strict answers, since the number of capillaries is known and their shape is very close to the ideal straight canals required by theory[5]. In an orientation test of this possibility, a glass filter composed of 816,000 fibrillæ, 6·275 microns thick, in tubing of 6·25 mm. inner diameter and an effective capillary length (zone of compression) of 10 mm., conveyed 22 ml. of water per 24·5 hr., the head being 121·5 cm. These flow data correspond to a capillary 'diameter' of 1·468 microns, whereas a geometrical computation yields 1·426 microns. (Assuming the arrangement of fibres as hexagonal–concentric, the ratio of holes to rods for the N'th row is $(2N-1):N$; the total number of capillaries tends to twice the number of rods with increasing counts of the latter.) On the other hand, the pore 'diameter' for the above cupro-ammonium filters with decreasing numbers of fibres has been calculated to be: 0·408, 0·530, 0·575, 0·600, 0·700, 0·750, 0·790, 0·869, 0·975 micron. These figures indicate 'diameters of pores'. However, under the microscope, cuts through closely packed swollen 'Rayon' fibres look more like regular hexagons of a tile-pavement, displaying no circular lumen. The pores are the rectangular gaps between hexagons, and the calculation of their width should probably be done by dividing the area corresponding to the above diameters, that is, 0·131, 0·221, 0·26, 0·283, 0·386, 0·44, 0·49, 0·58, 0·755 square microns by the length of a hexagon edge (approximately 8·5 microns). By this procedure the pore widths come out as: 0·015, 0·026, 0·030, 0·034, 0·045, 0·053, 0·060, 0·068, 0·090 microns. This should be closer to reality; but the ultimate determination of the size of the pores will be by filtration (diffusion, etc.) of particles of known diameters.

I may add that capillary coils as produced by wrapping sheets, and capillary boundaries between sheets in stacks (flat or curved) would give effects similar to capillaries between rods. As to specific action of surfaces, chemical and physical treatment of rods and sheets may result in interesting effects.

The foregoing is a by-product of sea-water demineralization research on the Berkeley Campus of the University of California. Though the study of capillary filters is only at its beginning, realizing their potentiality in many fields, Prof. E. D. Howe, director of the project, authorized this publication.

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A GENERAL CATION CARRIER IN THE YEAST CELL WALL

The General Carrier and its Amount per kgm. Yeast

It has been shown[1,2] that when yeast ferments 5 per cent glucose in the presence of potassium ions, they are taken up readily and in exchange for hydrogen ions. If there is no buffering outside and the volume of the suspending fluid approaches a minimum then the *p*H in this way can approach 1·5[3]. The uptake of potassium is much greater if the external fluid is buffered to a *p*H of 4·0–7·0. This exchange has been theoretically explained by the acceptance of metabolic hydrogen atoms by a metal catalyst in the cell wall, hydrogen ions being split off and electrons retained. The reduced catalyst then transports potassium ions internally[4,5].

It has been found that other ions besides potassium can be absorbed—sodium, for example[6], at a *p*H of about 6·0. The sodium had an affinity for the catalyst of about 0·04 that of the potassium ion. Not only sodium but also many other inorganic cations can be taken up by the carrier. The order of the affinities are: hydrogen, potassium, rubidium, cæsium, sodium, magnesium, calcium[7].

Magnesium ions can be taken up actively by the carrier in surprising amounts at a *p*H of 6·0–7·0 provided there is no other competing cation outside[8]. Thus in 7-hr. fermentation at room temperature with yeast in twenty times its volume of medium containing 5 per cent glucose and 0·2 *M* magnesium acetate, about 100 millimoles mgm. are taken up per kgm. yeast. The magnesium is taken up by the same carrier as potassium, as shown by the fact that as little as 0·5 m.equiv. potassium/litre outside can reduce the magnesium uptake from 200 m.equiv./litre by 50 per cent and a few m.equiv. can reduce it almost to zero. That magnesium should be taken up in this way is a property of the cation carrier and proceeds by a different mechanism from that occurring with phosphate at a *p*H of 4·0. In this case potassium facilitates the magnesium uptake[9]. Very probably the magnesium transport by the general cation carrier has no normal physiological significance since there will always be present more than enough potassium to inhibit it.

The same general cation carrier seems to be operative when external cations are being exchanged for the actively excreted sodium ions from a sodium-rich yeast (non-fermenting), the order of the affinities being in general very similar.

The actual concentration of the general cation carrier was measured from the amount of potassium instantaneously adsorbed by it and its subsequent displacement with excess of rubidium. The radioactive isotope potassium-42 was used for measuring the minute amounts of potassium so released into the external fluid. In the procedure adopted, yeast was suspended in 0·6 its volume of 5 per cent glucose containing 0·02 *M* magnesium acetate (to satisfy the anionic charges on the cell surface) and cooled to 4–5° C., a temperature at which potassium uptake is considerably reduced but is still measurable. Then labelled potassium chloride was added to produce a concentration in the suspending fluid of about 1 m.-equiv./litre, and after shaking vigorously for 30 sec. the potassium content of the supernatant was measured after centrifugation. To a similar suspension 30 sec. after addition of potassium, a very small volume of rubidium chloride solution was added to produce a Rb^+ concentration external to the cells of about 10 m.equiv./litre, and on shaking for a further half-minute the external potassium concentration was measured. The increase found was due to displacement of potassium from the carrier. The mean of thirteen such experiments gave 0·09 m.equiv. potassium displaced per kgm. yeast.

Since this method measured only the reduced form of the catalyst, the total concentration was measured by bubbling hydrogen through the suspension to remove all the oxygen present and so completely reduce the carrier. The potassium displacement, as a median for six experiments, was then found to be 0·12 m.equiv./kgm. It may be noted here that the difference between the amount of redox dye bound by the yeast in the completely reduced and completely oxidized conditions was approximately 0·15 m.equiv./kgm. yeast[10]. The iron content of yeast is about 0·60 m.equiv./kgm. wet yeast, mostly present in the cell wall[11], and the copper content about 0·06 m.equiv./kgm. Thus there is insufficient copper for binding the potassium but more than enough iron to act in the carrier enzyme.

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P. F. Duggan

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Active Transport of Magnesium

The general cation carrier in the yeast cell wall, referred to in the foregoing communication, can transport large amounts of magnesium into the cell during fermentation, when magnesium is the only cation present (apart from H^+) in the suspending fluid, and this has a *p*H of about 7·0. Thus when 1 gm. of centrifuged baker's yeast is suspended in 20–100 ml. of 5 per cent glucose containing 0·2 *M* magnesium acetate, about 100 millimoles of magnesium are taken up in 7 hr. The Mg^{++} exchange for hydrogen ions in a similar way to the active uptake of K^+ [1,2].

When sodium is taken up in a similar way it can be actively excreted by the yeast cells when these are washed and suspended in water. The excretion rate is much increased if the suspending fluid contains 0·1 *M* potassium chloride. In the latter case, sodium exchanges for K^+. On the other hand, magnesium accumulated in such a manner is not appreciably excreted on subsequent suspension in water or potassium chloride solution, even when glucose is added to the extent of 5 gm. per 100 ml.

Although very large amounts of magnesium can be taken up in this way by the yeast cell, the process seems to have no physiological significance, for it is almost fully inhibited by 2 m*M* K^+ in the presence of 200 m*M* Mg^{++}.

There is another mode of active magnesium uptake which has been studied by Rothstein[3], and also by Schmidt, Hecht and Tannhauser[4]. This occurs at or near a *p*H of 4·5 in association with phosphate and is increased by the presence of K^+. It would appear to be the normal mode of magnesium uptake during fermentation.

The active transport of magnesium by the general cation carrier requires the presence of oxygen, though the uptake of potassium by the same carrier can occur anaerobically. This may by explained by the inability of the redox system, when carrying the divalent Mg^{++}, to transfer its electrons to the acceptor system in anaerobic yeast. The active transport is inhibited by cyanide and azide as well as by anoxia. Of considerable interest is the fact that the active transport of magnesium, when this is present as the acetate, is not inhibited by 2,4-dinitrophenol (2 m*M*). Thus the evidence indicates that this active transport of magnesium after its attachment to the initial redox carrier requires the cytochrome–oxygen system for the further transfer of electrons and release of the transported Mg^{++} into the cell.

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July 29.

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A NEW METHOD FOR THE EXTRACTION OF DEOXYRIBONUCLEIC ACID FROM BACTERIA

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The extraction of deoxyribonucleic acid from bacteria, in a non-degraded state, raises some difficulties because of the presence around the bacterial body of resistant envelopes which prevent a rapid liberation in the medium of the molecules to be extracted. The method used by McCarty and Avery[1] consists of the lysis of the germs with sodium deoxycholate in the presence of sodium citrate as an inhibitor of deoxyribonuclease. This method yields a deoxyribonucleic acid highly polymerized and presenting a great biological specificity, but it is unfortunately limited to *Pneumococcus* and a very few other germs. The method of autolysis of bacteria, indicated by Boivin and Vendrely[2], allowed only the preparation of samples of deoxyribonucleic acid partially depolymerized. The methods, including mechanical processes of disruption of the germs (use of 'ball mills', shaking with glass beads, grinding with various abrasives)[3] are tedious and the yield is low and irregular.

We have devised a simple method for the extraction of bacterial deoxyribonucleic acid, using the lysozyme as a first step for the attack on the envelopes of the bacteria. This technique proved satisfactory for all

Table 1. RESULTS OF EXTRACTIONS OF DEOXYRIBONUCLEIC ACID FROM DIFFERENT BACTERIA

Germs	Time of action of the lysozyme (in min.)	Amounts of DNA released at the first extraction (in per cent of the total DNA)	No. of extraction	Amounts of DNA extracted at the end of the experiment (in per cent of the total DNA)	Percentage of the DNA collected in a fibrous form
Bacillus megatherium	6–10	45	2	90	100
	30	45	2	90	100
Proteus vulgaris	10	31	3	85	100
	10	25	3	62	100
	15	29	3	62	100
	45	—	3	62	70
Escherichia coli	6	45	3	80	100
	15	45	3	80	100
	30	45	3	80	100
Staphylococcus	3	30	2	50	90
	10	45	2	76	30
	30	45	2	80	0

the germs we have tried so far—*Bacillus megatherium*, several strains of *Proteus*, several strains of *Escherichia coli*, one of which was completely refractory towards the extraction by grinding.

The bacteria are grown for 12 hr. (*B. megatherium*) or 24 hr. (*Proteus*, *E. coli*, *Staphyloccocus*). They are collected and washed twice with physiological saline solution, then they are resuspended in water saturated with chloroform[4] and left for 30 min. in a cold room. The killed bacteria are then centrifuged in the refrigerated centrifuge and resuspended in a 4/1,000 solution of sodium chloride (pH 7·0)[5] in the proportion of 10 gm. of fresh bacteria for 100 c.c. of solution. Crystallized lysozyme is added (0·5 mgm. lysozyme to 1 c.c. of the suspension) and the suspension is incubated at room temperature (20° C.) for a time varying with the bacterium (3–15 min.). The action of the lysozyme is then stopped by rapid cooling at 2° C. and the bacteria are centrifuged in a refrigerated centrifuge, washed twice in distilled water in order to remove the lysozyme and the degraded polysaccharides and the supernatant are discarded—the residue is frozen at −30° C. overnight. The extraction of the deoxyribonucleic acid is then achieved by resuspending the frozen residue in ten times its volume of distilled water with glass powder (the weight of glass powder added is twice the weight of the residue) and shaking the suspension for 30 min. in a cold room. (Other abrasives such as quartz powder, aluminium oxide, are not so efficient as glass powder.) The suspension is then centrifuged at low temperature, and the supernatant containing the deoxyribonucleic acid is collected. This operation must be repeated three or four times until nearly total extraction of the deoxyribonucleic acid is achieved. The solution of deoxyribonucleic acid collected each time is very viscous and little coloured; it is precipitated immediately by addition of three volumes of 95° alcohol. Repeated dissolutions and reprecipitations give a good purification of the deoxyribonucleic acid, though further purification can be attained by one of the methods described by Zamenhof *et al.*[6,7].

Table 1 shows the results of the different experiments performed.

The most important step in this method is obviously the treatment of the bacteria with lysozyme. This enzyme, destroying the polysaccharides of the bacterial envelopes, allows the dissolution of the deoxyribonucleic acid in the medium together with other substances of the bacterial body (ribonucleic acid, proteins). The chloroformed water, by killing the bacteria, makes the action of lysozyme easier.

Freezing makes the bacteria more fragile and increases their permeability, and shaking with glass powder facilitates the solution of the deoxyribonucleic acid by dissociation of the gel and adsorption of the deoxyribonucleic acid on the surface of the glass particles. The results summarized in Fig. 1 are quite significant: it can be seen, for example, that if the action of lysozyme is omitted, almost no deoxyribonucleic acid can be extracted. Concerning the time of action of lysozyme, there is a threshold which is not the same for the different bacteria: 6 min. for *E. coli*, 10 min. for *Proteus*, 3–10 min. for *Megatherium*, 3 min. for *Staphylococcus*. Beyond this threshold, the yield remains the same for longer times, so there is no need to use longer times of action for lysozyme.

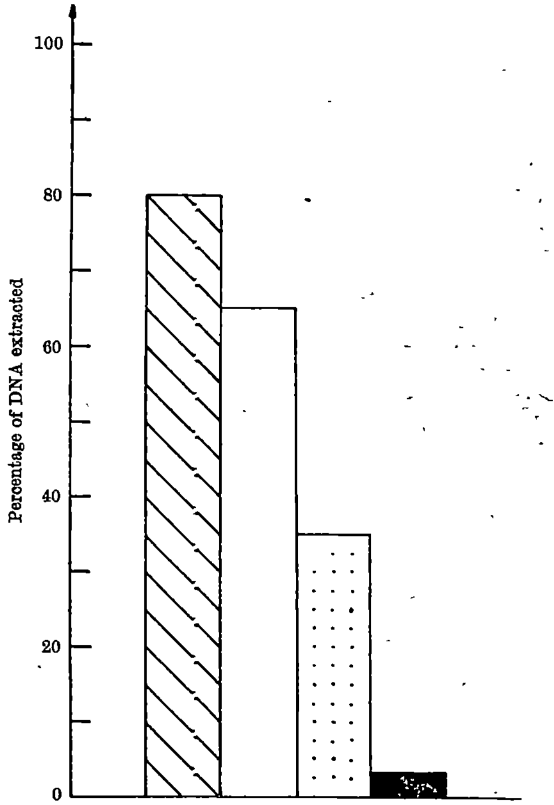

Fig. 1. Histogram showing the yield of the method for the extraction of deoxyribonucleic acid from bacteria (experiment performed on *Escherichia coli*) when various steps are omitted. Striped: optimal conditions. Plain: when germs are not frozen. Stippled: when chloroform is omitted. Black: when lysozyme is omitted

Moreover, the risk of autolysis is greater for long times and, in that case, the deoxyribonucleic acid extracted is no longer entirely polymerized. This fact is particularly striking in *Staphylococcus*, the deoxyribonucleic acid of which depolymerizes very rapidly in the course of extraction.

The degree of polymerization of the final product can be roughly estimated by considering the more or less fibrous state of the precipitate and the viscosity of the solution. When the method is used in optimal conditions, the yield of deoxyribonucleic acid is excellent. We have been able to extract 70–90 per cent of the acid contained in bacteria.

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A TEST OF A NEW TYPE OF STELLAR INTERFEROMETER ON SIRIUS

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We have recently described[1] a laboratory experiment which established that the time of arrival of photons in coherent beams of light is correlated, and we pointed out that this phenomenon might be utilized in an interferometer to measure the apparent angular diameter of bright visual stars.

The astronomical value of such an instrument, which might be called an 'intensity' interferometer, lies in its great potential resolving power, the maximum usable base-line being governed by the limitations of electronic rather than of optical technique. In particular, it should be possible to use it with base-lines of hundreds, if not thousands of feet, which are needed to resolve even the nearest of the *W*-, *O*- and *B*-type stars. It is for these stars that the measurements would be of particular interest since the theoretical estimates of their diameters are the most uncertain.

The first test of the new technique was made on Sirius (α Canis Majoris A), since this was the only star bright enough to give a workable signal-to-noise ratio with our preliminary equipment.

The basic equipment of the interferometer is shown schematically in Fig. 1. It consisted of two mirrors M_1, M_2, which focused light on to the cathodes of the photomultipliers P_1, P_2 and which were guided manually on to the star by means of an optical sight mounted on a remote-control column. The intensity fluctuations in the anode currents of the photomultipliers were amplified over the band 5–45 Mc./s., which excluded the scintillation frequencies, and a suitable delay was inserted into one or other of the amplifiers to compensate for the difference in the time of arrival of the light from the star at the two mirrors. The outputs from these amplifiers were multiplied together in a linear mixer and, after further amplification in a system where special precautions were taken to eliminate the effects of drift, the average value of the product was recorded on the revolution counter of an integrating motor. The readings of this counter gave a direct measure of the correlation between the intensity fluctuations in the light received at the two mirrors; however, the magnitude of the readings depended upon the gain of the equipment, and for this reason the r.m.s. value of the fluctuations at the input to the correlation motor was also recorded by a second motor. Since the readings of both revolution counters depend in the same manner upon the gain, it was possible to eliminate the effects of changes in amplification by expressing all results as the ratio of the integrated correlation to the r.m.s. fluctuations, or uncertainty in the final value. The same procedure was also followed in the laboratory experiment described in a previous communication[1].

There is no necessity in an 'intensity' interferometer to form a good optical image of the star. It is essential only that the mirrors should focus the light from the star on to a small area, so that the photocathodes may be stopped down by diaphragms to the point where the background light from the night sky is relatively insignificant. In the present case, the two mirrors were the reflectors of two standard searchlights, 156 cm. in diameter and 65 cm. in focal length, which focused the light into an area 8 mm. in diameter. However, for observations of Sirius, the circular diaphragms limiting the cathode areas of the photomultipliers (*R.C.A.* type 6342) were made as large as possible, namely, 2·5 cm. in diameter, thereby reducing the precision with which the mirrors had to be guided.

The first series of observations was made with the shortest possible base-line. The searchlights were placed north and south, 6·1 metres apart, and observations were made while Sirius was within 2 hr. of transit. Since the experiments were all carried out at Jodrell Bank, lat. 53° 14′ N., the elevation of the star varied between 15½° and 20°,

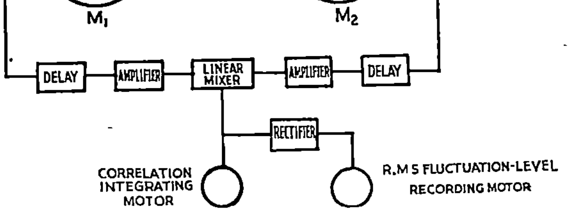
P1
P2
M1
M2
DELAY
AMPLIFIER
LINEAR MIXER
AMPLIFIER
DELAY
RECTIFIER
CORRELATION INTEGRATING MOTOR
R.M.S FLUCTUATION-LEVEL RECORDING MOTOR

Fig. 1. Simplified diagram of the apparatus

Table 1. COMPARISON BETWEEN THEORETICAL AND OBSERVED CORRELATION

1. Base-line in metres	2·5 (N.S.)	5·54 (E.W.)	7·27 (E.W.)	9·20 (E.W.)
2. Observing time (min.)	345	285	280	170
3. Observed ratio of integrated correlation to r.m.s. deviation: $C(d)$	+8·50	+3·59	+2·65	+0·83
4. Theoretical ratio of integrated correlation to r.m.s. deviation, assuming star has an angular diameter of 0·0063″: $C(d)$	+9·35	+4·11	+2·89	+1·67
5. Theoretical ratio of integrated correlation to r.m.s. deviation, assuming star is a point source: $C(o)$	+10·15	+5.63	+5·06	+4·40
6. Theoretical normalized correlation coefficient for star of diameter 0·0063″. $\Gamma^2(d)$	0·92	0·73	0·57	0·38
7. Observed normalized correlation coefficient with associated probable errors: $\Gamma^2(d)$	0·84 ± 0·07	0·64 ± 0·12	0·52 ± 0·13	0·19 ± 0·15

and the average length of the base-line projected normal to the star was 2·5 metres; at this short distance Sirius should not be appreciably resolved.

Throughout the observations the average d.c. current in each photomultiplier was recorded every 5 min., together with the readings of the revolution counters on both the integrating motors. The small contributions to the photomultiplier currents due to the night-sky background were measured at the beginning and end of each run. The gains of the photomultipliers were also measured and were found to remain practically constant over periods of several hours.

In order to ensure that any correlation observed was not due to internal drifts in the equipment, or to coupling between the photomultipliers or amplifier systems, dummy runs of several hours duration were made before and after every observation; for these runs the photomultiplier in each mirror was illuminated by a small lamp mounted inside a detachable cap over the photocathode. In no case was any significant correlation observed.

In this initial stage of the experiment, observations were attempted on every night in the first and last quarters of the Moon in the months of November and December 1955; the period around the full moon was avoided because the background light was then too high. During these months a total observation time of 5 hr. 45 min. was obtained, an approximately equal period being lost due to failure of the searchlight control equipment. The experimental value for the integrated correlation $C(d)$ at the end of the observations is given in the line 3 of Table 1. The value of $C(d)$ is the ratio of the change in the reading of the counter on the correlation motor to the associated r.m.s. uncertainty in this reading.

In the second stage of the experiment the spacing between the mirrors was increased and observations were carried out with east–west base-lines of 5·6, 7·3 and 9·2 metres. These measurements were made on all possible nights during the period January–March 1956, and a total observing time of 12¼ hr. was obtained. The observed values of the integrated correlation $C(d)$ are shown in line 3 of Table 1.

As a final check that there was no significant contribution to the observed correlation from any other source of light in the sky, such as the Čerenkov component from cosmic rays[2], a series of observations was made with the mirrors close together and exposed to the night sky alone. No significant correlation was observed over a period of several hours.

The results have been used to derive an experimental value for the apparent angular diameter of Sirius. The four measured values of $C(d)$ were compared with theoretical values for uniformly illuminated disks of different angular sizes, and the best fit to the observations was found by minimizing the sum of the squares of the residuals weighted by the observational error at each point. In making this comparison, both the angular diameter of the disk and the value of $C(o)$, the correlation at zero base-line, were assumed to be unknown, and account was taken of the different light flux and observing time for each point. Thus the final experimental value for the diameter depends only on the relative values of $C(d)$ at the different base-lines, and rests on the assumption that these relative values are independent of systematic errors in the equipment or in the method of computing $C(d)$ for the models. The best fit to the observations was given by a disk of angular diameter 0·0068″ with a probable error of ± 0·0005″.

The angular diameter of Sirius, which is a star of spectral type $A1$ and photovisual magnitude −1·43, has never been measured directly; but if we assume that the star radiates like a uniform disk and that the effective black body temperature[3,4] and bolometric correction are 10,300° K. and −0·60, respectively, it can be shown that the apparent angular diameter is 0·0063″, a result not likely to be in error by more than 10 per cent. (In this calculation the effective temperature, bolometric magnitude and apparent angular diameter of the Sun were taken as 5,785° K., −26·95, and 1,919″, respectively.) Thus it follows that the experimental value for the angular diameter given above does not differ significantly from the value predicted from astrophysical theory.

A detailed comparison of the absolute values of the observed correlation with those expected theoretically has also been made, and the results are given in Table 1 and in Fig. 2. In making this com-

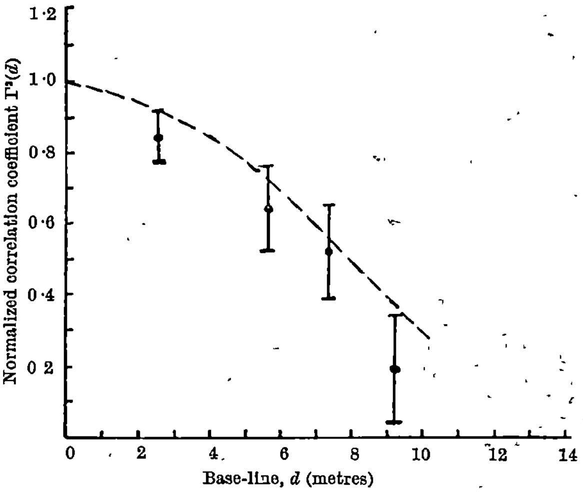

Fig. 2. Comparison between the values of the normalized correlation coefficient $\Gamma^2(d)$ observed from Sirius and the theoretical values for a star of angular diameter 0·0063″. The errors shown are the probable errors of the observations

parison, it is convenient to define a normalized correlation coefficient $\Gamma^2(d)$, which is independent of observing time, light flux and the characteristics of the equipment, where $\Gamma^2(d) = C(d)/C(o)$ and $C(d)$ is the correlation with a base-line of length d, and $C(o)$ is the correlation which would be observed with zero base-line under the same conditions of light flux and observing time. The theoretical values of $\Gamma^2(d)$ for a uniformly illuminated disk of diameter 0·0063″ are shown in line 6 of Table 1. For monochromatic radiation it is simple to evaluate $\Gamma^2(d)$, since it can be shown[5] that it is proportional to the square of the Fourier transform of the intensity distribution across the equivalent strip source; however, in the present case, where the light band-width is large, the values of $\Gamma^2(d)$ were calculated by numerical integration.

The theoretical values of $C(o)$, given in line 5, were calculated for the conditions of light flux and observing time appropriate to each base-line by means of equations (1) and (2) of our previous communication[1] (though in the present experiment the r.m.s. fluctuations were smaller by a factor $1/\sqrt{2}$ than the value given in the previous paper, which refers to an alternative electronic technique). The most important quantities in this calculation are the gains and output currents of the photomultipliers and the band-widths of the amplifiers; but it is also necessary to make a small correction for the combined spectral characteristics of the photocathodes, the atmospheric attenuation, the star and the mirrors. Finally, in line 4 of Table 1 the theoretical values of the correlation $C(d)$ are shown; they were calculated from the theoretical values of $C(o)$ and $\Gamma^2(d)$ by means of the relation given above.

The correlation observed at the shortest base-line (2·5 m.) can be used as a rough test of the effects of atmospheric scintillation on the equipment, since the corresponding theoretical value depends only on well-known quantities and is almost independent of the angular diameter of the star. Throughout the observations Sirius was seen to be scintillating violently, although the corresponding fluctuations in the d.c. anode currents of the photomultiplier tubes, which were smoothed with a time constant of about 0·1 sec., were only of the order of ± 10 per cent, as might be expected with mirrors large by normal telescope standards. Nevertheless, the observed correlation $C(d) = +\,8{\cdot}50$ does not differ significantly from the calculated value of $+\,9{\cdot}35$, and it follows that it cannot be greatly affected by scintillation.

The experimental values of $C(d)$ obtained at the four base-lines may be compared with the corresponding theoretical values $C(d)$ by means of lines 3 and 4 of Table 1. However, it is more convenient, since these values depend upon the different values of observing time and light flux at each base-line, to normalize the observed values of $C(d)$ by the corresponding values of $C(o)$, so as to give the normalized correlation coefficients $\Gamma^2(d)$ shown in line 7. In Fig. 2 these experimental values of $\Gamma^2(d)$ are shown together with their probable errors, and may be compared with the broken curve, which gives the theoretical values for a uniform disk of 0·0063″. It can be seen that both the relative and absolute values of $\Gamma^2(d)$ are in reasonable agreement with theory, and that within the rather wide limits of this preliminary test there is no significant difference between the correlation predicted and observed.

In assessing the potentialities of the technique described here, it is important to note that, although the measurements took five months to complete, the visibility was so poor that the total observing time was only 18 hr., while in this limited period additional absorption of 0·25–0·75 magnitudes due to haze or thin cloud was often present. If the observations had been made at a latitude where Sirius transits close to the zenith, the improved signal-to-noise ratio, due to decreased atmospheric absorption, would have made it possible to obtain the same data in a total observing time of about four hours.

Thus, despite their tentative nature, the results of this preliminary test show definitely that a practical stellar interferometer could be designed on the principles described above. Admittedly such an instrument would require the use of large mirrors. Judging from the results of this test experiment, where the peak quantum efficiency of the phototubes was about 16 per cent and the overall band-width of the amplifiers was about 38 Mc./s., one would need mirrors at least 3 metres in diameter to measure a star, near the zenith, with an apparent photographic magnitude + 1·5. Mirrors of at least 6 metres in diameter would be required to measure stars of mag. +3, and an increase in size would also be needed for stars at low elevation because of atmospheric absorption. However, the optical properties of such mirrors need be no better than those of searchlight reflectors, and their diameters could be decreased if the overall band-width of the photomultipliers and the electronic apparatus could be increased, or if photocathodes with higher quantum efficiencies become available. It must also be noted that the technique of using two mirrors, as described here, would probably be restricted to stars of spectral type earlier than *G*, since cooler stars of adequate apparent magnitude would be partially resolved by the individual mirrors.

The results of the present experiment also confirm the theoretical prediction[6] that an 'intensity' interferometer should be substantially unaffected by atmospheric scintillation. This expectation is also supported by experience with a radio 'intensity' interferometer[5,7,8] which proved to be virtually independent of ionospheric scintillation. It is also to be expected that the technique should be capable of giving an extremely high resolving power. Without further experience it is impossible to estimate the maximum practical length of the base-line; however, it is to be expected that the resolving power could be at least one hundred times greater than the highest value so far employed in astronomy, and that almost any star of sufficient apparent magnitude could be resolved.

We thank the Director of Jodrell Bank for making available the necessary facilities, the Superintendent of the Services Electronics Research Laboratory for the loan of much of the equipment, and Dr. J. G. Davies for his assistance with setting up the searchlights. One of us (R. Q. T.) wishes to thank the Admiralty for permission to submit this communication for publication.

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LETTERS TO THE EDITORS

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Time Courses of Motoneuronal Responses

THERE is now much experimental evidence supporting the postulate that excitatory and inhibitory synaptic actions are effective by the potential changes that are set up across the motoneurone membrane[1,2], the excitatory post-synaptic potential and the inhibitory post-synaptic potential being respectively in the depolarizing and hyperpolarizing directions. When generated by a virtually synchronous synaptic bombardment, these potential changes are approximately mirror images, the brief rising phases being followed by slower decays (Fig. *Aa*, *b*).

Further, it may be postulated that the subsynaptic currents (cf. inset, Fig. *B*) generating these potential changes have the same time courses as the synaptic transmitter substances that are responsible for them. Hitherto the time courses of action of the respective transmitters have been derived from analyses based upon the assumption that the approximate exponential decays of the excitatory and inhibitory post-synaptic potentials are determined by the passive decay of the charge that has been placed on the membrane capacity during the brief phase of transmitter action. It is known that the end-plate potential at the amphibian neuromuscular junction decays with the same time constant as that of the muscle membrane[3], and, as the time constants of decay of the excitatory and inhibitory post-synaptic potentials were considered to be approximately equal, it was argued that the electrical time constant of the motoneuronal membrane was the same as that of the decay of either type of post-synaptic potential, namely, approximately 4 msec.[4]. However, more accurate investigations, depending on the use of pure excitatory and inhibitory volleys, show that, while the time constant of decay of the excitatory post-synaptic potential is approximately 4·7 msec., that of the inhibitory post-synaptic potential is usually about 3·0 msec. (cf. Fig. *Aa*, *b*). Hence the time constant of the motoneuronal membrane cannot be derived by the above indirect procedure, and it becomes necessary to redetermine the electrical time constant of the membrane by more direct methods.

Motoneurones were impaled with double-barrelled micro-electrodes[1] filled with 0·6 *M* potassium sulphate solution, and the electrical properties of the membrane were determined by examining its response to rectangular current pulses passed through one barrel of the microelectrode. The consequent potential changes were recorded by means of the other barrel, using a cathode-follower input-stage the output of which was applied to one input of a differential

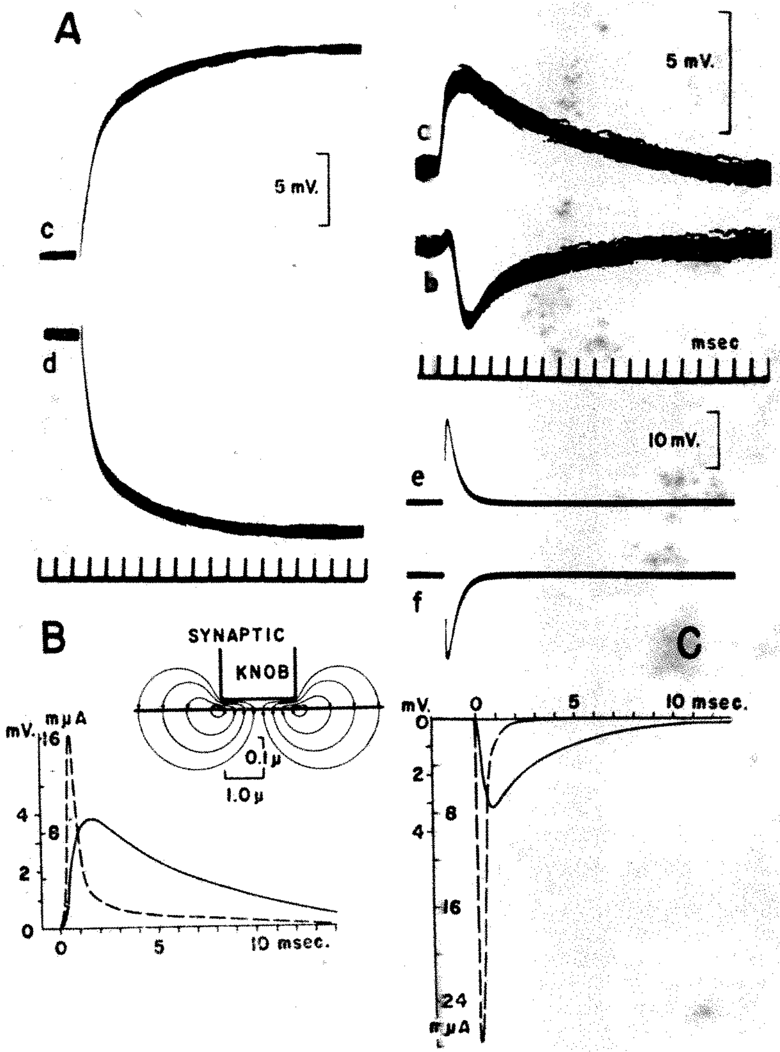

Fig. *A*. Potentials recorded from a biceps-semitendinosus motoneurone with a double microelectrode, both barrels being filled with 0·6 *M* potassium sulphate solution. Each record consists of forty superimposed traces. (*a*) Excitatory post-synaptic potential generated monosynaptically. (*b*) Inhibitory post-synaptic potential generated by impulses in the group I*a* afferent fibres from the quadriceps muscle. (*c*) and (*d*) Potentials generated immediately afterwards by rectangular current pulses of 12 × 10^{-9} amp. which are in the depolarizing and hyperpolarizing directions respectively. As shown in the extracellular records (*e* and *f*), the compensating network virtually eliminated all potential changes except those within 1·5 msec. after the onset of the pulse. The currents in *e* and *f* were 12 × 10^{-9} amp. in both the depolarizing and hyperpolarizing directions. Time constant values for this cell were higher than average, the membrane time constant derived from *c*, *d*, *e* and *f* being 3·1 msec. The excitatory post-synaptic potential decayed with a time constant of 5·5 msec. and the inhibitory post-synaptic potential with a time constant of 3·5 msec.

Fig. *B*. The continuous line is the mean of the monosynaptic excitatory post-synaptic potentials of Fig. *Aa*; ordinate in mV. The broken line shows the time course of the subsynaptic current required to generate this potential change derived by using the measured values of 3·1 msec. and 2·4 × 10^{-9} *F*. for the time constant and capacity of the membrane; ordinate scale in mμamp. The inset shows the direction of the subsynaptic current flow for an excitatory synaptic ending.

Fig. *C*. The continuous line is the mean of the 'direct' inhibitory post-synaptic potentials of the same cell (Fig. *A*,*b*). The time course of the subsynaptic current required to generate this potential change has been determined as in Fig. *B* and plotted by the broken line. It is of opposite sign, so would run in a direction opposite to that shown in the inset of Fig. *B* amplifier. The difficulties caused by the resistive and capacitative couplings between the two barrels were largely overcome by applying the same rectangular pulses to an electrical network, which was adjusted to reproduce similar artefacts to those of the double microelectrode alone and which fed this signal to the second input of the differential amplifier. In this way it was possible to balance out almost all the artefact generated in the electrode. For any one cell, potentials due to the current pulses were recorded both intra- and extra-cellularly without altering the balance network (Fig. *A*,*c*, *e* and *d*, *f*). Subtraction of these potentials for any one value of current gives the magnitude and time course of the membrane potential produced by this current pulse.

As determined in this manner, the membrane potential attained its new value with an approximately exponential time course, the time constant being about 2·5 msec., which may be taken to be the electrical time constant of the motoneurone membrane. Using this value, it has been possible to analyse the excitatory and inhibitory post-synaptic potentials on the basis of Hill's local potential theory[5,6], and to determine the time courses of the respective subsynaptic currents (Figs. *B*, *C*) and hence of the transmitter actions. Both transmitters have an initial intense phase of action. Contrary to previous accounts[2], a residuum of excitatory transmitter persists during the decaying phase of the excitatory post-synaptic potential (Fig. *B*). A smaller residuum is usually observed for the inhibitory transmitter, but sometimes it is negligible (Fig. *C*).

Independent confirmation of the prolonged residuum of excitatory transmitter action has been provided by firing an antidromic impulse into a motoneurone at varying times during a monosynaptic excitatory post-synaptic potential, which is thereby destroyed[2]. If the antidromic impulse so acts even several milliseconds after the onset of the excitatory post-synaptic potential, a very small rebuilding of that potential occurs after the antidromic spike potential, which was previously overlooked[2], and which must be attributable to a small residuum of excitatory transmitter action.

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Cardiac Repolarization and Metabolic Blockade

ADRIAN[1] in 1921 showed that monophasic action potentials of the frog heart lasted up to 2 sec. at 14·5° C. and corresponded to the refractory period which normally protects the heart from erratic beating. He found that the action potential of a premature beat was shorter in duration than the preceding action potential. Measurements with intracellular electrodes have confirmed these findings ; but no adequate explanation for the prolonged action potential of heart cells is available. Weidmann[2] has shown that the plateau of the action potential is a period of low conductance. He has suggested three types of change of K^+ or Na^+ permeability to account for this delay in repolarization. None of these hypotheses is quite satisfactory, so the problem has been approached by using metabolic blocking agents.

The plateau of depolarization in isolated frog atrium and ventricle is reversibly reduced in duration to about one-third of its normal length (Fig. 1*b*) by the action of 2 : 4-dinitrophenol at a concentration of 0·2 m.mole/l. [3]. Higher concentrations irreversibly shorten the action potential to one-sixth of its normal length. Sodium azide and neutral red, both of which interfere with oxidative phosphorylation, also reduce the duration of the plateau. Hypoxia acts in a similar fashion. The plateau appears to be linked, therefore, with supplies of high-energy phosphate. Further evidence for the dependence of recovery upon supplies of energy comes from the high-temperature coefficient of the plateau (Q_{10} 4–5)[4] and from the behaviour of the heart during extrasystoles and tachycardia. By driving excised amphibian hearts at different rates and recording intracellularly (Fig. 2), it was found that the rest pause coming before any action potential determines the duration of the next plateau of depolarization. In addition, the rate of depolarization becomes slower and the overshoot less, as the rest between beats is reduced. The relation between antecedent electrical diastole and the time of repolar-

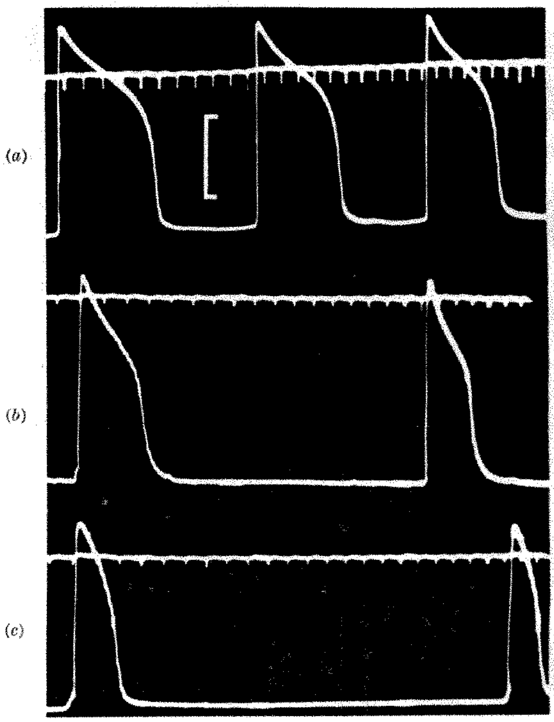

Fig. 1. Intracellular records of excised frog ventricle fibres at 22° C., beating spontaneously. (*a*) In normal Ringer solution, action potential duration 540 msec. and electrical diastole 360 msec.; (*b*) 10 min. in 0·2 m.mole/l. 2 : 4-Dinitrophenol + Ringer solution. Plateau shortened : action potential 320 msec., but rest pause 1,400 msec. ; (*c*) 30 min. in 0·2 m.mole/l. 2 : 4-dinitrophenol. Action potential 210 msec., pause 1,960 msec., resting potential reduced by 6 per cent. 2 : 4-Dinitrophenol reduces the time of repolarization, and a long diastolic pause does not assist recovery of the plateau. (Time marks 100 msec., voltage 50 mV.)

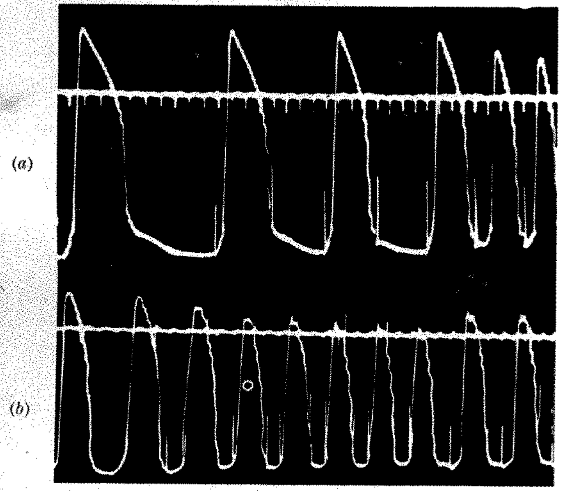

Fig. 2. Excised frog heart at 22° C. (a) Intracellular action potential of ventricle fibre. First potential shows fatigue after being driven, and action potential lasts only 350 msec. after 600 msec. rest; then driven at 2/sec. Shorter rest pause followed immediately by shorter action potential. (b) Drive 10/sec. with heart following each third and fourth stimulus. Reduced voltage and duration of action potential. (Time 100 msec.)

ization of the following action potential is linear in fresh hearts. The return of a long plateau after an exhausting period of fast activity is delayed, however, for several minutes (Fig. 2a), so the regression line then becomes a hysteresis loop. This behaviour may be interpreted as the restoration during electrical inactivity of specific energy sources to maintain the next plateau. When 2 : 4-dinitrophenol shortens the plateau of depolarization, however, a long rest is ineffective in prolonging the action potential (Fig. 1c).

Active transport of K^+ into nerve cells has been detected[5]. It is blocked by cyanide, 2 : 4-dinitrophenol and sodium azide. Acetylcholine shortens the plateau of heart fibres innervated by the vagus[6] and increases K^+ efflux[7]. None of these events, however, seems to provide a complete picture of the mechanism of the plateau. Active outward transport of such an anion as Cl^- offers a better, as yet untested, explanation. The plateau of the action potential is a period of low conductance, and it appears to be dependent on supplies of energy from oxidative phosphorylation which presumably are required for active ion transport. There is no conclusive evidence that the active ion transfer involves K^+ influx or Cl^- extrusion. Following the plateau, outward diffusion of K^+ would increase conductance and restore the membrane potential, though there may also be some active ion transport in this rather slow recovery phase.

This work was assisted by a grant from the Australian National Health and Medical Research Council.

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Essential Fatty Acid Activity of Docosapolyenoic Acids from Brain Glycero-Phosphatides

PREVIOUS work[1] has suggested that the presence of double bonds at the 6–7, 9–10 positions, counting from the terminal CH_3-group, is fundamental for the biological activity of essential fatty acids. This '6 : 9-(term.)'-hypothesis has directed attention to the highly unsaturated long-chain fatty acids from brain glycero-phosphatides[1]. According to Klenk[2], the C_{20} fatty acids of these phosphatides should contain two C 6,9-(term.)-acids, namely, C 11,14-eicosadienoic acid and arachidonic acid. The latter has long been recognized as an essential fatty acid, and, more recently, the former has appeared to be also active[1]. In the C_{22}-fraction of the brain glycero-phosphatides, six different fatty acids should occur, three possessing the 6,9-(term.)-configuration. Later, Klenk[2] succeeded in verifying the presence of these three 6,9-(term.)-acids by isolation and identification:

	Location of double bonds (terminal numbering)
C 7,10,13,16-tetraenoic acid	6, 9, 12, 15
C 4,7,10,13,16-pentaenoic acid	6, 9, 12, 15, 18
C 4,7,10,13,16,19-hexaenoic acid	3, 6, 9, 12, 15, 18

According to the theory, these acids should be active as essential fatty acids. In order to verify this supposition, fractions of highly unsaturated C_{22}-fatty acids from human brain glycero-phosphatides were tested for their bio-potency.

The isolation of these docosapolyenoic acids was carried out by one of us (H. de I.) under the guidance of Prof. E. Klenk at the Institute for Physiological Chemistry, University of Cologne, using a slight modification of Klenk's method[2] which involved the following steps: (1) dehydration of the brain and extraction with acetone; (2) extraction with ether of the phosphatides; (3) methanolysis of the phosphatides; (4) saponification of the methyl esters to fatty acids; (5) fractional crystallization by deep-freezing of the fatty acids in acetone solution; (6) esterification of the unsaturated fatty acids; (7) high-vacuum distillation of the ethyl esters, in order to separate the C_{18}-, C_{20}- and C_{22}-fractions.

In order to reduce losses on the walls and packing of the column, some paraffin oil (boiling point 160–190° C. at 10^{-4} mm. mercury) was added to the highly unsaturated fatty acid-ethyl esters prior to distillation. Eight fractions containing C_{22}-ethyl esters were collected (see Table 1).

It will be seen from Table 1 that the percentage unsaponifiable is fairly high. Very probably this is comprised entirely of the paraffin oil which was added prior to distillation.

Table 1. DATA OF THE INDIVIDUAL C_{22}-FRACTIONS

Fraction No.	Unsaponifiable (per cent)	Iodine value*	Conjugated dienes (per cent)	Conjugated trienes (per cent)
1	6	267		
2	6	293	1·5	—
3	9	293		
4	11	279	2·7	—
5	13	270		
6	16	268	6·9	0·1
7	16	246		
8	26	234	6·8	0·7

* The iodine values were determined by the method of Rosenmund and Kuhnheim and corrected for the percentage of the fractions which could not be saponified.

Table 2. Melting Points and Equivalent Weights of the Hydrogenated and Saponified Fractions

Hydrogenated fraction No.	Melting point (° C.)	Equivalent weight
1	77·0–79·0	354
2	78·0–80·0	341
3	78·0–80·0	340
4	79·0–80·5	339
5	80·0–80·5	339
6	78·5–79·5	339
7	75·5–76·0	346
8	75·0–75·5	349

Conjugated double bonds are present to a small degree, probably formed during distillation. Moreover, the corrected iodine values are somewhat lower than could be expected from the values found previously by Klenk[2].

To ascertain the purity of the fractions a small part of each fraction was hydrogenated, saponified and freed from the unsaponifiable portion, and after recrystallization of the fatty acids from acetone, their melting points and equivalent weights were determined.

As the melting point of behenic acid is theoretically 79·9–80·0° C. and its equivalent weight 340, it appears that fractions 2–6 consist of almost pure behenic acid.

The fractions were assayed in accordance with the method customarily used in this laboratory[1]. Some modifications were made. In order to avoid oxidation of the strongly unsaturated acids the animals (male Wistar rats) were given the total dose in one application instead of the usual daily dosing, the suitability of this depot method having been tested in preliminary experiments (unpublished work). For the same reason each animal was given 3 mgm. α-tocopherol (dissolved in 0·1 ml. of the ethyl esters of hardened coconut fatty acids). The ethyl esters of sunflower-seed oil fatty acids diluted with the ethyl esters of hardened coconut fatty acids were employed as a reference standard. The presence of paraffin oil in the distillate fractions might be an interfering factor; but one of the reference standards contained 10 per cent paraffin oil. It appeared, however, that paraffin oil in such small amounts did not influence the response.

As a unit for the bio-potency, the effect of 10 mgm. linoleic acid was taken[1]. The linoleic acid content of the reference standard was determined spectrophotometrically. The results of the bio-assay of the fractions are collected in Table 3.

The C_{20} fractions containing the highly active arachidonic acid and the weakly active[1] C 11,14-diene have a mean potency of 80 units/gm. The C_{22}-fractions, although somewhat less active than the preceding ones, also show a (significant) potency (mean : 38 units/gm.).

Table 3. Bio-potency of the Highly Unsaturated Fractions of Ethyl Esters of C_{20} and C_{22} Fatty Acids of Brain Glycerophosphatides

Fraction		Bio-potency (units/gm.)
A	C_{20}	100
B		62
C	$C_{20} + C_{22}$	78
1	C_{22}	48
2		52
3		30
4		39
5		36
6		23
7	C_{22} + traces C_{24}	40
8		50

In 1938 Hume[3] assayed a C_{22}-fraction obtained from cod-liver oil. The test animals showed only a slight positive reaction: their weights increased, but the skin lesions did not heal. Possibly a structural difference exists between the docosapolyenoic acids from the brain glycero-phosphatides of mammals and similar acids from fish oils[4].

Beauvallet[5] showed that the hexaene content of the brains of rats decreases by about 50 per cent when the animals receive fat-free diets. The present results are in accord with the theory that a relationship exists between the essential fatty acids and the central nervous system. Moreover, they furnish strong support for the 6,9-(term.)-hypothesis.

Our thanks are due to the advice and hospitality of Prof. E. Klenk, to Mr. Sparreboom for the spectrophotometric determinations and to the management of Unilever N.V. for permission to publish this communication.

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Factor I and γ-Aminobutyric Acid

Extracts of brain and spinal cord of mammals inhibit impulse generation in stretch receptor neurons of the crayfish[1]. The substance or substances responsible for this action has been referred to as Factor I[1]. In mammals this factor is present only in the central nervous system[1,2]. Partially purified preparations of the Factor have been found to imitate the action of inhibitory neurons in crustaceans[1,3] and to block synaptic transmission in autonomic ganglia[2] and monosynaptic spinal reflexes[4] of mammals. Factor I preparations were also found to activate the hypoglossal nucleus and often to stimulate polysynaptic spinal reflexes[4]. The inhibitory effects of Factor I in the spinal cord could be prevented by a subconvulsive dose of strychnine[4]. Partial purifications of Factor I have been obtained[1,2,4] by taking advantage of the observations that the factor is thermostable, dialysable, stable to acid and alkali, not precipitated by lead acetate or perchloric acid, soluble in methanol, moderately soluble in ethanol and insoluble in other organic solvents.

Factor I has now been found to be present in an occult, inactive condition in brain from which it can be released by heat, hypotonicity, or mild acid or alkali. Its production by brain is indicated by the fact that the activity found in brain suspensions increases with time. It has previously been reported that brain tissue can inactivate the factor[1]. The inhibitory effect of Factor I on the crayfish stretch receptor can be prevented by picrotoxin and metrazol, which are convulsants in the crayfish, but not by strychnine or camphor, which are not convulsants in this animal. These observations and those referred to above suggest that Factor I may be a transmitter substance of inhibitory neurons and that interference with its action may be the basis of the convulsive effects of some drugs.

A convenient and rather accurate method of assay of Factor I has recently been developed using the crayfish stretch receptor as test object. This assay has been used in work on the isolation of substances which exhibit Factor I activity. Acetone-dried beef brain was extracted with 70 per cent ethanol. The evaporated extract was precipitated with acetone, washed with petrol ether and re-extracted with 95 per cent ethanol, and the ethanol was removed. Taking advantage of the fact that the active material underwent exchange with both strong acid and strong base ion-exchange resins, but not with either weak acid or weak base resins, a purified fraction was obtained which crystallized on evaporation from the water solution, and which represented a one-thousand-fold concentration of the activity over that of acetone-dried brain.

Fractional crystallization of this material has yielded three crystalline substances. Out of ethanol, on slow evaporation, clear, striated, rhomboid plates were obtained which showed the highest Factor I activity of any material yet encountered. A concentration of about 2 μgm. per ml. was sufficient to block the activity of the crayfish stretch receptor neuron. This material was identified with γ-aminobutyric acid by infra-red analysis, melting point, and paper chromatography. An authentic sample of γ-aminobutyric acid was found to have the same activity when assayed on the stretch receptor preparation. Two other types of crystals were obtained from acetone-water but have not been identified. One of these—needle clusters—was active and may be γ-aminobutyric acid; the other type—rod-shaped crystals—was inactive. The residue from the 95 per cent ethanol extraction retained an amount of activity approximately equal to that which dissolved in the ethanol. This activity, readily soluble in water, did not undergo exchange with either strong acid or strong base resins. The nature of this fraction is not yet known.

Among many α-amino-acids and other substances of biochemical interest which have been tested, only one was found to show Factor I activity. This was β-alanine, which was about one-twentieth as active as γ-aminobutyric acid.

The activity of Factor I is thus apparently the composite effect of several different substances. It is possible that the ethanol-insoluble fraction may be a complex or modification of γ-aminobutyric acid. The activity of β-alanine is low and may not be of physiological significance; its activity is presumably a result of its close structural similarity to γ-aminobutyric acid. Preliminary studies by Dr. Elizabeth Florey indicate that the content of Factor I activity in different regions of beef brain varies widely. The average activity of whole cerebral hemispheres from rats corresponds to that of about 200 mgm. of γ-aminobutyric acid per kilogram. Tentative estimates by Awapara *et al.*[5] of the γ-aminobutyric acid content of rat brain are somewhat higher than this. It thus seems likely that γ-aminobutyric acid may account for much of the Factor I activity found in brain.

The presence of γ-aminobutyric acid in brain was discovered in 1950 by Awapara, Landua, Fuerst and Seale[5], Roberts and Frankel[6], and Udenfriend[7], and it was shown that it is produced from glutamic acid by the action of a decarboxylase[5,6,8] with pyridoxal phosphate as coenzyme[9]. The metabolism of glutamic acid and glutamine and the numerous effects of these substances on metabolic activities, especially in brain, have been reviewed repeatedly. It now appears that a product of glutamic acid metabolism, γ-aminobutyric acid, may play an important part in the control of neurophysiological activity. Recent studies by J. E. Hawkins, jun., and L. H. Sarett, of the Merck Sharpe and Dohme Research Laboratories, on the anticonvulsant activity of substances known to be involved in brain metabolism, have also converged upon γ-aminobutyric acid. This compound is effective in preventing certain types of seizures in mice[10].

Pharmacological studies on the activity of γ-aminobutyric acid are in progress. It may be mentioned that injection of 0·2 mgm. of the substance into the hæmocœl of a 45-gm. crayfish causes the animal to become remarkably flaccid.

Details of this work will be published elsewhere.

We are indebted to Merck and Co., Inc., Rahway, N.J., for aid and co-operation in these studies. One of us (A. B.) is a member of the staff of the Merck Sharpe and Dohme Research Laboratories.

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Benzene Hexachloride Metabolism in *Anopheles gambiae*

WE have recently been able to examine the absorption and metabolism of benzene hexachloride by susceptible and γ-BHC-resistant strains of *Anopheles gambiae*. The resistant strain, which originated in an area of northern Nigeria where dieldrin is being used as a residual spray[1], was dispatched to England by members of the Nigerian Malaria Service and has been reared in the laboratories of the Ross Institute, London, by Dr. G. Davidson, who has kindly supplied the insects for our experiments. The resistant strain is some 800 times resistant to dieldrin and 26 times resistant to γ-BHC as determined by Davidson[2] using a modification of the method of Busvine and Nash[3]. The susceptible strain has also been reared in the laboratories of the Ross Institute in London and originated from Lagos, Nigeria.

In order to determine the absorption and metabolism of BHC isomers, deposits of carbon-14-labelled isomers were made from carbon tetrachloride solution in stoppered 100-ml. Ehrlenmeyer flasks and a weighed batch of mosquitoes (50–100 mixed sexes) added. A piece of untreated filter paper was included in the flask to provide a resting place for the insects. After 24 hr. at 25° C., the insects

Table 1. ABSORPTION AND METABOLISM OF α- AND γ-BHC BY *A. gambiae*
(Results expressed as μgm. BHC/gm. insect)

	γ-BHC			α-BHC		
	Susceptible	Resistant		Susceptible	Resistant	
	1	1	2	1	1	2
BHC absorbed	130	132	151	115	138	152
Water-soluble metabolites	14·6	8·0	9·9	14·8	4·8	8·0
Water-soluble metabolites as per cent of BHC absorbed	11	6·1	6·6	13	3·5	5·3

were removed and the radioactive material recovered and estimated as carbon tetrachloride - soluble and water - soluble fractions using techniques already described[3]. Comparative results for the susceptible and resistant strains are summarized in Table 1 for γ-BHC and α-BHC. Experiments with the α-isomer were included because it is known that γ-BHC-resistant flies are able to metabolize this isomer and the γ-isomer with equal facility, whereas experiments with α-BHC have the advantage of allowing a much longer survival of the γ-BHC – susceptible strain with correspondingly increased opportunity for the insects to exhibit their power of metabolizing the compound.

The results show that the resistant strain absorbs no less BHC than the susceptible, and converts a smaller proportion of the absorbed chemical to water-soluble products. (In another set of experiments not reported here, where the absorbed dose of γ-BHC was greater, the susceptible and resistant strains converted approximately equal amounts to water-soluble products.) Isotopic dilution tests with the pure BHC isomers showed that the radioactivity in the carbon tetrachloride extracts was almost all unchanged BHC; carbon tetrachloride - soluble metabolites are therefore not produced in any significant amounts.

In all the experiments with γ-BHC, both strains were knocked down, the susceptible strain after some thirty minutes, the resistant strain after about three hours. A further experiment was therefore carried out in which exposure to the γ-BHC vapour was limited to 1 hr., after which the insects were transferred to a clean flask and stored at 25° C. for 24 hr. before analysis. The results are shown in Table 2.

Although the majority of the mosquitoes were alive at the end of 1 hr. exposure to insecticide and some of the resistant strain were still showing slight movements after 24 hr., the pattern of absorption and metabolism in the short-exposure experiment is very similar to that shown in the 24-hr. exposure experiments. Again the susceptible strain shows a greater percentage conversion of the absorbed γ-BHC to water-soluble products.

The results are published at this preliminary stage to direct attention to the fact that insecticide resistance can be exhibited by a strain of insects which possess no greater power of detoxication of the poison than the susceptible strain. The resistant *A. gambiae* can convert only 11 per cent or less of the absorbed poison to excretable products, the corresponding figures for a strain of resistant houseflies under similar conditions being more than 90 per cent[4]. It seems necessary to look to mechanisms other than detoxication for an explanation of the resistance of these *A. gambiae* to poisoning by γ-BHC.

Table 2. ABSORPTION AND METABOLISM OF γ-BHC BY *A. gambiae*.
(Results expressed as μgm. BHC/gm. insect)

	Susceptible	Resistant	
	1	1	2
Outside (CCl$_4$-soluble)	2·8	2·0	3·6
Inside (CCl$_4$-soluble)	12·5	15·1	10·7
Water-soluble	2·8	2·0	1·2
Residue	0·0	0·0	0·0
Storage flask (CCl$_4$-soluble)	8·3	4·0	3·6
Total	26·4	23·1	19·1
Per cent metabolized	11	9	6

We thank Dr. G. Davidson for his collaboration and help in these experiments.

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A Simple Method for the Investigation of Peptides containing Cystine and/or Cysteine

THE lability of sulphur-containing peptides makes their identification in tissues and fluids a peculiarly difficult problem. The simple procedure described here makes use of the fact that, while cysteine and cystine are held by a cation-exchange resin, cysteic acid is not. By transferring the cationic substances of a fluid to a cation exchange resin, washing it, and treating it with hydrogen peroxide, cysteine, cystine and peptides containing these residues are preferentially released into the supernatant fluid. Recovery of cysteine, cystine and homocystine was 77 per cent and of glutathione 25 per cent calculated from spectrophotometric estimation as their dinitrophenyl derivatives at 352 mμ. Methionine forms a sulphone which remains attached to the resin. Cysteic acid and oxidized glutathione could be separated by displacement chromatography from an anion exchange resin with $N/10$ hydrochloric acid. A simpler procedure utilized transfer of the oxidation products to a small amount of an anion exchange resin to remove them from the large excess of hydrogen peroxide, followed by displacement with hydrochloric acid and paper ionophoresis. The following examination of blood is typical.

The dialysate from 5 ml. of clotted human blood was mixed for one minute with the sulphonated polystyrene resin 'Amberlite' *IR* 120 (H) (2 gm.). Washing was performed by topping up the tube with distilled water, mixing, allowing the resin particles to settle, and sucking off the supernatant fluid. Sufficient 100 volumes hydrogen peroxide to cover the resin was added. After 6–18 hr. at 22° the supernatant fluid was washed through a filter paper into 'Amberlite' *IRA* 400 acetate (0·1 gm.), and mixed with it for one minute. After washing with water, 3 N hydrochloric acid (0·1 ml.) was added, and after one minute the supernatant fluid was taken to dryness at 22°. The residue was transferred to Whatman No. 31 paper and subjected to ionophoresis in $M/10$ diethylamine – acetic acid buffer pH 3·6 containing 5 per cent glycerol[1] in the apparatus of Flynn and de Mayo[2] at a potential difference of 200 volts for

3 hr. After drying the paper in a current of air, spraying with ninhydrin and heating, two spots, corresponding to cysteic acid and oxidized glutathione, appeared. The presence of glutathione in potato extracts was similarly demonstrated. Urine extracts contained substances which caused gross distortion of the ionogram. Considerable improvement was obtained by preliminary chromatography in butanol–acetic acid, the material running at the same rate as that giving a positive ninhydrin reaction on a marker strip being eluted and run ionophoretically. A strong cysteic spot and a weak spot moving at the same rate as oxidized glutathione was then detectable. Hydrolysates of blood and potato extract preparations contained only cysteic acid, glycine and glutamic acid; urine extracts contained, in addition, α-alanine and aspartic acid.

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Cleavage of N-Glycosidic Linkage in Peptide-ε-lysyl-N-glycosides by Ion Exchange Resin

It is well known that the sugar components of amino-acid-glycosides are not always detected in the acidic hydrolysates; this is in accordance with the general characteristics for the Amadori rearrangement[1]. However, there have been difficulties in elucidating the detailed structure of an amino-acid-glycoside which includes an oligosaccharide.

Recently, Finan and O'Colla have reported a method for the stepwise degradation of the glycosidic linkage in disaccharide osazones with the cation exchanger 'Zeo-Karb' 215 at room temperature[2]. This method has now been developed for the selective cleavage of the N-glycosidic linkage in ε-lysyl-N-glycoside without decomposition of the sugar components. The principle of this method is based on the observation that the anion resin 'Amberlite' *IRA*-410 hydrolysed the N-glycosidic linkage in peptide-ε-lysyl-N-glycosides, lactoside and lactuloside separated from the tryptic hydrolysates of milk products[3,4]; but the disaccharide remained unchanged under the same conditions.

A typical procedure is as follows: a column (10 cm. × 0·7 cm.) of 'Amberlite' *IRA*-410 (OH^- form) was washed with water and then 15 mgm. of the material dissolved in 1 ml. of water was placed on the column and left in contact with the resin for 10 min. The column was eluted with 1 per cent sodium hydroxide and passed through a column of 'Amberlite' *IR*-4*B* (H^+ form) in order to remove sodium. The neutralized elute was lyophilized to a syrup, which was shown by paper chromatography to contain disaccharide, lactose or lactulose and aglycone-peptide. The fact that the N-terminal-ε-amino group of lysine in the peptide was released by this treatment was also confirmed by means of the dinitrophenol method of Sanger and Tuppy[5].

On the other hand, somewhat similar experiments using 'Amberlite' *IR*-120 (H^+ form) as the absorbent and 1 per cent acetic acid as the eluting agent were not successful, since it was found that the lactoside remained and the lactuloside was split into several fractions. In addition, α-amino-acid-N-glycosides, namely, glycine-, alanine- and phenylalanine-fructoside prepared by the method of Abrams *et al.*[6], were also treated similarly with 'Amberlite' *IRA*-410. The results obtained, however, eliminated the possibility of degradation of N-glycosidic linkage in them.

On the basis of these results, it is accordingly suggested that the N-glycosidic linkage in peptide-ε-lysyl-N-glycosides are degraded selectively by 'Amberlite' *IRA*-410. This method was applied to the determination of the fine structure in the amino-acid-glycosides formed secondarily in the milk protein–lactose system[7]. Hence these results have perhaps a bearing on the nature and structure of amino-acid-N-glycosides formed in the protein–sugar complex and protein foods as the first intermediate in the amino-carbonyl (or Maillard) reaction of these systems. It is possible that further investigations, which are proceeding, will show that this result can be further generalized.

I wish to thank Profs. R. Sasaki and T. Nakanishi for their guidance; thanks are also due to Dr. K. Shibasaki for valuable suggestions.

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Genetic and Hæmatological Significance of Hæmoglobin H

Late in 1954, I discovered two adult Filipino men unrelated to each other with a thalassæmia-like blood picture. Electrophoretic examination of hæmoglobin at *p*H 8·6 and 6·0 revealed a major component of normal hæmoglobin and a minor component with electrophoretic mobility faster than normal hæmoglobin A; further work led to identification of the new fraction as hæmoglobin H. Detailed studies on these patients will be published elsewhere.

Family studies on the inheritance of hæmoglobin H in a Chinese[1] and a large Greek[2] family as well as in a number of Thai[3] kindreds failed to demonstrate the abnormal pigment in the parents of the index cases with hæmoglobin H. Genetical investigations of these families revealed that one of the parents and several other members of the family had the thalassæmia trait without hæmoglobin H. The hæmatological findings of all cases with hæmoglobin H hitherto studied suggested the additional presence of thalassæmia. It may therefore be postulated that hæmoglobin H is only shown electrophoretically in the presence of thalassæmia. In this respect hæmoglobin H differs from most of the other human hæmoglobins such as A, C and S (and probably D, E, G and I) which are easily detectable in the trait or carrier state and the production of which presumably is under the control of multiple alleles. The finding of hæmoglobin H in thalassæmia has certain resemblances to the behaviour of hæmoglobin F, which is sometimes found in the thalassæmia trait and is not inherited quantitatively.

Since my two original patients were Filipinos, I recently examined the hæmolysates of seventy-three Filipino sailors (through the kind co-operation of Dr. E. H. Giblett, King County Central Blood Bank, Seattle, Washington) and three Filipino patients with non-hæmatological disease by paper electrophoresis at pH 8·6 (barbital buffer) and pH 5·8 (phosphate buffer), it having been found that hæmoglobin H could be best demonstrated at acid pH. No example of hæmoglobin H or any other electrophoretically demonstrable abnormal hæmoglobin was found. The absence of hæmoglobin H carriers in this limited population known to be a possible reservoir for hæmoglobin H provides further suggestive evidence that the trait for hæmoglobin H may not exist, or else has poor penetrance with the presently used methods of electrophoresis. The presence of pure thalassæmia trait without hæmoglobin H in siblings of patients with 'thalassæmia–hæmoglobin H disease' supports the latter hypothesis. Multiple allelism between thalassæmia and hæmoglobin H appears to be excluded since the combination of hæmoglobin H and thalassæmia has been reported[2] in the son of a patient with 'thalassæmia–hæmoglobin H disease'. Further surveys among Filipinos, Chinese, Greeks and related races need to be performed. In the present state of our knowledge, the demonstration of hæmoglobin H apparently signifies the simultaneous presence of thalassæmia. 'Thalassæmia–hæmoglobin H disease' therefore may be considered a variant of thalassæmia in which the thalassæmia gene in a yet unknown manner activates the expression of hæmoglobin H.

This investigation was supported by State of Washington Initiative 171 funds for research in biology and medicine and by an American Cancer Society Institutional grant.

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Postnatal Formation of Hæmoglobin E

IN order to find out whether hæmoglobin E is formed during fœtal life or some time after birth, the following investigation was carried out.

A survey for pathological hæmoglobin was carried out among women who were about to give birth to a child in the delivery room of the Department of Obstetrics of the Central General Hospital in Djakarta. The blood of babies of mothers carrying hæmoglobin E in their blood was examined at birth and at varying intervals after birth up to the age of three to five months. Among two hundred pregnant women, nine were found to be carriers of the hæmoglobin E trait, having hæmoglobin E in their blood in addition to the normal hæmoglobin A. Eight babies of mothers carrying hæmoglobin E in their blood were examined. At birth none of them showed hæmoglobin E in their blood on paper electrophoresis. Five of those babies could be followed up. Three who were examined at intervals up to the age of three to five months did not show hæmoglobin E in their blood when examined by paper electrophoresis. In the two other babies, hæmoglobin E was detected some time after birth. In one it was found when the baby was four months old while the fœtal hæmoglobin was 28·7 per cent of the total amount of hæmoglobin. At birth and at the age of 1½ months no hæmoglobin E could be detected in this baby by paper electrophoresis. At the age of 5½ months the amount of hæmoglobin E had increased while the amount of fœtal hæmoglobin had decreased to 10·3 per cent of the total amount of hæmoglobin.

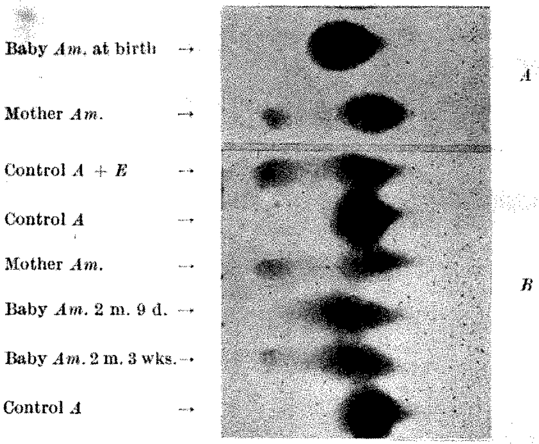

Fig. 1. Paper electrophoresis, pH 8·6, showing the postnatal formation of hæmoglobin E. (*A*) At birth no pathological hæmoglobin was found in the baby. (*B*) At the age of 2 months and 9 days a pathological hæmoglobin in a very low concentration with a mobility higher than that of hæmoglobin E was found, while at the age of 2 months and 3 weeks hæmoglobin E was clearly present in the blood

In the other baby no hæmoglobin E was found at birth, and the fœtal hæmoglobin was 80·1 per cent of the total hæmoglobin. At the age of 2 months and 9 days, however, a small amount of pathological hæmoglobin was found, which showed a mobility greater than that of hæmoglobin E. Since the father of the child was entirely normal, no pathological hæmoglobin other than hæmoglobin E was expected. Therefore the difference in mobility may be assumed to be caused by the very low concentration of hæmoglobin E found in the baby. However, the possibility of a transitional form of hæmoglobin E being formed at an early age could not be ruled out. This interesting point needs further investigation. At the age of 2 months and 3 weeks, the presence of hæmoglobin E in the baby was beyond doubt (see Fig. 1).

In these two babies, therefore, hæmoglobin E was formed some time after birth.

This investigation is the subject of part of a thesis written in Indonesian (May 1956). While the work was being carried out, a paper by Schneider and Haggard appeared[1] reporting the delayed formation of hæmoglobin S in several babies examined and the delayed formation of hæmoglobin C in one baby. Also, Thomas, Motulsky and Walters[2] have reported the postnatal formation of hæmoglobin C in one case examined.

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Multiple Hæmoglobins in the Blood of Animals

In the course of our investigations on the hæmoglobins in the blood of various animal species by the agar electrophoresis technique[1,2], it was found that the blood of buffalo contained two distinct hæmoglobins. Blood hæmolysates were prepared by the method of Drabkin[3] without using aluminium chloride. The hæmolysate was applied on the surface of the agar gel (0·5 per cent) containing 0·05 ionic strength barbital buffer of pH 8·6. Electrophoresis was carried out according to the procedure described before[4]. After electrophoresis (200 V., 6 m.amp., 6 hr.) the hæmoglobin bands could be observed visually. Under ultra-violet light using Wood's filter the bands could be seen more clearly. The hæmoglobin bands could be stained with amido black 10B after drying the agar plate and the concentrations of the components could be determined densitometrically. The region occupied by the hæmoglobins shows positive reaction with benzidine reagent. Rat blood hæmolysates showed the presence of two minor components of proteins in addition to the major component of hæmoglobin.

Typical hæmoglobin patterns of buffalo and rat, together with the normal human serum protein pattern obtained on the same agar plate for comparing the mobilities, are shown in Fig. 1. The mobility of the hæmoglobin of the rat blood haemolysate corresponds to that of β-globulin of human serum, while the other two minor components have approximately the same mobility as γ-globulin. Haurowitz *et al.*[5], in their study on the alkali denaturation of hæmoglobins, have suggested the presence of two or more components of hæmoglobins in rat blood as indicated by a break in the alkali-denaturation velocity curves. The identity or otherwise of these two minor components with hæmoglobin is being investigated further. The slow-moving component of hæmoglobin in buffalo blood has the mobility of β-globulin, and the fast-moving major component has a mobility higher than that of β-globulin. The blood of other animals investigated, namely, cow, sheep, goat, horse, dog, rabbit and guinea pig, contains only one hæmoglobin under the conditions of electrophoresis described, namely, at pH 8·6 and 0·05 ionic strength of barbital buffer. Harris and Warren[6] have, however, reported the occurrence of two hæmoglobins in the blood of some sheep examined by them.

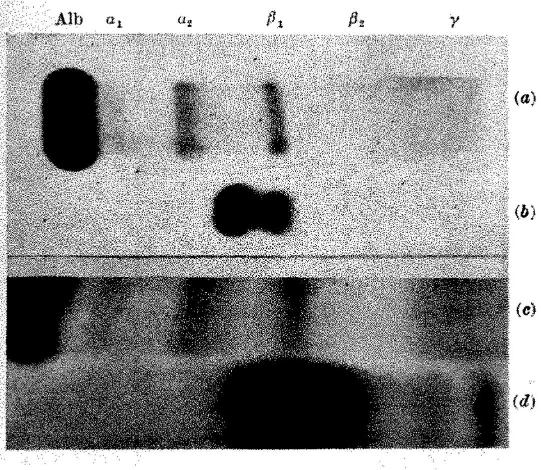

Fig. 1. Agar electrophoresis patterns of blood hæmolysates of buffalo and rat compared with the pattern of normal human serum proteins
a, normal human serum; *b*, buffalo blood hæmolysate; *c*, normal human serum; rat blood hæmolysate

Further characterization, isolation and amino-acid composition of the buffalo blood hæmoglobins are being studied. Investigations on the hæmoglobins of other animal species are in progress.

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Occurrence of *trans*-Unsaturated Fatty Acids in Horse Fæces

It has been shown recently[1,2] that whereas the depot fats of ruminants contain considerable amounts of *trans*-unsaturated acids (3·5–11·2 per cent) the depot fats of non-ruminants contain but little or none. Since the rumen bacteria exhibit a pronounced hydrogenating effect[3] and hydrogenation induces *trans*-isomerization, the occurrence of *trans*-acids in the fats of ruminants has been attributed by us to bacterial action[1,2]. This hypothesis has now found additional support from the determination of the *trans*-acids content of horse fæces from pasture-fed animals. The lipids isolated from fresh fæces (6·66 per cent on the moisture-free basis) contained approximately 14 per cent of these acids determined by the infra-red absorption technique[4] (Table 1), whereas no *trans*-acids could be detected in the depot fat of pasture-fed horses[1,2]. In view of the fermentative bacterial flora in the large intestines, and the reducing atmosphere in these organs, the above result is not unexpected, and points to a mechanism of *trans*-acids formation similar to that in the rumen, but occurring in the post-absorptive region of the gut. The iodine value and the diene and triene contents of the fatty acids from the fæces, shown in Table 1, indicate also extensive hydrogenation when compared with the corresponding data for the depot fat of the horse[5], and for pasture lipids[6].

On the other hand it is surprising that the carotene contents of the fæces (0·12 per cent of dry matter) was much greater than that of the pasture (0·05 per cent)[7], this being accompanied by a reversal in the ratio between carotene and xanthophyll, namely, 4 : 1 in the fæces against 1 : 2 in the pasture[8].

Table 1. CHARACTERISTICS OF FATTY ACIDS FROM HORSE FÆCES, HORSE DEPOT FAT AND PASTURE

Source	Iodine value	% Conjugated		% Unconjugated		% *trans*-acids
		diene	triene	diene	triene	
Horse fæces	37·8	1·2	nil	0·7	0·9	14·1
Horse depot fat	96·4	0·5	trace	3·3	16·1	Not detected
Rye-grass (*Lolium perenne*)	183·0	0·9	0·1	10·7	62·7	trace

The investigation of the *trans*-acids content of the fæces of various ruminants and non-ruminants is in progress.

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Influence of Nutrition upon Duration of Gestation in Sheep

Various effects of different planes of nutrition on pregnancy in the ewe have been studied; but there appears to be no record of an effect on duration of gestation. Four series[1] of observations were made, in which Merino ewes were maintained on high, medium and low planes of nutrition from the 108th, 129th, 136th or 143rd day of pregnancy to parturition. The distribution of the treatments among the four series is shown in Table 1. Prior to the experimental nutritional period, ewes had either been maintaining or gaining weight. During the experimental period, the ewes on the low plane in series 4 and 6 received chaffed wheaten hay only. All other ewes received a mixture of equal parts of oats and chaffed legume hay, with or without pasture. Ewes on the high plane of nutrition in each instance were allowed access to food *ad lib.* and gained about 0·2–0·4 kgm. in weight per head per day. In each series the ewes on the low plane of nutrition received about 0·2 kgm. (dry weight) of food per day each and lost about 0·2–0·4 kgm. in weight per day. Ewes on the medium plane received sufficient food to maintain constant body-weight.

All ewes in series 4, 5 and 7 bore single lambs. Some ewes in series 6 bore twins.

The mean duration of gestation in each group is set out in Table 1, together with the standard error of the mean, the number of ewes involved and the significance of differences. In each series, the mean duration of gestation of each group of low-plane ewes was less than that of each comparable group of high-plane ewes by amounts which ranged from 0·7 to 5·0 days. Most of these differences were statistically significant. In series 5, in which groups of ewes were subjected to a low plane of nutrition after the 108th or 129th day of pregnancy respectively, the mean duration of gestation was significantly the shorter by 2·3 days in the ewes in which the period of treatment was the shorter. The difference of 2·5 days was in the reverse direction in series 4, where ewes were subjected to a low plane of nutrition during the much shorter periods from the 136th and 143rd day of pregnancy to term.

A record was available of ewes which developed clinical signs of pregnancy toxæmia in series 7 the difference between means was still significant when ewes showing these symptoms were eliminated

Although attention has not been directed by other workers to an effect of undernutrition upon duration of gestation, the data which Thomson and Thomson present support the present findings. In their data concerning ewes maintained on high and low planes of nutrition during the second half of pregnancy, the mean duration of gestation of the low-plane ewes which bore twins, 146·5 days, was significantly shorter ($P = 0·05$) than that of the corresponding high plane ewes, 149·0 days; in ewes bearing single lambs the respective means of 148·4 and 149·0 days differed in the same direction but the difference was no significant. These data clearly demonstrate tha severe undernutrition may affect duration of gesta tion; but the lack of consistency between the results of series 4 and 6 indicates that the magnitude of the effect may vary in various circumstances.

The available data also suggest that in a group o comparable ewes the heavier the uterine contents are at the time treatment is commenced, the more is parturition advanced by undernutrition, provided treatment is not commenced within a few days o parturition. Thus it was more advanced among twins than among singles and among older fœtuses

Table 1. Mean Duration of Gestation of Ewes on Different Planes of Nutrition

Series	Group	Nutritional treatment		No. of ewes	Duration of gestation (days)			Significance of differences between means‡†
		Plane	Started (day of pregnancy)		Mean	S.E.M.†	Difference between means (high–low)	
7	*a*	High	108	33	148·8	0·36		
	b	Low	108	34	147·3	0·36	1·5	*a–b*, $P < 0·01$
5	*a*	Medium	108	19	150·5	0·57		
	b	High	108	20	151·0	0·56		
	c	Low	108	14	149·1	0·67	1·9	*b–c*, $P < 0·05$
	d	High	129	19	150·5	0·57		
	e	Low	129	18	146·9	0·59	3·6	*e–d*, $P < 0·001$ *c–e*, $P < 0·05$
6	*a*	High	136	4	148·5	0·52		
	b	Low	136	5	147·8	0·47	0·7	*a–b*, $P < 0·05$
	*c**	High	136	2	147·5	0·74		
	*d**	Low	136	3	144·7	0·60	2·8	*c–d*, $P < 0·05$
4	*a*	High	136	4	150·3	0·60		
	b	Low	136	5	145·3	0·53	5·0	*a–b*, $P < 0·001$
	c	Low	143	4	147·8	0·60	2·5	*a–c*, $P < 0·05$ *c–b*, $P < 0·01$

* Ewes bearing twins.
† In analysis of variance of each series, variance between groups was significantly greater than error variance ($P < 0·01$ or 0·001).
‡ Values of P were determined by '*t*' test using error variance from analysis of variance.

than among younger ones except where underfeeding was commenced close to term. This suggestion supports the hypothesis which was advanced as early as 1891 by Spiegelberg[3] that insufficiency of fœtal nutrition is a factor concerned in the initiation of parturition. Certainly the fœtus or fœtal placenta must be concerned in this process, as a sire influence on length of gestation in sheep has been demonstrated by Terrill and Hazel[4]. This suggestion and Spiegelberg's hypothesis provide a basis for an obvious explanation of the findings, reviewed by these workers, that gestation in ewes bearing twins is usually shorter than in ewes bearing singles.

The present results add another item to the list of those which must be explained by any hypothesis about the factor or factors which actually precipitate parturition.

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Visual Pigments of Deep-Sea Fish

Experiments have been made on board R.V. *Sarsia* with the fresh retinæ of four species of deep-sea fish caught in the Bay of Biscay. These species, *Stomias boa* (Risso), *Flagellostomias* sp., *Argyropelecus olfersii* (Cuvier) and *Myctophum punctatum* Rafinesque, are often caught around 500 m.[1], a depth close to that at which the human eye ceases to see the light of day[2].

Simple visual inspection showed that the unbleached retinæ were golden coloured. Fig. 1 demonstrates that the changes in spectral absorption on bleaching such retinæ were those of retinal photosensitive pigments differing from visual purple in having their maxima displaced about 20 mμ toward the blue end of the spectrum. The retina of the conger eel has recently been shown to contain a pigment with an absorption curve very similar to those described here[3,4] (Fig. 1). The conger begins life in the deep ocean and returns there when mature.

The golden-coloured pigments which were found in high density in all these retinæ are admirably suited to make the best use of that fraction of daylight which penetrates deep into oceanic waters. These waters are most transparent to blue light around 475 mμ [5], and at depth this is effectively the only light.

Wald[6] has made the generalization that the retinæ of fresh-water fish contain purple pigments (porphyropsins) and those of coastal marine fish contain rose pigments (rhodopsins). We may now add another group, those of deep-sea fish the retinæ of which have principally golden-coloured pigments for which we suggest the name chrysopsins or visual golds.

We are grateful to Mr. N. B. Marshall of the British Museum (Natural History) for identifying the deep-sea fish and to Captain C. A. Hoodless and the crew of the Marine Biological Association's research vessel *Sarsia* for their enthusiastic co-operation.

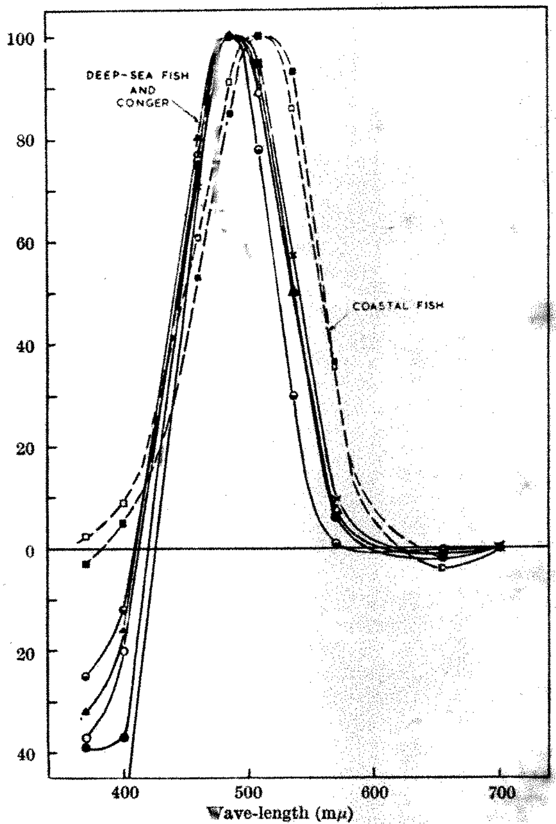

Fig. 1. The curves are of spectral density change of fresh retinæ when bleached with white light. Four deep-sea fish : ×, *Stomias boa* (Risso) ; ●, *Flagellostomias* sp. ; ◒, *Argyropelecus olfersii* (Cuvier) ; ▲, *Myctophum punctatum* Rafinesque. A migrating fish : ○, *Conger vulgaris*. Two coastal fish : □, *Scophthalmus rhombus* ; ■, *Cottus bubalis*. The ordinate is change in density (expressed as a percentage) ; the maximum density change is made equal to 100 per cent

The kindness of the Director of the National Institute of Oceanography has enabled the results described here to be confirmed and extended by experiments made aboard R.R.S. *Discovery II*. Fifteen species of deep-sea fish were found to have golden-coloured retinal photosensitive pigments and only one oceanic fish, a surface form, *Saurus scombresox*, to have visual purple.

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Sex Determination in Rats (*Rattus norvegicus* var. *albinus*) through the Ameloblasts of the Dental Germ

Since 1949, Barr *et al.* and others[1-3] have described the presence of 'sex chromatin' in various tissues of several animal species, arriving at the conclusion that in all of them behaviour of this 'sex chromatin' was practically identical. They excluded, however, certain rodents and lagomorphs, since it was impossible to determine their sex from nuclei of the tissues studied.

The importance of these studies became apparent when Barr[4] and Decourt *et al.*[5] applied these concepts to the determination of sex in human pathology.

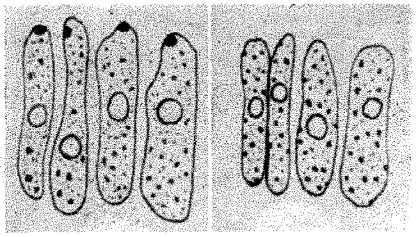

Fig. 1. (a) Nuclei in the adamantine epithelium of a female rat. They contain the 'sex chromatin' at the pole of the nucleus nearer to the growing enamel (Feulgen); (b) nuclei in the adamantine epithelium of a male rat, where no 'sex chromatin' is found (Feulgen)

Barr admitted that 'sex chromatin' consisted of the heterochromatic portions of the sex chromosomes. A new hypothesis[3], based on the studies of Pavan and Breuer[6,7], was suggested to explain the morphophysiological behaviour of the chromosomes of *Rhynchosciara angelae*.

With the view of extending the application of this method of sex determination to other fields, we decided to study the 'sex chromatin' of the ameloblasts in the dental germs of one-day old albino rats.

Ten females and ten males were used. The heads were fixed in 10 per cent formalin buffered to *p*H 6·9. Frozen frontal sections, 15–20μ thick, were obtained at the level of the first molars. After prolonged and repeated washing in distilled water, they were stained by Feulgen's technique.

The sex of the rats was previously determined by the examination of the ano-genital distance.

From each head, five sections were studied. In each section, one hundred ameloblasts were studied, that is, five hundred cells per animal.

In 89·8–91 per cent of the nuclei of the ameloblasts from the females, a chromatin mass was found, almost always on the side of the growing enamel, adhering to the nuclear membrane and having on the average a diameter of 1μ (Fig. 1*a*).

A similar mass, though smaller, was found in the ameloblasts from the males, in 6·8–18 per cent of the cases (Fig. 1*b*).

The ameloblasts present a special 'chromatic pattern', differing from that of other tissues, in which the 'sex chromatin' is not easily distinguished from the other chromatin masses; this, as Barr points out, makes it difficult to determine the sex.

One of us, however, after a great many counts of the chromatin masses found in the cells examined, and based on the distribution of the various 'chromatin patterns', arrived at the conclusion that sex determination in these animals is quite possible.

At present, we are studying the determination of the sex by the examination of the ameloblasts in other animal species.

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α- and γ-Lysin Production by *R* Variants of *Staphylococcus aureus*

IT was shown[1] that *R* variants of *Staphylococcus aureus* differ from *S* in producing more coagulase; this led to an investigation of other biological properties of the two variants.

The present communication concerns the production of α- and γ-lysin of the variants. β-Lysin was studied only qualitatively and δ-lysin not at all.

Ten coagulase-positive strains of human and animal origin were used: all were laboratory strains kept on artificial media for periods of upwards of one year; they differed quantitatively in production of α-lysin: four of the ten produced β-lysin. The strains included the well-known coagulaes-producing strain Newman (Duthie), two α-producing strains *C* 13 and *C* 16 (Elek) and strain 5664 (N.C.T.C.) the strain on which γ-lysin was originally described by Smith and Price[2].

Whereas one strain showed the presence of *R* variants on isolation and strains 5664 and 3917 (Burroughs Wellcome) gave an almost pure growth of *R* colonies on direct plating of the stock cultures, *R* variants of the remaining seven strains were obtained only by plating old broth cultures on chocolate agar[1]. The morphology of the colonies ranged from irregularity in outline to frank roughness. The rough character of the colonies was emphasized by growth on agar containing 0·5 per cent 'Dispersol *L-N*' (Imperial Chemical Industries, Ltd.).

The hæmolysins were prepared from *R* and *S* variants by Burnet's method[3], that is, by incubation on semi-solid media in a mixture of carbon dioxide and air; high yields of α- and γ-lysin were obtained in 24 hr.

Since both α- and γ-lysins are estimated by lysis of rabbit red blood cells, difficulty is often experienced in determining the presence and titre of one of the lysins when both are present. The difficulty was circumvented by using pure anti-γ and anti-α sera respectively. The anti-γ serum was obtained by immunization of a rabbit with the lysin of an *R* variant (5*R*) known to produce γ-lysin to a high titre and only traces of α-lysin; at the dilutions at which this serum was used only anti-γ was present. The anti-α serum was obtained by removing from an anti-α and anti-γ serum the anti-γ fraction by flocculation; the method is a slight modification of the one suggested by Marks[4].

It was found that all *R* variants were poor α-lysin producers; the α-lysin titres, expressed as the reciprocals of the highest dilutions of culture fluids showing lysis, ranged from traces to a maximum of 500: their γ-lysin titre was relatively high and ranged from 256 to 1,000. The *S* variants encountered fell into two types: one hæmolytically inactive, the other one producing the same amount of γ-lysin as the *R* variants but with higher α-lysin titres (ranging from 500 to 16,000). It was noticed that in the strains examined β-lysin was produced by both *S* and *R* variants or by neither.

If conclusions are permissible from the limited number of strains studied, *R* variants appear to be characterized by total or partial loss of α-lysin production without loss of γ-lysin. It also appears that *R* variants of suitable strains may in future be used in order to obtain good yields of γ-lysin free of α- and β-lysins.

I wish to thank Dr. E. S. Duthie and Dr. S. D. Elek for strains, Dr. Francis and Miss Mollie Barr of the Burroughs Wellcome Research Laboratories for strains and antisera, and Dr. J. Marks for antisera.

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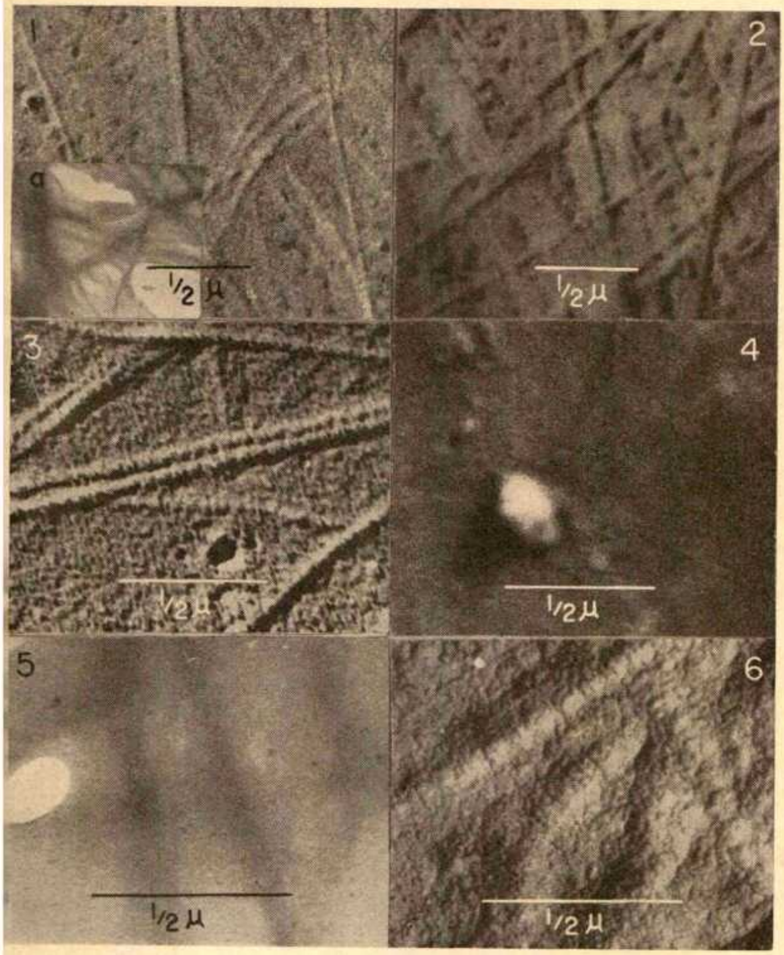
An Electron Microscopic Study of the Ground Substance of Connective Tissue

GROUND substance has been studied by histochemical, physiological and pharmacological methods. This communication reports some electron microscopic observations made on experimentally induced changes in ground substance. A technique is described for the study of ground substance with the electron microscope.

Cuticles of subcutaneous loose connective tissue of treated and untreated mice are spread on electrolytic copper specimen screens, air-dried, shadowed with uranium, and observed with an *RCA* electron microscope (Model *EMU* in accordance with standard procedures[1]. No artificial supporting membranes, enzymes or chemicals are used.

Animals employed in these experiments are *CBA* mice 12–16 weeks old, grouped as follows: (1) untreated control; (2) adrenalectomized; (3) stressed by excitement or starvation; (4) locally inflamed by mechanical irritation 2 hr. prior to killing; (5) injected subcutaneously with (*a*) 0·25 mgm. hydrocortisone 12 hr. before killing, (*b*) 0·25 mgm. deoxycorticosterone 12 hr. before killing, (*c*) 60γ heparin 30 hr. before killing, or (*d*) 35 T.R. units of hyaluronidase 3 hr. before killing.

The controls used are untreated intact *CBA* mice, the connective tissue of which is removed in the same manner as in the experimental groups, described above. The time intervals selected for observation of changes following treatment are the same as those successfully used in studies of inflammatory response, as well as other histochemical studies carried out in this laboratory.



Electron micrographs of intercellular elements of subcutaneous connective tissue of mice. All are shadowed with uranium except Fig. 1*a*, which is non-shadowed.

(1) Untreated control. ×27,000. (1*a*) Same as Fig. 1, but non-shadowed. (2) Treated locally with heparin. ×27,000. (3) Treated locally with hydrocortisone. ×40,000 (similar to that of intact stressed group). (4) Treated locally with deoxycorticosterone. ×40,000 (similar to that treated with hyaluronidase). (5) Adrenalectomized for 24 hr. ×40,000. (6) Stressed for 30 min. ×60,000

Shadowing with uranium reveals the surface morphology of ground substance, though in most cases it obscures the finer fibrillar network (Figs. 1, 1*a*). In the untreated controls the shadowed ground substance appears finely granular. The ground substance of the intact stressed (but not adrenalectomized) animals, and of those treated with hydrocortisone, is strikingly tufted and granular in appearance (Figs. 3 and 6). This tufted character is attributed to evenly distributed, uniform granules about 100 A. in diameter. Marked similarity is observed in the appearance of the ground substance in the groups treated with hyaluronidase or deoxycorticosterone and in the adrenalectomized or locally inflamed groups (Figs. 4 and 5). In these four groups the ground substance appears smooth, agranular, and homogeneous, whereas treatment with heparin increases the fibrous elements (Fig. 2).

In the groups treated with corticosteroids, irregularly shaped particles or crystalloids having diameters of 4,000 A. or less are observed in or on the matrix of the ground substance (Fig. 4).

It has been reported that cortisone and adrenocorticotropic hormones cause a decrease in the permeability of ground substance, while adrenalectomy, deoxycorticosterone and hyaluronidase induce an increase in permeability[2].

The hypothesis that changes in the physical and physiological behaviour of ground substance result from changes in its degree of polymerization[3] may be utilized to explain the morphological alterations shown here. Since hyaluronidase, deoxycorticosterone and adrenalectomy cause a marked increase in the permeability of ground substance and produce a strikingly similar morphological appearance, it is assumed that this appearance is that of 'depolymerized' ground substance. By comparison, the tufted appearance of ground substance produced by hydrocortisone treatment is apparently due to an increase in its degree of polymerization.

The morphological alterations in the surface of the ground substance may be explained on the basis of the resolving power of the electron microscope, which is, at best, about 10 A. Highly 'polymerized' components of ground substance consist of macromolecules, resolvable by the electron microscope, which give to the ground substance its characteristic granular appearance. In the 'depolymerized' state, on the other hand, the ground substance appears smooth and agranular because presumably it is composed of smaller molecules or structures which cannot be resolved by the electron microscope.

The increase in fibrous elements induced by heparin treatment may be explained by the possible influence of this drug on the precipitation of 'procollagen', which is reported to exist in soluble form in the intercellular matrix of connective tissue.

A detailed report of this work, which was supported by the United States Department of the Army Grant No. *DA*-49-007-*MD*-130, and a grant from the Armour Laboratories, is in preparation for publication elsewhere.

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Koch's Postulates applied to the Micro-ecology of Fungi inhabiting Root Surfaces

While Koch's postulates have frequently been applied for the demonstration of the pathogenic status of a fungus attacking plant organs, so far as we are aware these postulates have not been applied to the solution of problems of the micro-ecology of root-surface inhabiting fungi. This communication is presented in the hope that the method may be of interest to workers in the field of rhizosphere studies.

Investigations carried out in this Department of the incidence of fungi inhabiting the root-surfaces of numerous plants, employing the washing technique of Harley and Waid[1], have shown that sterile mycelial hyphæ of species of *Pythium* and of *Rhizoctonia solani* grow out from the surfaces of washed roots within the first 18–36 hr. of incubation at 25° C. Such fungi are considered to grow over the root surfaces. It was decided to examine the degree to which a strain of *Rhizoctonia solani* isolated from washed roots of *Taraxacum officinale* would colonize the root surfaces of a series of plants and could be recovered from such root systems.

An inoculum was prepared by allowing sterile, single cotyledons of garden pea to become thoroughly infected by incubating the cotyledons on actively growing cultures of the strain of *Rhizoctonia*. Air-dried soil, screened to pass a $\frac{1}{4}$-in. sieve, was adjusted to a water-holding capacity of 60 per cent, packed into glass tumblers, covered with 'Cellophane', and steamed for 45 min. It was allowed to stand for one week before inoculation and transplantation of the test seedlings. Such steaming reduces the soil microflora without effecting complete sterilization. Seedlings of lettuce, onion, pea, tomato, barley and oat were grown from seed and grain, surface-sterilized for one hour in calcium hypochlorite solution, washed in sterile water and incubated at 25° C. Three seedlings of each species were transferred to each tumbler of steamed soil and for each species three tumblers were inoculated with infected pea cotyledons and two were kept as uninoculated controls. During the subsequent three weeks of incubation the water content of tumblers was maintained by periodic addition of sterile tap water.

On harvesting, the roots of each group of seedlings were shaken free of loosely attached soil, vigorously washed in three changes of sterile tap water and transferred to a sterile Petri dish. Five pieces of root each 1 cm. long were selected at random from each group and plated on plain water agar. Table 1 sets out the degree of recovery, after 22 hr. incubation at 25° C., of *Rhizoctonia* in one set of experiments. Mycelium was recovered from some of the root pieces of the control plants but did not belong to *Rhizoctonia*. Repetition of these experiments gave entirely comparable results.

Table 1. Recovery of *Rhizoctonia solani* from Root Systems growing in Inoculated Soil

Root pieces	Species					
	Barley	Lettuce	Oat	Onion	Pea	Tomato
1	1	2	3	2	0	4
2	2	2	3	1	0	3
3	2	1	4	3	2	4
4	0	0	4	0	1	2
5	2	2	4	0	0	3

Figures represent the abundance of hyphæ growing from each root piece, 4 being the maximum score.

Since the experimental soil had been steamed and not sterilized, colonization of root systems was effected against a certain degree of competition but against much less than would have been the case in normal field soil. The results demonstrate that a fungus repeatedly isolated from the surfaces of thoroughly cleansed roots can be recovered from the root surfaces of seedlings growing in soil inoculated with that species under conditions of minimal competition from normal soil saprophytes. They also indicate that fungi, isolated from root surfaces when introduced into soil with a reduced microflora, find their ecological niche on the surface of root systems growing through such soil. In these experiments there was no evidence of preferential selection of root surfaces in relation to the higher plant species by the particular strain of *Rhizoctonia solani*. Inasmuch as this fungus has been repeatedly isolated from washed root surfaces, has been inoculated into steamed soil in which seedling roots have been growing, and has been recovered from vigorously washed root surfaces of a series of root systems, the experiments described represent an application of Koch's postulates to the micro-ecology of the fungal flora of root surfaces.

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Root Exudates of Paddy

THE importance of studying root exudates in understanding the behaviour of the rhizosphere microflora is now well recognized. Many techniques have been evolved for collecting root exudates under non-sterile conditions without regard to the attendant injury to root system and with the consequent sloughing off of the root cortex[1]. This communication records an attempt to overcome these defects in technique by collecting the exudates under sterile conditions, during the first week of the growth of the plants.

Two strains of paddy, one resistant (*GEB*.24) and the other susceptible (*MTU*.9) to the 'foot-rot' disease caused by *Fusarium moniliforme* were used as test plants. Two superimposed filter papers (Whatman No. 1) of approximately 8 cm. diameter were placed in 'Pyrex' flasks, moistened with 1/10 *N* Richard's solution without sucrose (prepared from 'Analar' salts and 'Pyrex' glass-distilled water) and sterilized at 15 lb. pressure for 15 min. Fifty seeds, surface sterilized and washed with several changes of glass-distilled water, were germinated under sterile conditions and transferred aseptically to each flask. After five days growth at room temperature (30–32° C.), the plants were carefully removed without leaving any rootlets on the filter papers. The possibility of bacterial or fungal contamination of the test plants was checked at every stage by plating and microscopic examination. The filter papers were finely ground with 80 per cent alcohol, the extract centrifuged and the supernatant concentrated for analysis.

The technique of ascending chromatography of Williams and Kirby[2] as modified by Lakshminarayanan[3] for unidimensional chromatograms was used to study the constituents of the exudates positive to ninhydrin employing *n*-butanol/acetic acid/water (4 : 1 : 5) as the solvent mixture. As anticipated, several free amino-acids were present in the root exudates of both the resistant and susceptible strains. Their relative concentrations in each exudate were determined by visual observation of the intensity of the spots developing on the chromatogram (Table 1).

Table 1

Material	Amino-acids	Relative concentration	R_F-values
Resistant	Cystine	+ + +	0·033
	Asparagine	+ + + +	0·073
	Aspartic acid	+ +	0·140
	Glutamic acid	+	0·176
	Tyrosine	+	0·320
	Methionine	+	0·376
	Tryptophan	+	0·446
	Lysine	+	0·602
Susceptible	Aspartic acid	+	0·140
	Glutamic acid	+	0·170
	Tryptophan	+	0·440
	Lysine	+	0·602

The extracts from the control flasks where no plants were grown gave negative reactions to ninhydrin.

The results indicate that the four amino-acids found in the root exudates of the susceptible strain, namely, aspartic acid, glutamic acid, tryptophan and lysine, were also present in the root exudate of the resistant strain, almost in the same concentrations. However, the latter had four other amino-acids as well, namely, cystine, asparagine, tyrosine and methionine. Of these, cystine and asparagine were exuded in high concentrations. This result is significant, especially in view of an earlier report from this laboratory on the presence of cystine in strains of cotton resistant to *Fusarium vasinfectum* wilt[4]. Such differences in the composition of root exudates of resistant and susceptible varieties have no doubt great influence on their specific rhizosphere microflora, and indeed further work in this direction appears to be a promising field of inquiry into the mechanism of resistance to root diseases in general.

We are indebted to Prof. T. S. Sadasivan and Dr. C. V. Subramanian for helpful suggestions.

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The Heterotrichous Habit in the Protonema of the Bryales

DURING recent investigations on the development in aseptic culture of a range of typical representatives of the Bryales (species of twelve genera, from six orders) we have found that the protonema possesses a more definite morphological pattern than would appear to have been appreciated previously. Examination of the advancing edge of isolated cultures growing on a solid substratum (Knop's agar or filter paper moistened with Knop's solution) has shown that in all the species studied, with the one exception of the aquatic moss *Cinclidotus fontinaloides* (Hedw.) P. Beauv., there is a striking distinction between a horizontal system of filaments creeping in or on the substratum and an aerial system of filaments arising vertically or obliquely from the horizontal system. This "heterotrichous habit", to use a term employed by Fritsch[1] for the corresponding condition in the algae, is well seen in *Funaria hygrometrica* Hedw. (Fig. 1), in which the prostrate system of a well-developed protonema is formed by stout brown-walled filaments with oblique septa and few chloroplasts, while the filaments of the aerial system, on the contrary, have hyaline walls, straight septa and numerous chloroplasts.

The relative degree of development of erect and prostrate systems, although influenced to some extent by environmental conditions, shows characteristic differences in the individual species, and some of the cultures are readily distinguished by their external appearance. In *Funaria* the prostrate system is extensive, while the filaments of the erect system are low and fairly widely spaced; but in a number of species (*Ceratodon purpureus* (Hedw.) Brid. (Fig. 1), *Pohlia nutans* (Hedw.) Lindb., *Leptobryum pyriforme* (Hedw.) Wils., *Bryum capillare* Hedw. and *Eurhyncium riparioides* (Hedw.) Jennings) although the prostrate system is still quite extensive, the aerial system is considerably better developed than in *Funaria*. The erect branches arise close together in this group of species and frequently become intertwined to form vertical tufts which rise from the medium like a miniature forest of pine trees. In *Pleuridium acuminatum* Lindb. (Fig. 1) and *Tortula muralis* Hedw. (Fig. 2) the prostrate system spreads very slowly and there is a corresponding increase in the aerial system, which undergoes an extensive development.

In all cultures, the filaments of the erect system have the characteristics of typical chloronema[2]; but those of the prostrate system are often somewhat different, and may have brown walls and oblique septa, although this distinction is not always as marked as in the case of *Funaria*. The aerial filaments are highly sensitive to light and markedly positively phototropic; but we have made no study of the factors responsible for the horizontal position of the prostrate system. A third tropic response is shown, in some of the cultures, by filaments which grow vertically downwards in the medium. These filaments have sometimes the morphological characteristics of typical rhizoids (for example, in *Ceratodon* (Fig. 1)); but frequently as in *Tortula muralis* (Fig. 2) they are merely narrower and paler than the normal chloronema filaments.

In *Cinclidotus* the growth pattern of the protonema differed considerably from that found in the other genera, and on all media the spores gave rise to compact, dark-green more or less globular masses which were formed from markedly short-celled irregularly branched filaments. Since the cultures produced numerous buds and leafy shoots, it is not unlikely that even under natural conditions the protonema of *Cinclidotus* may show a similar anomalous development.

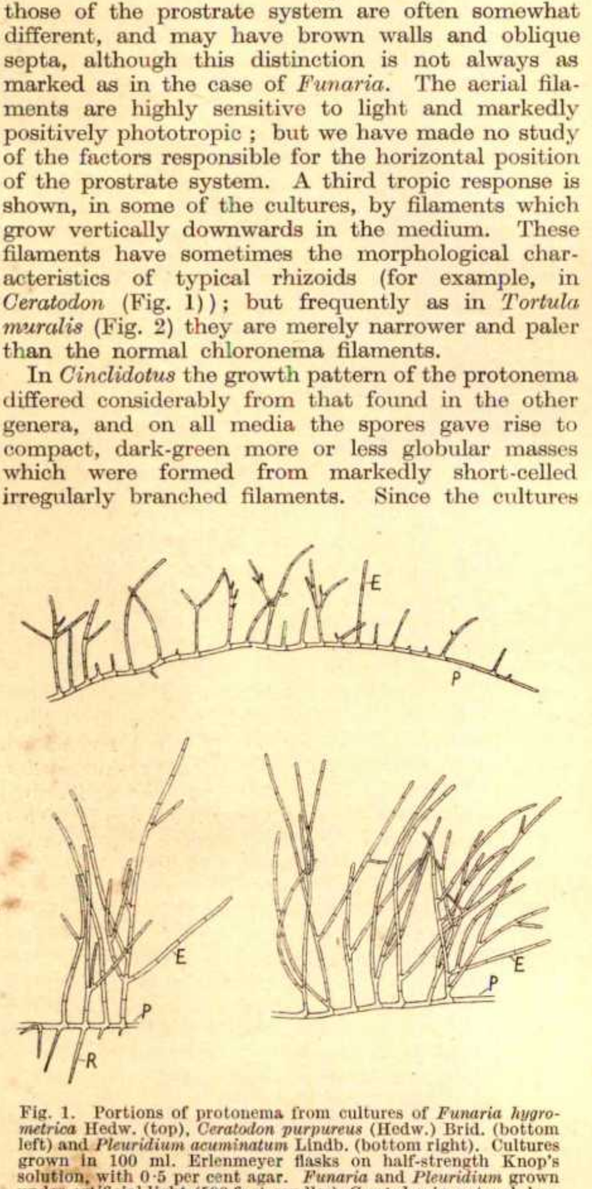

Fig. 1. Portions of protonema from cultures of *Funaria hygrometrica* Hedw. (top), *Ceratodon purpureus* (Hedw.) Brid. (bottom left) and *Pleuridium acuminatum* Lindb. (bottom right). Cultures grown in 100 ml. Erlenmeyer flasks on half-strength Knop's solution, with 0·5 per cent agar. *Funaria* and *Pleuridium* grown under artificial light (500 foot-candles) *Ceratodon* in natural daylight. *E*, Erect branches; *P*, prostrate system; *R*, rhizoidal branch. (*Funaria* × *c*. 15; *Ceratodon* and *Pleuridium* × 23)

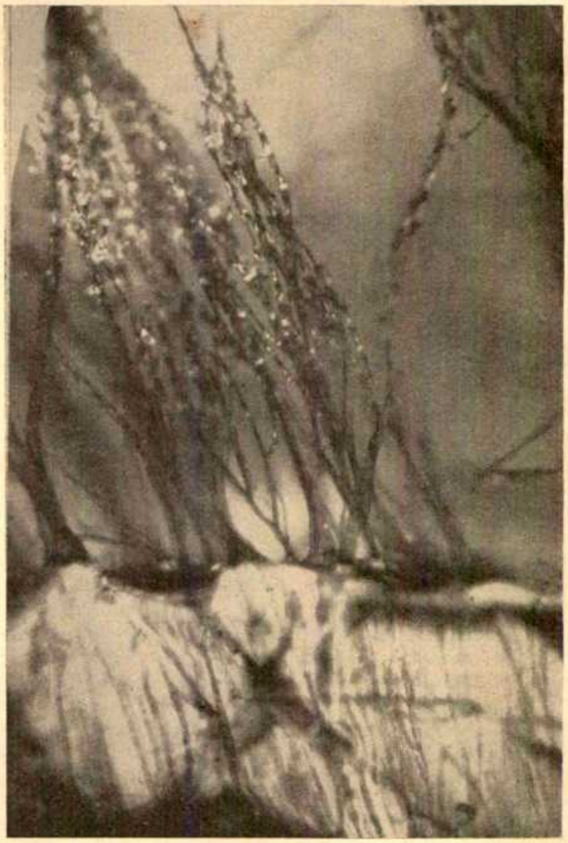

Fig. 2. *Tortula muralis* Hedw. Photograph of vertical slice through culture grown on half-strength Knop's solution with 1 per cent agar in culture tube under artificial light (500 foot-candles). Prostrate system, not clearly shown, lies between the stouter branches of the aerial system and the thinner branches penetrating downwards into the medium (× 64)

The course of bud formation was followed in detail in all the species in culture. Various arrangements of the buds were observed; but in most species the buds developed singly towards the base of the aerial filaments.

Although the heterotrichous habit is more marked in a well-grown protonema than in the earliest stages following spore germination, we have found no evidence of a distinct *caulonema* or bud-bearing stage of the kind described by Sironval[3] for *Funaria*. Sironval claimed that exposure to natural daylight is necessary for the formation of caulonema and consequently of moss buds; but in all our cultures buds were formed as readily in artificial light (500 ft.-candles) as in natural daylight.

We are indebted to Mr. G. Barker for the photograph reproduced in Fig. 2.

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Crossing of Two Allopatric Populations of *Culex fatigans* Wiedemann

Two colonies of *Culex fatigans* are maintained in the insectary: one from Lagos, the other from British Guiana (obtained through the kindness of Dr. L. J. Charles). The two strains were subject to a preliminary taxonomic examination and to experimental crossing.

There was no difference in the morphology of adults or pupæ of the two strains. There was no constant difference in the morphology of the 4th instar larvæ except for the presence of black tips on the anal papillæ of larvæ from British Guiana. Larvæ of both strains had the same survival threshold (9/1,000) when subjected to a salinity test with sodium chloride.

Two colonies were set up: British Guiana males with Lagos females and British Guiana females with Lagos males. The resulting generations were about equal in number. The F_1 generation from British Guiana mothers showed black-tipped anal papillæ in 80·0 per cent of examined larvæ. None of the F_1 generation derived from Lagos females possessed this character. Both these populations were selfed. The F_2 generation from British Guiana females had 100 per cent frequency of black-tipped anal papillæ, while none of the other F_2 generation possessed this character. On further selfing this character disappeared, however, and remained absent in further generations.

The two populations of *C. fatigans* are conspecific judging from the ease with which fertile hybrids were produced. There are, to our knowledge, no other records of experimental crossing of two allopatric populations of *C. fatigans*.

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Pugnacity of Marlins and Swordfish

FROM a wide area of the sea there have been reported occasional incidents illustrating the pugnacity of marlins and swordfish. This has been supported by recent evidence from South African seas, as a result of the Second World War, when a number of ships from the East were torpedoed in the Mozambique Channel. From these vessels quantities of bales of rubber were left floating awash, and from that time many thousands have continually been stranded, over an enormous stretch of the coast of South and East Africa. A good many bales must have remained in eddies, since even to-day they continue to come ashore. It was soon noticed that many bales contained the tips of spears of marlins, and it now appears that the longer a bale remains in the sea the more broken spears it is likely to contain, for those cast ashore in recent times have held as many as four. Most of these residues have been the tips broken near the front of the spear.

Marlin must deliberately charge floating or submerged objects, intending to impale them, possibly to secure food, but possibly also from plain aggressiveness. Almost all the spear tips found have been small, indicating marlins of 5–8 ft. in length, most found 4–6 in. within the bale, indicating very considerable penetrative force. This might suggest that small marlins are more aggressive than larger fishes; but it may equally be argued that the very much more densely ossified stout spear of the large fish would be less likely to break at any point, so that larger fish would have more hope of withdrawal. That large marlins also have this habit is indicated clearly by a bale recently found, in which was found embedded, to a depth of 13 in., virtually immovable, the apical 24 in. of the stout spear of a black marlin that could not have been less than 11 ft. in length with a weight of probably 400 lb. It is clear that to drive so stout a spear into a floating bale of resistant rubber so deeply, the fish must have been moving at great speed. It is equally clear that it must have taken very great force to break so stout a spear near its base in the skull, and the clue to what had happened was furnished by some teeth of a large shark (probably *Carcharinus*) also found embedded in the same bale. This marlin paid dearly for its pugnacity. Hampered by the heavy bale in that position, it would neither be able to withdraw the spear nor break so stout a bony rod. Its struggles must soon have attracted sharks, abundant in East African seas, that in increasing numbers would rapidly have torn it to pieces and become blood crazed in the process. In the mêlée one of them must have seized the bale of rubber and it was doubtless this that provided the extra force needed to fracture the stout spear. It was from this chance that the bale in question still retained sufficient buoyancy to reach the shore. In most such cases the weight of the severed head or of the skull of a large marlin would cause the bale to sink.

In one bale was also found the undoubted sword of the broadbill swordfish (*Xiphias*), indicating a similar habit for that species.

It was from this evidence that I had earlier come to believe that marlin were abundant in south-east African seas, as has been amply proved in recent times.

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Light Energy and Brightness Sensation

ENGINEERING problems demand a knowledge of the relation between energy stimulus and the resulting sensation. In the field of acoustics, scales of 'loudness' have been derived which are of engineering value.

In the field of lighting and vision, the derivation of scales of apparent brightness is made more difficult by the influence of adaptation and simultaneous contrast. The sensation which is given by a patch of given luminance (physical brightness) depends not only on the energy emitted from the patch but also on the luminances of the neighbouring parts of the field of view. Abribat[1] showed how a scale of apparent brightness, which took adaptation into account, could be derived from just noticeable differences. Data obtained by Pitt[2] using a binocular matching technique enabled scales of apparent brightness to be drawn up independent of the questionable Fechner integration. Hopkinson[3] derived a scale of apparent brightness from supra-threshold contrast judgments.

A new set of determinations of apparent brightness has recently been completed for a limited number of observers, following a discussion with Prof. S. S.

Stevens of Harvard University. The results are of interest in that they show certain affinities with and certain differences from the 'loudness' scales referred to above. In these determinations, direct estimations of brightness were made both of an adapting field covering 120 deg. and of a 2 deg. patch the luminance of which could be independently adjusted. The method used was similar to that described by Stevens[4]. Among the conclusions which can be drawn from the results are :

(1) The relation between the physical luminance of the 2-degree field alone and the resulting sensation of brightness follows approximately but not exactly the relation,

$$M = kL^{0 \cdot 3}$$

where M is the magnitude of brightness sensation as judged by the subject and L is the physical luminance of the 2-degree field.

(2) When the 2-degree patch is seen in the adapting field, the exponent of L varies with the luminance of the adapting field, increasing from 0·3 in a dark field to 1·0 at an adapting luminance of 450 foot lamberts.

(3) At high adaptation-levels, therefore, brightness sensation as determined by direct judgment bears a linear relation to physical luminance. Two luminances which appear the one 'twice as bright' as the other are actually related, at high adaptation-levels, by the ratio of two to one in luminance whereas when seen in dark surroundings they are related more nearly by a ratio of 10 : 1 luminance.

These conclusions agree with those derived from the supra-threshold contrast data[3] although there are significant differences between some of the data.

The relation $M = kL^{0 \cdot 3}$ is precisely the relation which Stevens and others have published for the relation between loudness and sound energy-level.

The third conclusion appears to be new, and to have no counterpart in the field of sound. On the other hand, most of the systematic loudness judgments were made in anechoic rooms, which might correspond to the visual condition of 'dark surround'.

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Mutarotation of Poly-L-proline

The synthesis and some of the properties of poly-L-proline were described recently[1]. A sample with an average degree of polymerization $n = 67$ which was obtained by bulk polymerization, dissolved in glacial acetic acid and precipitated with ether, gave the following specific rotations: $[\alpha]^{20}_{D}$ −483° (c. 1·5 in formic acid), $[\alpha]^{20}_{D}$ −372° (c. 2·0 in glacial acetic acid) and $[\alpha]^{20}_{D}$ −353° (c. 2·0 in water). As will be shown however, the optical rotation of a solution of poly-L-proline depends both on the history of the sample and on the manner in which the solution was prepared.

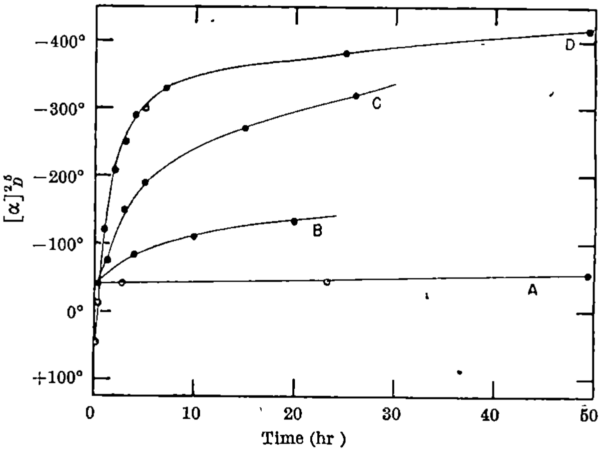

Fig. 1. Mutarotation of poly-L-proline (average degree of polymerization n = 75) in pyridine–water mixtures at 25° C. The solutions were obtained by diluting 1 ml. of the original pyridine polymerization mixture to 10 ml. with pyridine and water. Curves A, B, C and D give the mutarotation in solutions containing 10, 20, 30 and 90 per cent by volume of water, respectively

N-Carboxy-L-proline anhydride[1] (5 gm.) was polymerized in pyridine (50 ml.) for three days at room temperature. Dilution of 1 ml. of the polymerization mixture with 9 ml. pyridine gave a clear solution with $[\alpha]^{25}_{D}$ −24°. The optical rotation of this solution did not change for several days at room temperature. A solution obtained by dilution of 1 ml. of the polymerization mixture with water to a volume of 10 ml. showed a rapid change in optical rotation with time. Within 50 hr. at room temperature the specific rotation changed from $[\alpha]^{25}_{D}$ +48° (2 min. after mixing) to $[\alpha]^{25}_{D}$ −420° (Fig. 1, curve D). Curves A, B and C show the change of the optical rotation with time in different pyridine-water mixtures. Fig. 1 demonstrates that the rate of mutarotation increases with the concentration of water in the medium.

When poly-L-proline was precipitated from the pyridine polymerization mixture with ether a white powder was obtained which was insoluble in pyridine, only partly soluble in water, and readily soluble in formic acid and acetic acid. An average degree of polymerization $n = 75$ was derived from end-group analysis. The change of the optical rotation with time at room temperature of the precipitated material

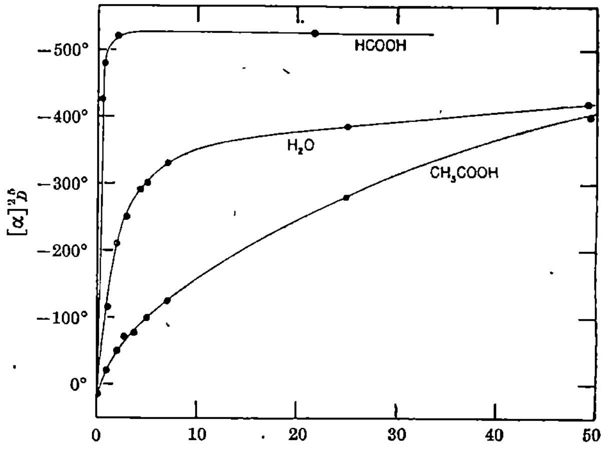

Fig. 2. Mutarotation of poly-L-proline (n = 75) precipitated by ether from a pyridine polymerization mixture in formic acid, acetic acid and water at 25° C.

dissolved in formic acid, acetic acid and water is shown in Fig. 2. Mutarotation in glacial acetic acid solution was also observed in a poly-L-proline preparation obtained by polymerization in dioxane using triethylamine as initiator.

When the poly-L-proline sample obtained from the pyridine polymerization mixture by ether precipitation was dissolved either in hot glacial acetic acid or in metacresol at 100° C. and reprecipitated from the cooled solutions by ether, it was found to dissolve readily in water. It gave $[\alpha]^{25}_{D}$ $-500°$ (*c.* 0·5 in water), $[\alpha]^{25}_{D}$ $-450°$ (*c.* 0·5 in glacial acetic acid) and $[\alpha]^{25}_{D}$ $-525°$ (*c.* 0·5 in formic acid).

In seeking an explanation of the above phenomena, a change in the chemical structure of poly-L-proline under the conditions leading to mutarotation can be ruled out. This is supported by the observation that all the forms of the polymer, on acid hydrolysis, yielded L-proline quantitatively. It seems reasonable therefore that the change in optical rotation is due to a change in the spatial configuration of the macromolecule, connected possibly with a *cis–trans* transformation in the amide bond.

A helical structure based on the *trans*-form of the amide linkage was established for the highly lævorotatory form of poly-L-proline by Cowan and McGavin[2] from the X-ray diffraction pattern given by oriented films of this polymer. It seems likely that the molecules of the highly lævorotatory form of the poly-L-proline have a similar helical structure also in water, acetic acid and formic acid. The poly-L-proline obtained in pyridine as described above probably represents an unstable form which changes into the more stable form under the influence of formic acid, acetic acid or water.

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Solubility of Albumin in Alcohol after Precipitation by Trichloroacetic Acid: a Simplified Procedure for Separation of Albumin

RADIOACTIVE proteins are prepared for counting in many laboratories[1-3] by slight modifications of the basic technique of precipitation with 10 per cent trichloroacetic acid, several washes with 5 or 10 per cent trichloroacetic acid, treatment with hot alcohol, hot alcohol–ether and drying with ether. When it is required to remove nucleic acids, the protein is treated with 5 per cent trichloroacetic acid at 90° for 15 min. before the hot alcohol wash.

During an experiment in which rat serum proteins were being prepared for counting, we noticed that some of the protein precipitated by trichloroacetic acid dissolved in the absolute alcohol. We have observed this phenomenon repeatedly while preparing other samples for counting, but only if albumin is one of the proteins present. Albumin is also soluble in other solvents (acetone, ether) after precipitation by trichloroacetic acid and continues to be soluble even if higher concentrations of the acid are used to precipitate the protein. The precipitated albumin is only soluble in alcohol or the other solvents if a small amount of acid is present. Trichloroacetic, hydrochloric and acetic acids all work well in this respect. Treatment with 5 per cent trichloroacetic acid at 90° for 15 min. did not entirely prevent the albumin from dissolving in the absolute alcohol.

If the proteins are boiled, albumin will no longer dissolve in the acid-alcohol. It seemed possible that precipitation by trichloroacetic acid did not denature the albumin. Rat serum was therefore precipitated with 10 per cent trichloroacetic acid, centrifuged, the acid poured off and absolute alcohol added. (The drop of acid remaining in the pellet is sufficient acid for our purpose.) The pellet was stirred and the undissolved protein spun down and the clear supernatant dialysed against distilled water for 24 hr. The dialysate was lyophilized and the dry protein powder examined. All the dry protein obtained by this means dissolved readily in water. Paper electrophoresis in 0·05 *M* veronal buffer at *p*H 7·4 and at *p*H 8·6 resulted in a single spot which was unretarded when compared with rat serum albumin separated by the Cohn procedure[5] and with the albumin spot of rat serum. Addition of rabbit serum immunized with rat serum albumin produced precipitation of our albumin from the solution whereas rabbit serum without antibody caused no precipitation. The protein obtained by the method outlined appears to be undenatured rat serum albumin. Preliminary experiments indicate that the albumin is not contaminated by other proteins. Similar findings were obtained with bovine albumin and human serum albumin.

We believe this simple procedure offers the basis for a rapid separation of serum albumin and a method for the detection and quantitative estimation of albumin in mixtures of other proteins, and we expect to publish full details of such methods at an early date. Meanwhile, we point out the necessity for care when preparing proteins for counting by the conventional techniques, especially if they contain albumin.

This work was supported by grants awarded to Dr. H. Tarver from the American Cancer Society.

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Molecular Weight Determination of Components by Gas-Phase Chromatography

THE gas-density balance apparatus developed by Martin and James[1] for detection and estimation of components in gas-phase chromatography might be used for a rapid process for evaluating the molecular weights of single components.

It has been shown that in a detector, which makes use of a gas-density balance, if the densities of two gas streams coming out of two columns, one where

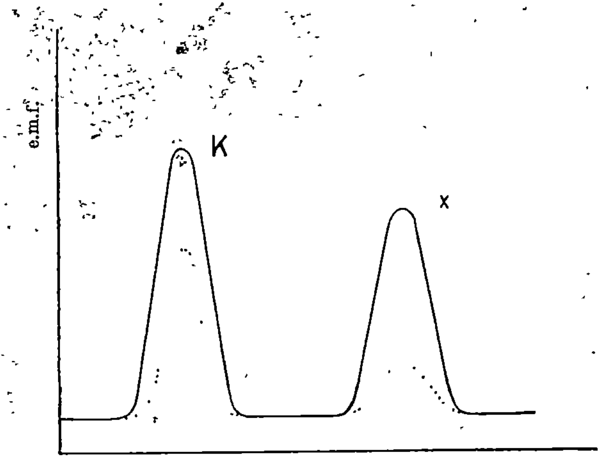

Fig. 1. Schematic diagram of a gas phase chromatogram of a mixture of a known (K) and an unknown (x) component. Heavy line, elution gas M_1; dotted line, elution gas M_2

the separation is achieved, the chromatographic column, and the other acting as a reference column, are continuously compared, the difference in density between the two gas streams can be converted into an electromotive force in a sensitive thermocouple.

The suggested procedure consists of the addition to the unknown mixture of a pure substance of known molecular weight, which is defined as the 'internal standard', and in running a chromatogram of the mixture on the same column by using two different elution gases.

To the unknown mixture, which for simplicity is assumed to consist of only one compound, x, the molecular weight of which is M_x, the 'internal standard' K (mol. wt. $= M_K$), is added and the chromatogram of the mixture by using as elution gas a gas (mol. wt. $= M_1$), will appear as in Fig. 1 (heavy line).

By replacing as elution gas one with a different molecular weight (M_2), the chromatogram will be as in Fig. 1 (dotted line). If the gas flow is kept constant, the volume of elution gas will be the same for both components; peak heights and areas will be, however, different for the different elution gases and for the different size of the sample analysed, which does not need to be known.

The density of the gas at the outlet of the reference column (reference gas: d_1) and at the outlet of the chromatographic column, when component x passes through the detector, (d_x), can be expressed in terms of the gas law equation:

$$d_1 = \frac{M_1 P}{RT} \qquad d_x = \frac{(n_1 M_1 + n_x M_x)P}{RT} \tag{1}$$

where n_1 and n_x are the mole fractions and M_1 and M_x the molecular weights of the elution gas and of the unknown component.

The density difference between the two gas streams in the detector Δd_{x-1} is:

$$\Delta d_{x-1} = \frac{n_x(M_x - M_1)P}{RT} \tag{2}$$

A similar expression is obtained by eluting with a gas of a different molecular weight, M_2:

$$\Delta d_{x-2} = \frac{n_x(M_x - M_2)P}{RT} \tag{3}$$

The amount, Q_x, of the compound, x, which was chromatographed in run A, can be expressed in terms of the volume of the gas mixture, v, coming out of the chromatographic column:

$$Q_x = \int_0^\infty \frac{n_x M_x P}{RT}\, dv$$

and by substitution of n_x value from (2)

$$Q_x = \frac{M_x}{M_x - M_1}\int_0^\infty \Delta d_{x-1}\, dv$$

The amount, q, of the compound, K, chromatographed in the same run A is given by a similar expression:

$$q_K = \frac{M_K}{M_K - M_1}\int_0^\infty \Delta d_{K-1}\, dv$$

where Δd_{K-1} is the density difference between the two gas streams when component K passes through the detector.

Similar expressions are obtained for amounts Q'_x and q'_K of compounds x and K chromatographed in another run, B.

It has been demonstrated that the e.m.f., E, of the thermocouple in the detector is proportional to the density difference at least for small density changes; this condition is fulfilled providing the sample size is in the range of a few microlitres as it is usually in gas-phase chromatography work. The integrals may be easily solved by taking:

$$\int_0^\infty \Delta d\, dv = K\int_0^\infty \Delta E\, dv$$

Experimentally Q_x, $Q'_{x'}$, q_K and q'_K cannot be directly measured with a high degree of accuracy; but since the ratio $\frac{Q_x}{q_K}$ is equal to $\frac{Q'_x}{q'_K}$ by combining the above-mentioned expressions and measuring the corresponding surface of the peaks A_x, a_K, $A'_{x'}$, and a'_K obtained in the automatic graphical registration of the chromatograms, in arbitrary units, the following expression is obtained:

$$\frac{A_x}{a_K}\left(\frac{M_K - M_1}{M_x - M_1}\right) = \frac{A'_x}{a'_K}\left(\frac{M_K - M_2}{M_x - M_2}\right)$$

which can be easily solved in terms of M_x.

This expression is valid providing the gas flow is kept strictly constant and the density changes are small.

For example, in a set of experiments carried out with a conventional apparatus using chromatographic columns, thermostated at 132°, filled with 'Celite' with which tricresylphosphate as stationary liquid was mixed, a known compound (ethylbenzene $M_K = 106{\cdot}2$), used as internal standard, was mixed with a hydrocarbon of unknown molecular weight (dodecane $= M_x = 170{\cdot}3$, nitrogen ($= M_1$) and hydrogen ($= M_2$) were used as elution gases; areas were measured in arbitrary units).

The following results have been obtained:

$\left[\frac{A_x}{a_K}\right]$	$M_1 = N_2$	$\left[\frac{A'_x}{a'_K}\right]$	$M_2 = H_2$	M_x
2·24		2·06		
2·25	Average	2·04	Average	
2·28	2·27	2·04	2·03	163
2·30		2·00		

The theory has been checked on many compounds in vapour-phase partition chromatography by using as elution gas hydrogen, nitrogen or carbon dioxide. By taking a convenient standard, an accuracy of about 4 per cent can be obtained.

Details of the apparatus, of the experimental data and the calculations will be published elsewhere.

One of us (A. L.) is greatly indebted to Dr. A. J. P. Martin and to his staff of the Medical Research Council for information and advice given to him in the building of the gas-density balance meter.

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An Unexpected Catalytic Dehydrogenation

During the course of an investigation which is being made on the decomposition of amines in the presence of hydrogen over evaporated metal-film catalysts, an unexpected example of selective catalytic action has been observed. The decomposition of cyclohexylamine on evaporated platinum films at 134° C. was expected to produce cyclohexane and ammonia according to the equation

$$C_6H_{11}NH_2 + H_2 \rightarrow C_6H_{12} + NH_3 \qquad (1)$$

The reaction was followed by continuous mass-spectrometric analysis of the reacting gases by a technique described elsewhere[1]. As the ions of mass 99 ($C_6H_{11}NH_2^+$) decreased in number, ions of mass 17 NH_3^+) appeared but very few ions of mass 84 $C_6H_{12}^+$) were observed. A search throughout the mass-range covered by the spectrometer indicated hat large quantities of ions of mass 78 were being produced, suggesting that the primary product of the reaction was benzene (C_6H_6) rather than cyclohexane. Now the position of the equilibrium[2] in the reaction

$$C_6H_{12} \rightleftharpoons C_6H_6 + 3H_2 \qquad (2)$$

s well over on the side of cyclohexane under the onditions used in this work. The initial reaction mixture consisted of 1·8 mm. cyclohexylamine and 23 mm. hydrogen and, assuming complete conversion ccording to reaction (1) and the known equilibrium onstant for reaction (2), the maximum pressure of benzene to be expected at 134° C. was only about 10^{-3} mm. The identification of the source of the mass 8 ions as benzene was therefore considered tentative ntil it was found that when most of the cyclohexylamine was used up the ions of mass 78 began o disappear again and in turn substantial quantities f ions of mass 84 were formed. This showed that he normal catalytic hydrogenation of benzene to cyclohexane, to be expected on a metal like platinum, was then taking place. The formation of benzene as also confirmed by stopping a typical reaction nd identifying the benzene in the reaction mixture y vapour-phase chromatography. The whole course f the reaction is shown in Fig. 1.

The initial reaction can be written as

$$C_6H_{11}NH_2 \rightarrow C_6H_6 + NH_3 + 2H_2 \qquad (3)$$

which is the sum of reactions (1) and (2). Although e equilibrium constant for reaction (1) is not nown, it is probably of similar magnitude to that for the corresponding hydrogenation of methylamine to methane and ammonia which is approximately 10^{12} at 134° C. Combining this figure with the known equilibrium constant[2] for reaction (2), a value of 10^{13}(mm.)^3 is found for reaction (3). The magnitude of this value indicates that it is thermodynamically feasible for benzene to be formed according to reaction (3) even in the presence of a large excess of hydrogen.

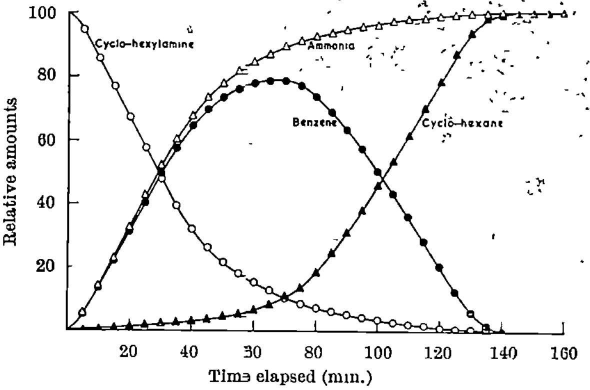

Fig 1. Relative amounts of cyclohexylamine, ammonia, benzene and cyclohexane during reaction of 1 8 mm. cyclohexylamine and 23 mm. hydrogen on a 5·65 mgm evaporated platinum catalyst at 134° C.

The selective action of the catalyst causes reaction (3) to take place in preference to reaction (1). It is not perhaps surprising that benzene should be produced on the surface of the catalyst since it is known that saturated hydrocarbons can lose hydrogen atoms on transition metal catalysts in this temperature-range. However, it is most interesting that the presence of the amine can inhibit the hydrogenation of benzene which is usually a facile catalytic reaction. Further work is in progress to elucidate the details of this type of phenomenon in connexion with the vapour-phase decomposition of cyclic amines on evaporated metal-film catalysts and will be published in due course.

One of us (R. L. M.) is the holder of a British Celanese studentship.

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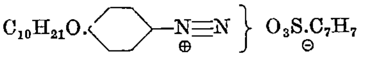
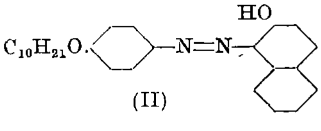
Benzene-soluble Aryldiazonium Salts

While typical salts are soluble in water and insoluble in hydrocarbons a few are soluble in both media. No member of the large and important group of diazonium salts is known to be soluble in weakly polar media, however, and this has prevented a study of the reaction of the salts with such reagents as the organometallic compounds, though their complexes with metallic salts have been used[1,2].

We have now found that *p*-*n*-decyloxybenzenediazonium toluene-*p*-sulphonate, *p*-cetyloxybenzenediazonium chloride and 2 : 5-di-*n*-*p*-decyloxybenzenediazonium chloride are all moderately soluble in warm benzene, though sparingly in the cold. The salts appear to exist in benzene as ion pairs, though more complex association compounds of molecules and ions may be present also. Thus they react easily with β-naphthol in the same solvent, in the presence of a small proportion of pyridine (1 mole), to form normal azo-compounds. *p*-*n*-Decyloxybenzenediazonium toluene-*p*-sulphonate (I) gives 1-(*p*-*n*-decyloxyphenylazo)-2-naphthol (II), a scarlet, crystalline compound. The salts also react very readily with typical Grignard reagents. α-Naphthylmagnesium bromide and (I) give 1-(*p*-*n*-decyloxyphenylazo)naphthalene (III), though only in 10–30 per cent yield, the highest yields being obtained at 60° and the lowest at the room temperature. In addition, the reaction gives *p*-*n*-decyloxydiphenyl (IV) (25–30 per cent), *n*-decyloxybenzene (V) (5–7 per cent), and naphthalene (30–40 per cent). There was no indication of the formation of diphenyl, 4 : 4′-di-*n*-decyloxydiphenyl, 1-(*p*-*n*-decyloxyphenyl)naphthalene, 1-phenylnaphthalene, 1 : 1′-dinaphthyl, *p*-*n*-decyloxyazobenzene or 4 : 4′-di-*p*-*n*-decyloxyazobenzene.


(I)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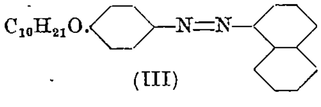
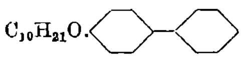
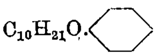

(III)


(IV)


(V)

The azo-compound (III) is the expected product of an ionic reaction between α-naphthyl anions and diazonium cations, but the formation of (IV), (V) and naphthalene appears to require the intervention of radicals.

Analogously, the same diazonium salt (I) and phenylmagnesium bromide gave *p*-*n*-decyloxyazobenzene, but the most abundant of the isolated products was *p*-*n*-decyloxydiphenyl (IV).

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Occurrence of Substances Similar to Gibberellic Acid in Higher Plants

If the fungal metabolite gibberellic acid is applied to dwarf varieties of pea, french bean (*Phaseolus*), broad bean (*Vicia*) or maize, growth is greatly accelerated and plants similar to the normal tall phenotype are produced; the tall varieties themselves are much less affected by gibberellic acid, if at all[1,2]. This suggests that this acid, or a substance with similar physiological properties, is a normal plant-growth regulator, produced less abundantly in dwarf varieties than in tall ones. The growth-promoting substance obtained from immature bean seeds by Mitchell, Skaggs and Anderson[3] was probably of this type; more recently, West and Phinney[4] have reported the probable occurrence of substances like gibberellic acid in seeds of several plant species; I have obtained evidence of such a substance in the shoots of dwarf and tall peas, and this is summarized below.

Shoots of pea seedlings grown in a greenhouse were frozen to − 15° C. and broken down to a coarse powder. This was covered with ethyl alcohol and stored at 0° C. overnight. The solvent was separated by filtering and pressing the plant material. The ethyl alcohol was then distilled off *in vacuo*, and the aqueous residue was filtered and extracted with ethyl acetate at *p*H 3. This was distilled off *in vacuo* over 30 ml. distilled water in order to precipitate water-insoluble material which had been carried over; the aqueous solution so obtained was filtered and extracted with fresh ethyl acetate, which was concentrated and spotted on chromatography paper The paper was eluted with water and the resulting eluate was acidified to *p*H 3 and extracted with ethyl acetate or ether. This was distilled off *in vacuo* and the residue was taken up in 0·25 ml. ethyl alcoho and spotted on 2-cm. wide strips of chromatography paper. These strips were run in a descending solvent system consisting of chloroform/ethanol/water/formic acid in the proportions 20 : 4 : 2 : 1.

The chromatograms were tested for gibberellic acid-like activity by an assay based on growth o sections of the first leaf of etiolated wheat seedlings Gibberellic acid produces little or no response in the coleoptile assays used for auxins, but leaf sections were shown by Hayashi and Murakami[5] to respond to gibberellin *A*, a substance similar in chemical and physiological properties to gibberellic acid. Four-day old wheat shoots, grown in the dark at 23° C., were cut close to the seed; 4 mm. sections were cu through both coleoptile and leaf 4 mm. from the base of the leaf. The chromatograms were divided into a number of pieces, which were moistened with water. Ten sections, each consisting of a leaf section still enclosed in a coleoptile section, were placed on each piece of paper and were incubated in a mois atmosphere in the dark at 23° C. for 48 hr. The final length of the leaf sections was measured with the aid of a projector. The wheat leaf test is exceedingly sensitive to gibberellic acid; sections on pape moistened with water increase in length by abou 5 mm.; in 3 × 10^{-6} *M* gibberellic acid length increas is of the order of 7 mm. and even concentrations c 10^{-8} *M* cause an appreciable growth increase ove controls. Growth is slightly enhanced by indoly acetic acid, but only at considerably higher concentrations. This test is thus to some extent specifi for gibberellic acid and related compounds.

Approximate R_F values for gibberellic acid and several auxins, using the solvent system described above, were: gibberellic acid, 0·46; indolyl aceti acid, 0·83; indolyl acetonitrile, methyl indolyl acetate and indolyl butyric acid moved with th solvent front. In a number of experiments, extract of shoots of two varieties of pea, Meteor (dwarf) and Improved Pilot (tall), have consistently shown chromatogram zone of growth stimulation corresponding in R_F to gibberellic acid. Some chromatogram of pea extracts have also shown an active zone simila in R_F to indolyl acetic acid; but growth-inhibitin substances, which are also found in the extracts, usually mask that area of the chromatogram.

Similar chromatograms sprayed with ethanolic Salkowski reagent showed no coloured spot typical of an indole compound, neither did they show the fluorescent zone characteristic of gibberellic acid after spraying with ethanolic sulphuric acid. This does not necessarily imply absence of indole compounds or gibberellic acid, but may be due to very low concentrations of such compounds on the paper.

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The Square Pyramidal Configuration in a Five-Co-ordinate Nitrosyl Complex

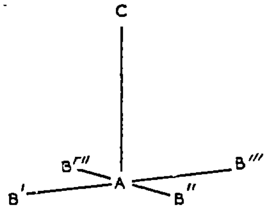
MOST molecules which have a five-co-ordinated central atom, and the structures of which have been accurately determined, have the shape of a trigonal bipyramid; for example, PF_5, $(CH_3)_3SbBr_2$, $Fe(CO)_5$. Nevertheless, in their study of valency theory, Daudel and Bucher[1] predicted that a five-co-ordinate molecule may in certain circumstances have a square pyramidal configuration. In their configuration (I), the central atom *A* is strongly bound to four atoms *B* at the corners of a square, these five atoms being co-planar; this square forms the base of a pyramid, and the fifth atom *C*, which is more weakly bound, is at the apex. They considered that this configuration would be most stable when the lower *d*-orbitals of the central atom are used in forming the bonds, that is, when the hybridization is dsp^3 rather than sp^3d.

Apart from the compound $[Ni(PEt_3)_2Br_3]$ prepared by Jensen and Nygaard, which is too unstable for detailed study but probably is square pyramidal, only two examples of this configuration appear to be well established. The infra-red and Raman spectra of iodine pentafluoride IF_5 require the molecular symmetry C_{4v}, that is, the configuration is square pyramidal, but the central iodine atom does not necessarily lie in the basal plane of the pyramid. The only example of this type of co-ordination which has so far been examined by X-ray crystallographic methods is K_2SbF_5, where the antimony atom appears to lie slightly below the basal plane of the square pyramid; the limits of accuracy claimed for this determination are rather wide, and it is not certain that this apparent departure from Daudel and Bucher's configuration is real. The molecule IF_5 and the ion $(SbF_5)^{=}$ are isoelectronic and in both cases the bonds must involve the upper *d*-orbitals of the central atom. It is simplest to regard the co-ordination as distorted octahedral, with one position occupied by a lone pair of electrons[2], the hybridization being sp^3d^2.

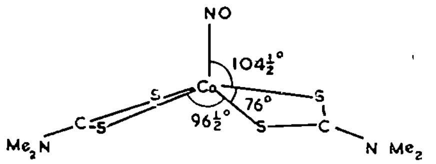
A molecule which fulfils more closely the conditions envisaged by Daudel and Bucher is *bis*-(NN-dimethyl dithiocarbamato)nitrosyl cobalt (II), $[Co(S_2CNMe_2)_2(NO)]$, and we have therefore determined its structure by X-ray crystallographic methods. It was first prepared by Malatesta, and Cambi reported it to be diamagnetic[3]; all the electrons are therefore paired, indicating that lower *d*-orbitals are used for σ-bond formation.

The crystals of this compound are monoclinic, space group $P2_1/c$, with four molecules in the unit cell; $a = 6{\cdot}49 \pm 0{\cdot}02$ A., $b = 13{\cdot}51 \pm 0{\cdot}05$ A., $c = 16{\cdot}95 \pm 0{\cdot}05$ A., $\beta = 116\frac{1}{2}°$. They were obtained by the slow evaporation at room temperature of a solution in chloroform, one of the few solvents in which the substance is appreciably soluble. The crystals, which form as prisms elongated along the *a*-axis, are opaque to light even when their thickness is as small as 0·01 mm. Their surfaces are highly reflecting like metallic mirrors, which indicates that some electrons in the molecule are bound rather loosely. All the crystals so far obtained have been twinned, and the X-ray analysis has therefore been limited to a study of the projections down the *a*- and *b*-axes.

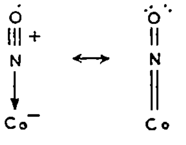
The crystal consists of discrete molecules, without any evidence of strong intermolecular forces. It became apparent very early in the analysis[4]—and subsequent refinement has confirmed—that the configuration of the molecule is indeed that of a square pyramid, or rather of a rectangular-based pyramid; but it is not exactly the configuration described by Daudel and Bucher. The central cobalt atom does not lie in the same plane as the sulphur atoms, but about 0·5 A. above it (II). The average cobalt–



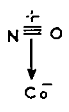
I



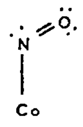
II



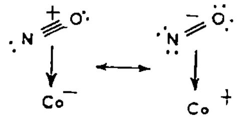
III



IV



V



VI

sulphur distance is 2·31 A., which is reasonably close to the sum of the octahedral radius for Co(II) and the tetrahedral radius for sulphur, 2·36 A. The inter-bond angles around the cobalt atom at the present stage of the analysis are shown in diagram II. The configuration is very similar to those derived theoretically, by two different methods, by Kimball[5] and by Linnett and Mellish.

The process of refining the structure so as to establish the positions of the lighter atoms is now nearing completion, and full details of the methods used and of the final results will be submitted for publication elsewhere. It is already clear that the nitric oxide group is not perpendicular to the basal plane of sulphur atoms, with the cobalt, nitrogen and oxygen atoms collinear (III), as has hitherto been supposed by analogy with carbonyl complexes[6]; nor is it parallel to the basal plane (IV), as in the π-type complexes, for example, of ethylene[7]. It lies between these two orientations, being inclined at an angle of approximately 135° to the vertical axis of the pyramid, and appears to be bound either by forming an electron-pair bond (V), or by the donation of π-electrons to the metal atom, the atoms being arranged unsymmetrically because of the difference between their electronegativities (IV). The existence of unsymmetrical π-complexes has already been shown by Holden and Baenziger's work on styrene palladous chloride[8], and we are indebted to Dr. L. E. Orgel for confirming that this type of bond can be justified on theoretical grounds in nitric oxide complexes. The arrangements in diagrams V and VI would both result in diamagnetism, but the angle Co—N—O of 135° is rather larger than would be expected for structure V. Structure VI fits our results better, but at the present stage of the analysis it is not possible to distinguish between V and VI with certainty.

We are indebted to Dr. J. Chatt, Dr. L. A. Duncanson and Dr. L. M. Venanzi, who also prepared the compound for us, for discussions on the structure.

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Photo-reduction of Pteridines

WHEN a solution of 7-hydroxypteridine[1] was spotted on a sheet of Whatman No. 1 filter paper, irradiated with ultra-violet light (principally 254 mμ) for 5 min., and developed (by ascending chromatography) in various solvents, two spots appeared. One of these was identical with the starting material (unirradiated material was used as a control on the same piece of paper), and the other proved to be 5 : 6-dihydro-7-hydroxypteridine[1]. This reaction did not take place in aqueous solution (although 2 : 6-dihydroxypteridine[2] undergoes photochemical change in water), but it did if allyl-thiourea was present as a hydrogen donor (unirradiated controls were not reduced). 2- and 4-hydroxypteridine were found also to be photo-altered on paper; but the products have not yet been identified.

Photosensitive pteridine pigments are believed to be important in the visual process of insects[3]. It will be interesting to see if a cycle of photo-reduction followed by enzymic oxidation is involved.

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Optical Properties of 'Cellophane'

SOME years ago, one of us[1] used commercial 'Cellophane' in conjunction with a polarizer and an analyser to produce colours in unstained microscopic sections of decalcified teeth. Subsequent investigation has shown that a sheet of this kind of 'Cellophane' exhibits the curious property of behaving like a half-wave plate. We do not think that this property can be explained in the usual way, that is, by 'Cellophane' thickness in conjunction with ordinary and extraordinary ray velocities, because it is improbable that the manufacture of commercial 'Cellophane' involves such precise control of thickness as the usual half-wave plate theory demands. We are therefore led to conclude that its surfaces are instrumental in giving 'Cellophane' this property.

If this phenomenon is indeed a surface, rather than a thickness, effect, it should appear with all colours equally. This would give 'Cellophane' the property of being a half-wave plate for all colours. In practice, when 'Cellophane' is viewed between two 'polars' it shows a definite coloration which becomes more marked when the thickness of the 'Cellophane' is increased (by using a number of sheets). This is indeed a thickness effect which makes it impossible to verify the supposed half-wave property precisely. Nevertheless, allowing for the limitations imposed by the thickness effect, we find, as already stated, that a 'Cellophane' sheet does satisfy the customary tests for a half-wave plate, no matter what colour of light be used. While the thickness effect can be explained in terms of current theory, we can think of no such explanation for an achromatic half-wave plate property dependent (as we believe) upon surfaces. Polythene sheets exhibit similar properties but less markedly.

Applications of the above-mentioned properties of 'Cellophane' and polythene to histology will be described later in the *Irish Journal of Medical Science*. We should like to thank the Medical Research Council of Ireland for apparatus used in this investigation, and Messrs. John Player and Sons, Dublin, for a generous gift of 'Cellophane'.

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Threshold Potential for the Low-Frequency Electric Discharge in Air

Studies of the threshold potential[1], V_m, for low-frequency (50 c./s.) discharges in atmospheric air dried over phosphorus pentoxide were made over a range of pressure, p, from 1 to 75 mm. of mercury, using cylindrical glass tubes with plane parallel glass ends as electrodes. V_m was indicated by a sudden rise in the current flowing through the discharge tube, the initiation of a glow characteristic of the gas, and the appearance of high-frequency pulses on the current waveform.

Fig. 1 shows the variation of V_m (a.c. peak value) with the product of pressure and inter-electrode distances, d in cm., (i) for hard 'Pyrex' glass electrodes and (ii) for soft soda glass electrodes. For comparison, values of the sparking potential, V_s, are also shown (iii) for brass electrodes under 50 c./s. a.c. excitation, and (iv) for mercury-contaminated copper electrodes under d.c. excitation recently reported by Llewellyn Jones and Davies[2].

It is seen that for a given value of $p \times d$, V_m (hard 'Pyrex' glass) is greater than V_m (soft soda glass), which in turn is greater than V_s (metal). The close agreement between the present values with brass electrodes and those of Llewellyn Jones *et al.* clearly indicates that the above difference is not due to the use of a.c. Moreover, the larger values of V_m with glass electrodes cannot be attributed to a difference in the work function of the electrodes, because differences in the breakdown potential for cathodes of different work function are a maximum near the minimum sparking potential and tend to become zero for higher pressures. In the present case, however, the difference $V_m - V_s$ is found to increase with $p \times d$. This difference may be attributed, at least in part, to a fall in potential on the glass electrodes depending on the resistivity, ρ, of the electrodes, which also changes in the sense that ρ (hard 'Pyrex' glass) is greater than ρ (soft soda glass) which is greater than ρ (metal).

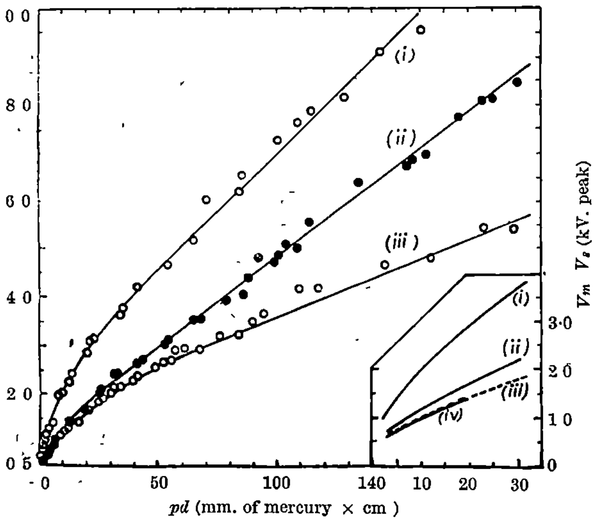

Fig. 1. Paschen's curves in air for various electrodes. (i) Hard 'Pyrex' glass electrodes ; (ii) soft soda glass electrodes ; (iii) brass electrodes ; (iv) copper electrodes (in inset), after Llewellyn Jones and Davies
(i), (ii) and (iii) : under a.c excitation ; peak values are plotted

Details of this work will be published elsewhere.

A similar difference in the Geiger threshold for Maze counters with external cathodes and that for Geiger counters with internal cathodes has been reported[3,4]. The plateau for Maze counters is also found to be appreciably longer[4]. Such results may also be due[5] to a corresponding fall in potential on the glass walls of the Maze counters.

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June 4.

[1] Joshi, S. S., *Curr. Sci.*, **8**, 548 (1939).

[2] Llewellyn Jones, F., and Davies, D. E., *Proc. Phys. Soc.*, B, **64**, 397 (1951).

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[5] Cockroft, A. L., and Valentine, J. M., *J. Sci. Instr.*, **27**, 262 (1950).

A Compact Soil Perfusion Apparatus

Lees and Quastel[1] described an apparatus for the perfusion of soil samples which obviated the need for disturbing the soil during the experiment. Their design was later modified by Audus[2], who used a negative pressure for circulating the perfusate. This apparatus was rather fragile and required a considerable amount of incubator space. A modified design, using the same principle as the Audus apparatus, has been used here successfully for twelve months and the alterations did not apparently affect the efficiency of the perfuser compared with the earlier models.

The apparatus consisted of a 500-ml. Florence flask (Fig. 1) in which the neck was replaced by the tube D (15 cm. by 2·5 cm. internal diameter). The bottom of the tube D was constricted to prevent the soil column from falling into the flask. The side-arm C was bent at right-angles and extended up to the same height as the flask. A constriction, 1–2 mm. in diameter, was made at the point of fusion (B) to restrict the movement of liquid from C into the flask A. When the diameter of the constriction at B was greater than 2 mm., air was drawn directly into the flask rather than into the tube F. The tubes E and F had an internal diameter of 7 mm. and were fixed as shown in Fig. 1. The tube F was sealed into the right-angle bend of the side-arm C, which was found empirically to allow the optimal flow of air and perfusate into the tube F. The tube E led to a water pump and the air-flow was controlled by an adjustable clip. No constrictions in tubes E or F were found to be necessary. A piece of glass tubing (G) filled with cotton-wool was placed in the open end of the side-arm *C* to prevent aerial contamination of the perfusate and to reduce the air flow into the tube *F*. The soil sample (30–50 gm. of soil crumbs) or small glass beads were placed in the tube *D* on a pad of glass wool and another pad was placed on top to prevent puddling of the soil. The rubber bung was replaced and 300 ml. 0·01 *M* ammonium sulphate was introduced into the flask via the side-arm.

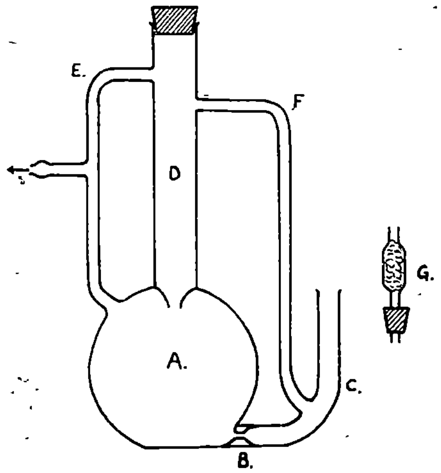

Fig. 1. Soil perfusion apparatus

The new apparatus was only 25 cm. high and could be housed in a small space as it did not require the support of a retort stand. The soil column was easily removed after the experiment by gentle shaking and the apparatus could be acid cleaned and then later sterilized in one piece, thus eliminating many of the breakages which occurred when assembling and dismantling the earlier models. The apparatus required no extensive adjustment prior to perfusion and worked for long periods without supervision. Finally, the apparatus was cheap and easy to make. The new design should be useful where large numbers of perfusers are used and the available incubator space is limited. Further details of the rate of nitrification by soils in this apparatus will be reported in greater detail elsewhere.

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Aug. 1.

[1] Lees, H., and Quastel, J. H., *Biochem. J.*, **40**, 803 (1946).
[2] Audus, L. S., *Nature*, **158**, 419 (1946).

Thermal Conductivity of Soil

IN a recent communication[1] J. Webb overlooks that his calculation of the thermal conductivity of a cubic arrangement of spheres is based on an inadmissible simplification and in consequence he is led to a false conclusion. This is true also of Gemant's[2] article which is criticized by Webb. A rigorous analytical treatment of the identical problem in electrical conductivity was published by Lord Rayleigh[3]. Full elaboration of the theory, however, meets with mathematical difficulties.

Rayleigh's approximate formula leads to 0·00033 cal. cm.$^{-1}$ sec.$^{-1}$ deg. C.$^{-1}$ for the thermal conductivity in the numerical example discussed by Webb. From other considerations[4,5] it follows that this value is approximately 30 per cent too low. The value for a mineral dry soil at the same porosity (47·6 per cent) is about 0·0005 cal. cm.$^{-1}$ sec.$^{-1}$ deg. C.$^{-1}$ (ref. 4) and therefore practically of the same magnitude. It is trivial that both systems are not quite comparable because they have different geometry.

The theory of thermal conductivity of granular materials with special reference to soils has been discussed by me[4,5]. An approximate method for calculating the thermal conductivity of soils from their composition, moisture content and dry density has resulted. The method has been tested against a large body of consistent experimental results.

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Aug. 10.

[1] Webb, J., *Nature*, **177**, 989 (1956)
[2] Gemant, A., *J. App. Phys.*, **21**, 750 (1950)
[3] Rayleigh, W. R., *Phil. Mag.*, v, **34**, 481 (1892).
[4] Vries, D. A. de, *Med. Landbouwhogeschool Wageningen*, **52**, 1 (1950).
[5] Vries, D A. de, Annexe 1952–51, *Bull. Inst. Int du Froid, Paris*, 113 (1952)

IN his article, Gemant directs attention to the non-rigorous nature of his method of determining the thermal conductivity of soil. His method, which I adopted in the communication to which Dr. de Vries refers, assumes that the lines of heat flow are parallel. Quite obviously, an assumption of this kind will introduce errors which will increase as the ratio of the conductivities of the two phases increases. For dry soil this ratio is of the order of 160 : 1, and the error involved in using my formula is very considerable.

For water-logged soil the ratio of the conductivities of the two phases is of the order of 7 : 1, and my formula yields the value 0·00486 cal. sec.$^{-1}$ cm.$^{-1}$ deg. C.$^{-1}$, which compares with an observed value quoted by Gemant of 0·005 cal. sec.$^{-1}$ cm.$^{-1}$ deg. C.$^{-1}$.

It would appear probable, then, that my formula would prove adequate for a composite material, in which conducting spheres are embedded in a matrix of lesser conductivity, provided that the ratio of the conductivities of the two components does not exceed say 10 : 1. This may be of little practical significance ; but to my mind it justifies, to some extent, Gemant's treatment of the capillary wedge-shaped rings in damp as opposed to water-logged soil.

In my communication, I should perhaps have stressed the non-rigorous nature of the derived formula, instead of assuming that the interested reader would automatically consult Gemant's article in which the approximation is commented upon.

My purpose in writing initially was to challenge the validity of Gemant's method of determining the conductivity of dry soil. In this method, the air-phase conductance is neglected, and consequently it becomes difficult to reconcile the infinite value of the thermal resistivity of the hypothetical dry soil with the finite observed value for an actual dry soil. Gemant was forced to assume that the spheres were chipped to facilitate heat flow from solid to solid.

In other words, the model is tailored to suit observed values.

Using Gemant's own method, I attempted to show that the effect of the shunt air-conductance may not be neglected, with impunity, in a dry soil. That the method is not rigorous is of less concern to me than this point, namely, that the air-conductance must have a considerable influence upon the conductivity of dry soil. This does not appear to be in dispute.

JOHN WEBB

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Sept. 15.

Effect of 'Rindite' on the Development of the Growth-substances in Potato Tubers

THE stimulating effect of 'Rindite' (ethylene chlorhydrin – ethylene dichloride – carbon tetrachloride 7 : 3 : 1) is extensively employed to break the rest period of potato tubers and thus to obtain two crops in a year. Although several articles dealing with the metabolism of the potatoes treated with 'Rindite' are known, the development of the growth-substances in the chemically treated tubers have not yet been analysed in detail. The purpose of this study was to elucidate the effect of 'Rindite' on the changes in the concentration of the growth-substances in the tubers.

The investigation was carried out on the 'Early Yellow' variety with a four-week rest period. Part of the freshly harvested tubers were exposed to the effect of 0·8 ml./kgm. 'Rindite' for 48 hr. and, after airing, were stored in wet sand. The untreated tubers were also stored. The sprouting of the treated potatoes began on the fifth day, while those of the controls began on the 28th day. Determinations of the growth-substances in the peelings of the treated tubers were carried out every second day for 12 days, that of the controls weekly for 42 days. The growth-substances were extracted with peroxide-free ether at 4° C. and the extractions were separated into acid and non-acid fractions. Chromatograms were made with *iso*propanol – ammonia – water and the growth-substance content of each 1 cm. paper-segment was examined by the *Avena* straight-growth test. The relative concentration of the growth-substances present could be inferred from the rate of the elongation of the coleoptile sections.

On chromatograms of the acid fractions of both the treated and untreated tubers, five active areas could be observed, as shown in Table 1.

Table 1

No.	R_F value	Bio-assay effect	Identification
1	0·10	stimulation	?
2	0·24	stimulation	indole-3-pyruvic acid
3	0·40	stimulation	indole-3-acetic acid
4	0·65	inhibition	?
5	0·87	stimulation	indole-3-acetonitrile

The substance having the R_F of 0·1 is unknown, though such a slowly moving accelerator has been demonstrated by Bennet-Clark and Kefford[1,2] and Nitsch[3] in several parts of plants. The substance with an R_F value of 0·24 is presumed to be indole-3-pyruvic acid. An inhibitor with the R_F of about 0·65 has been also found by several authors[1,2,4] in numerous plants including potatoes. Similarly, the presence of indole-3-acetonitrile in potatoes was demonstrated.

During the rest period and the sprouting, the concentration of the growth-promoting substances of the acid fractions in the stimulated tubers developed differently from that in the controls. In five days following treatment with 'Rindite' the concentration of indole-3-acetic acid in the peeling rapidly rose ; even that of the precursors (indole-3-pyruvic acid and indole-3-acetonitrile) distinctly increased. After this rapid rise, a definite decrease in the concentration of both indole-3-acetic acid and its precursors was observed. The concentration of these substances in the spontaneously sprouting tubers increased more slowly. The level of the free auxins, however, rose gradually even after sprouting.

The treatment with 'Rindite' considerably accelerated the disappearance of the inhibitors. While in the control tubers the inhibitors disappeared only in about 30 days, in the treated tubers they disappeared in five days. These results are in agreement with Hemberg's[5] data.

On the chromatograms of the non-acid fractions the presence was noted of a growth-promoting substance (R_F 0·55) identified as indole-3-acetaldehyde. Its concentration in the treated tubers also rapidly rose until sprouting, then it dropped to the initial level. In the controls, however, no diminished concentration was observed after sprouting. The presence of indole-3-acetonitrile (R_F 0·87) was noted also in the non-acid fractions. Inhibitors in the non-acid fractions have been found only in traces. In the tubers treated with 'Rindite' when sprouted another non-acid growth-promoting substance appeared with about 0·8 R_F value. No such substance was found in the controls.

Details will be dealt with in another publication.

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June 25.

[1] Bennet-Clark, T. A., and Kefford, N. P., *Nature*, **171**, 645 (1953).
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[3] Nitsch, J. P., *Plant Physiol.*, **30**, 33 (1955).
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Preparation of Copepod Mounts for Taxonomic Work and for Permanent Collections

DURING an investigation of the microfauna of the shore at Whitstable, Kent, it was necessary to examine and to identify the many Harpacticoid copepods which occurred there. At the same time it was desirable to build up a type collection of these animals.

For purposes of identification one must be able to examine both dorsal and ventral aspects of these copepods at high magnifications. Hence preparations should be mounted on rectangular cover-glasses rather than on conventional microscope slides so that they may be equally accessible to study when inverted. In my experience, the following technique has proved satisfactory. The copepod is placed on a 2 in. × $\frac{7}{8}$ in. No. 1 cover-glass and killed with hot 70 per cent alcohol. Traces of salt are removed by flushing with cold 70 per cent alcohol, and the alcohol afterwards removed by filter paper. Polyvinyl lactophenol, with chlorazol black in solution, is now applied to the specimen, which is then covered with a ½-in. diameter No. 0 cover-glass: by moving the top cover-glass with a fine mounted needle the animal may be correctly orientated.

Since the taxonomy of the Harpacticoid copepods largely rests on limb bristle characters it is essential that these bristles be well stained and clearly visible. By virtue of its permanence, chlorazol black has proved superior to lignin pink and cotton blue as a copepod stain in lactophenol preparations.

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Aug. 7.

Demonstration of Small-scale Water-currents by means of Milk

SMALL particles of relatively inert materials such as carmine, graphite, clay and starch are often used for showing up the currents of water produced by the feeding, swimming and other movements of small aquatic animals. Although such particles may be satisfactory for showing ciliary activity, when mucus is almost always present, in other cases they tend to disperse and sink, and are difficult to photograph. During work on the behaviour of barnacles we found that ordinary cow's milk offers a better means of detecting and measuring small water-currents, and is superior to artificial emulsions. We have since learned that milk has been used for showing the behaviour of aircraft models in a water-tunnel[1]. It seems possible, therefore, that the method may be of general use.

In our technique the animals are placed in a small vessel of still water and observed or photographed against a black background. The milk is injected into the water above the animal from a row of fine jets (Fig. 1, *A*) connected to a syringe. The syringe is operated manually by means of a screwed thread and knob, allowing the milk to be injected either in a steady stream or in blobs. The density can be adjusted by dilution with the medium or by varying the cream content. Normally the milk tends to clot slightly at the interface with sea water, and remains suspended as a trail, resembling thick smoke in air. The milk does not seem to have any harmful effect on marine animals; indeed, barnacles accept it as food, although if large quantities are administered it is found apparently unchanged in the fæcal pellets.

This method has enabled us not only to measure the external water currents set up by barnacle cirri, but also to establish the presence of an internal water-current passing through the mantle cavity during normal beating. The mantle current enters at the carinal end of the aperture near the mouth (Fig. 1, *B* and *C*), passes the filter net formed by the smaller cirri and mouth parts[2], flows around the branchiæ and is ejected as a strong jet between the prosoma and rostrum on the downward beat of the cirri (Fig. 1, *D*). A circulation of this type seems universal in cirripedes, and has been demonstrated in the following species: *Verruca stroemia* (O. F. Müller), *Chthamalus stellatus* (Poli), *Balanus amphitrite* (Darwin), *B. balanoides* (L.), *B. crenatus* Bruguière, *B. hameri* Ascanius, *B. improvisus* Darwin, *B. perforatus* Bruguière, *B. porcatus* da Costa, *B. spongicola* Brown, *Elminius modestus* (Darwin), *Acasta spongites* (Darwin), *Pyrgoma anglicum* Leach, *Hexelasma hirsutum* Hoek, *Alcippe lampas* Hancock.

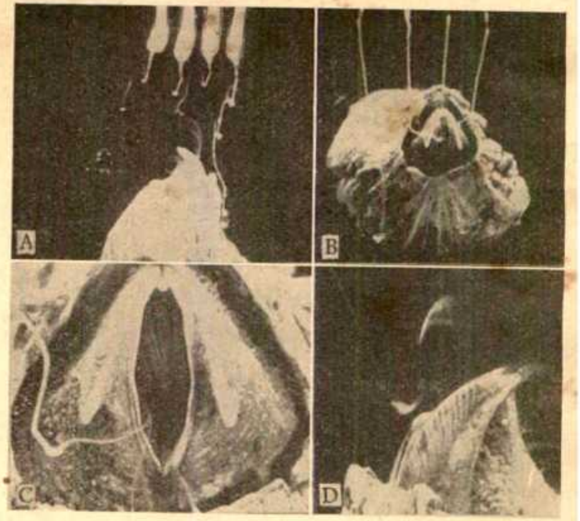

Fig. 1. *Balanus porcatus*: *A*, Side view with cirri extended showing displacement of all milk trails; *B*, top view with valves beginning to open, showing three trails drawn into mantle cavity; *C*, close-up of *B* with single trail; *D*, side view in close-up during downward beat of cirri, exhalant current indicated by upward loop in milk trail. (All enlarged from 16 mm. reversal film)

The mantle circulation depends on the movement of the prosoma and valves, and can be maintained when the movement of the larger cirri is scarcely noticeable; conversely, it is reduced during particularly active movements of the cirri.

These investigations will be published in detail elsewhere. In the meantime a ciné film demonstrating the milk technique, together with other aspects of the behaviour of barnacles, is available.

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[1] Dessoutter, D. M., *The Times* "Survey of British Aviation", 17 (1955).

[2] Southward, A. J., *Nature*, **175**, 1124 (1955).

Letters of J. Purkyně

HAVING recently completed an edition of the complete works of J. Purkyně, I am preparing to publish his letters. In this connexion I am seeking especially letters which he wrote to the British physiologist, Martin Barry (1802–55), and also any letters which show Purkyně's relations with the Royal Society. I should be grateful if anybody possessing letters by or concerning Purkyně, or anybody knowing of their whereabouts, would write to me.

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FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Sunday, November 11

British Broadcasting Corporation (Home Service), at 9.15 p.m. —Sir Edward Appleton, F.R.S.: "Science and the Nation". (First of six Reith Lectures. Further lectures on November 18, 25, December 2, 9 and 16.)

Monday, November 12

British Occupational Hygiene Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 10.30 a.m.—Conference on "Fires in Industry".

British Society for the History of Science, Philosophy of Science Group (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. W. Ross Ashby: "Basic Strategies of Research in Biological Systems".

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. H. Grüneberg: "Genes in Mammalian Development".*

Society of Chemical Industry, London Section (at 14 Belgrave Square, London, S.W.1), at 6.30 p.m.—Prof. F. Bergel: "The Study of Biologically Active Agents as a Vocation" (Jubilee Memorial Lecture).

Royal Institute of Chemistry (joint meeting with the Woolwich Polytechnic Scientific Society at the Woolwich Polytechnic, London, S.E.18), at 7.30 p.m—Prof. R. L. Wain: "Plant Growth-Regulating Substances".

Royal Geographical Society (at 1 Kensington Gore, London, S.W.7), at 8.30 p.m.—Lieut.-Cmdr. M. J. N. Foster, R.N.: "Operation 'Deepfreeze 1' ".

Tuesday, November 13

Institution of Mechanical Engineers, Automobile Division (at 1 Birdcage Walk, London, S.W.1), at 4.30 p.m.—Papers on "Research in Automobile Stability and Control".

Zoological Society of London (at the Zoological Gardens, Regent's Park, London, N.W.1), at 5 p.m.—Scientific Papers.

Royal Society of Arts, Commonwealth Section (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Prof. L. F. Wiggins: "Chemistry and the Sugar Cane".

Institution of British Agricultural Engineers (at 6 Buckingham Gate, London, S.W.1), at 5.30 p.m—Dr. P. Payne: "The Mechanical Properties of Soil in Relation to Basic Cultivation".

Institution of Civil Engineers (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. L. Barden and Mr. P. C. G. Isaac: "The Effect of Synthetic Detergents on the Biological Oxidation of Sewage".

Society of Chemical Industry, Chemical Engineering Group (at 14 Belgrave Square, London, S.W.1), at 5.30 p.m.—Mr. H. L. Riley: "The Manufacture of Phthalic Anhydride by the Fluidized Catalyst Method".

Institution of Electrical Engineers, London Graduate and Student Section (at Savoy Place, London, W.C.2), at 6.30 p.m.—Dr. M. V. Wilkes: "Digital Computers and how they may help the Engineer" (The Students' Lecture).

Royal Aeronautical Society (at 4 Hamilton Place, London, W.1), at 7 p.m.—Dr. E. W. Still: "Air Conditioning of Aircraft".

Wednesday, November 14

Physical Society, Colour Group (in the Lecture Theatre of the Institute of Ophthalmology, Judd Street, London, W.C.1), at 3.30 p.m. —Mr. D. L. Simms: "Colour in Fire Research".

Eugenics Society (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. J. A. H. Lee: "Some Problems raised by the Regional Variations in Intellectual Ability in Britain".*

Institution of Electrical Engineers, Radio and Telecommunication Section (at Savoy Place, London, W.C.2), at 5.30 p.m.—Scientific Papers.

University of London (at the School of Pharmacy, 17 Bloomsbury Square, London, W.C.1), at 5.30 p.m.—Brigadier-General Sir Harold Hartley, F.R.S.: "The Contributions of Pharmacy and Chemical Engineering to World Needs".* (Further lecture on November 15.)

Manchester Literary and Philosophical Society, Social Philosophy Section (in the Reynolds Hall, College of Technology, Manchester), at 5.45 p.m.—Prof. T. E. Chester: "Some of the Human Problems Present in Modern Industrial Society".

Royal Institute of Chemistry (at the Iron and Steel Institute, Grosvenor Gardens, London, S.W.1), at 6.30 p.m.—Annual General Meeting.

Society for Analytical Chemistry, Biological Methods Group (at "The Feathers", Tudor Street, London, E.C.4), at 6.30 p.m. —Discussion Meeting on "Biological Methods in the General Analytical Laboratory".

Thursday, November 15

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Dr. A. V. Hill, F.R.S.: "The Effect of Potassium on the Resting Metabolism of the Frog's Sartorius"; Mr. G. A. Horridge: "The Co-ordination of the Protective Retraction of Coral Polyps".

Institution of Mining and Metallurgy (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. Edward Rich: "A New Process for Pneumatic Stowing: Its Development and Introduction at the Rio Tinto Mines, Spain"; Mr. M. R. Goldick: "Some Developments in Tailing Disposal at Roan Antelope Copper Mines, Northern Rhodesia".

Linnean Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—The Fisheries Laboratory, Lowestoft. Papers by Mr P. M. J. Woodhead, Mr. A. D. Woodhead and Mr. J. E. Shelbourne.

London Mathematical Society (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Annual General Meeting. Sir Geoffrey Taylor, F.R.S.: "Some Simple Problems in Fluid Dynamics".

University of London (at King's College, Strand, London, W.C.2), at 5 p.m.—Dr. Grey Walter: "The Electrical Activity of the Brain".*

University of London (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 5 p.m.—Dr. Dorothy Needham: "The Biochemistry of Muscular Action".* (Further lecture on November 22.)

University of London, Institute of Education (at Goldsmiths' College, New Cross, London, S.E.14), at 5 p.m.—Prof. J. A. Lauwerys: "Education for Social Progress in Under-developed Countries".*

Institution of Civil Engineers (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. W. H. J. Vernon: "Metallic Corrosion and Conservation". (Fourth of a series of six lectures on "The Conservation of Natural Resources".)

Physical Society, Acoustics Group (at the Institute of Laryngology and Otology, Grays Inn Road, London, W.C.1), at 5.30 p.m.—Miss P. H. Strange: "Sensations of Pitch".

Society of Chemical Industry, Agriculture and Microbiology Groups (at 14 Belgrave Square, London, S.W.1), at 6.15 p.m.—Meeting on "Recent Developments in Virus Research". Mr. F. C. Bawden, F.R.S.: "Plant Virus Diseases"; Dr. Kenneth M. Smith, F.R.S.: "Viruses Attacking Insects".

Institution of Mechanical Engineers, Internal Combustion Engine Group (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p.m.—Discussion on "Are Diesel Engines an Interim Phase in Rail and Road Transport Development?"

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Reading of Original Papers to commemorate the 70th Birthday of Sir Ian Heilbron, F.R.S.

Thursday, November 15—Friday, November 16

Institute of Physics and The London and Home Counties Regional Advisory Council for Higher Technological Education (at the Institution of Electrical Engineers, Savoy Place, London, W.C.2)—Joint Conference on "Degree and Diploma Courses in Applied Physics".

Friday, November 16

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.15 p.m.—Geophysical Discussion on "Bombardment of the Earth by Meteors and Meteorites". Speakers: Prof. H. Bondi (who will read a contribution sent by Mr. T. Gold), Dr. J. G. Davies and Dr. M. H. Hey.

Institute of Navigation (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 5.15 p.m.—Mr. J. E. D. Williams: "Navigational Aspects of Turbo-Prop Operations over the North Atlantic".

Royal Meteorological Society (in the Conference Hall, County Hall, London, S.E.1), at 5.30 p.m.—Mr. N. Bradbury: "Aviation Meteorology"* (Lecture for Sixth-form Scholars).

Institution of Mechanical Engineers, Applied Mechanics and Lubrication Groups (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6 p.m.—Dr. A. W. Crook: "Simulated Gear Tooth Contacts—Some Experiments upon their Lubrication and Subsurface Deformations".

Institution of Chemical Engineers, Graduates and Students Section (at Caxton Hall, Westminster, London, S.W.1), at 6.30 p.m. —Mr. G. A. Dummett. "Research and Development in a Chemical-Plant Manufacturing Firm".

University of London (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6.30 p.m.—Sir Charles Dodds, F.R.S.: "Pharmaceutical Applications of Modern Biochemistry".* (Sixth of ten University Extension Lectures on "Technology and Industry". Further lectures on November 23, 30, December 7 and 14.)

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. I. A. Richmond: "Roman Military Engineering".

Saturday, November 17

Biochemical Society (at the Institute of Psychiatry, Maudsley Hospital, Denmark Hill, London, S.E.5), at 2 p.m.—Scientific Papers.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Biochemist, Senior grade (with a first- or second-class honours degree), in the Pathological Department, for duties which include both routine hospital biochemistry and work connected with the investigations into the uses of radioactive isotopes in medicine—The Secretary, Liverpool Radium Institute Management Committee, 1 Myrtle Street, Liverpool 7 (November 17).

Lecturer (with a good honours degree, and preferably a teaching diploma and experience) in Physics at the Nigerian College of Arts, Science and Technology—The Secretary, Advisory Committee on Colonial Colleges, 1 Woburn Square, London, W.C.1 (November 20).

Chemist (Metallurgist) (with an honours degree in metallurgy, chemistry or chemical engineering, or Associate of the Royal Institute of Chemists or Institution of Metallurgy, or equivalent qualifications) at the Ministry of Supply Royal Ordnance Factory, Birtley, Co. Durham, for research and development work in connexion with new manufacturing processes, the control of laboratory staff, and the preparation of reports for publication—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.740/6A (November 23).

Assistant Lecturer (preferably with a special interest in petrology) in Geology—The Secretary, Bedford College (University of London), Regent's Park, London, N.W.1 (November 26).

Research Officer (honours graduate in agricultural science and satisfactory postgraduate experience in crop and grassland husbandry) in the Department of Agriculture's Peatland Experimental Station at Glenamoy, Co. Mayo—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (November 27).

Assistant Principal of the Wright–Fleming Institute of Microbiology—The Secretary, Wright-Fleming Institute, St. Mary's Hospital Medical School, Paddington, London, W.2 (November 30)

Chair of Anthropology in the University of Khartoum—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (November 30).

Lecturer in Agricultural Zoology at Makerere College (University College of East Africa)—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (November 30).

Physicists or Engineers (university graduates with basic training in physics or engineering including an honours degree, and evidence of research experience and ability) in the Wool Textile Research Laboratory, Commonwealth Scientific and Industrial Research Organization, Geelong, to take charge and assist with new projects—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2 (November 30).

Scientific Officer (over 24, with an honours degree in zoology or botany (preferably with qualifications in both), or agriculture or forestry or equivalent, and a special interest in some branch of natural history), for conservation and regional work in South Wales—The Establishment Officer, The Nature Conservancy, 19 Belgrave Square, London, S.W.1 (November 30).

Senior Research Assistant or Research Assistant, for research on the electrochemistry of salts of low melting points—Prof. A. R. Ubbelohde, F.R.S., Chemical Engineering Department, Imperial College, London, S.W.7 (November 30).

Lecturer or Assistant Lecturer in Applied Mathematics—The Registrar, The University, Sheffield (December 1).

Lecturer or Assistant Lecturer in the Department of Geology—The Secretary and Registrar, The University, Southampton (December 5).

Lecturer or Assistant Lecturer in Gas Engineering, and a Lecturer or Assistant Lecturer in General Fuel Science—The Registrar, The University, Leeds (December 10).

Chair of Extraction Metallurgy in the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C.1 (December 12).

Lecturer (with special qualifications and experience in human geography) in Geography; and a Lecturer (with an honours degree or higher in psychology) in Psychology at the University of Tasmania—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Tasmania, December 15).

Reader in Physics at the University of Sydney, Australia, to assist the Professor in the direction of a laboratory concentrating on problems in high energy nuclear physics using cosmic rays and accelerators—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, December 15).

Senior Lecturer or Reader in Protein Chemistry, and a Lecturer (with research experience in biochemistry or organic chemistry, preferably, but not essentially with plant material) in Agricultural Biochemistry at the Waite Agricultural Research Institute—The Registrar, University of Adelaide, Adelaide, South Australia (December 15).

Chair of Biochemistry in the University of Malaya—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (December 31).

Senior Lecturer or Lecturer (Grade I or Grade II) in Tropical Agriculture, at University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (December 31).

Agricultural Librarian (with a university degree in agricultural economics, agriculture or biological science, and some experience of technical library work, especially abstracting) in the Department of Agriculture, Western Region, Nigeria, to take charge of the Departmental Technical Library, to make abstracts and prepare symposium for the use of Technical Officers, and to assist with the preparation of articles for publication, etc.—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.63/410/019.

Assistant Librarian at the University College of Rhodesia and Nyasaland—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1.

Assistant Teacher, Grade B, in Physiology and Pharmacology, in the Department of Pharmacy, College of Technology, Liverpool—The Director of Education, 14 Sir Thomas Street, Liverpool 1.

Curator/Technician (preferably with special interests in palæontology) in the Department of Geology, for duties which will include the care and cataloguing of geological laboratory and museum specimens and collections—The Registrar, University College, Singleton Park, Swansea.

Fisheries Officer (Fish Culture Research) (with an honours degree in biology with emphasis on zoology; appropriate knowledge of chemistry and statistical methods; ability to read French and possibly German, and preferably experience of similar or related work) with the Federation of Nigeria, to undertake research into the pond culture of local species of fish and into the chemistry and plankton populations of fish ponds to ensure the most profitable use of available nutrients, food-stuffs and fertilizers—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.65/14/01.

Lecturer (with a university degree, and preferably a qualification in engineering, and some experience in industry and teaching) in Mathematics—The Registrar, Loughborough College of Technology, Loughborough.

Physicist, Senior grade (with a knowledge of X-rays, radium and radioactive isotopes), in the Radiotherapy Department, for duties which concern routine radiotherapy physics, and the applications of radioactive substances in other branches of medicine—The Secretary to the Board of Governors, Charing Cross Hospital, London, W.C.2.

Plant Pathologist (with an honours degree in botany, or natural science including botany) in the Department of Agriculture, Kenya, to assist in producing new varieties of wheat and other cereals resistant to the increasing number of rust strains—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.63/7/030

Principal/Senior Scientific Officer (with a first- or second-class honours degree in physical or inorganic chemistry, and experienced physical chemist with a special interest in thermodynamics) to assist in the direction and carrying out of research on a variety of subjects—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting Ref. 1311/34.

Reader, Senior Lecturer or Lecturer in (*a*) Inorganic Chemistry and (*b*) Physical Chemistry at the University of Khartoum—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1.

Senior Technician (with F.I.M.L.T. or equivalent qualification, and experience in hospital biochemistry) in the Department of Chemical Pathology—The Secretary, Guy's Hospital Medical School, London, S.E.1.

Statistician/Physicist (preferably with a university degree or at least H.S.C. in science subjects or G.C.E. (advanced level) in two science subjects, or equivalent qualifications, and relevant experience), in the Electronics Division, for work associated with nucleonic instrumentation reliability studies—The Establishment Officer, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting Ref. 611/34.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

British Electrical and Allied Industries Research Association. Technical Report L/T346: Realizability, Kramers-Bronig Relations, and Fuoss-Kirkwood Dielectric. By H. Pelzer. Pp. 5. 4*s*. 6*d*. net. Technical Report L/T354: A Thermodynamic Treatment of Ferroelectricity and Antiferroelectricity in Pseudo-Cubic Dielectrics. By L. E. Cross. Pp. 18. 3*s*. net. (Leatherhead: British Electrical and Allied Industries Research Association, 1955 and 1956.) [18

What We are Doing, No. 5 (July, 1956). (Bulletin of the British Pape and Board Industry Research Association.) Pp. 28. (Kenley: Britis Paper and Board Industry Research Association, 1956.) [189

The Mond Magazine. No. 1, July 1956. Pp. 24. (London: The Mond Nickel Company, Ltd., 1956.) [189

Ministry of Health. Trial Case Lenses: Report of a Committe appointed by the Minister of Health. Pp. 25. (London: H.M. Stationery Office, 1956.) 1*s*. 9*d*. net. [18

Department of Scientific and Industrial Research. Forest Produc Research Bulletin No. 37: Working Stresses for Structural Softwoods By J. G. Sunley. Pp. iv+14. (London: H.M. Stationery Office 1956.) 1*s*. 3*d*. net. [18

Marine Biological Station, Port Erin. Annual Report for 195 (No. 68). Pp. 38. (Liverpool: Liverpool University Press, 1956. 3*s*. [18

Unmeasured Hazards: an Analysis of the Effects of Tests of Atomi and Thermonuclear Weapons. Prepared by a Committee of th World Federation of Scientific Workers. Pp. 40. (London: Worl Federation of Scientific Workers, 1956.) 2*s*. [18

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MACMILLAN & CO., LTD.,
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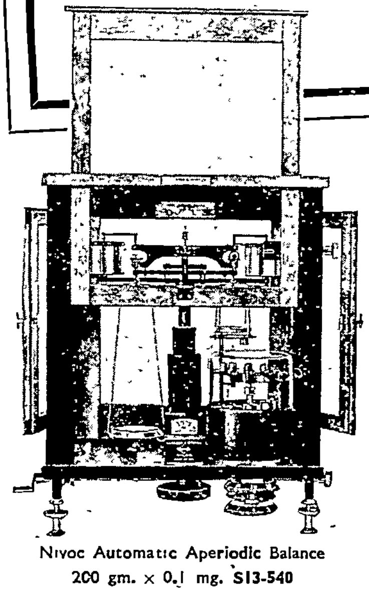

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TECHNICAL OPTICS SECTION

A course of six lectures on "Microwave Optics" will be given by Dr. J. Brown (University College, London) on Tuesdays and Thursdays at 4.30 p.m., commencing Tuesday, November 27, 1956, but omitting November 29. The lectures will be held in the Physics Department, Royal College of Science, Imperial Institute Road, South Kensington. The fee for the course is £2 2s. Students of the College and Inter-Collegiate students will be admitted free.

Copies of the syllabus and application forms may be obtained from the Registrar of the Imperial College, Prince Consort Road, S.W.7.

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Full-time courses, each of four weeks' duration, on the use of radioisotopes will be held in the Department of Chemistry.

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Further particulars and application forms may be obtained from the Secretary at the College.

OFFICIAL APPOINTMENTS

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

The Senate invites applications for appointment as Chief Examiners at the General Certificate of Education Examination in the year 1958 in the following subjects: Advanced and Scholarship Levels:—Art, Botany, British Constitution, Chemistry, Economics, French, Geography, Mathematics, Physics, Spanish, Zoology. Ordinary Level: Art, Biology, Cookery, English Economic History, English Language, French, General Science, Geometrical and Mechanical Drawing, Classical Hebrew, Human Anatomy Physiology and Hygiene, Latin, Logic, Pure Mathematics, Pure Mathematics (Statistics), Additional Pure Mathematics, Physics. Applications are also invited for appointment as Assistant Examiners at both Advanced and Ordinary Levels in Botany, British Constitution, Economics, English Economic History, History, Latin, Physics, Religious Knowledge, Zoology.

Application forms and particulars of remuneration and duties are obtainable from the Secretary to the University Entrance and School Examinations Council, University of London, The Senate House, London, W.C.1, to whom applications must be returned not later than December 14, 1956. The Senate desires that no application of any kind be made to individual members.

D. W. LOGAN,
Principal.

LIVERPOOL RADIUM INSTITUTE MANAGEMENT COMMITTEE

1 MYRTLE STREET, LIVERPOOL, 7

Applications are invited for the post of Biochemist (Senior Grade) in the Pathological Department of the Institute. First- or second-class honours degree essential. The appointment includes both routine hospital biochemistry and work connected with the investigations into the uses of radioactive isotopes in medicine. Ample opportunity and facilities are available for work of a research nature into the problems of the biochemistry of neoplastic disease. Salary and conditions of service in accordance with the recommendations of the Whitley Council.

Applications, stating age, qualifications and experience, together with the names and addresses of two referees, to reach the Secretary by November 17, 1956.

KENT EDUCATION COMMITTEE

MEDWAY COLLEGE OF TECHNOLOGY

Applications are invited from suitably qualified persons for the post of Assistant, Grade B, in Botany. Knowledge of zoology would be an added qualification.

Application forms and further particulars can be obtained from the Principal, Medway College of Technology, Horsted, Maidstone Road, Chatham.

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Requests for application forms, by postcard, to Senior Recruitment Officer at above address. Please quote ref. 1314/34.

MAURITIUS SUGAR INDUSTRY RESEARCH INSTITUTE

Applications are invited for the post of Entomologist. Candidates must have obtained an honours degree in zoology with training in entomology. Experience in the control of insect pests occurring in the tropics especially those attacking sugar cane is desirable. Terms of appointment: On agreement for three years in the first instance with prospects of permanent employment thereafter. Salary according to qualifications and experience in the range Rs.18,000 to Rs.24,000 per annum (£1,350 to £1,800 approximately). Compulsory pension contribution of 5 per cent of salary to the Mauritius Sugar Industry Pension Fund. Free passages on appointment and leave, for officer, wife and children up to a maximum cost of three adult passages. Six months' vacation leave after three years' service. Applications with proof of professional qualifications and the names and addresses of two referees must be sent by registered airmail to the Director, Mauritius Sugar Industry Research Institute, Reduit, Mauritius, so as to reach the addressee before January 17, 1957.

ST. MARY'S HOSPITAL MEDICAL SCHOOL

NICHOLAS FELLOWSHIP

Research Fellow required for an initial period of three years to investigate certain pharmacological or biochemical aspects of cardio-vascular disease. Medical qualification not essential. Salary £1,000 per annum.

Applications, together with the names of two referees, to the Secretary, St. Mary's Hospital Medical School, Paddington, W.2, by November 30, 1956.

H.M. OVERSEA CIVIL SERVICE

WESTERN REGION OF NIGERIA

Entomologist required in the Medical Department to advise on and supervise mosquito control measures in towns and rural areas in the Region, and carry out surveys on distribution and epidemiological importance of other insect vectors of disease. He will be required to tour extensively and spend considerable portion of his time living under field conditions. Honours degree in natural science and specialized training and experience in entomology required Experience in mosquito control work desirable. Appointment on short term contract with gratuity payable on satisfactory completion of engagement. Salary from £870 to £1,824 (starting point determined by age and experience). Gratuity of £37 10s. for each completed three months service (including leave). Male officers receive supplementary pay of £120 a year. Quarters provided at low rental. Taxes at local rates. Annual local leave permissible; generous home leave granted after each tour of 18 to 24 months. Free return passages for officer, wife and children (up to three).

Application forms from Director of Recruitment, Colonial Office, London, S.W.1 (quoting BCD.117/410/07).

UNIVERSITY OF KHARTOUM

Applications are invited for (1) Readershi (2), Senior Lectureship or (3) Lectureship in (Inorganic Chemistry, (b) Physical Chemistr Salaries (1) £E.2,175 per annum, (2) £E.1,602 b £E.75 to £E.1977 per annum, (3) £E.1,152 b £E.75 to £E.1,677 per annum. Entry point to (according to qualifications and experience. Co of living allowance approximately £E.120 p annum. Outfit allowance £E.50. Family allow ances: wife, £E.60 per annum; first child, £E.9 per annum; second and third child, £E.30 p annum. Passages for appointee and family o appointment, termination and annual leave. Ap pointments on contract for five years with poss bility of renewal. Superannuation scheme.

Applications (eight copies), detailing qualific tions and experience and naming three referee to be received as soon as possible by Secretar Inter-University Council for Higher Educatio Overseas, 29 Woburn Square, London, W.C. from whom further particulars may be obtained.

IMPERIAL COLLEGE OF TROPICAL AGRICULTURE

TRINIDAD, B.W.I.

Principal and Director of Research: G. A. C Herklots.

DEPARTMENT OF SUGAR CHEMISTRY AN TECHNOLOGY

Applications are invited for the post of Directo of Sugar Research, under the B.W.I. Sugar Re search Scheme, which became vacant in Octob due to the resignation of Dr. L. F. Wiggin Ph.D., D.Sc., F.R.I.C. Applicants must posse a good honours degree and considerable researc experience in physical or organic chemistry or technology which would enable them to dire a team of research workers and to take part i and supervise diploma courses in sugar technolog Applications from experienced chemical engi eers would also be acceptable. The salary woul be in the Senior Principal Scientific Officer sca which with allowances range from £2,050 t £2,300. An additional payment would be con sidered for an especially well qualified candidat

Applications should be submitted by Janua 15, 1957, to the Secretary, The Imperial Colleg of Tropical Agriculture, 40 Norfolk Stree London, W.C.2, from whom further particula are obtainable.

UNIVERSITY OF LEEDS

DEPARTMENT OF GAS ENGINEERING AN GENERAL FUEL SCIENCE WITH CERAMIC

Applications are invited for two posts of Le turer or Assistant Lecturer, one in Gas Enginee ing and one in General Fuel Science, at salari on the scale £650 by £50 to £1,350 a year for Lecturer or within the range £550 to £650 a ye for an Assistant Lecturer, according to age, qua fications and experience.

Applications (three copies), stating date of birt qualifications and experience, together with t names of three referees, should reach the Reg trar, The University, Leeds, 2 (from whom furth particulars may be obtained), not later tha December 10, 1956.

CITY OF LEICESTER EDUCATIO COMMITTEE

COLLEGE OF TECHNOLOGY AND COMMERCE

Principal: R. E. Wood, M.Sc., F.Inst.P.

Applications are invited for the post of fu time teacher in Physiology in the Department Biology Applicants must possess a good degr in physiology, preferably also with experience pharmacology and must be prepared to take pa in teaching these subjects to Part 2 B.Phar standard. Salary: Burnham Scale for Grade Assistants; for a graduate in the range £725 £1,225 per annum according to qualificatio teaching, and approved industrial experience.

Forms of application, to be returned as soon possible, and further particulars may be obtain from the Registrar, College of Technology a Commerce, The Newarke, Leicester.

ELFED THOMAS,
Director of Educatio

UNIVERSITY OF BRISTOL

Applications are invited for the appointment an Assistant Lecturer in Veterinary Medicin Grade III. Salary scale £550 by £20 to £600 for special qualifications or experience £600 £25 to £650.

Further particulars may be obtained from t undersigned, with whom applications, includi the names of two referees, should be lodged n later than December 1, 1956.

H. C. BUTTERFIELD,
Registrar and Secretary

NATURE

No. 4542 SATURDAY, NOVEMBER 17, 1956 Vol. 178

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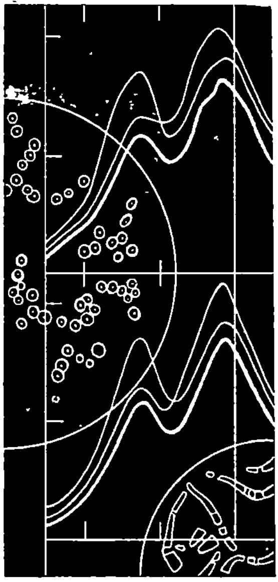

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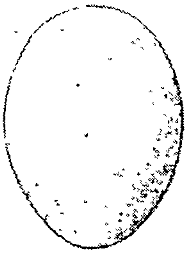

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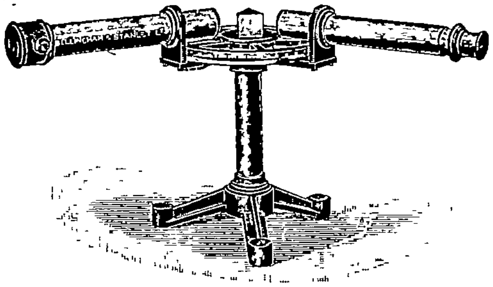

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DEVELOPMENT OF THE PEACEFUL USES OF ATOMIC ENERGY

T is not without significance that the opening by the Queen of Britain's first nuclear power station as almost coincided with the approval by a con-rence of eighty-two nations of the draft statute for e International Atomic Energy Agency and the lection of a preparatory commission of eighteen ountries with the task of bringing the Agency into eing. This preparatory commission is expected to eet, probably in Europe, early next year, and it is oped the International Agency, the headquarters of hich are to be in Vienna, will come into being by e end of 1957. The Commission will consist of ustralia, Belgium, Brazil, Britain, Canada, Czecho-ovakia, France, India, Portugal, South Africa, the S.S.R. and the United States, together with rgentina, Japan, Egypt, Peru, Indonesia and akistan, elected on October 23; and the draft atute now approved empowers the board of overnors of the Agency to send inspectors into ecipient countries to ensure that neither fissionable materials supplied to such countries nor the by-roducts of such materials are used for military urposes. The Agency is also empowered to require e recipient countries either to apply such by-roducts to peaceful purposes or re-deposit them ith the International Atomic Energy Agency.

This compromise was adopted after the United tates and India had withdrawn conflicting proposals r inspection. The former had sought to ensure that l by-products of fissionable materials furnished by e Agency should be open to complete inspection, hile the latter held that such controls were too weeping and would interfere with the internal conomy of recipient countries. In its amended rm, this controversial Article 12 is intended to revent building up of stocks of by-products for urposes not approved by the Agency, and while r Alec Randall, speaking on behalf of Australia, anada, New Zealand and South Africa as well as ritain, could with justice claim that the agreement ached on the safeguarding provisions is a happy gury for the future of the Agency, it remains to be en how far in practice the sensitive nationalism of astern countries, and especially the under-developed untries, will accept the restraints on sovereignty at are inescapable in any effective scheme of ternational co-operation.

What is most important at the moment is that e way is now open for world co-operation in the se of nuclear energy for constructive purposes on e lines first suggested by President Eisenhower in s message to the United Nations in December 1953. hen all allowance is made for the stimulus provided y the conference at Geneva in August 1955, much the credit for the success of this, the most repre-ntative international conference ever held, must be ven to its president, Señor Muniz, of Brazil, whose ilful guidance contributed largely to overcoming litical obstacles and reconciling conflicting views. ne way to co-operation is clear at the very moment hen the opening of the Calder Hall nuclear power station in Britain has given emphatic demonstration to the world that nuclear power can be generated on the scale on which electricity is normally generated.

Calder Hall is indeed something more than a milestone in the industrial history of Britain. The most impressive fact about Calder Hall is its size—the demonstration that nuclear power has arrived on a big scale and to stay. Mr. R. A. Butler, who deputized at the opening for Lord Salisbury, the Minister responsible for nuclear energy, remarked that the time when no power stations burning coal will be built is much nearer than had previously been thought. He suggested that soon after 1965 all the power stations built in Britain would be nuclear, and that by 1975 the output of electricity from nuclear power stations would exceed and might double that from all the power stations which supply our needs to-day. This means that in twenty years time, nuclear power will be doing the work of more than 40 million tons of coal a year and possibly of 80 million tons, and the theme of his short speech was in fact that nuclear energy has added a new dimension to our natural resources. The Atomic Energy Authority and all those associated with the Calder Hall venture have every right to be proud of an achievement which puts within our reach in the next twenty years something like a 50 per cent increase in the energy resources we at present derive from coal. It represents the culmination of a venture in which calculated risks were boldly and successfully taken, an effective compromise between what is scientifically desirable and what is physically possible with the methods and materials immediately available; and it has put Britain years ahead of the only other two countries yet within striking distance of making commercial amounts of power from uranium.

Sir Edwin Plowden justly remarked at the opening ceremony that we saw in it the birth of a new industry which, if we follow up our first success with vigour and determination, will assure both Britain and the world of a source of power which will be inexhaustible for generations to come. Our more pressing anxieties about the extra coal supplies which increasing productivity demands have been relieved, and while there is no early prospect of a fall in the price of electricity, there is at least a chance that its price may fall relative to the prices of other fuels and industrial materials. It is clear that nuclear generating capacity could easily approach 4 million kilowatts in 1965 and even 5 million kilowatts, or 15 per cent of Britain's generating capacity if all the fifteen stations projected were built. Mr. Butler's statement, in fact, indicates that the Government's programme for nuclear power will be accelerated, and industry has already submitted tenders for reactors of 300,000 kilowatts and could design them for 400,000 kilowatts, or double the capacity for which approval was given in July for the first two nuclear power stations for the Central Electricity Authority, at Bradwell-on-Sea and Berkeley.

It was the Queen herself, however, who emphasized the way in which this demonstration of the possibility of producing industrial power on a large scale from uranium is linked to the work of the international conference which has since met in New York. "Above all," said Her Majesty, "we have something new to offer to the people of the undeveloped and less fortunate areas of the world, who will continue to look to us for assistance and example as they have done in the past. This to me is the real importance of to-day's ceremony."

The urgent need is for some arrangement whereby the technical skill of Britain and those other nations within reasonable distance of producing nuclear power on a commercial scale can be made available to those less fortunate nations ; but it still remains to be seen how widely the new statute will be ratified by governments, and in particular how ready the smaller and undeveloped countries will be to accept the provisions of Article 12 of the statute. It cannot be forgotten that unilateral repudiation of international agreements has seriously damaged the mutual confidence in which alone technical assistance and economic aid from the more advanced to the under-developed countries are possible. The safeguards imposed by that article and the limitations on national sovereignty implied in it have become the more essential and reasonable ; yet at the same time, in many parts of the world where nuclear power offers the greatest possibilities of benefit to human welfare, the growth of nationalism has made those countries more impatient and suspicious of restraint.

The benefits of nuclear energy to mankind will be long postponed, however, unless nations are willing to pay the price and accept those limitations on national sovereignty which are a pre-condition of the co-operation that is needed. In Britain we have still to solve the problem of the right balance of scientific and technical effort between nuclear power development and those other technological developments that are necessary to enable Britain to maintain her place in the world's markets. Sir John Cockcroft last April put the number of scientists and technologists working on nuclear power development as about a thousand ; but the recent report on scientific and engineering man-power in Great Britain gives the number of scientists and engineers employed by the Atomic Energy Authority this spring at nearly 2,500 and forecasts that some 3,200 will be required by 1959—perhaps one-fifth of those already working for the Atomic Energy Commission of the United States.

These figures are not large, in view of the total of 135,000 scientists and engineers estimated as now available in Britain, or 150,000 forecast as required in 1959 ; but they could easily represent an excessive proportion of particular categories of scientists or technologists. Moreover, they do not take account of those engaged on nuclear energy projects outside the Atomic Energy Authority or of those required abroad. It is essential if Britain is to reap the full advantage of the Calder Hall achievement that she should be able to provide other countries with the skilled man-power that they will need unless they are prepared to embark on expensive development work for themselves. As Prof. E. W. Titterton emphasized in his recent book, "Facing the Atomi Future", it is expected that these new developmen will lead to Britain exporting nuclear power station on a large scale, in addition to the export trad already developed in radioactive isotopes and fu filling her traditional role as an exporter of skill. A export trade for the British nuclear energy authorit of at least £300 million by 1975 with a home trad at a similar figure is believed to be possible. Whi the technical aspects of such developments a primarily a matter for the industry itself, the Gover ment should be thinking of the possible repercussior on our economy and our balance of man-power, an of the creation of the conditions most favourable t such an export trade, whether it is to the unde developed areas or elsewhere.

There are two points to be noted here. First, has been suggested that for the present Britain ca best contribute to the development of nuclear energ elsewhere by exporting skill rather than the actu plant—either the full-scale power plant or tl 'package' reactors which are likely to be best suite to the needs of many of the under-developed area This would make smaller demands on our resourc of trained man-power, and it is also an essenti preliminary if many areas lacking indigenous fue and water-power are to operate such plants succes fully. Technical assistance is an essential factor f the full exploitation of the export possibilities, an Mr. Butler's speech at Calder Hall gave perhaps tl first hint that the Government is really alive to the possibilities. The changes in the organization of tl Oversea Civil Service respecting officers with exce tional administrative or professional qualificatio announced in the White Paper last May are a st in the right direction, but something much bold and more imaginative is also required.

The decision as to the proportion of trained ma power and resources Britain can afford to put in the development of nuclear energy may well be o of the most critical that faces the Government in tl immediate future. The establishment of the politic and economic conditions most favourable to such export trade in this field, either through technic assistance or through the new International Atom Energy Agency, is one of its most important politic tasks. The Agency, it should be remembered, is n intended to be a charitable institution, although will be necessary for some means of providing t necessary finance to be found to make possible tl building of nuclear power stations in places whe they are most needed. It cannot yet be said th the under-developed countries—which are usual also impoverished—will accept the safeguards la down in the statute creating the Agency, safeguar which while designed primarily to prevent abuse be closely also on the question of confidence which essential to attract the necessary financial assistanc

If the statement is ratified widely, the Agency m well hasten the day when the under-develop countries will gain some benefit from nuclear energ but international confidence and goodwill must fir be established. Calder Hall should remind us h great is Britain's interest in maintaining peace a in fostering international confidence; and in that respect the Government has its primary responsibility in regard to the new export trade to which we may now look, quite apart from the humanitarian aspect to which the Queen referred. Here it might well be wise for the Government to be more forthcoming in regard to co-operation with the European Atomic Agency, and the fact that agreement has been reached at New York in regard to this vexed question of supervision may perhaps stimulate a fresh effort to deal successfully with that problem in Europe. At least it appears to be more doubtful whether Britain can afford to remain outside, even if to participate fully involves accepting a degree of control over the civil and military uses of nuclear energy which infringes national sovereignty more than we would wish, and, more important, could even impede our internal development and exploitation of nuclear power, as Sir George Thomson notes, at least in respect of the Euratom proposals, in his article on Britain's drive for atomic power in *Foreign Affairs* for October. Risks have to be taken, and Calder Hall is first and foremost the vindication of a policy of calculated risks, imaginatively conceived and boldly taken. The fruits of such an achievement will be reaped in no lesser way. The first task in the present troubled world is the restoration of international confidence. This is principally a duty of statesmen and politicians, though scientists can play their part by demonstrating, as they have already done in organizing the project for the International Geophysical Year, that co-operation is still possible in certain fields of activity among the nations.

CORRESPONDENCE OF LAVOISIER

Oeuvres de Lavoisier

Correspondance. Par René Fric. Fascicule 1: 1763–1769. Pp. xviii+252. (Paris: Éditions Albin Michel, 1955.) 2,750 francs or 8.5 dollars.

THE appearance of the first part of the seventh volume of Lavoisier's collected works marks, we hope, the beginning of the last phase in the publication of the literary remains of this many-sided genius. The first four volumes, containing his contribution to hemistry and physics, appeared during 1862–66 under the editorship of Dumas; Volumes 5 and 6, ontaining his work in geology, meteorology, agriculture, economics and education, were edited by Grimaux during 1894–95; and now comes the beginning of the seventh volume, containing his correspondence between the years 1762 and 1769, ollected and edited with scholarly care by M. René Fric and published under the ægis of the Paris Academy of Sciences, helped by a grant from Unesco.

Lavoisier was born in 1743. His mother died in 748, when his father then went to live with his mother-in-law, and Lavoisier's aunt, Mlle. Punctis, devoted her life to her nephew and his sister. In 760 Lavoisier went to the Mazarin College, where he had distinguished teachers in the sciences, inluding the chemist Rouelle. His interests turned first to geology and for three years he assisted Guettard, the foremost geologist of France, in his researches In 1767 he went on a geological tour in Alsace and Lorraine with Guettard, to collect material for the first geological survey of France. The first half of this volume consists mainly of the correspondence between Lavoisier and his father and aunt during this journey, which lasted four months. They travelled on horseback with an old family servant who carried Lavoisier's barometer and scientific instruments. Lavoisier's letters give a lively description of the incidents of the journey, the progress of his work, and the scientific people they met. The letters from his father and aunt kept him in touch with the life of the family, and reveal their anxiety about the safety of the young traveller and the affectionate home-circle in which they all lived. Travel in France was not without its dangers in those days; but the journey was successful in its object, and Geikie in "The Founders of Geology" speaks of the great promise shown by Lavoisier in his early geological papers.

One of his occupations on the journey was the analysis of the mineral waters in each locality they visited; this and the analysis of minerals first turned Lavoisier's attention to chemistry. His papers were already attracting notice, and the correspondence in 1768 includes letters of congratulation on his election to the Academy at the early age of twenty-five. In the same year Lavoisier joined the Tax Farm, a step which was to have such a tragic ending. The King's Farmers General in France enjoyed the privilege of collecting the indirect taxes on salt and tobacco and certain dues by paying in advance an agreed sum to the Treasury once a year, so that the profitability of their investment depended on the skill of their administration. Lavoisier became an assistant to his future father-in-law, Paulze, and the second half of the volume consists almost entirely of Lavoisier's reports of his work in supervising the collection of the duty on tobacco in the district between Chalons and Lille. The letters describe Lavoisier's daily work and the great care he devoted to his tasks. They show, too, his firm grasp of the administrative problems involved in checking the purchases, the manufacture and the sales of tobacco. Lavoisier makes suggestions for improving the routine of inspection, he sends shrewd comments on the character and ability of the officers, and he devotes much care to the analysis of samples of tobacco to detect adulteration. It was the irony of fate that the chief crime of which he was accused during the Terror was the adulteration of tobacco by increasing its moisture content.

The letters give a revealing picture of Lavoisier as a young man just embarking on his career as a scientist and administrator, and they whet one's appetite for a sight of the next section, which will cover the period when his classic researches on combustion were beginning.

The possibility of continued publication of the remaining volumes must depend partly on the support they receive, and it is to be hoped that nothing will delay their publication. It is confidently expected that the second part of Vol. 1 will appear early in 1957. M. Fric has also traced the missing volume of Lavoisier's laboratory note-books, so that the set is now complete and ready for printing. The extracts published by Berthelot in "La Révolution Chimique" show the intense interest of these daily records of Lavoisier's work. Their publication would throw much fresh light on what was probably the most decisive event in the history of chemistry.

HAROLD HARTLEY

THE ROTHSCHILD COLLECTION OF FLEAS

An Illustrated Catalogue of the Rothschild Collection of Fleas (Siphonaptera) in the British Museum (Natural History)

By G. H. E. Hopkins and Miriam Rothschild. Vol. 2: Coptopsyllidae, Vermipsyllidae, Stephanocircidae, [Macropsyllidae], Ischnopsyllidae, Hypsophthalmidae and Xiphiopsyllidae. Pp. xi+445+32 plates. (London: British Museum (Natural History), 1956.) 6 guineas.

THE first volume of this great work, covering the Pulicoidea, was published in 1953 and a review appeared in *Nature* (173, 1203; 1954). The second volume covers seven (of fifteen) families of the Ceratophylloidea. Most of these families are small, and some may be termed obscure. With one or two exceptions, the families are not especially closely related; their treatment together is therefore largely artificial and has the undesirable feature that their closer relatives will be dealt with sporadically in the remaining volumes of the series. The authors are aware of this defect; but their grouping was dictated by practical considerations. Only three of the families treated are represented in the north temperate parts of the world; of these the Ischnopsyllidae are world-wide in distribution; the Vermipsyllidae, Nearctic and Palæarctic; and the small family Coptopsyllidae, restricted to the Mediterranean and Siberian subregions of the Old World. Xiphiopsyllidae and Hypsophthalmidae are Ethiopian, and Macropsyllidae and Stephanocircidae are Australian, the latter also being well represented in South America. The Coptopsyllidae (one genus and nine species or subspecies) are parasites of gerbilles; the Vermipsyllidae (three and twenty-nine), of ungulates and carnivores; Stephanocircidae (eight and twenty-eight), of marsupials, rodents, and perhaps shrews; Macropsyllidae (two and two), apparently of rodents; Ischnopsyllidae (fifteen and seventy-six), exclusively of bats; Hypsophthalmidae (seven and twenty-six), of rodents and insectivores; and Xiphiopsyllidae (one and four), of rodents.

The introductory sections of the book contain much material that is virtually repeated from Vol. 1. However, these sections, including the phylogenetic 'tree' and lists of genera and subgenera, have been corrected and supplemented to bring them up to date. Much of the glossary of technical terminology is repeated, too; but the definitions and illustrations apply especially to the large superfamily Ceratophylloidea, whereas the glossary of the previous volume emphasized the Pulicoidea. The key to superfamilies, families, and subfamilies of fleas is also repeated, but is provided with illustrations that greatly increase its usefulness.

The general plan of the volume is similar to that of the preceding one; superfamilies, families, subfamilies, and genera are fully defined, but species and subspecies must be determined by use of the keys and illustrations, which are, however, adequate for the purpose. Citations are given for original descriptions and important subsequent publications, and complete records of specimens in the Collection are provided. If satisfactory published illustrations were available, they have been reproduced; in other cases new figures of high quality have been prepared by F. G. A. M. Smit and Arthur Smith. The generosity of the authors and the publishers in the matter of illustrations may be appreciated when one considers that 707 drawings and 193 excellent photographs (mostly by Arthur Barron) are provided to illustrate a volume dealing with only 174 specie and subspecies.

Although primarily a catalogue of the Rothschild flea collection, the finished work will treat all describe species and therefore will virtually constitute a monograph of the fleas of the world. Typographica and other errors in the present volume appear to be few; unfortunately, reference to the Macropsyllida was omitted from the title page. The book is authoritatively written, lavishly illustrated, and beautifully printed and bound. Like its predecessor, it is a credit to the authors and the publishers.

G. P. Holland

THE HOST–PARASITE RELATIONSHIP

Parasites and Parasitism

By Prof. Thomas W. M. Cameron. Pp. xix+322. (London: Methuen and Co., Ltd.; New York: John Wiley and Sons, Inc., 1956.) 35*s*. net.

WITH the experience of more than thirty year teaching of parasitology in London, Edinburg and Quebec, Prof. Cameron has written this book which is outstanding for the new approach it make to the subject. It treats parasitism as a natura biological phenomenon and as a branch of ecolog and not from the anthropocentric or economic view point because, all too often in the past, parasitism has had its true nature obscured by a concept o disease and has been regarded subjectively rather tha objectively. It is not a substitute for texts on medica or veterinary parasitology as it deals with principle rather than with practice.

Because of the many unsuccessful attempts tha have been made to formulate an accurate definitio of a parasite, the author attempts to present a concept of the organism by considering how it feed and discusses nutrition and its evolution in an intro ductory chapter. There follows a general survey o parasites in which representative types from th bacteria, fungi, spirochaetes, protozoa, viruse rickettsias, coelenterates, helminths, annelids, arthro pods, molluscs, and vertebrates are discussed. Th is followed by a consideration of the evolution an development of the defence mechanism of the host The consequences of parasitism are then discusse The concluding chapters deal with infectious diseas the factors involved in the distribution of parasite the principles of control of parasites and parasit diseases, host specificity and the evolution of parasite There is a list of 156 selected and annotated reference and a separate list of some important catalogues an indexes. These are followed by a classification of th parasites mentioned in the text and by an adequat glossary and index. Many of the 115 diagram throughout the text are used to replace detaile morphological descriptions which, with systematic have been kept to a minimum mainly for considera tions of space. Misprints and errors are, happil scarce but the following corrections should be noted *Fasciola* metacercaria excysts in the alimentary tra (p. 89), *Polystoma* (p. 98), *Caryophyllaeus* (p. 105 pine-weevil (p. 137) and *Braula* (p. 180).

Prof. Cameron suggests that, to read and unde stand his book, a working knowledge of biology i general is a pre-requisite but not necessarily a knowledge of parasitology. Be that as it may, the reader who already knows something about parasites will get fuller enjoyment from reading this interesting and absorbing account, written in the author's inimitable style, of the various host–parasite relationships. Some parasitologists may not agree with all the author's points of view and may have doubts, misgivings and reservations, which would meet with Prof. Cameron's approval and sympathy, for no one knows better than me how one's personal views depend largely not only upon one's idea of what constitutes parasitism, but also upon one's approach to, and interpretation of, any given 'facts' about parasitic life. J. N. OLDHAM

IONIZED GAS IN PHYSICS AND IN ASTRONOMY

Physics of Fully Ionized Gases

By Lyman Spitzer, Jr. (Interscience Tracts on Physics and Astronomy, No. 3.) Pp. ix+105. (New York: nterscience Publishers, Inc.; London: Interscience Publishers, Ltd., 1956.) Paper, 1.75 dollars; hard cover, 3.50 dollars.

THIS slender volume, the third of a series of "Interscience Tracts on Physics and Astronomy", contains a comprehensive and accurate introduction to the study of physical phenomena exhibited by fully onized gases. Both in electronics and astrophysics the nterest in different manifestations of ionized gases has of late been growing; and its urgency has been nhanced by the fact that the behaviour of such gases s likely to be quite different from that of neutral gas of the ordinary kinetic theory. In point of fact, in certain respects it is likely to be simpler; for most quantum-mechanical effects (except, perhaps, for nteraction with the radiation field) can legitimately be ignored; and, likewise, the encounters between harged particles in ionized gas become simplified owing to the long-range character of the inverse-square forces involved. Although the basic physical principles are thus simpler than in an ordinary gas, the actual motions of gas particles become more complicated; for the ordinary hydrodynamical equations governing their motion must be coupled with Maxwell's equations. In the presence of a magnetic field this coupling gives rise to a whole class of novel phenomena (hydromagnetics); and even in the absence of such fields the electrical properties of onized gas admit of motions which have no parallel n neutral gases.

To which of the two fields of science—physics or astronomy—should the present tract be considered to belong? Its subject has, in recent years, become quite *à la mode* among some astrophysicists, who are apt to regard the more thoroughly studied branches of their cience as 'worked out', and to whom the vistas opening with the combination of hydrodynamical and Maxwell's equations seem to offer an unlimited ground for practising their physical insight or manipulative skill. Yet the fact remains (which is perhaps not made sufficiently clear by the author of the present book) that the connexion between theories of fully onized gases and their experimental verification emains still quite tenuous—both in the laboratory (plasma oscillations) and in the study of certain celestial phenomena (sunspots, or magnetic variable stars being the most conspicuous cosmic examples necessitating hydromagnetic treatment for their understanding). Although some observational data are available on certain aspects of these subjects, their discussion has been entirely excluded from the volume under review, and its contents restricted to those topics which may serve for a theoretical understanding of the subject. This deliberate policy may have helped to keep the size of the book within its modest limits; and a restriction to fundamentals will no doubt extend its useful lifetime.

However, the fact that the gap between theoretical foundations and their possible application to practical cases has been left so wide is probably the most serious criticism of the book which can be raised. Some readers may feel that the book does not bring, at times, its subject sufficiently 'down to earth', and its readability leaves occasionally something to be desired; but its accuracy and reliability as a source of theoretical information should be nowhere in doubt. Like its two predecessors already published in the series of these Interscience Tracts, this present book should thus be viewed primarily as a contribution to physical, rather than astronomical, literature. It should, however, be of interest, not only to research students, to whom it is primarily addressed, but also to all physicists and astronomers interested in a gradual merger of two great physical theories—hydrodynamics and electromagnetism—into a single edifice.

ZDENĚK KOPAL

THE TRANSITION FROM CLASSICAL TO MODERN PHYSICS

Modern Physics

By Prof. John C. Slater. Pp. xi+322. (London: McGraw-Hill Publishing Company, Ltd., 1955.) 39*s*. 6*d*.

THIS book describes the development of theoretical physics during the past sixty years. An introductory chapter on the atom in nineteenth-century physics prepares the ground for a chapter on electron theory and relativity and another one on the beginning of quantum theory. The next five chapters are concerned with the development of the Rutherford–Bohr atom in the period 1912–26. Up to this stage Prof. J. C. Slater uses only elementary mathematics (easy algebra and occasionally calculus). When he comes to deal with the wave-mechanics and its applications, partial differential equations and solutions in terms of Legendre polynomials are used, though he still avoids matrix multiplication and general ideas of operators. The final chapter, on nuclear physics and fundamental particles, is almost entirely non-mathematical and is perhaps the most clearly expressed in the whole book. Rather little space (about ten pages) is devoted to the special theory of relativity. The general theory of relativity and modern field theory are not included. The numerous examples given at the ends of the chapters (with solutions at the end of the book) are of a kind very useful to the student of average ability.

The author says, in the preface, that he wished to write a book which would be suitable not only for the professional physicist but also for "students of history, of human thought and of general culture". He therefore restricted the mathematics "to a rather low level"—which is in fact an impossibly high level for most students of history and general culture. I cannot share the author's belief that the general reader can skip the mathematics and still apprehend the main ideas when so many of the ideas are expressed in mathematical equations. I propose, therefore, to consider the usefulness of this book to physicists and other readers who have some mathematical ability and training.

The teacher of advanced physics to-day never has enough time to deal with all the topics which he feels are important. It is necessary to omit something to make room for new discoveries, and often it is easiest to sacrifice an account of the way in which ideas have developed. The wave-mechanics is presented to the student as a logically complete system—with only a passing reference to earlier theories of atomic physics. Many of the younger university lecturers in physics have been taught in this way, and the sense of continuity with the nineteenth century is lost. Prof. Slater's book is designed to fill this gap, to show how the failures as well as the successes of earlier theories prepared the way for wave-mechanics. His final chapter reveals wave-mechanics apparently completely successful in the world of atoms, molecules and solids and struggling to prepare the way for its successor by its own successes and failures in the world of nuclei and of unstable particles.

The average student for a first degree can with difficulty assimilate the vast meal which is placed before him. It would not be fair to ask him to add this book to his reading list, though an exceptionally good student of this standing might do so. To a graduate who is beginning research or teaching in physics, this book should be very easy reading. It offers him an opportunity to survey his degree course from a new point of view and to learn why and how physical theory has grown into its present form. Those who are old enough to have followed this growth may also be interested to read this systematic account of an exciting period in the history of physical science. R. W. DITCHBURN

WOOD STRUCTURE

The Structure of Wood

By Prof. F. W. Jane. Pp. vii+427. (London: Adam and Charles Black, Ltd., 1956.) 60*s.* net.

ALTHOUGH the average university student of botany devotes no more than a small fraction of his time to the anatomy of the angiosperms and gymnosperms, there has, in recent years, been an increased interest in the study of wood structure. This is because it is being realized more and more that the accurate identification of timbers is impossible without a knowledge of their microscopical structure. For many years the rule-of-thumb methods by which timber merchants were able to recognize the comparatively small number of woods which they normally had to handle, proved adequate for their needs, although mistakes were undoubtedly made. Nowadays, however, with more and more timbers coming into use, especially from parts of the world which were not formerly thought of as timber-producing areas, the task of identification is becoming more difficult. Then again, as Prof. Jane points out in the book under review, although it is still possible to recognize many of the common hardwoods with the aid of a hand lens and a sharp knife, the precise identification of softwoods is well-nigh impossible without resort to the compound microscope. Furthermore, it is impossible to understand the physical and working properties of timber without a knowledge of their structure, while for th study of the molecular structure of the cell walls th electron microscope is now playing its part. For al these reasons there should be a big demand for reliable modern text-book of wood structure such a this one which Prof. Jane has now produced.

The book is written in such a way that it can b used not only by those with an advanced knowledg of plant anatomy, but also by intelligent readers wh can use a microscope and want to learn how to identify timbers, and to know something of the relationships between their properties and structure. It mus have been a difficult problem for the author to decid precisely what aspects of such a wide subject h should deal with in a book of just over four hundre pages; but to the reviewer he appears to have mad a wide and balanced choice of topics. The approac is along traditional lines, for the various types of cell and tissues of which wood is composed are fir described, and it is shown how these are differentiate from the cells of the apical meristem and the cambium and organized in the mature wood. Not only is th structure of ordinary softwoods and hardwood described, but also some attention is devoted t trees and lianes that increase in girth by method which are often thought of as being anomalous, an to the structure of woody monocotyledons, cycad and tree ferns. The chemical nature and sub microscopical structure of wood are considered in chapter written in collaboration with Dr. K. Wilson The last six chapters are concerned with the identification of timbers, not only in a general way; but it also shown, for example, how the various timber that pass in the trade under the names of teak mahogany and walnut may be recognized. Th author also discusses the difficult problem of distinguishing between timbers from closely relate species of a single genus, with special reference t oaks, ashes, elms and maples. The book ends wit an appendix on technique, followed by a selecte bibliography and an index.

The numerous excellent photomicrographs, prepared with the help of Mr. R. Brinsden, add considerably to the value of the book. The autho however, stresses the limitations of photomicrograph as a means of portraying the structure of wood, an rightly emphasizes how line drawings can direc attention to certain diagnostic characters mo effectively. The numerous ingenious diagrams in th text serve to confirm this point of view.

Prof. Jane has provided us with a welcome additio to the literature of wood technology and he ha performed his task very effectively. In readin through the text, however, one cannot fail to no some minor blemishes. For example, it is rath startling to read on p. 32 that a vessel is a conductin "element", and to find on p. 106 the obsolete ter vessel "segment" still in use, while in the last lin on p. 156 there is an incorrect figure reference. would also have been helpful to readers if the rath solid masses of text could have been broken up mo frequently with additional headings and subheading Small defects such as these will, however, no doub be corrected in future editions. It is to be hoped th the book will be used not only by students of woo technology, but also that it may serve to remind students of botany that a good understanding of pla structure lies at the very heart, and not, as so man are apt to believe, at the fringe of their subject.

C. R. METCALFE

ROCK MAGNETISM

At a meeting of Section A of the British Association on September 4, Prof. P. M. S. Blackett opened a discussion on "Rock Magnetism" by giving a brief account of the history and the present state of the subject. He pointed out that although it has been known for the past hundred years that certain rocks, when formed, acquire a weak but definite magnetism in the direction of the Earth's field, it is only recently that this fact has been used for deducing two types of information of the highest scientific importance: first, to trace back for many millions of years the history of the direction and intensity of the geomagnetic field; and secondly, to attempt to settle the old and acute controversy as to whether the continents have always occupied the same positions relative to one another and to the geographical poles.

Discussing the first of these two aspects of palæomagnetism, Prof. Blackett said that his interest in the subject was originally aroused by the work of Johnson, Murphy and Torreson[1] in the United States, who, in 1948, examined the remanent magnetization of a series of varved clays of New England. These clays were laid down in stream beds, and contain small quantities of detrital magnetic material in the form of fine grains, which were oriented along the Earth's magnetic field at the time of deposition. By measuring changes in the direction and intensity of magnetization with depth, over a continuous vertical sequence, it was possible to trace the history of the geomagnetic field over a period extending back to 15,000 B.C. The results showed that during the whole of this time it has undergone regular variations in direction about geographic north. More recent nvestigations have confirmed this view, and it now appears that for at least several million years the main Earth's field has corresponded on the average to that which would be produced by an axial magnetic dipole situated at the centre of the Earth; but that there has been a continuous secular variation about the mean direction, with a time period of 500–1,000 years.

Of the greatest importance was the discovery by Brunhes[2] in 1906 that certain lavas from the Massif Central mountain system in France are magnetized n a direction opposite to that of the Earth's field. Many other examples of reverse magnetization in Tertiary igneous rocks have since been discovered, notably by Bruckshaw and Robertson[3] in Britain, by Roche[4] in France, and by Hospers[5] in Iceland, and more recently by Campbell and Runcorn (unpublished work) in America. All these workers found that while approximately half the rocks sampled had an average palæomagnetic direction corresponding losely to that of an axial dipole, the remaining half were magnetized in the opposite direction. Roche and Hospers, in particular, considered that their findings could be most plausibly interpreted on the assumption that the Earth's main field has reversed periodically during Tertiary and recent times. They suggested that these reversals must have occurred rather suddenly at intervals of the order of a million ears, and that the field intensity in both the opposite irections has been the same. This result, if true, is of extreme importance, and must dominate all future theoretical thinking on the origin of the Earth's magnetism. Many geophysicists, however, regard the hypothesis of the Earth's field reversal with reserve, and Néel[6] has put forward theoretical arguments to show that there are four possible physical mechanisms whereby a rock, in cooling from above its Curie temperature, can acquire a thermo-remanent magnetization in a direction opposite to that of the applied field. The first two of these mechanisms depend on the properties of ferrimagnetic materials, in which the magnetism is associated with two distinct categories of electron, the spins of which are aligned in antiparallel directions. Gorter[7] has recently succeeded in synthesizing a ferrimagnetic material which exhibits magnetic self-reversal in the laboratory, and there is no reason for supposing that such a material may not have been produced naturally in certain rocks. The third and fourth of Néel's mechanisms are based on the supposition that the rock contains two distinct magnetic components with different Curie points, which exist as an intimate mixture of fine grains. When such a rock cools, it is possible in certain circumstances for one component to become magnetized in the reverse field of the other, and for the final direction of magnetization to be opposite to that of the externally applied field. One example of a naturally occurring rock, which exhibits a self-reversing property of this kind in the laboratory, has been found by Nagata[8]. On the other hand, the great majority of reversely magnetized rocks do not exhibit any self-reversing property when tested in the laboratory.

Considering the whole of the evidence at present available, Prof. Blackett thought that while it is very probable that the Earth's field has reversed periodically in the past, this must not be taken as being finally proved.

Turning to the geological aspects of palæomagnetism, Prof. Blackett said that it was realized at least thirty years ago that, by the study of magnetism of rocks, it should be possible to discover whether there has been any relative movement between the continents during past geological ages, as suggested by Wegener[9], du Toit[10] and others. For, by measuring the present direction of magnetization of a system of rocks, it is possible to deduce both the latitude and the orientation relative to the Earth's rotational axis at the time when it was laid down.

The first palæomagnetic evidence of past continental land movement was obtained in 1954 by Clegg, Almond and Stubbs[11], who found rocks of the New Red Sandstone system, over a wide area of England, to be consistently magnetized along a north-east to south-west axis with magnetic dips considerably shallower than that of the present Earth's field. This suggests that England has moved northwards from a position near the equator, and has rotated in a clockwise sense relative to the poles, at some time since the rocks were formed about 150 million years ago. During the past two years, there have been many more startling results from various parts of the world. It now looks as though the land masses of the northern hemisphere have moved collectively some 40° northward from the equator, while both India and South Africa appear to have been much nearer to the South Pole several hundred million years ago.

These substantial changes in latitude may have been attended by a relative drift between the continents as required by the continental drift hypothesis, or they may represent a movement of the crust as a rigid whole across the poles—often called polar wandering. At present it seems as though relative drift has occurred, but the experimental observations are very incomplete. It should be possible, by piecing together evidence from rocks of all ages and lands, to resolve this question during the next few years.

Dr. A. E. M. Nairn gave an account of the work carried out by members of the group working for the past five years under Prof. S. K. Runcorn, first at Cambridge and later at King's College, Newcastle upon Tyne. Rocks have been collected from almost every geological formation in Great Britain, and from many formations in North America, Europe and South Africa.

Speaking of the evidence for polar wandering and continental drift, Dr. Nairn said that the results of palæomagnetic measurements on rocks of a particular locality and geological period are best expressed in terms of the pole position, which is calculated on the assumption that the direction of magnetization corresponds on the average to that of the axial dipole field at the time of deposition. The pole position obtained in this way represents the mean of many measurements, and its reliability can be expressed in terms of a 'circle of confidence', which is a statistical measure of the dispersion of the results. For a particular rock formation, the dispersion depends on the origin and geological history of the rocks, and it has been found to be least for red sandstones and basic extrusive rocks, so that on the whole the work has tended to be concentrated on these lithological types. Since red sandstones and basic extrusions are rare in the Jurassic, Cretaceous and Ordovician systems, in the northern hemisphere, these periods have not been so well studied as others. From extensive observations accumulated from palæomagnetic measurements in Britain, dating back to the Precambrian, Creer[12] assembled the pole positions in chronological order, and plotted them on a polar projection. He showed that the points can be joined into a continuous curve. Later, Runcorn[13] was able to produce a similar curve based on his and Du Bois's results from North America, which, although similar in form, showed a systematic displacement, the pole positions as calculated from the American measurements lying consistently to the west of the British. Further work has tended to confirm the existence of this discrepancy between the two curves, and there is now strong evidence for the supposition that the American continent has drifted about 2,000 miles westward relative to Europe. This drift seems to have occurred since the late Triassic period, and to have been completed before the end of the Miocene. The extension of the work to continents other than Europe and North America is generally handicapped by the imperfectly known geology; but a series of samples have been obtained from Kenya, Bechuanaland and Rhodesia. These all belong to the Karroo system, which extends in time from the Upper Carboniferous to the Lower Jurassic. The collection of reliable material from surface exposures in this part of the world is rendered difficult by the very deep weathering that has occurred, and the only satisfactory result available so far has been obtained from the Lower Jurassic basalts of the Victoria Falls area. The measurements made on these rocks suggest that the African continent has moved some 2,000 miles with respect to the poles since they were laid down.

The value of an independent check on this palæomagnetic evidence for past continental land movements is obvious, and there are, in the geological record, a number of phenomena such as the occurrence of coal facies, desert sands and red beds, salt deposits, ice ages and tree rings, which depend on climatic conditions, and which can be used for this purpose. The most reliable palæoclimatic data available at present are those obtained from fossil wind directions, which can be found by examination of dune bedding in ancient deserts; for, since the directions of the trade winds are controlled by the Earth's rotation, it is unlikely that their directions could have changed radically during the Earth's history. The subject of fossil winds is being studied at present by N. D. Opdyke at Newcastle upon Tyne and by workers in the United States, and preliminary results for a number of geological periods appear to confirm the pole positions traced for the same epochs from rock magnetic measurements. However, all palæoclimatological evidence does not support the palæomagnetic findings. One particular problem still unsolved concerns the palæomagnetic pole position during the Permo-Carboniferous period, which is situated in China, where, according to palæobotanical evidence, warm conditions prevailed at that time.

Discussing the question of reversals of the Earth's field, Dr. Nairn considered the best evidence of past reversals to be found in the work of Hospers[5], mentioned previously, and that of Irving[14] on the Torridonian sandstones of Scotland.

Dr. J. A. Clegg described palæomagnetic research carried out at the Imperial College of Science and Technology in London, and elsewhere. Discussing the subject of continental drift, he first compared the original measurements made by Clegg, Almond and Stubbs[11] on the British Triassic sandstones, which had been described earlier by Prof. Blackett, with more recent results obtained by Graham[15] fo similar Permian and Triassic sandstones in th western United States. The mean directions of magnetization of the British and American rocks correspond respectively to pole positions 155° E., 48° N., and 106° E., 34° N., both lying in eastern Asia. It appears, therefore, that there has been a considerabl change in the positions of both these land area relative to the Earth's rotational axis since Triassi times. The two positions lie approximately 20 apart, and this suggests that there may also hav been a relative movement between Britain and Nort America; but the dispersion of the results and th uncertainties in dating are such that there is grav doubt as to the significance of this discrepancy After mentioning measurements by Gough[16] on th Pilansberg dyke system of Africa, which indicat that South Africa probably occupied a position o the other side of the south pole some 250 millio years ago, Dr. Clegg went on to describe some mor recent work being carried out at present by th Imperial College group on lavas of the Deccan Tra system of India[17]. These latter rocks are found t have consistent directions of magnetization corr sponding to a position of the north geographic pole close to Florida (85° W., 28° N.), which impli that at the time when they were laid down, som 70–100 million years ago, the Indian subcontinen must have been situated considerably to the sout of the equator. This result is supported by palæoclimatic evidence, for it is well known that during the Permo-Carboniferous period there was heavy glaciation in India, and that the ice was flowing northward.

The Imperial College group has also made palæomagnetic measurements, in collaboration with Prof. J. C. Jaeger at Canberra, on certain Tasmanian Jurassic–Cretaceous dolerites, 100–120 million years old, together with overlying Tertiary basalts. The samples were taken from unoriented diamond-drill cores, so that it was not possible to measure the azimuthal direction of magnetization. However, the magnetic dips proved to be much steeper than that of the present dipole field in Tasmania, the mean directions of magnetization of the dolerites and basalts lying respectively within 5° and 7° of the vertical. This means that some 100 million years ago Tasmania was within 10° of the south pole, and that its latitude remained substantially unchanged at least until early Tertiary times. It is interesting to compare this result with that previously quoted for the Indian rocks of similar age. For, expressed in terms of pole position, it places the north pole close to a point antipodal to Tasmania in the western North Atlantic, at least 2,500 miles from the position obtained for the Deccan Trap measurements. This seems to supply good presumptive evidence of a relative movement between Tasmania and India.

Finally, Dr. Clegg described two experiments carried out on reversely magnetized rocks. The first was concerned with a volcanic tuff from Tasmania, obtained from the same borings as the basalts and the dolerites mentioned previously, but from a greater depth. A single five-foot length of core was examined, and was found to be magnetized, like the overlying dolerite, in an almost vertical direction; but whereas over the major part of its length the magnetic dip was in a normal (upwards) sense, over a single five-inch portion the polarization was reversed. The reversed and normal portions appear to be identical in all respects, and so far no satisfactory explanation of the phenomenon has been found. The result does, however, serve to emphasize the complexity of the problem of interpreting magnetic reversals. The second experiment was carried out by J. H. Leng on three Tertiary dykes from Arran. Two of these dykes, together with the baked sediments in contact with them, were uniformly magnetized in directions close to that of the present Earth's field; but in the third case, both the dyke rocks and the contact sediments had acquired a thermo-remanent magnetization in the reverse direction. Since the magnetic minerals present in the igneous intrusion are very different from those in the surrounding country rocks, it seems unlikely that this reversal of both dyke and contact sediments can be due to a Néel effect. Experiments of this type would appear to provide strong evidence for the hypothesis of the reversal of the Earth's field.

All the speakers emphasized at the meeting their belief that while information of great importance has already been obtained from palæomagnetic studies, the present conclusions must be regarded as purely tentative, and will be subject to continuous modification as the work develops.

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THE CHEMICAL RESEARCH LABORATORY

THE annual open days of the Chemical Research Laboratory (Department of Scientific and Industrial Research) were held during October 2–5. Some of the exhibits by the six main research groups are described in the following paragraphs.

One laboratory has been reconstructed to house the larger apparatus used in corrosion research. A preparation room is equipped for the surface preparation of specimens, maintenance of testing equipment, and water treatment. A constant-temperature room, of brick and glass-brick construction with double glazing on the windows, is provided with humidity control. Four model boilers, each with six electrically heated tubes giving a heat-transfer rate of 7,000 B.Th.U./59 sq. ft. of tube surface per hour, are used in an investigation on behalf of the British Shipbuilding Research Association. A circulation apparatus for studying corrosion and its prevention in flowing water was in operation. The test solution is pumped from a tank into a header tank and runs back into the lower tank through the test specimens, which are in the form of mild-steel tubes. Non-corrodible stoneware pumps and glass tanks are used, so that the only metal in the circuit is the material under test.

Goods are often protected during storage and transit by enclosure in impervious wrappings. Although such wrappings prevent the entry of corrosive agents from outside, they may aggravate corrosion of the metallic contents by accumulation of relatively reactive compounds evolved from non-metallic components. At the Laboratory, corrosion in radio receivers has been traced to vapours evolved from synthetic resins and glues. Exploratory studies are being made of the corrosive effect of some likely contaminants in conditions simulating those of an undesiccated package.

The Inorganic Group provided an interesting exhibit on the use of zone-refining for the purification of some of the metals which are of interest as semi-conductors, such as bismuth, indium, tellurium and tin. Etched specimens of bismuth and tin, before and after treatment, provided a striking visible demonstration of the effect of zone-refining. Special studies have been carried out using selected impurities in the form of radioactive tracers. This method not only overcomes the analytical difficulties attendant on such work, but also, with a tracer of relatively long half-life, it enables numerous experiments to be carried out on the same ingot. The use of a cathode-ray polarograph in aiding the analytical side of the research was demonstrated, while the other analytical facilities of the Group—well-equipped spectrographic and microchemical laboratories—also attracted attention. Separation of the rare earths by ion-exchange processes and demonstrations, on the laboratory scale, of separations using the Spedding and the Loriers methods were exhibited. Large ion-exchange columns, and ancillary equipment required for processing kilogram quantities of mixed earths, were in operation. A collection of ores containing the rare earths was on view.

Exhibits in the Radiochemical Laboratory included a small pilot plant for the treatment of uranium-bearing ores. This consists of leaching, continuous filtration and clarification units by which a sulphate liquor containing the uranium dissolved from an ore can be obtained. A further unit enables the uranium to be recovered by adsorption on columns of ion-exchange resin, and finally by precipitation as a concentrate from an eluting solution. The leaching unit was being used for illustrating the possibility of leaching uranium from certain types of ores by adding sulphuric acid in such a manner as to maintain a low but constant acid concentration. A new type of resin-in-pulp apparatus was also on view. This enables uranium to be recovered from a suspension of finely ground ore in dilute acid without the necessity for filtration. It employs a series of semi-continuous belts consisting of sheets of ion-exchange membranes which move counter-currently through the flowing suspension. Part of the work being carried out on the extraction of thorium from minerals was illustrated by the demonstration of a process for obtaining thorium from monazite in which monazite is initially attacked and broken up by reaction with a strong boiling solution of sodium hydroxide. After filtration, sodium phosphate can be removed from the filtrate and thorium from the residue by differential solution with hydrochloric acid. Examples of further advances in the use of modified celluloses for the chromatographic separation of inorganic mixtures were illustrated by exhibits of promising separations of mixtures of the rare earths obtained on sheets of carboxymethyl cellulose.

A colourful exhibit by the Organic Group was the application of a new series of compounds to certain analytical problems. These coloured complexes contain as a common characteristic the pentacyanoferrate radical co-ordinated with an organic molecule. Some, owing to their intense colour, are particularly useful as spray reagents for the qualitative and quantitative detection of inorganic cations in paper chromatography. Thus trisodium pentacyano-*p*-hydroxyanilino ferrate yields blue precipitates insoluble in dilute acetic acid with many cations, and as little as 1 μgm. of the following can be detected: Cu^{2+}, Zn^{2+}, Cd^{2+}, Zr^{4+}, Mn^{2+}, Fe^{3+}, Co^{2+} and Ni^{2+}. Another reagent, prepared by the reaction of trisodium pentacyanoammino-ferrate and rubeanic acid, is especially useful in that it produces distinctive colours with different cations.

The stability of some of these complexes is so influenced by steric and constitutional factors that they can be adapted to the analysis by colorimetric methods of mixtures of certain closely-related organic compounds. Trisodium pentacyanoammino-ferrate develops a red colour with *iso*nicotinic acid, but not with its common congeners, nicotinic and dipicolinic acids, and thus provides a method for determining the purity of *iso*nicotinic acid, which is a substance with important chemotherapeutic applications. Another example shown was the estimation of the proportion of quinoline and *iso*quinoline in a mixture of these bases.

In recent years the use of water triple-point cells for setting up a thermometric fixed point has been well established. An obviously desirable extension of technique would be to use a triple-point cell containing carbon dioxide as a reference point in measurements below 0° C. Such a cell has been constructed in metal and, while strong enough to withstand storage and transport at ordinary temperatures, it enables the triple point of carbon dioxide, $-56 \cdot 60°$ C., to be reproduced to $\pm 0 \cdot 002$ deg. This cell can be obtained on loan by other workers.

Two other notable exhibits shown by the Organic Group dealt respectively with the preparation and use of finely-divided dispersions of sodium, and the convenience of oxazolidone-2 as a source of ethylene-imine for polymerization and other reactions.

The Microbiology Group illustrated various activities of sulphate-reducing bacteria: their function in the natural production of elemental sulphur in Cyrenaican lakes, the contamination of aviation fuels in storage tanks, and their use in a process for producing sulphur from indigenous raw materials. One exhibit, loaned by Rolls-Royce, Ltd., showed how the grounding of both piston-driven and jet aircraft through failure of their fuelling system, was traced to petrol or kerosene stored over water which became grossly infected with sulphate-reducing bacteria. The hydrogen sulphide produced by these organisms percolated through the fuel, forming sulphur compounds which caused heavy corrosion of fuel pumps in the aircraft, sometimes after as little as four hours flying time. To prevent future trouble, the use of water bottoms in fuel storage tanks should be avoided. Where this is not possible, a bacterial inhibitor such as chromate should be added to the water. Another exhibit illustrated pilot-plant (50 gallons) trials, carried out at the L.C.C. Northern Outfall Sewage Works, Beckton, of a process devised at the Chemical Research Laboratory for the production of hydrogen sulphide from sewage sludge enriched with calcium sulphate. Results equal to those from laboratory experiments have been obtained, and trials on a much larger scale are contemplated. The National Collection of Industrial Bacteria used illuminated panels for showing pigment production, methods of counting and cultural characteristics of micro-organisms. The Collection distributed more than 1,500 cultures last year.

Work in progress on the fractionation of polymers and on the preparation and properties of ion-exchange membranes was shown in the High Polymers Group. The mechanical and physical properties of many industrially important polymers are dependent on molecular weight; two promising new techniques for determining molecular weight distributions were exhibited. One method consists of fractionating polymers in solution by causing the heterodisperse polymer to diffuse across membranes of varied selectivity. Advantages of this procedure are that the polymer is in true solution throughout the fractionation, and relatively large amounts of material can be treated in apparatus which is much more compact than that used in techniques employing fractional precipitation or dissolution. The other method, primarily of value for low-molecular weight polymers, is a development of the technique of paper-strip chromatography to provide a rapid semi-micro procedure for determining molecular-weight distributions.

Much interest is now being shown in the possible large-scale application of multicompartment electrodialysis cells to the demineralization of brackish water, and to treatment of industrial effluents. The efficient operation of such cells is markedly dependent on the properties of the ion-exchange membranes used, and extensive studies of the preparation and properties of ion-exchange films are in progress at the Laboratory. One exhibit showed the results of a systematic study of membranes prepared by incorporating finely divided ion-exchange resins of different degrees of cross-linkage into an inert polymeric binder.

POMOLOGICAL RESEARCH IN POLAND

By L. C. LUCKWILL

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ON May 23 the new buildings of the Polish Research Institute of Pomology at Skierniewice, about forty miles south-west of Warsaw, were officially opened by the Polish Vice-Minister of Agriculture, Mr. Szajer. This event, which marks the beginning of a new era of pomological research in Eastern Europe, was the occasion for a conference attended by Polish research workers and by twenty-four foreign delegates representing thirteen different European countries.

The Research Institute of Pomology was founded in 1951 as part of the post-war plan to co-ordinate pomological research in Poland, which previously had been conducted at many different centres controlled either by the State Agriculture Institute at Puławy or by the agricultural colleges at Warsaw, Lublin, Poznan, Kraków and Wrocław. The Institute is housed in a large three-storied building which, in addition to modern laboratory and library facilities, contains a large conference room, canteen and com-

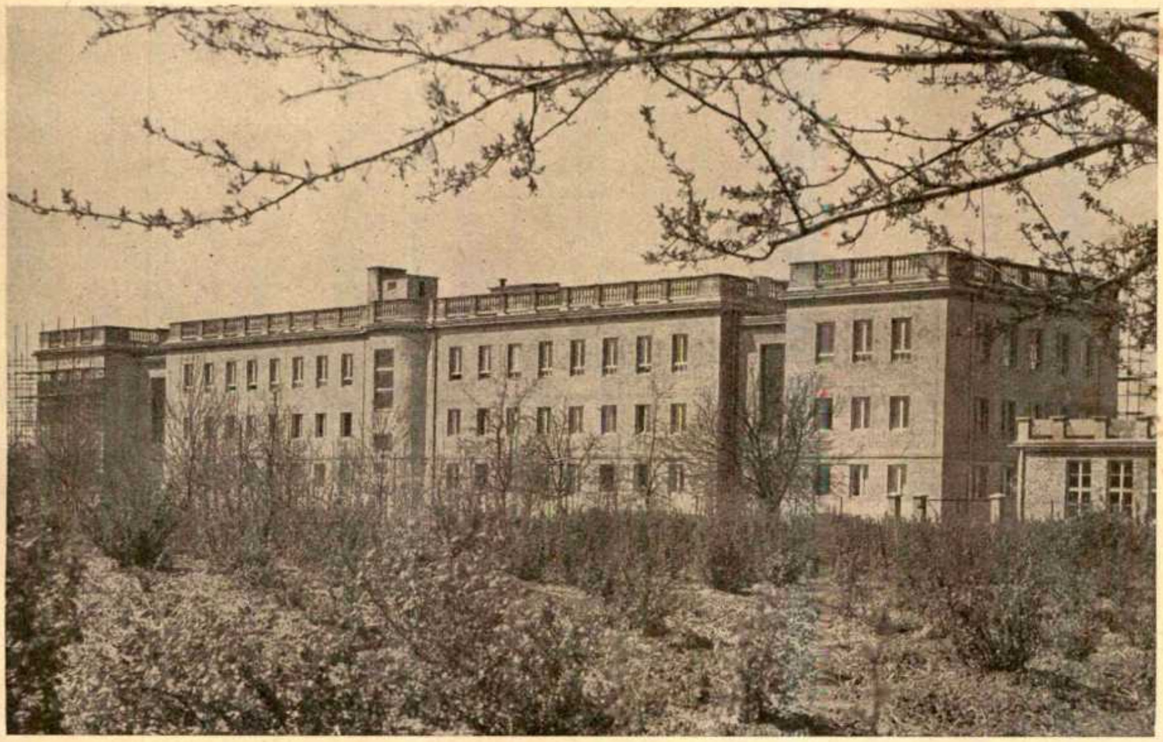

Fig. 1. Institute of Pomology, Skierniewice, Poland

mon rooms for the staff, living accommodation for visiting workers and a permanent exhibition room containing demonstrations for visiting fruit-growers. Adjacent to the Institute are a number of apartment houses for the staff, and future plans envisage the addition of an extensive block of experimental glass-houses and cold stores. On one side of the building lies the large experimental orchard of the Warsaw College of Agriculture containing demonstration experiments and an important collection of 1,800 species and varieties of cultivated fruits.

Most of the field experiments of the Institute are carried out at field stations situated in the different fruit-growing regions of the country. In all there are eleven such field stations, varying in size from 140 to 1,440 acres, each under the control of a director and small scientific staff, working in close co-operation with the staff of the Institute. The total area available for such field experiments is about 5,800 acres, of which a considerable proportion is at present devoted to extensive variety trials of tree fruits, currants, gooseberries and strawberries. The chief object of these trials is to find high-yielding varieties of good quality that are capable of surviving the extreme cold of the Polish winter. The trials themselves are well laid out and are randomized and replicated to an extent sufficient to satisfy the most fastidious statistician. In addition to these field stations the Institute has also planted many experimental and demonstration orchards on the State farms, and a few on peasants' holdings.

The creation of the Research Institute is due largely to the enterprise and initiative of the present director, Prof. S. A. Pieniążek, who returned to Poland from the United States in 1946. One of his chief difficulties throughout has been the acute shortage of trained scientific workers. At the end of the Second World War there were only four persons with Ph.D. degrees working in pomology in Poland: to-day the number has risen to about twenty, but most of the ninety-nine members of the scientific staff of the Institute are recent graduates with relatively little research experience. A few have received training in Moscow, and almost all have the ambition to work for a time in England in order to broaden their experience or to acquire specialist techniques.

The work of the Research Institute is divided into twelve departments designed to cover most of the problems of importance for fruit growing, such as soil cultivation, fruit breeding, mechanization, plant protection, and fruit technology. Winter killing is undoubtedly the most serious problem confronting fruit growers in Poland, and much research effort is devoted to the study of this problem, particularly to methods of increasing winter hardiness of trees and the selection of cold-resistant varieties. The importance of this problem is shown by the violent fluctuations of the fruit tree population during recent years. It is estimated that in 1939 there were about fifty million fruit trees in Poland. More than half of these were destroyed by cold in the winter of 1939–40, and by the end of the War the population had further decreased to twenty-two million. Extensive post-war plantings, which are still continuing, had raised the number to approximately thirty-five million in 1955; but a further severe winter during 1955–56 again wrought great havoc, particularly among pears and plums, in the orchards of central Poland.

In the Soviet Union, pomological science, under the influence of Michurin, has developed along lines different from those pursued in Western Europe and Scandinavia, and many concepts basic to Russian pomological work (for example, graft hybridization; the 'mentor' theory) are regarded with scepticism by pomologists in other countries, including, incidentally, many in Poland. Soviet pomologists, on the other hand, are equally sceptical of much Western work, particularly that relating to virus diseases in fruit crops and the application of statistical methods to field experiments. Poland, open to cultural influences from both East and West, is bound to neither school of thought, and the present policy of pomological research is to make use of those ideas and techniques that seem most appropriate to the problems in hand, irrespective of their origins. Here, indeed, in a limited field of endeavour, we have a true hybrid between Eastern and Western scientific thought which, though yet young, already manifests the marked vigour characteristic of crosses between widely dissimilar parents.

DISLOCATIONS AND THE MECHANICAL PROPERTIES OF CRYSTALS

During September 6–8, about forty metallurgists and physicists from various countries met at Lake Placid, New York, to discuss the mechanical properties of dislocated crystals. The conference was sponsored jointly by the U.S. Office of Scientific Research, Air Research and Development Command and by the General Electric Research Laboratory, Schenectady, and organized by Dr. J. C. Fisher. The discussions were quite informal and their purpose was to assess, in the light of recent work, the extent to which we understand the mechanical effects of dislocations in crystals. A few related questions were also taken up, such as the growth of whisker crystals and the nature of radiation damage.

Comparing this conference with those held in the United Kingdom in 1954, I was struck by two major changes in the subject, both of which were foreseen at the earlier conferences. First, the study of dislocations has now become very definitely an experimentalist's subject. By contrast, the development of dislocation theory has, temporarily at least, almost ceased. The reason for this is fairly clear. The geometrical and elastic theories of single dislocations and of simple arrays of dislocations have now been almost completely worked out, and only the very hard problems of the dynamics of fast-moving dislocations and of the detailed atomic structures in the cores of dislocations remain. But to understand work hardening, creep, fatigue, fracture and recrystallization, we have to study the collective behaviour of large, complex assemblies of dislocations, and the theory of this can go forward only when experiments have shown what are the decisive aspects of this behaviour in practice.

The second striking change is that the experimentalists are no longer content to look merely at slip lines. Stimulated mainly by the development of etch-pit techniques and by methods of precipitating atoms on the cores of dislocations, they now insist on seeing the individual dislocations in their specimens. As a result, when they now speak about dislocations gliding and multiplying in slip lines, and climbing out of these lines and polygonizing, they are no longer making theoretical conjectures, but are describing what they have actually seen taking place.

One of the most vivid examples of this was provided by Dr. P. B. Hirsch's motion-picture film of dislocations in aluminium foils observed by transmission electron microscopy. Here we were able to see single dislocations gliding, sometimes slowly, sometimes quickly, along close-packed planes. We saw them bow out under applied stress, interact with each other, reach unstable configurations and then run rapidly into nearby sub-boundaries. We also saw how remarkably effective an applied stress can be in breaking up dislocation nets within the crystal and driving the dislocations into boundaries, a fact often inferred previously from results of creep and recovery experiments, but never before actually seen.

It is pleasing to see how many of the predictions of dislocation theory, made a few years ago, are now being confirmed. The study of dislocation networks in ionic crystals, made visible by the precipitation of metallic atoms on the dislocation lines, has gone forward actively, and Dr. S. Amelinckx and Dr. J. W. Mitchell showed many examples of networks in silver halides, sodium chloride and calcium fluoride, which conformed closely to the patterns expected from considerations of Burgers vectors and elastic stability. Isolated closed dislocation rings and spiral dislocation ines were also seen in the calcium fluoride specimens, so confirming the ideas of Prof. F. Seitz about the condensation of point defects into platelets and on to screw dislocations. We were also shown some beautiful examples of Frank–Read sources in operation in silion, photographed by Dr. W. C. Dash, using copper atoms to mark the dislocation lines and infra-red light o photograph them.

Drs. J. J. Gilman and W. G. Johnston have developed a versatile etch-pit technique for studying dislocations in lithium fluoride. One type of etchant attacks all types of dislocations in the material, whereas another type attacks only those dislocations that have (presumably) absorbed some impurity during annealing; freshly created dislocations can thus be distinguished from old ones. The symmetry f an etch-pit differs according to whether the dislocation it marks is an edge or a screw, so that these two ypes of dislocation can be distinguished. When a islocation is pulled away from its etch-pit, that pit hen develops a flat bottom, so that the present and last positions of a dislocation can be identified. Perhaps the most outstanding of the many observaons made on lithium fluoride with this technique that, at a stress of about 1 kgm. mm.$^{-2}$, small islocation loops can nucleate, grow and multiply nto fully active slip bands in apparently perfect egions of the crystal. These intriguing results roused much discussion. It seems clear that here a omplete slip band can be formed independently of a islocation network. One suggestion, made by Dr. W. M. Lomer, is that parts of an expanding dislocaon ring may in fact jump from one slip plane to nother, by cross-slip, so that segments of dislocation nes capable of acting as Frank–Read sources may be rmed in the neighbouring slip planes. The nature f the primary defects, from which the first loops are ucleated, remains a mystery. Dr. J. C. Fisher sugsted that they may be small platelets of condensed vacancies; but so far it has not been possible to reveal them by etching.

Several experiments were described that gave evidence about the location of the original sources of slip in various crystals. Dr. W. T. Read deduced, from an observation that more dislocations are formed when a germanium crystal is bent than would be expected from the theory of plastic bending, that some dislocation sources became operative in the interior of the crystal. In a somewhat similar experiment on an aluminium crystal strained in tension, Prof. B. Chalmers deduced from the character of X-ray reflexions obtained by the Schultz method, that the dislocations must have moved into the crystal from the surface. Further evidence for slip starting at the surface was presented by Dr. T. Suzuki, who worked with potassium chloride, and the present writer, who described some work of Mr. M. A. Adams on copper. Suzuki showed that birefringent bands first appeared on two opposite faces at the beginning of slip, and that the effect of contaminating these faces with impurity caused the yield stress to increase. Adams showed that a copper crystal normally does not yield discontinuously or strain-age, but that it can be made to do so by introducing 1 per cent of zinc into its surface. These effects, which suggest that slip begins at surface sources, disappear when the zincified layer is removed.

Several examples of impurity yield points were reported; arsenic in copper (Dr. W. Boas) and oxygen in silicon (Dr. W. T. Read) both produce the effect. Dr. K. Lücke described an extensive investigation of the pinning of dislocations by impurity atoms, based on the damping of high-frequency (10^8 c./s.) oscillations. The rates of migration of impurity atoms to dislocations and their binding energies in dislocations were both measured in these experiments: for example, bismuth in lead is bound to dislocations with an energy of 0·11 eV. Dr. W. Boas showed some effects of impurities on the annealing behaviour of cold-worked copper, which Prof. N. F. Mott interpreted in terms of the anchoring of jogs by impurity atoms, so hindering the climb of dislocations. The rate of climb of dislocations was also discussed by Prof. F. R. N. Nabarro in an analysis of the straightening of kinked whisker crystals.

One point which emerged strongly at the conference is that in many materials dislocations glide rather 'stickily', suggesting that they are hindered by a large Peierls–Nabarro force. We saw examples of this in Gilman's work, in which the stress to move visible dislocations varies sensitively with temperature and rate of strain and always remains large even in apparently perfect regions of the crystal; also in silicon, in which the yield stress is very sensitive to temperature even after the impurity yield point has been overcome (W. T. Read), and in which the dislocation lines follow crystallographic directions closely (W. C. Dash) and take up positions in the slip plane which appear to be determined by their rate of glide rather than by their mutual elastic interactions. Gilman showed that fast-moving cracks (more than 10^4 cm. sec.$^{-1}$) do not produce dislocation loops at their tips, whereas slow ones (less than 10^4 cm. sec.$^{-1}$) do. Since large amounts of energy can be dissipated by slip at the tips of cracks, the stickiness or otherwise of dislocations undoubtedly plays a major part in determining the tendency towards brittleness or ductility of crystals. Even in metals, it begins to look as if the Peierls–Nabarro force is small only for slip on close-packed planes. According to Dr. A.

Seeger, the force does not make itself felt in these planes until rather low temperatures (lower than 100° K.) are reached, where the internal friction of the metal rises up to the 'Bordoni peak'. In the face-centred cubic metals, we scarcely ever see slip on planes other than close-packed ones, except possibly at high temperatures; similarly, in close-packed hexagonal metals, only the basal slip system has a flow stress that is insensitive to temperature, and the high sensitivity of other systems to temperature is strongly suggestive of a large Peierls–Nabarro force. It now seems probable that the sensitivity of the yield stress in iron is due at least partly to a large Peierls–Nabarro force, which may help to account partly for some of the observations on delayed yielding in iron that were reported to the conference by Dr. D. S. Wood.

In the discussions of solid-solution hardening and radiation hardening, the point was brought out from the work of Prof. R. W. K. Honeycombe and Dr. T. Blewitt that the yield stress of such materials is quite a sensitive, parabolic, function of temperature. Dr. H. Suzuki offered an explanation of the solid solution case in terms of the impurity yield-point mechanism, and several views were expressed about radiation hardening. Dr. J. Friedel suggested that vacancies agglomerated into large voids along dislocations, Dr. T. Blewitt considered that aggregates of point defects formed in the lattice would produce a type of precipitate hardening, while the present writer explored the possibility that the absorption of point defects by dislocations would cause the latter to climb out of their glide planes and thereby give them a large Peierls–Nabarro force.

The discussions of work-hardening were centred mainly around the nature of the obstacles responsible for work-hardening. Dr. A. Seeger showed that slip dislocations escape from their barriers in the slip planes by undergoing cross-slip and he proposed a variant of the Lomer–Cottrell barrier in which slip dislocations in screw orientation would become locked against barriers formed from two secondary slip systems. Prof. N. F. Mott raised the question of the behaviour of such systems on unloading. It seemed to the writer that the back-stress from its own piled-up group of dislocations could not be the reason why a given dislocation source ceased to act during unidirectional straining; for if this were the case, the stored elastic energy in the system would be nearly equal to the total work done, and most of the plastic strain would be recovered during unloading. The hardening of the Frank–Read sources must originate in some other way, perhaps from the internal stresses due to other nearby dislocation groups, as in the theory suggested a few years ago by Prof. Mott.

The problem of understanding fatigue failure still appears very difficult. The idea that vacancies are formed during the glide of dislocations has met with difficulties, mainly because we are still not sure how dislocations can produce vacancies; in fact, when gliding screw dislocations intersect they are more likely, if they produce any point defects at all, to produce interstitials rather than vacancies. Prof. Mott proposed a new mechanism whereby a gliding screw, oscillating to and fro with the applied stress, jumps cyclically from one plane to another by means of cross-slip at the ends of its path; this causes the material between these planes to be squeezed out of the crystal, leaving behind a void in the slipped region. This ought to be just the type of process that could be examined directly by the new experimental techniques mentioned above.

Interest has grown rapidly in recent years in the mobilities of various types of defects in solids, particularly at very low temperatures. Prof. J. S. Koehler, Dr. T. Blewitt and Dr. W. Boas summarized recent work on the annealing of point defects in quenched, irradiated and cold-worked metals, and Dr. G. Leibfried concluded that zero-point motion may contribute to the mobility of point defects at very low temperatures, but is unlikely to be important in the motion of dislocations because the vibrational modes useful for helping dislocations over barriers have long wave-lengths and low Debye temperatures. Dr. Blewitt showed that copper crystals can be work-hardened in liquid helium up to yield stresses greater than one per cent of the elastic constant, and that at these high stresses it is possible to pull partial dislocations away from one another, so forming stacking faults and deformation twins. Prof. C. S. Barrett described some recent work by Dr. P. Haasen and Dr. A. Kelly which showed that nickel and copper crystals develop yield points after plastic straining unloading and reloading, in liquid helium, and Dr Blewitt mentioned that internal friction experiments have shown that dislocations can become pinned as a result of neutron irradiation at 17° K. Certainly, one of the most fascinating developments of the subject in recent years is the discovery of so much evidence fo atomic movements in crystals at temperatures of a few degrees above absolute zero.

A. H. COTTRELL

OBITUARIES

Mr. H. N. Ridley, C.M.G., F.R.S.

MR. H. N. RIDLEY died in his one hundred and first year at his home at 7 Cumberland Road, Kew, on October 24. On the occasion of his hundredth birthday (December 10, 1955), Mr. J. W. Purseglove contributed to *Nature* an appreciation of Ridley's many-sided activities in Singapore and Malaya, and the reader is referred to this for a fuller survey of his life and work.

He was born at West Harling, in Norfolk, son of the Rev. Oliver Matthew Ridley and Louisa Pole (Stuart). He was proud to count among his ancestors Nicholas Ridley (Bishop of London, 1550–55), William Penn, and the third Earl of Bute, who wa botanical adviser to the Princess Augusta, founde of the Royal Botanic Gardens, Kew.

Ridley took all Nature for his province. In hi boyhood he was interested mainly in birds an insects; after studying natural science at Oxford h was awarded a scholarship in geology; he cam finally to an intensive study of botany almost as a accident when, having failed to obtain a zoologica post, he applied in 1880 for a post in the Botan Department of the British Museum (Natural History In the following eight years he specialized in th study of tropical Monocotyledons, but did not neglec other groups of plants; and he maintained an activ interest in animal life, especially in the relations between plants and animals, in insects as pollinators and pests, and in birds and mammals as distributors of plants.

He thus went to Singapore in 1888 (as director of Gardens and Forests, Straits Settlements) well equipped to make the pioneer investigations of plant and animal life which were then needed, and to them he devoted the next twenty-three years of his life. In addition to the wide scope of his knowledge and interest, his other prime characteristic was the intensity of purpose with which he applied himself to everything that he did. With small financial resources, and little help from others, he achieved original pioneer work of a variety and scope such as few men have accomplished in a comparable period of time.

By his investigation of the tapping of Para rubber trees, and his persistent advocacy of the need for, and possibility of, a plantation rubber industry, he was largely responsible for making possible the development of modern Malaya. He was a wonderful field botanist, because he knew and could recognize such a great range of plants; he knew at once if he was looking at something new and interesting, when another collector might pass it unnoticed. He took every opportunity of travelling, and made by far the largest single contribution to our present knowledge of the Malayan flora. Several species of plants are still known only from his original specimens.

In addition to Para rubber, Ridley cultivated experimentally many other useful plants from outside Malaya. He wrote reports upon these plants, and on the techniques of handling them for local use. He also investigated, and reported upon, the many kinds of timber trees and other useful plants of the Malayan forest. His zoological papers were numerous and varied.

But because he had so many interests, and attempted such a wide range of work, and because he had so little help, everything he did was done in a hurry, and there is frequent evidence of this in Ridley's published papers and books. One thing he apparently had not the ability (or the patience) to do was to correlate his observations with those of other people; and through the habit of hasty work he apparently lost the ability of making careful and methodical records of his own observations. But it is not as a finished worker one must judge him; he was a pioneer, and showed the way for others who came afterwards, each to deal with only a fraction of the field he tried to cover.

Among those who travelled with him on his expeditions (as some of them have told me) Ridley had the reputation of being a good companion, always cheerful and resourceful. In his later years he had an inexhaustible fund of stories of his life in Malaya, and greatly enjoyed recounting them; from them one could appreciate his zest for life. He had a fine scorn of those with whom he disagreed, but a warm heart that made him beloved by many, especially by those to whom he quietly and generously gave practical help in time of need. One of his larger benefactions, which (at his own request) was never publicly announced, was a considerable gift towards the cost of A. F. R. Wollaston's expedition to New Guinea in 912–13 (see *Geographical Journal*, 43, 248–268).

At the age of eighty-two, Ridley married Lily Doran, who, with her sister, most devotedly cared for him during his later years and in his final illness.

R. E. HOLTTUM

Prof. Doris L. Mackinnon

AFTER an illness lasting almost three months, Prof. Doris Livingston Mackinnon died on September 10, at the age of seventy-two. She was the eldest of five talented children born to Lachlan Mackinnon, advocate of Aberdeen, and Theodora Mackinnon, *née* Thompson, of London, and she was born on September 30, 1883. Doris could draw skilfully, she had a good knowledge of music, and she had a great literary gift. Why then did she choose science as a career? Her father, who was a lover of animals, as well as an ardent amateur botanist, ornithologist and astronomer, would take the children for rambles in the country, to observe Nature in all its forms. Another influence in Doris's life was that of the late Mrs. Ogilvie Gordon, a noted geologist, who encouraged her to take up science seriously. She took her B.Sc. at the University of Aberdeen with the subjects botany, zoology and geology, graduating with distinction in 1906 and being, as I believe, the second woman to be capped in that University. A Carnegie Scholarship then enabled her to spend one year in the laboratory of Richard Hertwig at Munich, some months at the Biological Station at Roscoff, collaborating with M. F. Vlès in protozoological research, and a further period in the Quick Laboratory at Cambridge under the supervision of Prof. G. H. F. Nuttall.

During 1908–9 Miss Mackinnon acted as personal assistant to Prof. J. Arthur Thomson at Marischal College, Aberdeen, and in 1909 she was invited by Prof. W. D'Arcy Thompson to become his assistant at University College, Dundee. She remained in Dundee until the spring of 1916, and was then granted leave of absence to undertake war-work. During these years she established her reputation both as a brilliant lecturer and a protozoologist. In addition to her academic work, she gave a number of popular lectures in Dundee, Perth and Aberdeen, and by 1914, when she gained the degree of D.Sc. at Aberdeen, she had published fourteen papers, most of them dealing with the parasites of insects. In May 1916 she came under the influence of Clifford Dobell, who trained her at the Wellcome Bureau in matters relating to the study of amœbic dysentery. Another potent influence was that of her father's first cousin, Sir Patrick Manson. She then took up a War Office appointment as protozoologist attached to military hospitals. At the 1st Western General Hospital and at the School of Tropical Medicine, Liverpool, and later (1917) at the University War Hospital, Southampton, she collaborated with a number of colleagues in the publication of several important papers and reports concerned with *Entamoeba histolytica* and amœbic dysentery.

In 1918, when D'Arcy Thompson accepted the chair at St. Andrews, the Council of University College, Dundee, obtained her release from war-work, and she returned in April, running the Zoology Department single-handed. A year later she was appointed Prof. Arthur Dendy's senior lecturer at King's College, London, and in 1927 she became professor of zoology in the College.

Prof. Mackinnon's contributions to the original literature on her subject, most of which were concerned with the parasitic Protozoa, numbered about forty papers. Her sound knowledge of German was utilized in the translation of J. von Uexküll's "Theoretische Biologie" (1926) and in a translation of a musical book by Paul Mies, "Beethoven Sketches, an Analysis of his Style, based on his Sketchbook" (1929). She also edited Berg's "Nomogenesis". Another side of her character is revealed by numerous articles, many of them studies of children and some of them childhood memories, which were published during the period 1913–19 in the *Manchester Guardian* and other periodicals. A course of broadcast talks for schools formed the basis of her book "The Animal's World" (1936), which appeals to adults even more than to children, and which reached an enlarged new edition in 1950. For many years Prof. Mackinnon worked on the preparation of her *opus magnum*, an illustrated text-book on protozoology, but she did not live to see this work quite completed. There is every hope, however, that it will appear in the near future, and those knowing the unusually fine quality of her teaching will look forward to its appearance.

As a colleague of Prof. Mackinnon for twenty years, I can vouch for the smoothness with which she ran her Department. She was an able administrator, and such a friend to her staff that her merest wish was equal to her command. Always ready to seek advice on such technical matters as perplexed her, she was equally ready to offer guidance to staff and students, whether on academic or personal matters. Many would testify to her kindness to them, for she lived for communion with her students, past and present. How she found time and energy to write to so many students so often and so fully, I for one cannot guess; but her self-imposed duty must have given joy both to herself and to many, particularly during the arduous years of war. All who have known Prof. Mackinnon will feel deeply saddened by the passing of a charming and gracious lady.

BEN DAWES

NEWS and VIEWS

Appeal from the University of Szeged, Hungary

THE following communication, dated November 4, has been received from Prof. A. Szent-Gyorgyi, of the Marine Biological Laboratory, Woods Hole, Mass.: "I obtained from Hungary the wire quoted below, posted on November the 3rd, 6 p.m. I should be grateful if you could give room to it on your pages. 'To A. Szent-Gyorgyi, Marine Research Laboratory, Woods Hole, Massachusetts, U.S.A. The University of Szeged makes the following declaration: the newly born democratic Hungary wants to live in peace and friendship with its neighbours and all peoples of the world. We call on all Universities to support and help us with their moral authority in our endeavour to restore peace and independence to our country, which are the basic conditions of all scientific work. We ask all those men of learning with whom we established contacts at home or abroad, to come to our help. Up to the present we strived with all the modest means at our disposal to serve the progress and better future of mankind. We want also in the future to do everything possible to work in concert with the researchers of the whole world. We would be overjoyed if this desire could be fulfilled. We ask you to make this declaration known in possibly wide circles.' Here follows a great number of signatures, representing practically the whole senate and faculty."

Nobel Prize in Chemistry for 1956

THE Nobel Prize in Chemistry has this year been divided between Sir Cyril Hinshelwood, president of the Royal Society and Dr. Lee's professor of chemistry in the University of Oxford, and Prof. N. Semenov, of the Academy of Sciences, Moscow, for their work on the kinetics of chemical reactions.

Sir Cyril Hinshelwood, F.R.S.

SIR CYRIL HINSHELWOOD was elected president of the Royal Society in 1955, and reference was made to his many interests in *Nature* of December 10, 1955, p. 1101. This further honour which has come to him is a worthy recognition of the fundamental significance of his work on the study of chemical processes by kinetic methods.

Academician N. Semenov

NIKOLAI NIKOLAIEVICH SEMENOV, member of the U.S.S.R. Academy of Sciences and director of the Institute of Chemical Physics in Moscow, to whom, jointly with Sir Cyril Hinshelwood, this year's Nobel Prize for Chemistry is awarded, has long been known to all chemists for his outstanding contributions to the theory of chain reactions and explosions. The first major impact of his ideas on the world came with the explanation in terms of branching reaction-chains of the sudden ignition on slight increases of pressure of mixtures such as phosphorus vapour and oxygen in which, below the limiting pressure, there is little sign of chemical activity. His book, "Chemical Kinetics and Chain Reactions", published in England in 1935, contains an exhaustive analysis of the applications of the chain-theory to reactions of the most varied types, but notably to those involved in combustion processes. Among the many fruitful ideas which Semenov has advanced is that of degenerate branching, in terms of which some of the rather mysterious phenomena associated with the induction periods of oxidation reactions can be understood. Less well known, because published only in Russian, is his work on the propagation of explosion waves. Semenov has been, and still is, the centre of a distinguished group of Russian workers in various fields of physical chemistry, but principally devoted to the study of the mechanism of chemical transformation. It is an interesting circumstance that the two chemists who share this year's award have been on very friendly terms for many years, and met in Moscow on the occasion of the Academy's celebration of its 220th anniversary in 1945.

Royal Society: Medal Awards for 1956

THE QUEEN has been graciously pleased to approve the following recommendations made by the Council of the Royal Society for the award of the two Royal Medals: Dr. Dorothy M. C. Hodgkin, reader in X-ray crystallography, University of Oxford, for her distinguished work in the elucidation of the structures of penicillin, vitamin B_{12} and other important compounds by the methods of X-ray crystallography; Dr. O. T. Jones, lately Woodwardian professor of geology in the University of Cambridge, for his distinguished studies of the Palæozoic rocks, particularly in Wales, his work on sediments, his palæontological researches and the application of geological knowledge to practical problems.

The following awards of medals have been made by the President and the Council of the Royal Society: *Copley Medal:* Prof. P. M. S. Blackett, professor of physics in the Imperial College of Science and Technology, London, for his outstanding studies of cosmic ray showers and heavy mesons and in the field of palæomagnetism; *Rumford Medal:* Dr. F. P. Bowden, reader in physical chemistry in the University of Cambridge, for his distinguished work on the nature of friction; *Davy Medal:* Prof. R. D. Haworth, Firth professor of chemistry and head of the Chemistry Department in the University of Sheffield, for his distinguished contributions to the chemistry of natural products, particularly those containing heterocyclic systems; *Darwin Medal:* Dr. J. S. Huxley, for his distinguished contributions to the study and theory of evolution; *Hughes Medal:* Lord Cherwell, lately professor of experimental philosophy in the University of Oxford, for his distinguished work in many fields: the melting-point formula and theory of specific heats; ionization of stars; meteors and temperature inversion in the stratosphere.

The American Geographical Society: Medal Awards

THE Council of the American Geographical Society has made the following awards: *Cullum Geographical Medal:* Prof. J. Russell Smith, emeritus professor of economic geography in Columbia University, and author of several books on North America that have become classics in their field; *Charles P. Daly Medal:* Prof. Raoul Blanchard, long associated with the University of Grenoble, whose monumental work on the Alps will be completed with the appearance of the twelfth volume; *David Livingstone Centenary Medal:* Prof. George McCutcheon McBride, emeritus professor of geography in the University of California at Los Angeles, a leading authority on problems of economic and cultural geography in Latin America.

The National Zoological Park, Washington: Dr. William M. Mann

DR. WILLIAM M. MANN, who has been director of the National Zoological Park at Washington for thirty-one years, retired on October 31. Dr. Mann, who recently reached the statutory retirement age of seventy, was the fifth director the National Zoological Park has had since it was established by the Smithsonian Institution in 1889. He began his career in 1916 as an entomologist with the Bureau of Entomology, United States Department of Agriculture. It is widely recognized that under Dr. Mann's direction the Washington zoo has become one of the best and most representative collections of living animals in the world. The physical equipment of the zoo also has steadily improved, and during Dr. Mann's administration four modern exhibition buildings were added and others are planned. Dr. Mann is one of the world's greatest authorities on ants. He has collected and studied these insects around the globe, and only last year he presented to the Smithsonian Institution his huge personal collection of these insects, numbering more than 117,000 specimens. For the zoo Dr. Mann has made trips to many foreign lands to obtain live animals for the collection. For example, in 1926 he headed the Smithsonian–Chrysler Expedition to East Africa, in 1937 a National Geographic Society Expedition to the East Indies, and in 1940 the Smithsonian–Firestone Expedition to Liberia. He will continue his association with the Smithsonian in the capacity of honorary research associate, the Institution's highest honorary scientific designation. Dr. Theodore H. Reed, of Portland, Oreg., who has held the post of chief veterinarian of the zoo since July 1955, has been appointed acting director of the National Zoological Park.

The D.S.I.R. Research Council

THE Department of Scientific and Industrial Research Act, 1956, has now come into force, and the composition of the new Council of the Department is: Sir Harry Jephcott, chairman, Glaxo Laboratories, Ltd. (*chairman*); Sir Eric Ashby, president and vice-chancellor, The Queen's University of Belfast; Prof. C. E. H. Bawn, Grant-Brunner professor of inorganic and physical chemistry, University of Liverpool; Sir Hugh Beaver, managing director, Arthur Guinness, Son and Co., Ltd.; Prof. P. M. S. Blackett, professor of physics, Imperial College of Science and Technology, University of London; Mr. H. Douglass, general secretary, Iron and Steel Trades Confederation; Sir Walter Drummond, a director of George Angus and Co., Ltd., and also Smith's Dock Co., Ltd.; Mr. W. L. Heywood, general secretary, National Union of Dyers, Bleachers and Textile Workers; Dr. Willis Jackson, director of research and education, Metropolitan-Vickers Electrical Co., Ltd.; Sir Philip Johnson, deputy chairman, R. and W. Hawthorn, Leslie and Co., Ltd.; Prof. E. A. G. Robinson, professor of economics, University of Cambridge. Dr. H. W. Melville, secretary of the present Advisory Council, will be secretary of the new Council. Payment of £1,000 a year to the chairman and £750 a year to each member of the Council is authorized under Section 2 (5) of the Act.

Large Heavy-water Reactor at Harwell

BRITAIN'S first large heavy-water reactor, DIDO, built for testing materials and making powerful radioactive isotopes, has started operating at Harwell. DIDO will develop about ten megawatts of heat at full power, and its neutron flux will be about 10^{14} neutrons per sq. cm. per sec. It is the most powerful experimental reactor in Western Europe. Heavy water is used as the moderator, and the fuel is highly enriched uranium. The reactor will be formally opened by Sir Cyril Hinshelwood, president of the Royal Society, on November 21. The name DIDO is derived from the formula D_2O for heavy water.

Precautions in handling Radioactive Isotopes

PARALLEL to the increasing use of radioactive isotopes by industry, there has been an increase in the demand for advice on the precautions required to ensure safe handling and disposal of radioactive materials, and both the Health Physics Division and the Isotope Division's Advisory Service on the Industrial Applications of Radioisotopes of the Atomic Energy Research Establishment, Harwell, have been active in this regard. During 1955 it was decided to supplement the services provided by the Divisions by a series of short courses of instruction on radiological protection, and the first course was held during November 1955 at Harwell. The course lasted four days and consisted of lectures, demonstrations and practical work. Cyclostyled summaries of the nine lectures delivered during the course have been collected together in *A.E.R.E. H.P./L.*23, an unclassified publication which is now available for purchase (H.M.S.O., 13*s*. 3*d*. net). The subjects of the lectures included: "Elements of Nuclear Physics" (R. A. Faires); "The Organization of a Radiation Protection Service" (I. S. Jones); "Units in Radiation and the Detection of Radiation" (H. J. Dunster); "The External Radiation Hazard and its Control" (E. M. Flew); and "Decontamination and Waste Disposal" (R. H. Burns).

Traffic Problems in Britain

THE present level of use of motor-vehicles in Great Britain was reached many years ago in the United States and it is desirable that we should profit by experience there when we decide how to tackle our traffic problems. That presumably is the object of the recent P.E.P. pamphlet, "Solving Traffic Problems: Lessons from America", and in it one might reasonably expect to find factual information as to the value or otherwise of American practice. Unfortunately, the report is confined almost entirely to quotations of American opinion, some of which fairly certainly comes from people with vested interests in particular branches of transport. It is thus difficult to know from the supporting evidence what value to attach to the conclusions drawn. It is particularly important that we should draw on American experience of the value of urban motorways in solving traffic problems. The report, however, gives no information such as Mr. Arthur S. Hodgkiss, the eminent and experienced expert from New York, gave to the recent conference in London on urban motorways when, in speaking of conditions in Great Britain, he expressed the view that "the development of urban motorways as a part of a national system of modern highways will more than pay for itself through direct and intangible benefits". Instead, the report emphasizes possible difficulties which might arise from the use of these roads by large amounts of car traffic travelling to and from work. Of course, the report is right in drawing the conclusion that the urban motorway will not of itself solve the traffic problem of Britain, which must be considered in relation to other factors and in particular to public transport and to parking policy.

It is disappointing, however, that the report can provide no clear indication from the United States as to whether the various restrictive measures that it seems to advocate are likely to be either acceptable or successful; whether in fact a proper balance which the report says "must be achieved between private and public transport" has been achieved anywhere; and whether it would be considered in the United States profitable to wait until traffic needs are "properly defined", whatever that may mean in present rapidly changing conditions, before getting on with the job. Great efforts should, of course, be made to collect facts—indeed, the Americans are the world's great fact collectors; but in reviewing American opinion, it is significant that Mr. Hodgkiss recommended the building of one urban motorway in Great Britain, so that we could see for ourselves the advantages that it gave, and suggested that if we studied too long in highway matters everyone became scared. This is an American 'get-on-with-the-job attitude' to which the report does not refer, but which is still held strongly in America's biggest city. It is indeed true that the United States has not solved the problem of traffic congestion; but it is a fact that the American cries out for more and more urban highway capacity. It would be wrong to convey the impression that the urge is diminishing, although it is right to say that more thought is being given to the better integration of all forms of transport, and to the conditions of use and to the provision of parking facilities.

Water Research News

RESEARCH in Great Britain on problems concerned with the availability and treatment of water for domestic supply was, for many years, carried out mainly by the technical staffs of local authorities. It had long been felt, however, that some central organization for conducting research in this field was desirable and the Institution of Water Engineers formed a Research Committee which, working through a number of groups, stimulated work on some of the many problems with which the water industry is concerned. This organization, though it did a great deal to foster research, suffered from the disadvantage that it had no permanent staff and could therefore act for the most part only as a co-ordinating body. In 1953 the British Waterworks Association, which represents all the public water undertakings in Great Britain, in conjunction with the Institution of Water Engineers, formed a Water Research Association, which last year appointed a permanent staff, housed, for the moment, in a large house at Redhill, Surrey. It is this body which has just issued the first number of *Water Research News*, a publication which is very attractively written and produced. It contains notices of two of the first technical publications of the Association—on instruments available for the detection of leaks in water mains, and on the treatment of aggressive water by aeration—together with short articles on the permeability of polythene to coal gas (a problem which has arisen in a few instances where polythene water pipes have been used), and on cathodic protection of buried mains.

Spaceflight

THE British Interplanetary Society was founded in 1933 to promote the development of interplanetary exploration and communication by the study of rocket engineering, astronomy and other associated sciences, and it now includes among its members many British and foreign workers prominent in these fields. For many years the Society has published a bi-monthly journal, issued free to members, containing original papers of a highly technical and research nature. However, there is now a growing public interest in astronautics and since one of the Society's aims is to ensure the spreading of correct information, a new publication, *Spaceflight*, in addition to the Society's journal has been launched. *Spaceflight*, the first popular magazine of its kind, will appear quarterly and aims at giving a picture of the research work being undertaken as well as discussing related historical and astronomical matters. The first number contains a typical 'mixed bag'. The introductory article "Flight into Space", by W. N. Neat, gives a general introduction to the new science of astronautics and clears up a number of popular misconceptions about the basic principles and methods to be used. "Ideas behind the Rocket", by D. Hurden, is a very clear statement of the principle of rocket propulsion, what rockets look like and of the performance to be expected, and "The Vanguard

Project", by K. W. Gatland, is a 7,000-word article in which the United States of America's satellite project —called "Vanguard"—is explained in considerable detail and with numerous illustrations. The orbit selected for the satellite is inclined at 40° to the equator, and the launching is expected to be made before the spring of 1958 from the proving ground at Cape Canaveral, Florida, in a direction between 28° and 35° south of east. The satellite will move in an ellipse about the Earth, coming perhaps as close as 200 miles on one side and swinging out to as far as 800 miles on the other. It will complete a full circuit every ninety minutes. Details are also given of other proposed satellites to be launched as part of the programme of the International Geophysical Year and of the methods of tracking the progress of the satellites.

The Cambridge Instrument Co., Ltd.: 75th Anniversary

THE Cambridge Instrument Co., Ltd., celebrated the seventy-fifth anniversary of its foundation this year, and in commemoration of this interesting event a 28-page illustrated brochure has been issued in which the history and development of the Company are briefly outlined. The Company was one of the few pioneers in the introduction of instruments into industry, and it has played an important part in the subsequent progress over the years from the time when the scientific instrument was solely a university research tool to the present day when instrumentation is capable of controlling a complete factory. Some well-known instruments—the rocking microtome, the thread recorder, the electrocardiograph, the Wilson cloud chamber, Mallock's calculating machine, to mention but a few of those referred to and illustrated in the brochure—the Cambridge Instrument Co. can rightly claim as peculiarly its own. The original personnel consisted of Horace Darwin, a mathematician and a genius at designing instruments on kinematic principles; Dew-Smith, a wealthy experimenter; three mechanics and two boys. To-day, the Company has two factories and a head office and showrooms in London (13 Grosvenor Place, S.W.1); a factory in Cambridge; a separate mechanical thermometer division at one of the London factories; an associated American company; and representatives in most countries overseas.

The Miripinnati: a New Order of Teleost Fishes

THE creation of a new order of vertebrates is worthy of notice, even if it is only yet another order of fish. The teleosts are nowadays divided by many systematists into thirty or more orders, and in Dana Report No. 42 (pp. 34+1 plate. Copenhagen: Andr. Fred. Høst and Son, 1956; 10 Dan. kr.) E. Bertelsen and N. B. Marshall propose that four newly described species of teleost fish are sufficiently distinct to constitute a new order, the Miripinnati. The four species fall into three genera and two families. They are all oceanic, pelagic or bathypelagic fish, scaleless and apparently feeding on Copepods. One species, *Mirapinna esau*, known from a single specimen caught in 1911, is remarkable in having the body covered with 'hair', composed of branched outgrowths of the epidermis which bear glandular cells of an uncertain nature. The lateral-line organs of *Mirapinna* are raised on projections. In the second family, the Taeniophoridae, the skin is smooth and the lateral-line system apparently reduced; larval stages of members of this family are described. The Miripinnati are considered to be related to the order Iniomi.

Announcements

THE Royal Society is holding a conversazione and exhibition on November 21 to celebrate the tercentenary of the birth of Edmond Halley (see *Nature*, October 27, p. 891). The exhibits have been chosen by a special Tercentenary Committee of the Society under the chairmanship of Sir Edward Bullard.

THE 123rd meeting of the American Association for the Advancement of Science will be held in New York City during December 26–31, with headquarters in the Statler Hotel. In addition to the eighteen sections of the Association, eighty-five affiliated and associated societies will be holding meetings. Further information can be obtained from Sidney S. Negus, Medical College of Virginia, Richmond, Virginia.

THE following appointments have been made in the University of Birmingham: Dr. J. S. C. McKee, lecturer in physics; W. G. Ainslie, lecturer in engineering production; J. F. Soothill, lecturer in experimental pathology (metabolic diseases).

DR. D. S. BERTRAM, reader in entomology at the London School of Hygiene and Tropical Medicine, has been appointed to the University of London chair of medical entomology tenable at that School, in succession to the late Prof. P. A. Buxton. The title of reader in statistics in the University of London has been conferred on Dr. N. L. Johnson in respect of his post at University College.

COMMENCING January 12, a course of twelve lectures and appropriate practical work, designed to survey the principal branches of chemistry in which small-scale methods have been successfully applied, will be held on Saturday mornings, from 9.15 a.m. to 12 noon, at Norwood Technical College, Knight's Hill, London, S.E.27.

THE Thames Valley Section of the Royal Institute of Chemistry has arranged a symposium on "Techniques in Polymer Science" at Courtaulds' Research Laboratory, Maidenhead, on November 30 at 2.15 p.m. The topics to be considered include light scattering and osmometry, chromatographic fractionation, infra-red methods, surface films, tracer techniques and kinetic techniques. Further particulars can be obtained from the honorary secretary of the Section, Dr. P. F. Holt, University, Reading.

THE Fourth General Assembly and International Congress of the International Union of Crystallography will be held in Montreal during July 10–17, 1957, and will be followed by two symposia on July 18 and 19, dealing with physical techniques of crystallographic interest and with electron diffraction, respectively. A brochure on the Congress can be obtained from the secretaries of the national committees of the member countries of the Union; from the general secretary of the Union, Dr. D. W. Smits, Laboratorium voor Anorganische en Fysische Chemie, Bloemsingel 10, Groningen; or from the secretary of the Canadian Committee, Dr. W. H. Barnes, Division of Physics, National Research Council, Ottawa 2, Ontario (envelope to be marked 'Personal'); or from the chairman of the Programme Committee, Dr. W. N. Lipscomb, School of Chemistry, University of Minnesota, Minneapolis.

THE Society for Analytical Chemistry has moved its offices, and its new address is 14 Belgrave Square, London, S.W.1.

PAPER-MAKING APPARATUS AT THE MANCHESTER COLLEGE OF SCIENCE AND TECHNOLOGY

THE Paper-Making Section of the Textile Chemistry Department of the Manchester College of Science and Technology has been given laboratory equipment worth £5,000 by the Reed Paper Group. Mr. T. E. G. Baker, a director of Albert E. Reed and Co., Ltd., handed over the apparatus officially on October 24. The gift was received by Dr. B. V. Bowden, principal of the College, at a small ceremony attended by representatives of the Northern District of the British Paper and Board Makers' Association, executives of the Reed Paper Group and members of the College staff.

Although classes in paper technology were held in the Mechanics Institute, which preceded the College, they received their first big impetus in 1903 when the newly founded Municipal School of Technology acquired a demonstration paper machine 24 in. wide, and set it up in the new dyehouse. This fifty-year old machine is still put to good use for teaching and research. In 1905 the Faculty of Technology in the University of Manchester was instituted, and it then became possible for students in the Department of Applied Chemistry to take paper manufacture as a principal subject when studying for the degree of B.Sc. Tech. The Paper Technology Section later became part of the Department of Textile Chemistry, in which Dr. R. H. Peters was appointed to the first chair in 1955. The University approved the institution of an honours degree course in paper technology in 1954, and the first students taking this revised course obtained their degrees in the summer of 1956. The new degree course is based mainly on physics, to meet the current requirements of the industry. The course was designed by the late Dr. W. W. Barkas, who was appointed senior lecturer in paper technology in 1949 but died at the early age of fifty-six in 1955. The previous senior lecturer, Mr. F. W. Bailey, retired in 1949 after nearly twenty-five years at the College. He was a very welcome guest at the presentation of the new apparatus.

In 1954 the Northern District of the British Paper and Board Makers' Association instituted a scholarship fund, and since 1955 seven George Rackley scholarships have been awarded to full-time students reading for degrees. These scholarships have had more effect than might be expected, as in addition to the Rackley scholars other students have joined the Department with local authority grants. Research students have always been encouraged, and a new postgraduate diploma course has just been instituted for those who wish to study paper technology for one year only. At present there are twenty full-time students in the Section and, in addition, ten part-time students taking evening and part-time day classes.

The new equipment includes a Wennberg electrically heated rotating autoclave specially designed for making paper pulp on the pilot scale. This can be used either for demonstrations with regular raw materials such as wood, cotton rags or straw, or for research on any vegetable raw material. It will treat about 2 kgm. at a time. A disintegrator and strainer on the same scale are used for breaking up the pulp and removing uncleared fibre bundles.

'Beating' is the main mystery of paper making. The cellulose fibres suspended in water are passed between bars (usually bronze), which are rubbed together under considerable pressure. It is not easy to design a beater which will do this really well in the laboratory, as stock does not circulate properly in scale models of conventional beaters at the correct solids content. The Reed Group has given the College a 'Medway' beater designed in its laboratories. Though unlike a commercial beater in appearance, it will work over a wide range of operating conditions and is particularly suitable for demonstration and research.

The 'substance' (area-density) of paper is its most important property and has always been checked during manufacture by tearing out samples at intervals and weighing them; this necessitates joins in the reels. Substance is now controlled by beta-ray gauges in which the permeability of the paper to beta-rays from a thallium source is measured in a suitable apparatus. The gift includes a Baldwin 'Atomat' apparatus which is to be fitted on the College machine. By measuring substance at both ends of the machine, the water content at the wet end can be estimated.

A low *p*H in paper is bad for its permanence, and a high *p*H is detrimental to sizing. The control of *p*H is, therefore, important, and the apparatus includes an *EIL* *p*H meter which can be coupled to Honeywell–Brown recording and control instruments. The control system can be used, alternatively, for controlling temperatures and pressures and will be useful for demonstrating the principles of controllers to students.

The Van de Korput dynamic tensile tester measures the work done in breaking paper by applied tension. It correlates better with practical behaviour than conventional tensile testers. The Somerville fractionater is used for separating paper pulps into fractions of different fibre-length, and can also be used for straining. The study of coatings for paper is increasingly important, and the gift includes a Ferranti viscometer for checking the apparent viscosity and investigating the flow of these suspensions.

F. L. HUDSON

AGRICULTURAL POLICIES IN EUROPE AND NORTH AMERICA

THE Organization for European Economic Co-operation has issued an interesting report on agricultural policies in all European countries except the U.S.S.R. and its satellites, and also in Canada and the United States*. The picture is on the whole reassuring. In Europe the population has been increasing at the rate of about 1 per cent per annum, but the agricultural output has risen by 4 per cent per annum since 1949/50. Food consumption per head has increased because of higher purchasing power; real income per head has during the past four years increased by 2·75 per cent per annum, and about half of this is spent in food.

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* Agricultural Policies in Europe and North America—First Report of the Ministerial Committee for Agriculture and Food, May 1952. Pp. 372 (Paris: O.E.E.C.; London: H.M.S.O., 1956.) 18s.; 3 dollars; 900 fr.

The policies in the various countries have had the common aim of increasing agricultural output with the single exception of Sweden, where the present output of 107 per cent of domestic food requirements is to be reduced to 90 per cent. Planning has been generally abandoned; there are no longer targets for individual commodities as during the Second World War. What mostly happens now is that farmers are exhorted to produce all they can. A few countries have over-all targets: Great Britain is aiming at 60 per cent increased output over pre-war and has already achieved 56 per cent.

Germany has made the most remarkable recovery. During 1948–49 the agricultural output was nearly 30 per cent below pre-war; during 1954–55 it was 23 per cent above pre-war and was providing 70–75 per cent of the total food requirements in spite of the fact that the agricultural area per head had fallen by nearly one-third in consequence of the flow of refugees from Eastern Germany. There are no specific regulations—only a general requirement that food output must be as large as possible. Of the European exporters of food, Denmark, two-thirds of the export earnings of which are derived from food, aims at improved quality and higher degree of processing so as to increase the value per ton, rather than increasing the number of tons produced. The Netherlands have only the general aim of making agriculture contribute as much as possible to the national wealth: the exports include about 25 per cent of the crop output, 40 per cent of animal production and more than 50 per cent of horticultural production. In 1954, the total value of these exports was nearly 900 thousand dollars; but against this was an import of feeding stuffs, other agricultural commodities and human food amounting to 650 thousand dollars. Switzerland and the Irish Republic are among the few countries with a declared demographic aim: both desire to organize their agriculture in such a way as to maintain a large peasant population.

SIXTH INTERNATIONAL CONGRESS OF SOIL SCIENCE

The Sixth International Congress of Soil Science, organized by the International Society of Soil Science, was held in Paris at the Maison de la Chimie during August 29–September 8, under the presidency of A. Oudin, Inspecteur Général des Eaux et Forêts, France. The Congress was divided into six commissions, the chairmen of which were as follows: Dr. M. B. Russel (United States), physics; Dr. A. C. Schuffelen (Holland), chemistry; Dr. P. Simonart (Belgium), biology; Dr. E. W. Russell (East Africa), fertility; Dr. A. Muir (Great Britain), classification; and Dr. J. V. Botelho Da Costa (Portugal), soil technology. The Congress attracted the largest number of members, the enrolment being 850 representing fifty countries, as compared with the two previous congresses in Amsterdam and Léopoldville (Congo), where the attendances were 600 and 250, respectively. Naturally, the largest group was from France, the next biggest groups being Great Britain, Belgium and the Congo, Holland, West Germany, United States, Spain, Italy, the U.S.S.R., Yugoslavia, East Germany and Switzerland.

The six hundred papers presented at the Congress, most of which were available in printed form, making four separate volumes, covered a wide field of problems, the most important being the influence of climate on soils, soil structure, soil colloids, acid soils, saline and alkali soils and their reclamation, phosphate and potash contents and nutrition, nitrogen transformations, soil micro-organisms, symbiotic, non-symbiotic, photochemical nitrogen fixation, trace (oligo) elements, forest soils and desert soils. Each author was given a quarter of an hour for outlining his contribution, followed by a discussion lasting 15–20 minutes.

In the afternoon of September 1 there was an interesting colloquium on fertilization and production of paddy, in which several soil scientists from Japan, China, India, the Congo and other tropical parts of the world took active part. A session on the morning of September 8 was devoted to a colloquium on the physico-chemical aspects of mineral nutrition by the plant roots. Some interesting papers were read; but there was no general unanimity of views regarding the mechanism of this process in crop production. As a side-issue of the Congress, there was an important colloquium on leaf analysis and plant nutrient supply, organized by Dr. P. Preaud, in which an introductory paper by Prof. T. Wallace was read.

Dr. Bruin, of Holland, put forward the proposal that soil scientists hailing from temperate countries should co-operate in obtaining accurate data on the influence of nitrogenous fertilizers in crop production, and he arranged the convening of a meeting for this purpose in Groningen in November. It is well known that nitrogenous fertilizers are not much used in Asiatic countries, where the majority of the human beings of the world subsist. Moreover, only 3 per cent of the world crop yield has been attributed to artificial nitrogenous fertilizers, as reported at the meeting of the British Association in 1949 in Newcastle (see *Nature*, 164, 597; 1949): "At present only some three per cent of the world food production can be attributed to the use of nitrogenous fertilizers To raise the available food by ten per cent, that is to say, one hundred million tons, involves a fourfold increase in supplies of fixed nitrogen, at an approximate capital cost of £1,500,000,000. . . . This . . . would take a minimum of 15 years to achieve". Hence, even to-day world food production has to be mainly attributed to the soil nitrogen present in the soil organic matter or humus, the study of which from different angles attracted the attention of a large number of members of the Congress.

On September 7 there was a whole-day excursion for the study of soil profiles and other topics of agricultural importance in the Paris area. After the Congress, excursions lasting a week were made in different parts of France for the study of soils. In addition, on September 2 several members were taken around the National Agricultural Research Institute at Versailles, and the following week a group visited the Institute at Bondy, 20 km. from Paris, for training French soil scientists for work in the Colonies and research work on problems of Colonial agriculture.

The general conclusion among members was that this Congress not only contributed to the difficult problem of the amelioration of the world food situation, but also achieved progress in international fellowship and goodwill in the friendly atmosphere of the meeting and parties. The next Congress will be held in the United States in the summer of 1960 under the presidency of Prof. R. Bradfield, of Cornell University.

N. R. DHAR

UNITED NATIONS TECHNICAL ASSISTANCE PROGRAMMES

THE eighth report of the Technical Assistance Board to the Technical Assistance Committee of the United Nations Economic and Social Council* describes the progress and developments during 1955 of the Expanded Programme of Technical Assistance for Economic Development and includes also some details of activities to be undertaken in 1956 and of plans for 1957. The general level of activities was markedly higher, and the contributions of 27·9 million dollars from seventy-one countries, compared with 25 million dollars in 1954, permitted assistance to be given to a hundred and one countries and territories. At the end of the year, some fourteen hundred experts were collaborating with their counterparts in the less-developed countries, and while it is not practicable to isolate the impact of technical assistance on economic development or to measure it precisely, it is clear that significant results have been achieved in many technical assistance activities.

During the year, geological maps of forty-five regions of Bolivia, to be used in prospecting for oil and other minerals, were completed, as was a similar survey in the Yemen. The first geological map of Nepal is being prepared, and a geological survey institute was set up in Afghanistan. Assistance was given in aerial surveys of forests in Brazil and Iraq, and surveys of ground-water resources in Jordan and Pakistan were being expanded, while in Indonesia a team of eight experts assisted the National Planning Board with the preparation of a five-year development plan and investment programme. Expert advice and the assistance of workers trained abroad under fellowships has enabled the production of DDT and penicillin to be commenced in Chile, Egypt, India, Pakistan and Yugoslavia, while the petrochemical industry in Venezuela has been assisted in the establishment of what will be the largest factory in South America manufacturing fertilizers and insecticides. Assistance given since 1951 to the cottage and small industries of Burma has led to these industries playing an increasingly important part in the country's economy, while throughout the world, nearly a thousand engineers, foremen and skilled workers from all branches of industry have been trained under the worker-trainee programme and large vocational training schools have been opened in Brazil, Guatemala, Haiti, Indonesia and Iran.

Port and shipping experts were assisting the Governments of Jordan and Yemen with the reconstruction of the ports of Aqaba and Ras-el-Khatib, and nineteen countries received expert advice on the improvement of their civil aviation; more than 1,140 students completed courses at schools in various countries of the International Civil Aviation Organization during 1952–55. Irrigation and land reclamation received much attention in Syria and in large river basins such as those of the Ganges–Brahmaputra, the Tigris and the Euphrates. In a pilot area of 230,000 acres on the right bank of the Ganges in East Pakistan, about one-fifth of the main canal has been excavated with the support of the Colombo Plan and the International Co-operation Administration of the United States, and it is expected that irrigation water will be available in the Kushtia area by the end of this year. Recommendations made by specialists of the Iraqi Development Board on the advice of a geologist of the United Nations Food and Agriculture Organization have led the Government to allocate 4·5 million dollars for drilling wells, fifty of which have been completed or are under construction. A pilot area on the Volta River in the Gold Coast has been brought under experimental cultivation, and in Afghanistan, Egypt, Iraq and Libya demonstrators have been trained to introduce new techniques and improved small tools to farmers. Some of the field workshops in the large-scale farm-mechanization plan of Uttar Pradesh in India have increased their output by nearly 300 per cent, and more than five hundred instructors and operators have been trained by international experts.

New varieties of cotton are being tried in Iran, and cultivation trials in Yugoslavia have given a substantially increased yield of cotton per acre. Programmes for increasing the production of wheat and rice have been undertaken in Egypt, and a scheme for developing coffee cultivation has been started in Ethiopia. Assistance given in Central America and Mexico has enabled local authorities to keep the locust plague under control everywhere except Northern Honduras, and the control of olive and fruit flies has been developed in Libya. With the building up of supplies of vaccine to control rinderpest and other animal diseases in Afghanistan, Austria, Burma, Ceylon, Ethiopia, Honduras, India, Iraq, Pakistan, Thailand and Yugoslavia, the emphasis of technical assistance has shifted to the organization of field control schemes.

The training of school teachers has from the start been an important feature of the Expanded Programme of Technical Assistance, and in 1955 more than a thousand rural teachers attended courses in Haiti, while about 2,500 have been trained in the Philippines since work started in 1953. In Indonesia more attention has been paid to training teachers for rural communities, while assistance in teaching science has ranged from the organization of a chemica laboratory and of a scientific instruments centre for the National Council of Research in Egypt to the development of institutions for arid zone research in Brazil and Peru. In Turkey the Institute of Hydrology has now reached the stage when its work can proceed satisfactorily under the direction of nationa staff, and an international team, which in 1954 completed the organization of a scientific and technica documentation centre in Mexico for the Latin American countries, is organizing a similar centre in Egypt to serve the Arab States.

Much assistance has been given to governments i training health staff, the control of communicabl diseases and in strengthening national health services. During the year about 570,000 persons in Morocco and Tunisia were treated for trachoma, a high percentage of cures being obtained. Measures were taken to protect about two-fifths of the estimated population of South-East Asia against malaria, and epidemic malaria is no longer prevalent in about half the island territories of the Caribbean; but it has become a matter of urgency to intensify the effects to eradicate malaria in these regions before the anopheline vectors develop too great a resistance to the insecticides at present used for their control. In Indonesia the mass campaign against yaws has brought the disease under control in about thirty areas, while in Thailand 7·5 million people have been surveyed and about 750,000 treated for the same disease. As examples of assistance given to improve housing conditions, the report cites the establishment in India of a research centre to study the socio-economic and technological aspects of housing development in a dry tropical climate and of another in Indonesia to study these factors in a humid tropical climate. More than a thousand Civil servants of various grades received training during the year, and in Jordan, on the recommendation of an expert on Civil Service reform, a Civil Service Department and a Civil Service Commission were set up; technical consultants in Bolivia helped to draft legislation establishing a permanent Civil Service, and the postal services in Iran, Lebanon and Uruguay have been considerably improved as a result of international advice and assistance.

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* United Nations: Technical Assistance Committee. Eighth Report of the Technical Assistance Board. (Economic and Social Council. Official Records: Twenty-second Session, Supplement No. 5.) Pp. vi+104. (New York: United Nations; London: H.M.S.O., 1956.) 1 dollar; 7s.; 4 Swiss francs.

Although most of the experts supplied in 1955 were recruited from Europe and North America, they were drawn from sixty-nine countries and territories, and workers in receipt of fellowships studied in ninety-four. During the year, 2,431 fellowships were granted, as compared with 1,524 in 1954 and 1,195 in 1953, and there has been a growing trend towards the establishment of training institutes within countries which are receiving technical assistance. Special attention has been paid to co-ordination of the technical assistance provided under the expanded programmes and under bilateral aid programmes, while the general financial stability of the Expanded Programme considerably improved during the latter part of the year.

INDIA'S CONTRIBUTION TO THE HISTORY OF MEDICINE

THE publication, in June, of the first number of the *Indian Journal of the History of Medicine** is in itself an event of historic importance. Much of the credit for this noteworthy step is due to Prof. D. V. Subba Reddy, who founded the Indian Association of the History of Medicine nine years ago, and became its first secretary. Prof. Reddy is editor of the new *Journal*, which is to be the organ of the Association and will be published twice a year, and he will also shortly vacate his chair of physiology in the University of Madras in order to assume the duties of a chair of history of medicine, the first of its kind in India.

By the creation of a new chair and a *Journal*, India has recognized, most opportunely, the importance of a historical perspective in medicine. The Medical Education Conference, set up by the Government of India, which met in Delhi in November 1955, acted wisely in recommending that history of medicine should be included in the medical curriculum. This decision was made for several reasons. Not only has the subject a special cultural and humanistic value, but also, as the report of the Conference states, "after studying the history of medicine, the future medical practitioner will be better equipped for his profession under conditions prevailing in this country. Our people think and talk about their illnesses in terms of ideas and expressions based largely on our ancient systems of medicine. How can a physician understand fully what his patient describes as his symptoms unless he has an acquaintance with these ideas and ways of giving expression to them?"

This very appropriate argument in favour of the study of medical history may not apply in every country, but it is certainly valid for India. Events have moved rapidly, and already the report has borne fruit. Dr. Reddy is to be warmly congratulated on the high standard which has been attained in the first number of his *Journal*. It is a veritable mine of information on the early medicine of India and the East. The opening paper, which was originally an address to the Association, is a scholarly contribution by Prof. J. Filliozat (French College at Pondichery) on Ayurveda and foreign contacts, showing the links between Indian medicine and Greek medicine; Prof. P. Kitumbiah (Christian Medical College, Vellore) contributes a paper on the concept of heart and blood-vessels in ancient Hindu medicine; and Prof. M. V. Sastry (Madras) writes on training for medical practice in ancient India. Prof. Reddy himself supplies an article on Buddha's discourses on medicaments, treatment and nursing; other authors deal with nursing under ancient Indian systems, with Arabian medicine and with Rhazes' *magnum opus*, "Al-Hawi, or Continens". The *Journal*, which is well produced and clearly printed, will be published twice a year. It deserves every encouragement.

This recognition by India of the importance of history in medicine is a welcome sign of progress. Many other countries have become aware of their medical heritage. Throughout Europe, nearly every university has its chair of history of medicine and there are many institutes which serve as centres of knowledge. In the United States and in South America, especially in Brazil and Venezuela, close attention is given to the history of medicine.

Towards this widespread awareness of the value of history as a cultural and ethical basis of medical education, Britain alone shows an attitude of almost complete indifference. In London, the Wellcome Historical Medical Library and Museum continue to stimulate and keep alive an interest in the past, as also do the various societies of history of medicine, in England, Scotland and Ireland. The tale of neglect is truly surprising. Nevertheless, a more cheerful attitude is foreshadowed by the recent news that a British journal—the only one of its kind—entitled *Medical History*, will commence publication next January under the editorship of the well-known medical historian, Mr. W. J. Bishop, and will appear quarterly.

One of the strongest arguments in favour of medical history is that it directs attention to the ever-present need for an application of the principles originally embodied in the Oath of Hippocrates. Recognizing this need, the universities and medical schools of Europe, since the days of the School of Salerno, have demanded of their graduands some form of promise based upon the Hippocratic Oath, and this practice is now followed in many parts of the world. In Britain, although each of the four Scottish universities follows the age-long tradition, only two or three of the many English universities accord any official recognition to the great charter of medical conduct which has come down to us through the centuries from the time of Hippocrates. Surely a knowledge of such ethical principles, if not also of the pioneers who codified and practised them, should be regarded as a feature essential to every medical curriculum ?

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* *Indian Journal of the History of Medicine*, 1, No. 1 (June 1956). Pp. iv+69. (Madras: Indian Association of the History of Medicine, 1956.) Rs. 8 per year (two issues) or foreign currency equivalent to Rs. 12.

Accordingly, while we in Britain may well congratulate our Indian colleagues upon their foresight in appreciating the value of the historical aspect of medicine, we may at the same time feel ashamed of our own failure to do so. There is still much to be accomplished in the reform of medical education, and, if medicine is to remain one of the learned professions, more stress must surely be laid upon ethics and humanism, which only reveal their importance during a study of the history of medicine. For Hippocrates, medicine was ever "The Art". Only as an art can it preserve its fine tradition. All honour, therefore, to India for reminding us that only by looking backward can we recapture the true spirit of medicine. In this way alone can we effectively face the future.

Douglas Guthrie

THE MYXOPHYCEAE AND CHLOROPHYCEAE OF NEW ZEALAND

Some comparatively recent American marine Floras have set a satisfactory standard against which a reader is prone to measure new works of a similar kind. Of prime scientific importance would seem to be the provision of concise but complete diagnoses of the various taxa, namely, orders, families, genera and species, including details of both vegetative and reproductive characters. Good keys based on easily discernible characters (and, so far as possible, macroscopic features of the vegetative parts of the thallus) should lead to the relevant descriptions. Good illustrations should reinforce the statements about the salient characters of the genus, both vegetative and reproductive. In some genera this would need to be supplemented by illustration of one particular character for all the species, where it is of prime taxonomic importance. Lastly, in a group of plants in which terminology is notoriously imprecise, a glossary is necessary. From the practical point of view, a Flora should be of manageable size and provided with firm covers.

The first part of the "Marine Algae of New Zealand", by Prof. V. J. Chapman, that dealing with the Myxophyceae and Chlorophyceae (*J. Linn. Soc. Lond.*, 55, No. 360, 333–501; July 1956; 42*s.*), falls short of these standards. Since the work is published in a journal, the author may not have had an orthodox Flora as his aim; but if not, what was it, as the paper has the form of such but without much of the substance ? The species descriptions are brief and would probably prove difficult, therefore, for beginners. One of the shortest is that for *Ostreobium reineckei* Born., namely: "Filaments intricately spreading, the ends of the branches consistently free". Even the newly described species are not given very lengthy treatment. Throughout the work, mention of the reproductive organs is very meagre, and illustrations of these parts of the thalli are conspicuous by their absence. References to other works are given under the binomial system; but it is not clear what rule has governed the choice of citations when it is not the original description. Keys at the beginning of each of the two sections lead to families and not orders and yet keys are given again under each order to the families of that order, so that there is considerable duplication. The Wittrockiellaceae is an exception, as it occurs under the order heading only. No glossary is provided, and sometimes the choice of terms is not good; for example, "plant body". Again, in Table 1 "exposure" is used to mean something different from the same word on the opposite page (p. 339), where it is the equivalent of emergence (cf. p. 335). "Filamentous" is also used in more than one sense, in some instances to signify the construction of the thallus and in others to describe its filiform shape.

An editor's note explains that the twenty-seven plates are reproduced as faithfully as the quality of the illustrations provided allowed, and this would appear to be the case. Legends for these plates would have added to their value, especially since notes on the illustrations are not always legible. Some of the one hundred and fifty-three text-figures, which are the work of the author and his associates, lack information about magnification and also precision as regards other details. Hence they are not always as informative as could be wished. In spite of its certain lack of perfection, the work is a considerable advance on Laing's list of 1926. In the latter, there are only seven species of Myxophyceae and forty-six Chlorophyceae, whereas in the work under review there are fifty-four species of Myxophyceae and two hundred and five species of Chlorophyceae. This indicates the amount of work which has gone into the preparation of this Flora in the comparatively short amount of time since Prof. Chapman went to New Zealand. Moreover, the paper was read at the Linnean Society more than two years ago.

Although the number of species of Myxophyceae listed is greatly in excess of that of Laing's list, the author points out that it is likely that more exist on the shores of New Zealand, and this is doubtless the case. The species known already are ones with a wide distribution in the world and there is only one doubtfully endemic species, *Tolypothrix irregularis.* In contrast, out of two hundred and five species of Chlorophyceae listed, ninety-two (47 per cent) are endemic. Some of these have a restricted distribution so far as is known at present. The new genus, *Gemina*, is characteristic of southern cold waters, and *Bryopsis* is a conspicuous genus in South Island, from which district have come species not previously described. The author goes so far as to suggest that the South Pacific is either the home of the genus or that active evolution is taking place around the shores of New Zealand. The genera *Lobata* (Ulvaceae) and *Rama* (Cladophoraceae) as well as *Gemina* (Ulvaceae), all described earlier by Chapman, are included in the Flora, as well as many new species.

In the Myxophyceae, the author has accepted Drouet and Daily's (1948) views on the classification of the Chamaesiphonaceae, but apparently not on the Chroococcaceae. The classification is said to be that of Fritsch (1945). Likewise, although the author states that the classification of the larger taxa of the Chlorophyceae in this work follows that of Fritsch (1935), this is not strictly so, but is modified, as Chapman has himself advocated in other papers. Five families, the Ulotrichaceae, Monostromaceae, Ulvaceae, Caposiphonaceae and Prasiolaceae, are included in the Ulotrichales. The Siphonocladales also has not the same limits as the Cladophorales in Fritsch's book of 1935. However, this is not the place to digress into questions of the much-debated classification of the Chlorophyceae; but it is perhaps opportune to emphasize that the existing classificatory systems rest primarily on the comparative morphology of the adult thalli and that there is need that this should be supplemented by intensive studies of developmental morphology and life-histories. As for the smaller taxa, the Chlorophyceae includes some genera which are notoriously difficult, such as *Ulva*, *Enteromorpha* and *Cladophora*, genera which would provide suitable material for investigation by one of the modern methods of taxonomic treatment such as have been used successfully for 'difficult' genera of higher plants. Here they are classed as species, varieties and forms; but in the case of *Enteromorpha*, Chapman uses "*ecad*" as a taxonomic term. This may indicate his views on the cause of variability in this genus; but its use here is valueless as well as illegitimate.

KATHLEEN M. DREW

AGRICULTURAL RESEARCH AT THE SUDAN CENTRAL RAINLANDS STATION, 1952–56

By DR. A. H. BUNTING*

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THE clay plains of the eastern Sudan occupy many thousands of square miles under normal annual rainfalls of 500–800 mm. In 1952, following several years of experience of partly mechanized sorghum production in part of the region[1], the Research Division of the Sudan Ministry of Agriculture opened the Central Rainlands Research Station (Tozi Research Farm) to explore its wider potentialities. Tozi is about a hundred miles south of Sennar and eight miles west of the Blue Nile (lat. 12° 30′ N., long. 34° 00′ E. approximately). The fifth season of farming and research is now in progress on about 1,300 acres, while housing and essential services have been produced for a community of several hundred, and simple offices and laboratories have been built and partly equipped. The senior staff has fluctuated from three to eight. This article records the more significant results and indications of the work so far.

The programme has been based on the study of crops in the field. About 1,700 rows and plots of a wide range of crops and varieties were grown in 1952 for observation and selection. American cotton, sorghum, groundnuts, sesame and safflower (and more recently maize) appear best suited to the conditions. In 1953 simple and separate trials were used for locating the critical ranges of crop population, planting date and fertilizer nitrogen-level in the main crops, and bulk production, mechanized so far as possible, occupied about 1,000 acres. In the third season somewhat complex multifactorial experiments were introduced to unravel the interrelations of crop population, nitrogen-level, varietal type and sowing date. Around this central agronomic core, soil, plant protection, breeding and other specialist studies have developed. Results, indications and even speculations from research and production are co-ordinated to guide the field-cropping programme each season, so that progress is by successive approximation. Conversely, an annual analysis of field-scale results opens up new lines for research.

The Environment

Over four seasons the rainfall has averaged 680 mm., against a probable normal value of around 700 mm. (about 27½ in.), mostly received during June–October. Part of it falls in cyclonic storms, the intensity of which has varied seasonally. During July–September the temperatures are buffered around 30° C. maximum, 20° C. minimum, with dew points around 20° C. In late October the southerly transit of the intertropical front suddenly brings in dry air and markedly increases evaporation-rates. The dry season (November–May) is long and hot (up to 44° C. max.), though the winter nights (December and January) are cool.

The vegetation is an *Acacia* spp. (largely *A. seyal*), open woodland with tall grass, 10–15 ft. high, with areas of open grassland of various types. The grasses are almost all upright annuals, burnt off each year by fierce bush fires. The stringent ecological conditions restrict the number of plant species to about three hundred; most of the important forms are legumes. Methods for ecological land-use selection have been broadly determined.

Soils and Water Relations

The soils are formed from deep unleached, alkaline alluvial clays, and have about 70 per cent montmorillonitic clay content and *p*H 8·5–9·0. They are fully plastic at field-capacity and crack heavily on drying, while the top few inches fall to a friable mulch. Their colour and extent of base accumulation (but not their content of clay, nitrogen or organic matter, which is less than 1 per cent under natural vegetation) are related to slight topographic differences: lower sites are darker and more alkaline, with more salts and calcium carbonate.

There is no permanent water-table in the soils. After the rains they are dried to wilting point (20–25 per cent moisture on dry weight or less) by transpiration or evaporation. In the new season, water enters, at first down the cracks and then by bulk penetration with a defined front. The ultimate depth of penetration depends on the current balance between percolation and evapo-transpiration, which in turn depends on the seasonal rainfall pattern. The penetration in undisturbed bush, where transpiration starts soon after the first showers, seems generally less than in cropped fields sown a few weeks later. Concentrated rainfall can lead to serious local flooding on unplanted land, so that permanent surface drainage systems may prove essential.

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Since crop roots do not enter the physiologically dry soil below the water front, the depth of soil exploited for nutrients and water also depends in part on the rainfall pattern, as well as on the root behaviour of particular crops or varieties. This broadens considerably the concept of soil fertility. Though nitrogen is the only nutrient to which responses are regularly obtained, they have been economic so far only in groundnuts and maize. Cotton and safflower, the growth of which at Tozi is primarily restricted by water shortage, do not respond, and sorghum and sesame are intermediate. The response in groundnuts perhaps reflects the relatively late stage of the crop's short life (90–95 days at Tozi) at which nitrogen becomes available from the numerous, large and apparently effective nodules. Important phosphate effects have been seen only in maize, while potash improves leaf appearance in Virginia tobacco. Zinc is important (together with nitrogen and phosphorus, though the interactions have yet to be worked out) only for maize; but this appears to be more a question of poor root penetration than of a soil deficiency in the conventional sense. No doubt if humus were more abundant, trace element shortages would be more frequent.

Crop sequence experiments were started in 1952 using a two-year design measuring residual effects of crops, fallows and fertilizer nitrogen. Many of the effects can be interpreted conventionally in terms of nitrogen or water relationships. Maize and sesame do not penetrate the soil far enough to use all the available water, so that some accumulates. Bare fallowing checks subsequent crops, even if the stored water is removed with late-sown safflower; but striking benefits of half-fallowing have been seen.

Crop Breeding and Agronomy

A collection of nearly a thousand local and introduced varieties of sorghum is maintained at Tozi. Three high-yielding combine varieties, selected from indigenous material, are being grown on a field-scale in 1956. The optimal population ranges and planting dates are found to be respectively higher and earlier than has been usual in the past, with the result that yields of 2,500–3,500 lb./acre are common in experiments, while 79 acres of bulk production in rotation averaged 2,200 lb./acre in 1955.

The highest-yielding cotton varieties tested have been the Sudan-bred blackarm resistant BAR. 7/8.1 and BAR. 7/8.2. Early sowing (June) and high population (more than 30,000 plants/acre) have given experimental yields of 1,500 lb. seed cotton/acre and more; field-production in 1955 averaged about 1,170 lb./acre on 86 acres, and a small area, about a third of an acre, following an accidental half-fallow, yielded at the rate of 2,200 lb./acre.

More than 250 uniform, classified varieties[2] of groundnuts are maintained. The upright bunch variety, Barberton, established for several years in the Sudan, has hitherto proved the best; but progeny testing has now given similar experimental yields from the newly introduced Natal Common. Yields of 1,500 lb. kernels/acre are quite common, and well over a ton has been harvested, in experiments, while field yields averaged 900 lb./acre on 106 acres in 1955. High populations (60–80,000 plants/acre) and timely harvesting are essential.

Breeding programmes in sesame aim at transferring the Venezuelan indehiscence, and the early and profuse flowering of certain American types, to the local material, which is at present used in field-production. Root penetration is relatively poor, and the crop is sensitive to drought in its later stages. While experimental yields have reached 1,200 lb./acre of seed, the general run is similar to the field-yields at 500–700 lb./acre.

Safflower, a crop extremely resistant to drought, is sown late after a summer fallow, to mature on stored moisture. Yields are unaffected by fertilizer or variations in population. Selection is aimed at the production of early and profusely flowering upright types. Field yields are 400–500 lb./acre only, although in experiments up to 1,200 lb./acre has been realized.

The work on maize nutrition at Tozi (see above) permitted the production of this crop on the clay plains for the first time in 1955. Introduced varieties including hybrids yielded 3,000–3,800 lb./acre in preliminary observation plots and rows; local Sudan material (from recent riverain silts) gave 2,000 lb./acre on 6 acres.

Minor crops studied include deccan hemp (kenaf), sunflower (where some progress seems to have been made in concentrating a self-fertilizing character), soya bean and Virginia tobacco. The local perennials Rhodes grass (*Chloris gayana*) and *Clitoria ternatea* (a prostrate legume) seem likely to be useful, perhaps in mixture, in sown pastures.

Crop Protection and Farming Practice

Though many potential sources of trouble, including stainers, bollworms, grasshoppers, stemborers and the *Puccinia polysora* rust of maize, have been recorded, no serious attacks of pests or disease have so far occurred at Tozi. Rosette disease of groundnuts is absent from the region, and the cotton varieties in use are sufficiently resistant to blackarm. Soil-borne diseases and pests of the seed-bed make it essential to use combined insecticidal and fungicidal seed dressings for sorghum and groundnuts, and for the latter a soil dressing of 1 lb./acre of dieldrin is standard practice and helps to control thrips and termites.

All land preparation, sowing, inter-row cultivation, ridging and field spraying are mechanized, though on a heavy clay soil under tropical rainfall a high degree of farming skill is necessary to use machinery efficiently. Sorghum and safflower are combined. Groundnuts can be harvested, threshed and decorticated mechanically, but so far the operations are slow and require very careful timing and organization. Cotton and sesame are harvested by hand at present. Tractor-hour records suggest that all the main crops, and particularly cotton and sorghum, are economic at the present levels of field-yield.

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[1] Sudan Government, Ministry of Agriculture, 1954. Working Party's Report on the Mechanical Crop Production Scheme. Rotaprint. Pp. iv+48+22 diagrams.

[2] Bunting, A. H., *Emp. J. Exp. Agric.*, 23, 158 (1955).

MARINE FISH FAUNA OF THE GOLD COAST

By Dr. E. A. SALZEN

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PART of the work of the West African Fisheries Research Institute is to explore the whole of the West African continental shelf for potential trawling grounds, and to determine the nature and extent of such grounds for possible future exploitation. A recent survey with the F.R.V. *Cape St. Mary*, a 100-ft. diesel trawler, of the continental shelf off Tema in the Gold Coast gave results which are of considerable interest because of their similarity with those obtained by Postel[1] working off French Guinea. Yet these two areas are a thousand miles apart and the French Guinea shelf is more than 70 miles wide compared with 14 miles at Tema. It may be, therefore, that the results for Tema are typical of a great deal of the West African shelf in the dry season.

The survey covered the whole of the shelf for 20 miles on either side of the port of Tema. Twenty-eight stations in depths of 10, 20, 30, 50, 100 and 200 fathoms were distributed in five transects at eight-mile intervals along the shelf. Fifty-eight hauls were made, mostly of one hour duration. One day and one night haul were made at each 10–50 fathom station, and one day haul was made at each 100 and 200 fathom station with hauls of 2-hr. duration at the latter depth. All the hauls were made with the same gear (Peter Carey trawl, 72 ft. head-rope, 10 ft. legs, 15 fathom sweeps and Dan Lenos with rollers), towed at the same engine speed but in varying relation with the direction and speed of the tide. Three hauls were made at each station on one of the transects in order to obtain a measure of the variance in rate of catch for the same ground. This showed that the variance and mean rates of catch for different stations at the same depth did not differ significantly from the variance and mean rates of catch for repeated hauls at the same station and same depth. This suggests that the fish population in the Tema area does not vary along the shelf.

The results for the hauls were, therefore, grouped according to depth. The rates of catch for the various depths and for day and night trawling are shown in Table 1. They are comparable with rates of catch obtained by Whiteleather and Brown[2] in the Gulf of Paria and off British Guiana, and with fishing in Australian waters reported by Houston[3] and Fairbridge[4]. They are better than the results obtained off Bombay by Hefford[5] and on the Patagonian shelf reported by Hart[6]. The changes in rate of catch with increasing depth are very similar to those found by Postel for the French Guinea shelf. The correspondence between this region and the Tema area extends to the nature of the bottom and to the nature and distribution of the fish species, the same species occurring at the same depths in both areas. Postel found a distinct change from euryhaline and eurythermal species in the shallow inshore water, to red and brown marine species below 10 fathoms. The results for the Tema area show the same change involving the same species. In addition, as can be seen from Table 2, there is a more subtle change in species which takes place from 20 to 100 fathoms. The predominant species change with depth, and this is a very important change from the fishery development point of view because the species become of smaller average size and lower commercial value with increasing depth. At 200 fathoms the fauna appears poor and abyssal in nature, with a few coryphenids and stomiatids.

Table 1. RELATION BETWEEN RATE OF CATCH AND DEPTH FOR DAY AND NIGHT TRAWLING

Depth in fathoms	Day fishing		Night fishing	
	No. of hauls	Rate of catch kgm./hr.	No. of hauls	Rate of catch kgm./hr.
10	10	98·6	5	127·9
20	7	78·4	6	156·6
30	8	69·6	4	94·6
50	5	46·5	4	97·0
100	5	103·5	—	—
200	2	1·4	—	—

Table 2. DISTRIBUTION WITH DEPTH OF THE PREDOMINANT FISH SPECIES IN THE TEMA AREA

The table shows the number of hauls in which more than 1 kgm. of the species occurred expressed as a percentage of the total number of hauls at that depth. The species are therefore the ones which are of economic importance

	Percentage frequency of occurrence (values greater than 25 per cent only)				
Depth in fathoms	10	20	30	50	100
Species					
Otolithus macrognathus	33	—	—	—	—
Ephippus lippei	27	—	—	—	—
Drepane africana	67	—	—	—	—
Scoliodon terrae-novae	53	—	—	—	—
**Hemiconiatus guttifer*	47	—	—	—	—
Balistes forcipatus	27	—	—	—	—
Galeoides decadactylus	33	—	—	—	—
Lethrinus atlanticus	33	31	—	—	—
**Ostracion tricornis*	40	54	—	—	—
Lutjanus maltzani	47	38	33	—	—
Pagrus ehrenbergii	60	77	67	36	—
Lutjanus guineensis	—	38	—	—	—
Epinephalus aeneus	—	54	58	—	—
Cephalacanthus volitans	—	46	33	—	—
Pagellus sp. aff. *P. erythrinus*	—	31	75	82	40
Otoperca aurita	—	—	50	27	—
Selar crumenophthalis	—	—	25	27	—
**Lepidotrigla cadmani*	—	—	42	64	80
Priacanthus arenatus	—	—	—	45	—
Umbrina canariensis	—	—	—	27	40
Sciaena sp.	—	—	—	25	80
Dentex congoensis	—	—	—	36	60
**Antigonia capros*	—	—	—	—	60
Smaris macrophthalmus	—	—	—	—	60
Scomber colias	—	—	—	—	60
**Trigla lyra*	—	—	—	—	40
Hypoclydonia bella	—	—	—	—	40
Families, etc.					
Ephippidae	40	—	—	—	—
Drepanidae	67	—	—	—	—
Lutjanidae	47	54	31	—	—
Serranidae	—	—	54	—	—
Sciaenidae	47	—	—	36	60
Pomadasidae	47	38	62	30	—
Sparidae	60	77	92	100	80
Flatfish	—	46	33	27	40
Skates and rays	60	77	—	64	40
Sharks	80	—	83	45	40

* Non-marketable species

The correspondence between the Tema area and the French Guinea shelf poses the question as to whether the same description will hold for the greater part at least of the West African shelf. An extensive trawling and hydrographic survey of the region, from Dakar to the Cameroons, was made by the *Cape St. Mary* during 1952–53. The results of this survey, though not very detailed, tend to support such a generalization. The eurythermal and euryhaline fish fauna inshore of the 10-fathom line suggests that the water of this region is subject to fluctuations in temperature and salinity, probably as a result of heavy rainfall and freshwater run-off from the land. It is interesting to note that both the extent of this region and the rainfall are smaller in the Gold Coast than in French Guinea. The inshore region of French Guinea (Postel[7]) and indeed of much of the West African coast (unpublished results of the *Cape St. Mary* cruises, 1952–53) is greatly affected in salinity and temperature in this way. Currents and upwelling may be important modifying factors because of their mixing action. In their absence, stratification with its usual adverse affect on the fauna would tend to occur. It is possible, therefore, that heavy rainfall and freshwater run-off from the land are important factors, though not necessarily the only factors, in determining the nature and distribution of the inshore fish fauna of West Africa.

I wish to thank the Director of this Institute for permission to publish this work. A full account will be published elsewhere.

[1] Postel, E., *Cons. Internat. Explor. Mer, Rapp. et Proc.-Verb.*, 137, 10 (1955).

[2] Whiteleather, R. T., and Brown, H. H., "An Experimental Fishery Survey in Trinidad, Tobago and British Guiana" (Anglo-American Caribbean Commission, U.S. Government Printing Office, Washington, 1945).

[3] Houston, T. W., Technical Paper No. 2, Division of Fisheries, Commonwealth Sci. Indust. Res. Organization, Australia (1954).

[4] Fairbridge, W. S., *J. Coun. Sci. Indust. Res., Australia*, 21, 75 (1948).

[5] Hefford, A. E., "Report of the Work of the Steam Trawler, *William Carrick*". Dept. of Industries, Government of Bombay (Government Central Press, Bombay, 1923).

[6] Hart, T. J., Discovery Reports, 23, 223 (1946).

[7] Postel, E., *Cons. Internat. Explor. Mer, Rapp. et Proc.-Verb.*, 137, 5 (1955).

MODIFICATIONS OF MICROSCOPIC TISSUE REACTIONS TO HOMOLOGOUS GRAFTS IN RABBIT PARABIONTS

By Dr. RICHARD H. ANDRESEN, Dr. CLARENCE W. MONROE, DOROTHY A. MADDEN and Dr. GEORGE M. HASS

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PREVIOUS investigations using musculofascial transplants have led to an accurate means for distinguishing between autografts and homografts by a microscopic study of the tissue reactions at the site of grafting. Though the musculofascial transplants did not survive permanently, they were suitable for our purposes for the following reasons: (1) resection and implantation could be done under strict aseptic conditions; (2) the grafts were simple in structure; (3) tissue for grafting was available in large amounts; (4) the transplants were sufficiently uniform so that they could be fractionated by available chemical methods without much variation in the composition of the fractions.

New Zealand rabbits of the same source and strain were used. Autografts and homografts of erector spinæ muscle were regularly made to sites comparable with those from which the grafts were resected[1]. After the first week, transplants were well healed in place. Thereafter, gradual organization and resorption ordinarily occurred so that by the end of three or four weeks most of each type of transplant had disappeared. On this account, microscopic study of host–graft reactions at sites of transplantation were most satisfactory at the end of the second week. At this time autologous transplants were well healed in place. A bursal space had formed immediately over the transplant and just beneath the superficial fascia of the skin of the back overlying the transplantation site. A pannus of vascularized granulation tissue regularly grew over the fascia of the transplant forming the base of the bursal space. The fascia of the transplant was œdematous and thickened, presumably due to retraction. Vascular channels arising from the host and growing along with the pannus penetrated the fascia perpendicularly and ramified in the musculofascial zone. As vascularization occurred, the musculofascial zone became broad and filled in with a plexus of small vascular channels supported by proliferating fibroblasts and newly formed collagenous fibrils, which occupied the zone vacated by the resorption of subfascial skeletal muscle. Infiltration of inflammatory cells was negligible in the autologous grafts.

Microscopic study of homologous musculofascial transplants, two weeks of age, showed that patterns of degeneration and resorption of muscle with organization of the musculofascial zone began in much the same way as in the autologous transplants. However, there were factors in the host–homograft relationship which interfered with the successful completion of the autologous pattern of resorption and organization. These factors led to a massive infiltration of lymphoid cells into the musculofascial zone. This infiltration was accompanied by a variable amount of angiitis affecting small vessels within the pannus, fascia and musculofascial zone of the transplant. These microscopic findings allowed us to distinguish accurately between homologous and autologous transplants.

Although the above response which was designated as the basic homologous host–graft tissue reaction was characteristic of the microscopic response to an initial transplant, the nature of this reaction changed when multiple, successive transplants of musculofascial tissues to the same host were made from the same donor[1]. This change consisted of an acute thrombotic necrotizing reaction with hæmorrhage involving especially the musculofascial zone of the second and third transplants in succession. In connexion with this acute reaction, there was conspicuous impairment of fibroblastic proliferation and formation of collagen. Infiltration of lymphoid cells was also reduced, and most cells in the musculofascial zone were eosinophiles and polymorphonuclear leukocytes. This form of reaction was designated as an acute 'sensitized' homologous host–graft tissue reaction.

In an attempt to discover factors responsible for the basic and sensitized homologous host–graft tissue interactions, it seemed desirable to study the effect on the interactions of exposure of musculofascial transplants to X-irradiation and thermal treatment *in vitro* prior to transplantation[2]. These studies disclosed that by sufficient exposure either to X-irradiation at high and low temperatures, grafts could be so modified that the microscopic host–autograft and host–homograft interactions were identical. The observations also led to the conclusion that the customary host–graft interactions appeared to depend to a large extent upon the mutual admixture of proliferating vascularized mesenchymal tissues of the graft and the host. Anything which impaired the rate of proliferation or the admixture of the tissues seemed to impair the intensity of the homologous or autologous reactions. Indeed, the classical autologous and homologous reactions both disappeared when the thermal and irradiation treatments were sufficient to eliminate the stimulus to admixture, despite prolonged persistence of the grafts in the host.

In view of the apparent significance of the activity of the cells of the host, as well as those of the graft, it was decided to study the reactions which occurred between surgically united homologous tissues, each retaining its own blood supply. For this purpose, rabbits were joined surgically by the ears[3]. Within three to four days after surgical anastomosis, continuity of circulation between the two animals was demonstrated and the dermal epithelium of the parabionts was also united. Furthermore, collagen and reticulum were mutually deposited at the site of anastomosis so that a firm connective-tissue union between the two ears was established. After seven to thirteen days, it was no longer possible to demonstrate a cross-circulation; and its failure to persist was correlated with the development of an inflammatory reaction along the plane of anastomosis of the tissues. During this time the united dermal epithelial surfaces of the parabionts also became discontinuous. The infiltration of lymphoid cells and the angitic reactions on each side of the plane of anastomosis persisted almost unchanged for as long as five months in some animals even though the mesenchymal tissues remained firmly united by persistence of collagen and reticulum which had been deposited during the early stages of healing[4]. The question arose as to whether the persistent collagen and reticulum belonged specifically to each animal or whether the intercellular products resistant to the incompatibility reaction were a third compatible form of tissue developed by the joint activities of cells and fluid substrates of the two animals.

With the experience of repeated musculofascial grafting and the resultant sensitized reactions in mind, pairs of parabionts were separated and then reunited in parabiosis by surgical anastomosis of the two other ears. In these instances the aural junctions failed to heal and separated spontaneously on the fifth or sixth day after anastomosis. This was regarded as another form of sensitized homologous incompatibility reaction, for when a parabiont was united to a control animal which had never been in parabiosis, healing of the ears occurred in much the same way as between two control animals. These observations indicated that it might be profitable to make a microscopic study of the host–graft interactions to musculofascial grafts following parabiosis rather than to use inbred strains of animals in successful parabiosis, as had been done in a study of renal grafts[5]. Therefore, rabbits were united in parabiosis for periods of two to three weeks and then separated from one another. One group was reunited in parabiosis a second time and then separated a second time. Another group was placed in parabiosis but once. Animals in both groups were then cross-transplanted with musculofascial grafts derived from their respective parabiotic twins. The grafts and adjacent tissues showed two types of host–graft interactions which were about equally distributed between the two groups of parabionts. The first type consisted of a fibro-collagenous encapsulation of the transplant with excellent preservation of the architecture of the graft. There was no penetration of the graft by vascularized mesenchyme from the host.

The second type of reaction was similar to the first, except that vascular penetration of the graft by vessels arising in the tissues of the host occurred, often developing a strange angiomatous pattern of large patent channels which ramified throughout the fascia and subjacent musculofascial zone of the transplant. Despite the conspicuous vascularization, the musculofascial zone of the transplant was not materially modified because fibroblastic proliferation, collagen formation and inflammatory reactions did not occur. In other words, the characteristic features of either the basic or sensitized homologous host–graft interactions did not develop. The parabiotic response was very specific and was readily reproduced between parabiotic twins after separation for as long as ninety days. However, if cross-transplants were made between parabionts which had never been joined together, the incidence of the parabiotic type of host–graft interaction was reduced about one-half. When the musculofascial transplants to parabionts were obtained from animals which had never been in parabiosis or exposed to grafting procedures of any kind, the types of host–graft interactions at the site of transplantation in the parabiont were variable and unpredictable. These studies, however, did show that the parabionts retained the capacity to react with the classical homologous types of response to tissues derived from animals which had never been in parabiosis or subjected to free grafting procedures.

Further permutations of musculofascial grafts between control and post-parabiotic animals have indicated that about one-third of the control rabbit population falls into a class characterized as follows. If the parabiont reacted to the transplant from the control animal with a parabiotic type of reaction, transplants to the control animal from the parabiont were accepted by the control animal with an autologous-like tissue reaction. In other words, the parabiont's musculofascial tissues were almost as acceptable to the control animal as similar grafts from the control animal into itself. This observation led us to consider the possibility of carrying out successful homologous transplants with the assumption that by use of post-parabionts and non-parabionts a beginning has been made in developing a means for placing genetically impure strains of rabbits in groups according to their tissue types.

This study was supported by funds from the National Heart Institute, National Institutes of Health (*H*-1630), the Muscular Dystrophy Associations of America, Inc., and the Otho S. A. Sprague Memorial Institute.

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METHOD OF MOLECULAR FIELDS

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THE applications of ligand field (crystal field) theory have brought about a great deal of clarification in the realm of the magnetism, structure and spectra of inorganic transition metal complexes, mainly of the spin-free type. In this method the inorganic ion is placed in an electric field of suitable symmetry and the changes in the free ion energy-levels resulting from the Stark splitting of the free space five-fold degeneracy of the *d*-electrons are calculated.

The Stark field is supplied by a system of negative ions or by dipoles oriented with negative poles towards the positive ion, and under the perturbation thus caused the 'non-bonding' *d*-electrons of the ion assume the position of lowest potential. In a cubic field this perturbation causes a split of the *d*-levels into the now familiar essentially non(σ)bonding $d\varepsilon$ triplet, which decreases in energy, and the essentially non- or anti-bonding $d\gamma$ degenerate pair, which are shifted to higher energies.

It is important to point out that this general type of approach can be applied with equal success to elements in the periodic table prior to the first transition series, where the spin-paired behaviour is the rule rather than the exception. In its application to this class of compounds the term ligand, or crystal field, theory has little significance and is rather misleading so that it is suggested that the theory be called the method of molecular fields.

The essential difference between the approach in this case and in the ligand field theory consists in the use of positive charges as the origin of the perturbing Stark field. Positive charges are used because any atom in a spin-paired molecule acts towards its near neighbour as a source of positive potential, attracting electrons towards itself rather than repelling them as in the ligand field theory.

Consider the case of acetylene. As a first approximation we may consider a carbon atom at the origin of a set of Cartesian co-ordinates with unit positive charges at $(0,0,a)$ and $(0,0,-a)$, that is, along the z-axis.

Since no electric field can remove a Kramers two-fold degeneracy it is only the $2p$ orbitals which split in the linear Stark fields. This triply degenerate $2p$-level splits to give a low-lying singlet and a high-lying doublet. This splitting is indicated in Fig. 1.

It is easy to see even intuitively that the p_z orbital is the one depressed to lower energies and so its energy becomes much more compatible with the $2s$ atomic orbital.

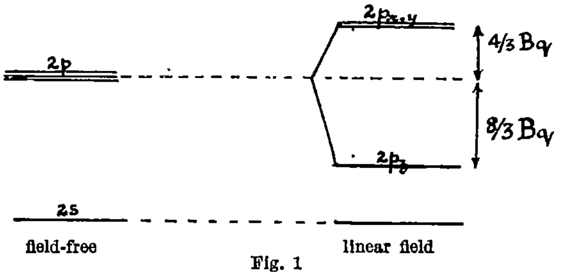

Fig. 1

The four electrons can now be fed into the levels and the configuration will depend upon the magnitude of the p splitting. Thus, if the splitting is large, then the configuration will be (ignoring the $1s$ electrons) $2s^2\ 2p_z^2$, giving a $^1\Sigma_g^+$ state.

This can also be shown for the states of the free carbon atom subjected to a very strong Stark field. The atomic states arising from the configuration s^2p^2, namely, ^3P, ^1D and ^1S, are split by the field as follows. The lowest atomic state ^3P is split into a pair of states $^3\Sigma_g^-$ and $^3\Pi_g$ (in $D_{\infty h}$ notation), ^1D gives rise to a low-lying $^1\Sigma_g^+(1)$ state and two higher lying states $^1\Pi_g$, $^1\Delta_g$, and the ^1S is not split but is now designated $^1\Sigma_g^+(2)$ (Fig. 2).

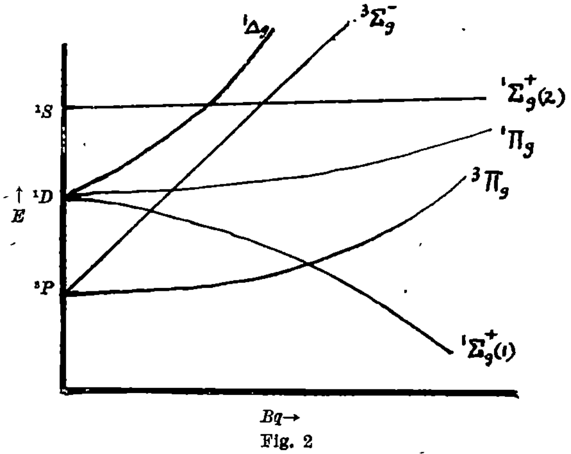

Fig. 2

If the field is not too strong then the $^3\Pi_g$ state will lie lowest and the configuration will be $2s^2\ 2p_z\ 2p_{x,y}$. In this case the excitation of an s electron to the $p_{x,y}$ shell will produce, among other configurations, a carbon atom with four parallel spins, the difference from the usual sp^3 configuration being that the p orbitals are no longer equivalent.

The solution of a perturbation secular determinant for the s- and p_z-levels will yield the familiar sp digonal or linear hybrid orbitals and these may be occupied by replacing one of the positive charges by a hydrogen atom with opposite electron spin to the bonding sp electron. The other positive charge may be replaced by a similarly constituted CH group also with opposite sp bond electron spin. Provided also that the p_xp_y electrons on the two CH groups are opposite in spin, then the two π bonds will form and complete the acetylene molecule.

The analogous case of ethylene can be similarly considered by using a plane trigonal array of positive charges in the x,y plane, when it is easily shown that the p_x and p_y energies fall and the p_z rises as in Fig. 3.

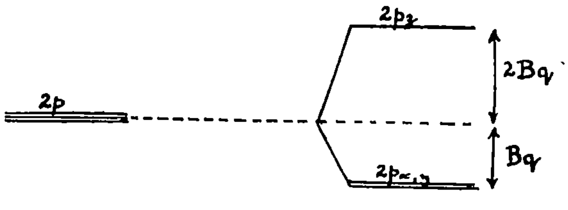

Fig. 3

The further splitting of the levels during 'covalent' or spin-paired molecule formation has been ignored in this preliminary discussion but can be included without altering the final results. The theory also shows that in the case of the tetrahedral carbon atom there is no splitting of the p shell and so all p orbitals are equivalent.

One important feature of this description is an added reason for the relative success of the σ–π electron approximation. The Huckel approximation thus owes part of its success to the differences in energy of the σ and π shells which develop under the influence of the Stark perturbation as well as the differences in symmetry of the shells, since electrostatic perturbations will be less effective in mixing orbitals with greatly differing energies.

In π electron calculations it is not usual to minimize the energy with respect to the effective potential of the carbon nucleus for each problem, and the value of Z^* usually used is that due to either Zener (3·18) or the Slater value (3·25). The above considerations suggest that this value is too high and that a lower value would lead to more correct estimates of the π energy in the absence of a complete calculation.

Bayliss directed attention to this fact[1] in 1949 when he pointed out that if the π energy of butadiene was minimized with respect to the effective potential field of the carbon atom using a free electron model then the value of Z^* was 1·2. This is perhaps too low an estimate but shows the correct trend. The molecular field correction to the Z^* value for π calculations is reduced somewhat when the effect of resonance splitting during molecule formation is taken into account.

The splitting magnitude to be expected for the p shell may be calculated theoretically in terms of a parameter Bq (analogous to the parameter Dq in ligand field theory) which can also be calculated theoretically. It seems more desirable at first, however, to consider Bq as an adjustable parameter which once obtained can be applied to other cases of interest. Reasonable estimates of Bq result in a value of the order of 1 eV, thus giving an overall split in the acetylene p energy-levels of about 3 eV.

The method of molecular fields is not limited in its application to first- and second-row elements but can be applied to the transition series of metal spin-paired complexes, as an example readily shows.

In the case of octahedral spin-paired complexes such as potassium ferricyanide the situation is that instead of negative charges surrounding the central ion at points along the co-ordinate axes, the perturbing potential is assumed to be, in addition, a *pair* of positive charges situated above and below the ligand co-ordinates. This is simply because if CN is used as ligand (*not* CN^-) it can be reasonably supposed that the effect of the positive ion on the ligand will be to lower the energy of the $x\sigma$ antibonding orbital relative to the $w\pi$, and this can be regarded as leading to a hole in the π shell with a completed σ shell. This results in a tendency for the $d\varepsilon$ shell to become stabilized by two methods which cannot be strictly resolved: (1) The attraction of $d\varepsilon$ electrons into the π shell of the ligand; (2) the repulsion of the $d\gamma$ electrons by the lone σ pair of the CN group.

Thus, in the case of these spin-paired complexes the push-pull operation of these two factors results in a very large splitting compared to the spin-free complexes.

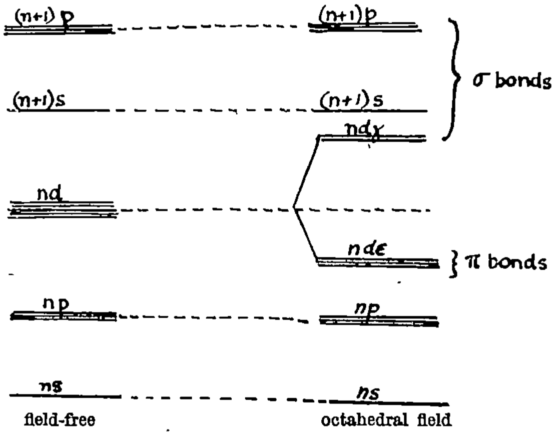

Fig. 4

In this way the $nd\gamma$ orbitals of the central ion become comparable in energy with the $(n+1)s$ and $(n+1)p$ atomic orbitals of the ion as well as with the σ lone pairs of the ligands and so effective overlap can occur. The complete scheme is shown in Fig. 4 and shows one reason why the calculations of Craig *et al.*[2] showed a disappointingly small overlap of nd with $(n+1)s$ and $(n+1)p$.

The full details of the calculations, together with wider applications of the theory, will be published shortly. [Sept. 26

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

A Microchemical Method for the Preparation of Sources of Actinium and Europium for β-Ray Spectroscopy

The preparation of adequate sources is one of the most critical problems in β-ray spectroscopy. In general, chemical means alone have not proved sufficient. Crystal formation and the tendency for a non-uniform distribution of the source material make the effective thickness of the source considerable, even in cases where the amount of material is small enough to make the average thickness negligible. In addition, it is often difficult to concentrate the activity on a sufficiently small area of the supporting foil. For these reasons, use has been made of evaporation *in vacuo*, of electrolysis, and of isotope separators.

The method to be described here is nevertheless a purely chemical one. It has the advantage of high efficiency, and potentially the advantage of general applicability. We believe that the procedure described for actinium and europium can be applied with little modification to the thirty lanthanides and actinides. We also see no reason why in principle the procedure cannot be utilized with the same or other resins to concentrate many of the seventy remaining atomic species, provided they are in an essentially carrier-free form.

The basic principle is the concentration of the activity on a very small ion-exchange column and the subsequent elution with a strong eluting agent to get out the activity in a very small volume.

Actinium-228, a 6-hr. beta minus emitter, is used as an example in the procedure which follows. The initial actinium sample (volume 0·3 c.c., activity 10 μc.) is a carrier-free solution of 5 per cent ammonium citrate (*p*H 4·3) obtained by ion-exchange separation of actinium-228 from its long-lived mother substance, radium-228, the ion exchanger being 'Dowex 50'. Concentrated hydrochloric acid is added to adjust the *p*H to about 1 ; that is, the citric acid is largely brought to its undissociated form and hence actinium will exist as Ac^{3+} :

$$\mathrm{Ac(H\,Ctr.)_2^-} + 4\mathrm{H}^+ \rightarrow \mathrm{Ac}^{3+} + 2\,\mathrm{H_3Ctr.} \qquad (1)$$

The sample is now forced through a 'Dowex 50-*X*12' column which has previously been conditioned in order to bring it either to the hydrogen or to the ammonia form. Although the particle-size of the resin may be varied within limits, the particles of the resin used in most of our experiments have a settling rate in water of 0·3–0·5 cm./min. The column dimensions are 0·03 mm.^{2} by 13 mm., the free column volume thus being 0·2 μl. Even when the actinium is forced through at a flow-rate in excess of 10 μl./min., more than 80 per cent of the activity remains with the resin (*R* denotes resin skeleton):

$$\mathrm{Ac}^{3+} + 3R\mathrm{SO_3NH_4} \rightarrow (R\mathrm{SO_3})_3\mathrm{Ac} + 3\,\mathrm{NH_4}^+ \qquad (2)$$

Finally, the column is eluted with a 1 *M* ammonium lactate solution (*p*H 5–7) :

$$(R\mathrm{SO_3})_3\,\mathrm{Ac} + 3\ \mathrm{Lact.}^- \rightarrow 3R\mathrm{SO_3}^- + \mathrm{Ac\ (Lact.)_3} \qquad (3)$$

The activity comes out with the front of the eluent in a volume of 0·5–2 μl. This small volume is picked up on a 150-μgm./cm.^{2} aluminium foil and dried under an infra-red lamp. The foil, which has previously been fastened on a 0·5-mm. metal frame with the aid of a minute amount of 'Zapon' lacquer, is now transferred to a crucible and heated with a Bunsen burner. The ammonium lactate evaporates leaving the activity on an area of 1–3 mm.^{2} in a very thin and quite uniform layer which is often invisible. The overall yield is, apart from decay, 30–80 per cent. The procedure takes 2–3 hr. The effective thickness of the source has been estimated from the resolution of internal conversion lines in the low-energy region (< 50 keV.) (see Fig. 1). Comparison with the internal-conversion lines resulting from isotope-separated activities in which the ions have been driven into the aluminium backing to a depth of approximately 5 μgm./cm.^{2} indicates that equally thin sources can be obtained with the present method.

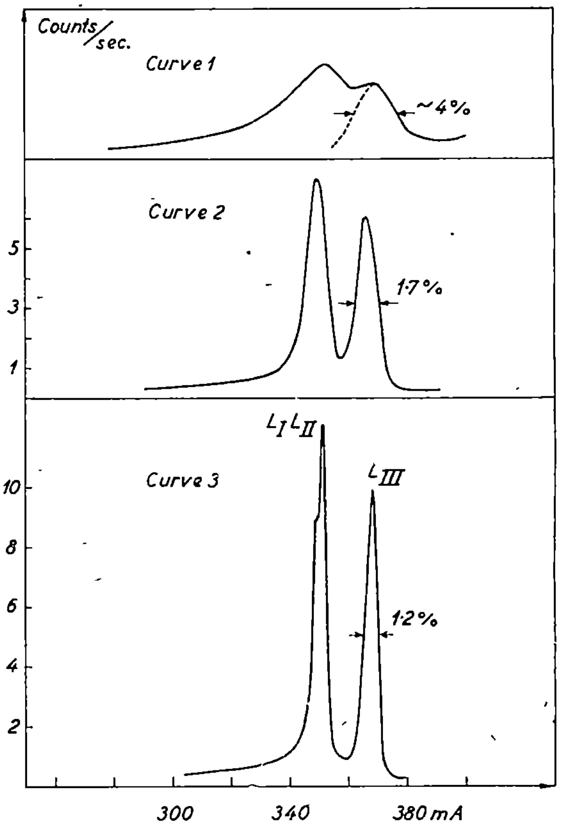

Fig. 1. $L_I L_{II}$ (37 keV.) and L_{III} (41 keV.) conversion lines of the 57-keV. *E*2 transition in thorium-228 measured in a β-ray spectrometer with sources of different thickness

The most serious difficulty in connexion with the method arises from the fact that impurities will also be concentrated by processes (1), (2), and (3). This is true for alkaline earths, particularly calcium and magnesium, and third-group metals, particularly aluminium. The ion-exchange separation which precedes the concentration procedure just described is not specifically worked out in order to eliminate impurities. If as an example we assume an ash content of 10 p.p.m. by weight in the initial 0·3-c.c. sample, this results in a mean thickness of 100 μgm./cm.^{2} when spread over a 3-mm.^{2} area. The effective thickness would presumably be considerably greater (Fig. 1, curve 1).

We have overcome these difficulties by using 'Dowex-50' ion-exchanged reagents. This greatly decreases the thickness of source while maintaining a yield as high as 80 per cent (Fig. 1, curve 2).

A further improvement can be achieved by using a weaker eluent in process (3). If, instead of a 1 *M* ammonium lactate solution, one uses a molarity of 0·7, an actual separation takes place on the micro-column between the ash and the activity. However, this happens at the expense of the yield, which decreases to 30–50 per cent, apart from decay. Also the time required for preparation of the source is increased to three hours. Curve 3 (Fig. 1) shows the maximum resolution obtained from a source made in this way.

The procedure has also been successfully applied to the preparation of a source of europium.

We wish to thank Prof. Niels Bohr for the ideal working conditions in his Institute, Prof. I. Perlman for discussions and for some of the graded resin used in these experiments, and Prof. K. Linderstrøm-Lang and Mr. Sigurd Olaf Nielsen for valuable suggestions with respect to microtechniques.

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High-Resolution Microwave Zeeman Spectrometer

A HIGH-RESOLUTION microwave Zeeman spectrometer has been constructed, and measurements of molecular magnetic moments are now being made on a series of molecules.

The apparatus is similar in principle to that described by Jen[1]. A resonant-cavity absorption cell is located between the poles of a large electromagnet. A *Q*-band klystron the reflector of which is modulated simultaneously by a 25-c./s. saw-tooth voltage and a 100-kc./s. sine-wave supplies power to the cavity at a frequency of ∼ 35,000 mc./s. The power reflected from the cavity is detected by a silicon crystal, amplified and displayed on one trace of a double-beam oscilloscope, the time-base of which is the source of the 25 c./s. saw-tooth modulation.

The gas under investigation is let into the cavity at a pressure of a few microns, and when the klystron frequency and modulation index, the power-level and the crystal detector unit have all been correctly adjusted, the appropriate rotational absorption line is displayed (Fig. 1). This line splits into two (or more) components when the magnetic field is applied (Fig. 2).

To facilitate the initial adjustments a 3-metre wave-guide absorption cell is simultaneously employed. The signal from the crystal at the output end of this cell can be switched on to the first oscilloscope trace in place of the cavity-resonator signal. Power from a second klystron the reflector of which is modulated at a variable radio frequency of ∼1 Mc./s. is mixed with that of the first, and the difference-frequency spectrum detected by a 30-mc./s. frequency-modulated receiver. The output of this receiver is applied to the other beam of the oscilloscope, and consists of a ladder of sharp marker pulses the spacing of which, on a frequency base, is the modulation frequency of the second klystron. Frequency difference of lines displayed on the first oscilloscope trace can thus be measured by superimposing the markers displayed on the second trace (Fig. 3).

The wave-guide cell and the cavity cell can be heated or cooled to 'dry-ice' temperature, and in this way the intensities of the absorption lines increased.

For the $J,K = 13,13$ line in the ammonia inversion spectrum, we have verified that the temperature dependence of the line intensity is of the expected form $\alpha T \equiv A \exp(-B/T)$, where α is the line intensity, T the absolute temperature and A and B constants for the line[2].

The magnetic field is measured with a nuclear magnetic-resonance field meter, which is also used for field stabilization.

Thus the Zeeman effect is measured in terms of two radio frequencies—that of the signal generator modulating the second klystron, which measures the Zeeman splitting, and that of the nuclear magnetic resonance oscillator, which measures the magnetic field. Both frequencies are calibrated in terms of an accurate crystal-controlled wave-meter. The spectrometer has been used for measuring the Zeeman splitting (σ-transitions) of four lines in the $^{14}NH_3$ inversion spectrum, namely:

$J,K = 12,12$ at 31,424·97 Mc./s.
$J,K = 13,13$ at 33,156·95 Mc./s.
$J,K = 14,14$ at 35,134·44 Mc./s.
$J,K = 15,15$ at 37,385·18 Mc./s.

Because of the large quantum numbers, the hyperfine structure due to the ^{14}N quadrupole coupling cannot be resolved, and the Zeeman splitting yields the molecular magnetic moment directly.

The Zeeman splitting of these lines is linear up to the highest magnetic fields so far applied, namely, 0·5 weber/metre².

The same molecular g-factor is obtained for all four of these lines, within the limits of error of approximately ± 2 per cent.

The mean of all the measurements on the four lines is $g_{\text{mol.}} = 0{\cdot}490 \pm 0{\cdot}008$. With the values of $g_{xx} = 0{\cdot}560$ and $g_{zz} = 0{\cdot}484$ obtained by Eshbach and Strandberg[3] from measurements of seven ammonia lines in the region $J,K = 3,1$–$6,6$, an effective molecular g-factor, $g_{\text{mol.}} = 0{\cdot}490 \pm 0{\cdot}007$, should be expected for the J-values used in our measurements, provided that g_{xx} and g_{zz} are independent of J.

The close agreement shows that this condition holds over the whole range of rotational-levels so far

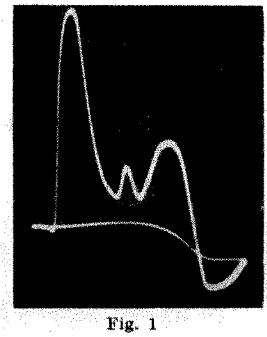

Fig. 1

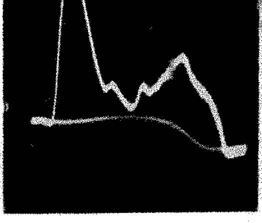

Fig. 2

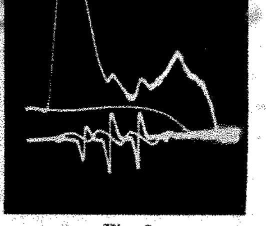

Fig. 3

observed, and implies that there is no significant dependence of valence electron 'slip' upon the angular momentum of the molecule.

From the Zeeman splitting of the $K = 1$ component of the $J = 1 \rightarrow 2$ doublet in the spectrum of CH_3CCH, we have obtained $g_{zz} = 0{\cdot}30 \pm 0{\cdot}02$, in close agreement with the values found by Cox and Gordy[4] from the $J = 2 \rightarrow 3$ and $J = 3 \rightarrow 4$ transitions, namely, $g_{zz} = 0{\cdot}298 \pm 0{\cdot}006$. In agreement with Cox and Gordy, we find no observable splitting of the $K = 0$ component, that is, $g_{xx} \approx 0$.

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Combustion of Methane

It is known that the most reactive mixture of methane and oxygen is $2CH_4 + O_2$, the most easily detonated $CH_4 + O_2$ and the most inflammable $CH_4 + 2O_2$. Methane is not unique in this respect because, as Coward and Payman[1] have pointed out, the most reactive mixtures of each of the simple paraffin hydrocarbons with oxygen are those containing hydrocarbon and oxygen in the molecular proportion 2 : 1; yet none of these mixtures can propagate flame at normal temperature and pressure. An interpretation of these curious facts may be suggested on the following lines.

The 2 : 1 ratio of methane to oxygen in the most reactive mixture implies that the determining step in the slow combustion of methane involves two molecules of methane and one of oxygen. (The word step is used in the thermodynamic, not the kinetic, sense. That is, we are concerned with equilibrium states, not the route from one to the other.) The slowness of the reaction is probably indicative of the low frequency of three-body collisions involving specifically two molecules of methane and one of oxygen. Its easy initiation, on the other hand, argues that relatively little energy is needed to disturb the equilibrium of this tri-molecular grouping and enable it to pass into the next equilibrium state. The simplest rearrangement would appear to be the splitting of the oxygen molecule, which must always happen, and the assimilation of one oxygen atom by each methane molecule. Thus,

$$CH_4 + (O + O) + CH_4 \rightarrow 2CH_3OH \ + \ 78 \text{ k.cal.}$$

This initial formation of methanol fits in with Bone's[2] scheme for the slow oxidation of methane.

The fact that the equimolecular mixture of methane and oxygen is the most readily detonated suggests that the initial step here is a two-body collision process involving one molecule of each kind. The products of the detonation reaction[2] are $CO + H_2 + H_2O$ and so it may be inferred that the determining step in the detonation of methane–oxygen mixtures can be represented thus:

$$\begin{aligned} CH_4 + O_2 &\rightarrow (C + H_2 + H_2) + (O + O) \\ &\rightarrow CO + H_2 + H_2O \qquad + 77 \text{ k.cal.} \end{aligned}$$

Hence the methane molecule also divides and, since three new molecules are formed, it must divide into three. This implies that much more energy per mole is required to trigger detonation than slow combustion.

The optimum proportions in the case of deflagration seem at first sight to suggest a three-body collision process involving one molecule of methane and two of oxygen; but this is statistically improbable in view of the speed of this reaction. The alternative would appear to be two successive bi-molecular encounters involving first one oxygen molecule and then the other. The first event, however, must be distinguished from detonation and, since deflagration is easier to initiate, it is reasonable to suppose that, in this case, the methane molecule divides into two instead of three. In other words, the methane molecule is stripped of one hydrogen pair instead of two. This may be represented:

$$\begin{aligned} CH_4 + O_2 &\rightarrow (CH_2 + H_2) + (O + O) \\ &\rightarrow CH_2O + H_2O \qquad + 78 \text{ k.cal.} \end{aligned}$$

followed by:

$$\begin{aligned} CH_2O + O_2 &\rightarrow (CO + H_2) + (O + O) \\ &\rightarrow CO_2 + H_2O \qquad + 135 \text{ k.cal.} \end{aligned}$$

The second stage of the reaction will, of course, benefit from the energy released in the first and may require no other help to initiate it, in which case the second stage follows spontaneously. Thus the activation energy of the whole process may correspond to that of the first stage whereas the total energy released is the sum of the two, namely, 213 kcal. per mole of methane.

The interesting point emerges that the energy released in detonation may represent only part of the total energy available and may in fact be much less than that generated by deflagration. The violence of the detonation process thus appears to be due more to the speed of the reaction than to the amount of energy released, and this depends on the statistical frequency of encounters between the appropriate species. This probably explains why the maximum detonation velocity in mixtures of methane and oxygen occurs not in the stoichiometric but in the equimolecular mixture.

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Use of Irradiated Polymers as Initiators of Polymerizations

It has been demonstrated by physical methods[1] that in some polymers free radicals are formed during exposure to high-energy radiations, and that in some cases they can survive for long periods. These radicals can also be detected by chemical methods, and under suitable conditions they can be used for initiating the polymerization of typical monomers to give graft co-polymers[2]. In the preliminary work described here the formation of graft co-polymers has been detected by using a monomer labelled with carbon-14; by this means it has been possible to determine accurately very small weights of grafted material.

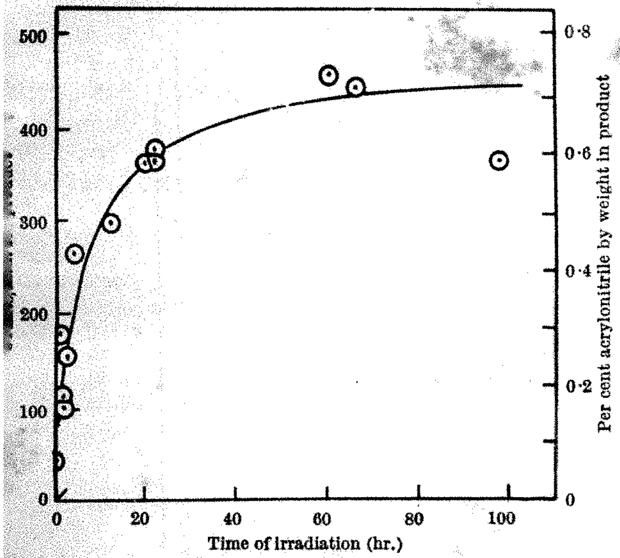

Fig. 1. The variation in activity and composition of the polymer with the time of irradiation, for 60 min. exposure to ^{14}C-acrylonitrile vapour at a pressure of 78–79 mm. mercury; samples at 18·5°–19·5° C. during exposure

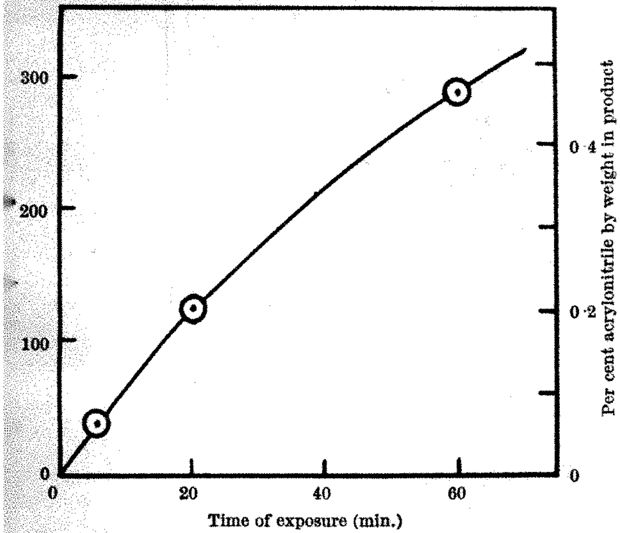

Fig. 2. The variation in activity and composition of the polymer with the length of exposure to ^{14}C-acrylonitrile vapour at 73·5 mm. mercury, for irradiation of 17 hr.; samples at 19·5° C. during exposure to monomer

Polymers, for example, polystyrene, polyacrylonitrile, 'Terylene' and 'Nylon', are irradiated in vacuum with γ-rays from a cobalt-60 source (nominally 100 curies). The irradiated polymers are afterwards exposed to the vapour of ^{14}C-acrylonitrile. After the residual vapour has been pumped off in high vacuum, the specimens are assayed by gas-counting. In some cases, as much as 10 per cent by weight of acrylonitrile is introduced into the polymer. Only a negligible amount of vapour is taken up by a sample which has not been irradiated. For example, two samples of powdered polyacrylonitrile were exposed to the vapour of ^{14}C-acrylonitrile at 78 mm. mercury for 2¼ hr.; the first had previously been irradiated for 18 hr., but the second had not been exposed to γ-rays. The first sample gave a counting-rate of 6,350 counts/min. whereas the second gave only 81 counts/min.; the counting-rate for polymer prepared directly from the labelled monomer was 59,300 counts/min.

With 'Nylon', the same results are obtained when the specimen is exposed to ^{14}C-acrylonitrile vapour 100 hr. after irradiation as when there is only a short interval after irradiation. If air is admitted to the specimen after irradiation, its activity is almost completely destroyed.

To obtain reproducible results, it is necessary to control carefully a number of factors, namely: (1) the physical state of the polymer, in particular its specific surface area; (2) the irradiation dose; (3) the time of contact with vapour of labelled monomer; (4) the pressure of the monomer vapour; (5) the temperature of the specimen during exposure to monomer.

Experiments with 15-denier monofil 'Nylon' yarn (kindly supplied by British Nylon Spinners, Ltd.) have shown that the quantity of ^{14}C-polyacrylonitrile formed increases with irradiation dose but approaches a limiting value (Fig. 1). With samples of 'Nylon' given the same dose, the amount of monomer taken up increases with the time of exposure to the vapour but it is not a linear function of the time (see Fig. 2 for typical results).

It is believed that free radicals at, or very near, the surface of the irradiated polymer act as centres for the polymerization of ^{14}C-acrylonitrile, and that polymer chains grow out from the surface of the irradiated material. If this is the case, the importance of the factors mentioned above can be understood. Work is in progress to elucidate the precise mechanisms of these reactions, and in particular to determine the number and average length of the branches grafted on the stock polymer.

The cobalt-60 source was installed by the Atomic Energy Research Establishment, Harwell. We thank the Department of Scientific and Industrial Research for a maintenance grant to one of us (D. E. E.) and Dr. H. W. Melville for his interest in this work.

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Water Sealing of Detached Aluminium Oxide Anodic Film

The formation of boehmite on anodized and non-anodized aluminium surfaces by boiling-water treatment has been discussed by Hart[1]. He found by electron diffraction study of ammonium borate anodic films on aluminium that such treatment changed the quasi-amorphous structure of the coating to boehmite, whereas with films stripped from the metal this change did not occur. Hart suggested that the formation of boehmite was due to an electrochemical reaction in which aluminium ions from the aluminium base moved outward through the oxide film to meet hydroxyl ions and formed boehmite in the pores or on the outer surface. Application of this theory to sulphuric acid anodic coatings which are much thicker and more porous than the borate films is of interest since it is generally believed[2] that the formation of boehmite during boiling-water sealing of such coatings is due to hydration of the aluminium oxide.

Aluminium sheet (99·87 per cent) of 0·5 mm. thickness was anodized (15 per cent wt. sulphuric acid, 21° C., 1·6 amp./sq. dm., 60 min.) to form an oxide film approximately 0·030 mm. thick. The weight gain on water sealing (de-ionized water, 100° C., *p*H 6·1, 30 min.) of such coatings was determined. The film weight was determined by dissolution of the coating, in a chromic – phosphoric acid solution[3]. Panels anodized in a similar manner were sheared into 1 cm. × 2 cm. squares and the unsealed oxide film was detached from these by a modified Wernick[4] technique (5–10 gm. mercuric chloride/100 ml. ethyl alcohol). The detached films were rinsed twice in absolute methyl alcohol. The weight gain on water sealing of detached oxide film was determined and compared with that of the non-detached film.

Electron diffraction patterns were obtained on non-detached and detached oxide films, in both the unsealed and water-sealed conditions. (Only results of examination of exterior film surface are discussed. Interior surfaces (metal side) give indefinite amorphous patterns.) A 50-kV. intensity beam was employed in an *EMU*-type *RCA* electron microscope. In examining the detached films it was necessary to evaporate a thin coating of aluminium on to both the non-examined side of the film and the diffraction sample holder. The treated film and holder were bonded together by use of Wood's metal to make a unit with increased heat capacity. This minimizes the heating of the oxide by the electron beam, which otherwise affects the structure as shown by a marked change in the observed pattern. (Heating of samples in this manner might be a useful technique in studying dehydration of various aluminas.)

The weight gain on sealing the film, which was sealed after being detached (7·1 per cent), was in good agreement with the value obtained for the non-detached film (7·7 per cent). No ring diffraction patterns were obtained with unsealed coatings, either detached or non-detached. Clear boehmite patterns were secured for sealed films (Fig. 1), including those sealed after removal from the aluminium. The patterns were compared with standard *ASTM* X-ray data and with results given by others[5,6]. A steam-sealed (115° C., 30 min.) stripped coating was examined and gave a slightly clearer boehmite ring pattern than did the water-sealed films.

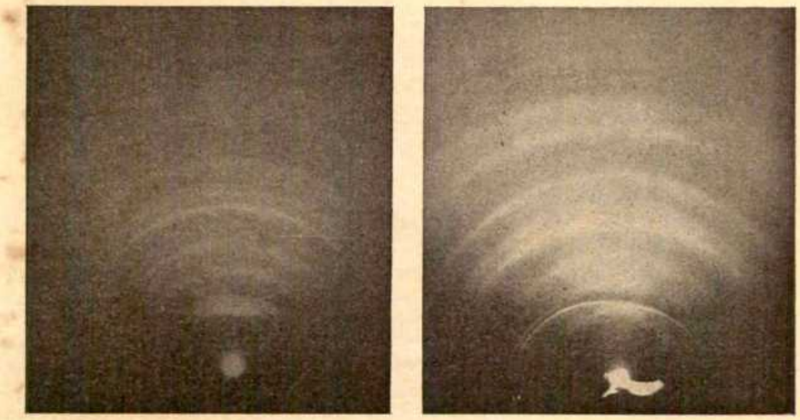

Fig. 1. Boehmite electron diffraction patterns of water-sealed sulphuric acid anodic films. Left, sealed on aluminium; right, sealed after removal from aluminium base

The similarity of the results obtained with films detached from their aluminium base to those for non-detached films confirms that water sealing of sulphuric acid type anodic films is a hydration process and does not require the presence of metallic aluminium.

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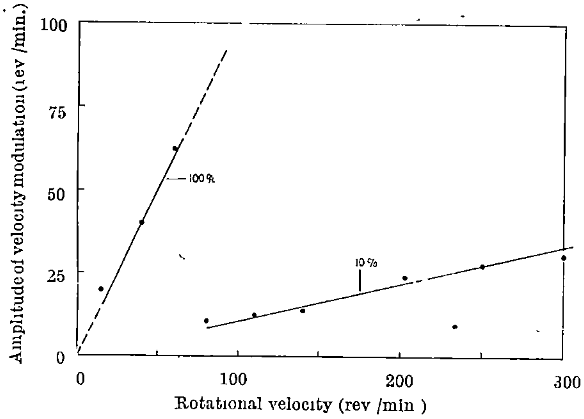
Torsional Vibrations of Rotating Shafts

A ROTATING shaft can exhibit torsional vibration when, because the dynamic coefficient of friction is less than the static value, the frictional force at the bearings supporting the shaft decreases as the shaft begins to rotate. The torque in the shaft when it begins to turn is greater than is required to overcome the running friction in the bearings, and the shaft accelerates and may overrun the drive until the speed of the shaft is reduced to zero. Then superposed on the steady rotation of the shaft there is a vibration of an amplitude such that the instantaneous angular velocity of the shaft varies between zero and rather more than twice the mean value. So-called 'stick-slip' vibrations of this type are well known—they may, for example, be responsible for brake squeal in automobiles.

With true 'stick-slip' vibrations the depth of modulation of the relative velocity of the two surfaces in contact is 100 per cent, and except when the mean relative velocity is very low, the frequency of the vibrations is determined primarily by the natural frequency of the system. Thus the amplitude of the velocity modulation of a vibrating shaft will be expected to increase linearly as the mean speed of the shaft is increased. In practice it is found that the amplitude increases in this way until a point is reached at which the vibrations suddenly cease. The transition does not occur at a fixed speed; but the chance of a system exhibiting 'stick-slip' vibrations decreases as the mean relative velocity of the surfaces in contact increases.

We have recently found, in experiments with a shaft of natural frequency about 25 c./s. and of diameter, at the bearings, of 0·625 in., that, on continuing to increase the speed of the shaft beyond the point at which 'stick-slip' vibrations ceased, the shaft vibrated at the same frequency but with an amplitude corresponding to a depth of modulation of only about 10 per cent. The behaviour of the shaft is shown in Fig. 1. In between the regions of



steady vibration with 100 or 10 per cent velocity modulation was a region of instability in which the shaft might run smoothly or might exhibit 'stick-slip' vibrations. The bearings were lubricated with a plain mineral oil, the conditions being such that a continuous oil film could not be maintained by hydrodynamic wedge action.

This small-amplitude vibration is believed to be associated with the time required for conditions in the bearings to come into equilibrium after a change in the velocity of the shaft.

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Aluminium Molybdate and its Formation in Clay Minerals

The availability to plants of molybdate in some acidic soils may be increased by raising the pH. This behaviour of molybdate is analogous to that of phosphate, and suggests a study of its compounds with iron and aluminium, which are presumably responsible for holding molybdate in an insoluble form.

Unlike iron[1-3], aluminium has not been found as a naturally occurring molybdate. We have, however, prepared aluminium molybdates by precipitation from solutions of aluminium chloride and sodium molybdate. The precipitates have a Mo : Al ratio of 0·5, and have minimum solubility at pH 4·8. The temperatures of precipitation and digestion were varied, but no matter what these were over the range 20°–50° C. and 20°–90° C. respectively, the X-ray powder pattern and composition of the precipitates remained the same. The X-ray powder pattern consists of reflexions at 9·4 A. (weak), 4·78 A. (very strong), 3·25 A. (very weak), 2·44 A. (medium), 2·23 A. (strong), 1·99 A. (weak), 1·74 A. (strong), 1·46 A. (weak), and 1·35 A. (very weak). The material is highly hydrated and loses 34 per cent of its weight on heating to 800° C., and a further 17 per cent on heating to 1,000° C. The Mo : Al ratio suggests a basic salt; the formula $2(Al(H_2O)_4(OH)_2)MoO_4$ would agree with our analyses.

The aluminium minerals boehmite and halloysite are both found to adsorb large amounts of molybdate from solution over the pH range 4·0–5·5. At pH's above and below this range the amounts of adsorbed molybdate decrease sharply. These observations led us to examine the products obtained in the range of maximum adsorption. The minerals were therefore digested with sodium molybdate in aqueous suspensions at pH's 4·5–5·5 at 20° C. for 10 days, and soluble molybdate was then removed by washing. On examining the solid phases by X-ray diffraction it was found that two of the strongest reflexions in the powder pattern of aluminium molybdate (4·78 A. and 2·23 A.) had appeared in the boehmite and halloysite patterns. These reflexions cannot be attributed to any other material of which the X-ray powder pattern is known, and we may assume that molybdate has been chemisorbed and aluminium molybdate thus formed. This presumably is analogous to the formation of aluminium phosphates obtained on phosphating aluminium minerals[4]. Likewise it may be one way in which molybdenum is held in soils.

This work was done while one of us (A. A. M.) was holding a fellowship of the International Federation of University Women and working in the Department of Geology, University of Melbourne.

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A Randomly Interstratified Kaolin–Montmorillonite in Acid Clay Deposits in Japan

It has been accepted that, in general, the principal clay mineral in so-called bentonite and acid clay from Japan is montmorillonite. This fact is generally true, but closer examination has shown that these clays are, in general, very complex with regard to their mineral components. Recently, we have found certain clays closely associated with acid clay deposits and showing unusual properties; moreover, such clays are not so rare as we have hitherto anticipated. The purpose of this communication is to discuss the general mineralogical properties of such clays as illustrated by two representative reference specimens (Awazu and Nata clays from Ishikawa Prefecture) selected as samples which are as free from impurities as possible.

The X-ray powder reflexions of these clays consist of several broad reflexions near those of montmorillonite or hydrated halloysite (Fig. 1, 1, Awazu clay; 2, Nata clay), and a quartz reflexion (Q) is found associated with them. There is almost total absence of basal reflexions in the range 0°–20° (2θ) in spite of clear occurrences of principal prism reflex-

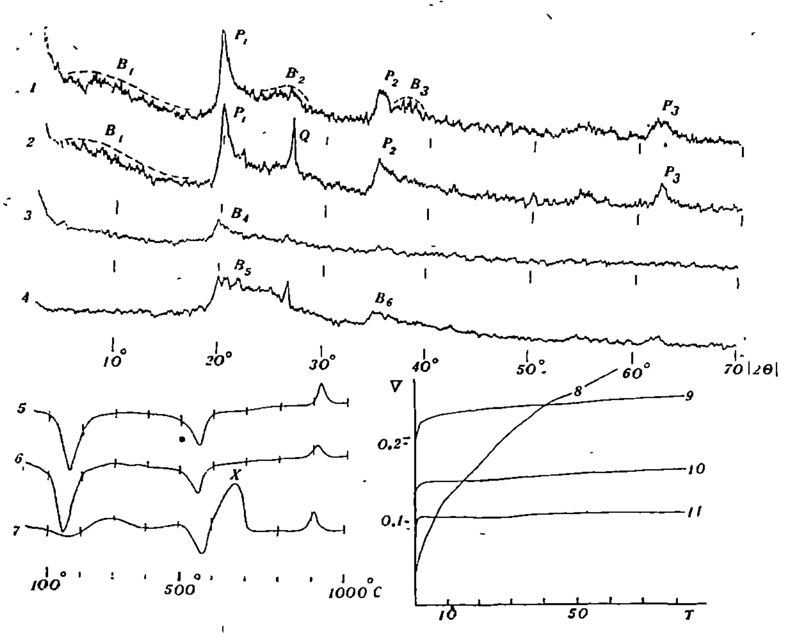

Fig. 1. Some properties of white clays associated with acid clay deposits in Japan. (1–4): X-ray diffractometer patterns. (5–7): differential thermal analysis curves. (8–11): the volume of absorbed water (V) in relation to time (T)

ions as P_1 (02,11), P_2 (13,20) and P_3 (06,33). The (06,33) reflexion occurs as a doublet (1·49 A. and 1·50 A.); the former spacing approximates to that of the kaolin minerals (1·486–1·497 A.) and the latter to montmorillonite (1·501–1·508 A.); these reference data have been obtained from Japanese specimens by us. On close examination, although basal reflexions are almost absent, it will be noticed that very broad bands (B_1) occur, spreading over the angle range of 5°–12° (2θ) (about 7–15 A.), including broad peaks having spacings of intermediate value between the two values above. Further, two broad bands are frequently noticed at about 3·5 A. (B_2) and 2·5 A. (B_3), which approximate to the (002) and (003) reflexions of a 7-A. kaolin mineral respectively. The effect of heat treatment at 600° C. and then air-quenching caused almost all powder reflexions to be weakened; only the (02,11) reflexion can be seen as a very broad band (Fig. 1, 3, B_4, Awazu clay). Treatment with ethylene glycol caused almost all reflexions to be weakened; even the (02,11) and (13,20) reflexions become very broad like a reflexion from a one-dimensional crystal (Fig. 1, 4, B_5, and B_6, Nata clay).

Differential thermal analysis curves (mean heating rate: 10 deg. per min.) are of the type of those of kaolin minerals (Fig. 1, 5, Awazu clay; 6, Nata clay). The thermal curves for the specimens treated by piperidine show the additional exothermic peak (X), indicating the presence of montmorillonite in the clays (Fig. 1, 7, Awazu clay). The chemical composition indicates an intermediate type between montmorillonite and a kaolin mineral; the data for Awazu clay are: SiO_2, 41·94; Al_2O_3, 30·12; Fe_2O_3, 2·42; FeO, 0·21; MgO, 1·52; CaO, 0·32; ignition loss, 11·10; H_2O (−) 12·88; TiO_2, 0·40 per cent; MnO, trace; total, 100·91 per cent. Electron micrographs indicate mainly plate-like crystals with somewhat irregular outlines, which mostly have elongated shapes. Crystals with pipe-like shapes are sporadically patchy. The change of the volume of absorbed water (V in c.c.) in relation to time (T in min.) (Fig. 1, 10, Awazu clay) is nearer to that of kaolinite (Fig. 1, 11) rather than those of montmorillonite (Fig. 1, 8, a specimen from Aterazawa, Yamagata; 9, a specimen from Ochiaizawa, Hanaoka).

These properties can be explained from our knowledge of clay mineralogy. Crystallites of these clays probably consist both of montmorillonite layers and kaolin mineral layers, and the proportion of these layers varies from portion to portion even in each crystallite. One hypothesis is that the core of each crystallite consists of montmorillonite (M) with kaolin mineral layers (K) becoming dominant, as one goes towards the edges, forming a randomly mixed layer mineral (Fig. 2). When such a crystallite is treated with ethylene glycol, swelling will occur selectively in the montmorillonite layers and it will give rise to small foldings in this crystallite, producing considerable disorder in the origina crystal structure. An alternative hypothesis is that the core is largely occupied by a kaolin mineral, and on going toward its margin, montmorillonite layers become dominant. Such a scheme of interstratification leading to swelling of water-layers was proposed for the first time by MacEwan[1] for soil clay minerals. On the basis of the ideal chemical formulæ of kaolinite and montmorillonite, the proportion of these two kinds of minerals can be estimated from the chemica composition as about 80 per cent kaolinite and 20 pe cent montmorillonite. It is very difficult to decide whether the kaolin mineral in question is kaolinit or hydrated halloysite as usually understood. X-ray diffraction data suggest that its crystallinity i lower; the 3·5 A. and 2·5 A. bands approximate to the (002) and (003) reflexions of a 7-A. kaolin minera respectively; but pipe-like shapes are only noticed sporadically.

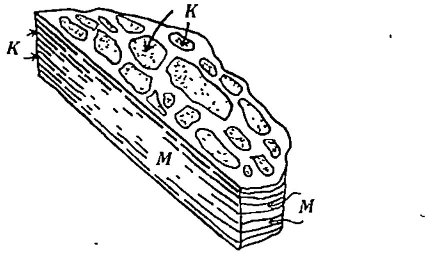

Fig. 2. Scheme for a mixed-layer mineral. K, Kaolin mineral layers; M, montmorillonite

We consider that such clays are alteration produc representing an intermediate stage in the alteration o montmorillonite toward a kaolin mineral or vice vers

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Sensitivity to Ultra-violet Light of Infectious Tobacco Mosaic Virus Nucleic Acid

STRAINS of tobacco mosaic virus differ markedly in sensitivity to inactivation with ultra-violet light[1]. It is of interest to determine the basis for this difference in terms of the chemical structure of the virus strains. The discovery that the nucleic acid portion of the virus is by itself infectious[2,3] has enabled us to carry out experiments on the problem.

We have confirmed the observation that the nucleic acid fraction, prepared by the method of Fraenkel-Conrat and Williams[3], is infectious. We have also observed that an increased infectivity is obtained when the protein fragments are added to the nucleic acid preparation (reconstitution)[3,4]. Representative results are given in Table 1.

Table 1

	Conc. γ/ml.	Lesions on 30 half-leaves*
Untreated tobacco mosaic virus	0·10	2,400
Nucleic acid	60	1,355
Protein	50	0
Reconstituted tobacco mosaic virus:		1,566
Protein	25	
Nucleic acid	3	

* The assay consisted of a 5 × 5 Graeco-Latin square replicated three times.

Ultra-violet radiation survival curves were determined for the nucleic acid preparations from strains *U*1 and *U*2 [5]; strains which differ $5\frac{1}{2}$-fold in sensitivity to inactivation with ultra-violet light. Survival curves were also determined for preparations of reconstituted *U*1 strain. The preparations were irradiated at a concentration of 5×10^{-2} mgm./ml. in $M/15$, *p*H 6·9 phosphate buffer with a Westinghouse germicidal lamp, 782*L*-30, the output of which is primarily at 2537 A. Other techniques used for these experiments have been described[1]. The results are presented in Fig. 1. The nucleic acids from both strains *U*1 and *U*2 as well as the reconstituted *U*1 strain have the sensitivity of the *U*2 strain. It is of significance that the nucleic acids from the two strains do not differ in ultra-violet sensitivity; the difference in sensitivity of the strains thus cannot be attributed to differences which may exist in composition or structure of their nucleic acid fractions. Two preparations of reconstituted *U*1 strain had precisely the sensitivity of the nucleic acid, as indicated in Fig. 1. However, another preparation was intermediate in sensitivity between the nucleic acid and the untreated *U*1 strain. Fraenkel-Conrat and Williams[3] have indicated that the properties of reconstituted virus preparations may differ, depending upon the precise conditions of the experiment. Our data agree with theirs in indicating that preparations of reconstituted virus differ to varying degrees from the untreated virus. The fact that some of the reconstituted virus preparations have the same ultra-violet sensitivity as nucleic acid strongly suggests that the difference in ultra-violet sensitivity of the *U*1 and *U*2 strains cannot be attributed to a differential ultra-violet screening by their protein moieties.

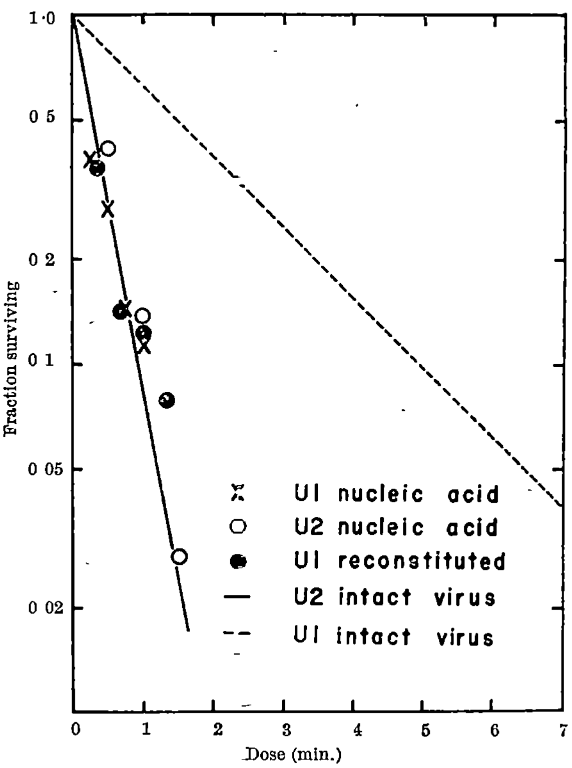

Fig. 1. The ultra-violet sensitivity of tobacco mosaic virus strains *U*1 and *U*2, the infectious nucleic acids derived therefrom, and one of the preparations of reconstituted *U*1 strain

The results presented here are most easily interpreted to signify that the difference in sensitivity of the two strains to inactivation with ultra-violet irradiation resides in the nature of the bonding between the nucleic acid and the protein moieties of the virus. The type of bonding existent in the *U*1 strain protects the virus from the full effect of the ultra-violet light, whereas the *U*2 strain is not so protected.

Since little is known of the chemical alterations induced by ultra-violet light which lead to the inactivation of biological materials, it is difficult to speculate upon the possible bonding mechanisms which would lead to the type of protection observed in the *U*1 strain. Two possibilities are: (1) that energy absorbed by the nucleic acid can be transferred into the protein, where it may have little effect upon biological activity; (2) that the protein holds the nucleic acid in such a configuration that damage to the nucleic acid is easily repaired. We have made two observations which suggest that the bonding between nucleic acid and protein is different for strain *U*1 compared to strain *U*2. One of these observations is that the nucleic acid of the *U*2 strain is released more easily than that of the *U*1 strain by the heat-detergent method of Fraenkel-Conrat and Williams[3]; the other, that the *U*2 strain is considerably more sensitive to heat denaturation than is the *U*1 strain.

There are other biological materials which, although similar, differ in sensitivity of response to ultra-violet light. For example, a two-fold difference in sensitivity to inactivation of a bacterial virus is controlled by a single gene locus[6]. Another case is that of the inosito locus in *Neurospora* in which alleles have different ultra-violet induced reverse mutation-rates[7]. It is possible that in these cases, as in the one presented in this communication, the nature of the bonding between the genetic and non-genetic material affects the response of the genetic material to ultra-violet light.

We are indebted to Miss Carol Hoelle and Mr. Charles Ford for technical assistance. This work was

supported in part by a research grant, *RG*-4124, from the National Institutes of Health, U.S. Public Health Service, and contract *AT*(11–1)–34, Project 8 of the Division of Biology and Medicine, U.S. Atomic Energy Commission.

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Enzymic Oxidation of Glyceric Acid

THE reduction of hydroxypyruvate to glycerate is brought about by crystalline L-lactic dehydrogenase of muscle[1] with the production of L-glyceric acid[2]. A substrate-specific D-glycerate dehydrogenase, which may or may not be accompanied by lactic dehydrogenase, occurs in extracts of higher plants[2]. Hydroxypyruvic acid phosphate is not able to replace pyruvic acid as a substrate for lactic dehydrogenase[3]. These enzymes require diphosphopyridine nucleotide, and their equilibrium, being far towards the reduced metabolite, is unfavourable for the study of the oxidative production of hydroxypyruvate. The importance of this substance as a substrate for transketolase[4] and transaminase[5] led us to study the action on glyceric acid of preparations containing lactic dehydrogenase from yeast, which is not so inhibited by pyruvate and requires no coenzyme[6–8].

An aqueous maceration extract of dried Delft baker's yeast was fractionated by precipitation with ammonium sulphate (final concentration 0·65 saturated), dialysis against versene (10^{-1} *M* disodium ethylenediamine tetraacetate) and removal of interfering impurities by precipitation at *p*H 5 and adsorption on small quantities of calcium phosphate gel. Lithium hydroxypyruvate, $CH_2OH.CO.COOLi + 1\ H_2O$, was crystallized analytically pure from water, the molecule of water being very firmly bound and possibly constitutive (crystalline salts of this acid have not previously been reported). Hydroxypyruvate (and glycolaldehyde) were assayed, in the presence of glycerate, by a new colour reaction with naphthoresorcinol in 23 *N* sulphuric acid at 100° for 20 min., the absorption of the resulting green solution being read at 660 mμ. The enzymic reduction-rates with methylene blue as hydrogen acceptor showed widely different *p*H optima for lactate (*p*H 5·5) and glycerate (*p*H 6·7). D-Glyceric acid was not attacked, and with DL-glycerate the extent of oxygen uptake and of hydroxypyruvate formation indicated the oxidation of one isomer (L-glycerate) only. The ratio of oxidation-rates at *p*H 6·7 for glycerate/lactate was $\frac{1}{2}$, and the Michaelis constants at 37° were approximately $3\cdot5 \times 10^{-4}$ *M* (calculated) for L-lactate and $2\cdot5 \times 10^{-3}$ *M* for L-glycerate. DL-3-Phosphoglyceric acid was oxidized at about half the rate of DL-glycerate under these conditions, but some phosphate was split off; D-3-phosphoglycerate was not oxidized. Cytochrome *c*, like methylene blue, is reduced by glycerate in the presence of the enzyme preparation.

It is not yet clear if the same enzyme is responsible for the oxidation of lactate and glycerate in these experiments. The widely differing *p*H optima and the statement of Boeri *et al.*[7] that their highly purified yeast lactic dehydrogenase (cytochrome b_2) is unable to oxidize "any other α-hydroxy acid" would indicate different enzymes; on the other hand, no summation of reaction-rate occurs when lactate and glycerate are both present with our preparations. Further purification of the enzyme, now being undertaken, should decide this point.

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An Apparent Anomaly in the Distribution of Radioiodinated Serum Albumin when added to Red Cell Suspensions

WHEN 15 ml. of suitably diluted (1 in 500) serum albumin tagged with iodine-131 ('*RISA*', Abbott) is added to an equal volume of washed human red cells with a volume concentration ρ of about 0·4, and when the red cells are thrown down by centrifuging at 7×10^2 *g* for 15 min., the radioactivity of the supernatant fluid is invariably 10–15 per cent greater than that found in a blank system containing 15 ml. of '*RISA*' plus 15 $(1 - \rho)$ ml. of saline, even after a correction is made for the volume of the blank system being smaller than the volume of the system with which it is compared. If the red cells are first rendered spherical by the addition of 1·5 ml. of a distearyl lecithin sol (5 mgm./5 ml.), the supernatant fluid obtained by centrifuging is 20–25 per cent more radioactive than the supernatant fluid from an appropriately prepared blank.

This apparently anomalous result is explained by the examination, with phase optics, of the respective supernatant fluids. While the red cells are thrown down by the centrifuging, the supernatant fluids from the systems to which '*RISA*' has been added contain minute fragments and myelin forms which are not thrown down even at a centrifugal force of 2×10^4 *g*. These fragments and myelin forms apparently take up '*RISA*'. They are not found when only distearyl lecithin is added to the red cells; they appear, usually as tiny spherical fragments, when '*RISA*' is added to the red cells, and usually as much more numerous worm-like myelin forms when '*RISA*' is added to red cells rendered spherical with lecithin. Their association with '*RISA*' accounts for the relatively high radioactivity of the supernatant fluids containing them, and suggests that the effect of serum albumin in reversing the disk–sphere transformation produced by lecithin is related to the loss of myelin forms from the red cell surfaces.

By using a device which consists of a scintillation probe mounted against a 1-mm. slit in a mass of lead, and by moving the centrifuge tube (25 mm. in diameter) containing the supernatant fluid upwards and downwards, some indication has been found that there are more radioactive myelin forms in the upper than in the lower layers of the supernatant fluids.

The tiny fragments and myelin forms in the supernatant fluids can be demonstrated excellently with the interference microscope (AO-Baker). The refractive index of the myelin forms is about 1·48, which is about the same as that of lipids, and their water content must be small. The measurements, however, are difficult to make because of the smallness of the objects and because they are in active Brownian movement, so these results are given as approximations only.

This investigation was made under a grant, *H* 1598, from the U.S. Public Health Service.

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Effect of Thyroxine on the Swelling of Mitochondria isolated from Various Tissues of the Rat

Several recent investigations[1-4] have suggested that an important function of thyroxine may be an 'uncoupling' of oxidative phosphorylation. However, studies with a multi-enzyme system (isolated from digitonin extracts of mitochondria[5]) capable of performing oxidative phosphorylation have indicated[6] that thyroxine and its analogues have no direct effect on this process. Concurrently[7], it has been observed that these compounds alter the morphology of rat liver mitochondria *in vitro*. In concentrations as low as 10^{-6} *M*, both thyroxine and triiodothyronine produce a prompt and marked swelling of the mitochondria. In contrast, 2,4-dinitrophenol, in concentrations which completely 'uncouple' oxidative phosphorylation, provides protection against swelling. It has therefore been postulated[6] that the uncoupling of oxidative phosphorylation produced by thyroxine in intact mitochondria is secondary to an alteration in the morphology of the mitochondria and not the result of a direct interaction of the hormone with the enzymes of oxidative phosphorylation.

Not all tissues respond in the same degree to the *in vivo* administration of thyroxine. Gordon and Heming[8] found that the oxygen consumption of slices of liver, kidney, diaphragm and heart from thyrotoxic rats was significantly greater than normal, while that of slices of spleen, brain and testis was not increased. Gross and Leblond[9] investigated the distribution of injected iodine-131 thyroxine in the rat and found that high concentrations occurred in plasma, liver and kidney and considerably smaller or negligible amounts in all other tissues tested. Likewise, we have found differences among the various tissues in the degree of mitochondrial swelling produced *in vitro* by thyroxine and its analogues.

Table 1 illustrates the markedly different susceptibilities of mitochondria from several organs. Mitochondria were isolated from the liver, kidney, heart, spleen and testis of adult male Wistar rats and the swelling assay conducted spectrophotometrically in a medium containing 0 3 *M* sucrose and 0·02 *M tris*-(hydroxymethyl)aminomethane at *p*H 7·4, as previously described[7]. Diaphragm mitochondria were isolated in a similar fashion following homogenization in a Waring blendor. Brain mitochondria were isolated by method I of Brody and Bain[10]. Each value in Table 1 represents the percentage decrease in optical density of a suspension containing the compound tested (3×10^{-5} *M*) less that observed in a control sample without the added compound. These values are taken as a measure of the swelling produced by the compound. The relative effects of thyroxine and triiodothyronine varied with different samples of these substances; one lot of thyroxine was more effective than triiodothyronine and one less so. Table 1 demonstrates that the swelling produced is striking with mitochondria from liver and kidney, while that with mitochondria from diaphragm and heart is much less marked. In accordance with failure of slices of spleen, brain and testis to show any change in oxygen consumption in thyrotoxic rats[8], essentially no swelling was produced by thyroxine or its analogues with the mitochondria from these tissues.

Table 1. Degree of Mitochondrial Swelling produced *in vitro* by Thyroxine and Various Analogues

	L-thyroxine	D-thyroxine	L-triiodothyronine	D-triiodothyronine	Tetraiodo thyroacetic acid	Triiodo thyroacetic acid
Liver	30	33	47	41	25	17
Kidney	12	10	18	14	20	12
Diaphragm	5	4	7	7	5	5
Heart	2	2	9	5	9	9
Spleen	0	0	0	0	0	0
Brain	4	1	1	0	4	2
Testis	1	2	2	2	4	3

We wish to thank Dr. G. D. Greville for his interest, helpful suggestions and criticism.

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Amœbicidal Action of Azaserine

In 1954, a group of workers reported on a new tumour-inhibitory substance[1]. This substance, called azaserine, also possessed antibacterial activity against numerous microbial species[2]. Chemically, this substance is O-diazoacetyl-L-serine[3]. It has been reported that azaserine is a profound inhibitor of formate incorporation into the nucleic acids[4]. Since the role of nucleic acid synthesis is particularly important in *Endamoeba histolytica*[5,6], the effect of azaserine on the amœbæ was studied.

The activity of azaserine was assayed in bacteria-free cultures of *E. histolytica* in a medium previously described[7]. Azaserine was amœbacidal in concentrations of 1/10,000 (100 µgm./ml.)–1/20,000 (50 µgm./ml.). Adenine (100 µgm./ml.), adenylic acid (100 µgm./ml.) and 2,6-diaminopurine (100 µgm./ml.) completely reversed the inhibitory effects of azaserine. Serine, methionine, 4-amino-5-imidazolecarboxamide and leucovorin (tested singly and in various combinations) effected only a partial reversal of the toxic action of azaserine. Guanine, guanosine and guanylic acid were completely inactive in reversing the action of azaserine.

It seems that azaserine functions as an antimetabolite in purine ring biosynthesis. Its mechanism of action against *E. histolytica* may be the prevention of 1-carbon incorporation as postulated[4,8] in the *de novo* synthesis of purines or the prevention of the closure of the acyclic purine ring precursor, thus blocking the synthesis of nucleic acids. Although 6-diazo-5-oxo-L-norleucine, another new tumour-inhibitory substance, was reported to inhibit the incorporation of formate into nucleic acids[8], no activity could be demonstrated against the amœbæ.

This work was supported (in part) by the Office of the Surgeon General, Department of the Army, Contract No. *DA*-49-007-*MD*-711. I am indebted to Dr. C. C. Stock for a gift of azaserine and 6-diazo-5-oxo-L-norleucine.

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Riboflavin in Milk

SUCH studies as have been made on the riboflavin in milk point to the existence of species differences in respect of the forms in which this vitamin occurs in milk. Thus Kon and Mawson[1] reported that the concentration of riboflavin in human milk is very low, and found that the method of Emmerie[2], in which riboflavin is extracted by methanol was inapplicable to it. Davis *et al.*[3] found the methanol method unsuitable for sow's milk, and at the same time suggested that riboflavin might be present in sow's milk in a form different from that occurring in cow's milk. In view of the foregoing observations, the partition of riboflavin between free riboflavin, flavin mononucleotide and flavin adenine dinucleotide in the milk of several species has been studied.

Riboflavin was extracted from milk by the method of Bessey *et al.*[4]. From the neutralized extract the riboflavin was extracted with liquid phenol. Addition of ether threw out an aqueous phase containing all the riboflavin. Both by paper chromatography and by paper electrophoresis, free riboflavin, flavin mononucleotide and flavin adenine dinucleotide were separated. For the chromatographic separation a butanol/acetic acid/water system was used (Crammer[5]). For the paper electrophoresis a borate buffer (0·05 *M* borax, *p*H 9·2) was used, and a potential of 300 volts was applied for 5 hr. giving a current of 1·5 m.amp. per cm. width. Distinctly separated spots were made visible by ultra-violet illumination, and known samples of free riboflavin, flavin mononucleotide and flavin adenine dinucleotide were used for their identification. R_F values of the flavins for the solvent system used in the chromatography were 0·04 for flavin adenine dinucleotide, 0·13 for flavin mononucleotide and 0·35 for free riboflavin.

With the milk of cows, goats, ewes and rabbits two spots were observed, the larger one corresponding to free riboflavin and the smaller one to flavin adenine dinucleotide. On the other hand, with human, mare's and sow's milks usually only one spot was obtained, which corresponded to flavin adenine dinucleotide. Occasionally, however, with these last three types of milk, faint spots corresponding to flavin mononucleotide and free riboflavin were observed, but they probably resulted from slight hydrolysis of the flavin adenine dinucleotide. The authenticity of the flavin adenine dinucleotide was always established by enzymatic assay in the D-amino-acid oxidase system.

The ultrafiltrates from cow's and goat's milk were yellow, and under ultra-violet light they showed the characteristic greenish fluorescence of free riboflavin, whereas the ultrafiltrates of human and mare's milk were colourless. None of the ultrafiltrates contained flavin adenine dinucleotide, which suggests either that this molecule was too large to pass through the filter membrane or that it was present in the milks in a bound form.

Since in human, mare's and sow's milks the riboflavin is present as flavin adenine dinucleotide it might be thought that these milks, compared with cow's, goat's, ewe's and rabbit's milks, would contain greater amounts of enzymes, such as xanthine oxidase, that have flavin adenine dinucleotide as their prosthetic group. However, preliminary experiments have shown that xanthine oxidase is absent from human, mare's and sow's milks but is present in the milks of the other four species. This work is still in progress.

Our thanks are due to Dr. F. E. Hytten of the Midwifery Department, the University of Aberdeen, for sending us frozen samples of human milk, and the Veterinary Investigation Officers of the West of Scotland Agricultural College, for obtaining samples of sow's and ewe's milk.

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Nuclear Behaviour in Migrating Cells of the Rat's Corneal Epithelium

WHILE conducting a series of experiments on the healing of needle pricks applied to the corneal epithelium of albino rats, perforating the epithelium only, it was seen that migration and proliferation of cells occur simultaneously, and before the commencement of mitosis. Multiple injuries were made. The eyes were then left to heal in the animal for varying periods after injury and, after removal, fixation and staining with hæmatoxylin, cross-sections were made and examined in series.

As is known, in these minute wounds migration of cells of the wound wall and around the wound commences roughly one and a half hours after application[1]. My investigations revealed an occasional split nucleus in a migrating cell one and a half hours after injury.

Two hours after application, and before any appreciable mitotic activity of the cells could be detected, there was considerable increase in the number of cells of the wound wall. This increase was manifested by an annular prominence of the epithelium of the wound wall, around the wound hole, made up of cells with clearly discernible membranes, of varying size, for the greater part smaller than average, although cells of average and more than average size were seen, too. Exceptionally, cells of a size much greater than that of ordinary epithelial cells were encountered.

Among the cells of average or more than average size, some with split nuclei or nuclei with furrows were often found. The occasional very large cells were always either bi- or tri-nucleate, or the nuclei displayed one or more furrows. Split nuclei were not limited to cells of the basal layer. Although infrequently, abnormal mitoses were sometimes seen. These could not be detected one and a half hours after injury.

Three hours after injury, a fair number of abnormal mitoses were observed in the annular prominence. Occasionally, these occurred in layers other than the basal. Many approached the appearance of normal figures more than did those two hours after injury. Cells with split nuclei persisted.

At times a normal mitotic figure was found in the normal epithelium between the wounds.

Four hours after application of the injury many normal mitoses were seen in the epithelium between the wounds. In the annular prominence cells with split nuclei and abnormal mitoses persisted.

That there is strong inhibition of mitosis following such injuries of the corneal epithelium in rats was found by Friedenwald and Buschke[1]. They state that *in vivo* a return to normal count is found around the fourth hour and some overshooting occurs between four and six hours after injury.

From the above it was concluded that, as in this instance there is cell proliferation without any normal mitotic figures present, cell multiplication has occurred by a process other than mitosis. Consequently, injury as such causes a change in the mode of cell division in the immediate vicinity of a wound.

Further, from a detailed study of the mechanism of wounding[2] which showed that, at least in a certain area, the only injury to the migrating cells is through compression, it was concluded that, of itself, compression of the epithelium produces a change in the mode of cell division.

This work received financial support from the Council for Scientific and Industrial Research, South Africa.

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Influence of Atropine and Morphine on the Liberation of Acetylcholine from the Guinea Pig's Intestine

IT has been shown by Chujyo[1] that distension of the lumen of the guinea pig's intestine results in an increased output of acetylcholine. Distension of the lumen also leads to a contraction of the longitudinal muscle, which is probably brought about by the acetylcholine released. Atropine and morphine abolish this contraction; but the mechanism of the action of these two drugs appears to be different. The following experiments show that whereas atropine apparently acts by preventing the action of the released acetylcholine on the longitudinal muscle, morphine inhibits the release of acetylcholine.

Distended strips of the guinea pig's small intestine were incubated in Tyrode solution aerated with 95 per cent oxygen + 5 per cent carbon dioxide at 38° C. in the presence of 10 μgm./ml. eserine. Four samples were obtained from the intestine of one animal; two were incubated in the presence of atropine or morphine, the other two served as controls. After 1 hr. incubation the Tyrode solution was removed, cooled, made isotonic to frog saline and assayed for acetylcholine on the eserinized frog rectus muscle. 1 gm. of intestinal tissue released between 2 and 6 μgm. acetylcholine per hr. The same release, or an insignificant increase in the release, was obtained when the experiment was carried out in the presence of 5 μgm./ml. atropine in the bath fluid. On the other hand, the presence of 10 μgm./ml. morphine in the Tyrode solution reduced the output of acetylcholine by 40–60 per cent although morphine is 3–5 times less effective in paralysing the guinea pig's ileum than atropine[2]. These results are given in Table 1; each figure represents the mean of two samples.

The present observation agrees with the corresponding one of Paton[3], who found that the output of acetylcholine from the intestine on co-axial electrical stimulation of the guinea pig's ileum was depressed by morphine.

The effect of morphine in preventing the release of acetylcholine brought about by distension or stimulation of the gut is best explained on the assumption that the acetylcholine is released from nerve fibres or nerve endings which are inhibited by

Table 1

	Liberation of acetylcholine* (μgm./gm./hr.)				
Exp. No.	Control	Atropine (5 μgm./ml.)	Exp. No.	Control	Morphine (10 μgm./ml.)
1	2·55	2·80	5	2·25	1·35
2	2·75	3·20	6	3·00	1·35
3	5·95	6·50	7	5·30	2·25
4	4·90	5·10	8	5·00	2·15
			9	4·10	1·60

* Expressed in terms of acetylcholine chloride.

morphine. The nature of these nervous structures, however, is uncertain. Ganglion cells can be excluded according to the results of Feldberg and Lin[4] and also because morphine does not inhibit ganglion cells in the intestine[2]. On the other hand, morphine was found to abolish contractions of the guinea pig's duodenum on stimulation of the vagi, probably by an action on postganglionic structures[5].

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Incorporation of Methionine (Sulphur-35) into the Central Nervous System

TWENTY-FOUR hours after administration, methionine (sulphur-35) in the central nervous system is largely found in protein molecules[1,2]. In other words, incorporation of methionine (sulphur-35) is a good indicator of proteosynthetic activity of different parts and structures of the central nervous system.

A number of authors have studied the incorporation of methionine (sulphur-35) into the central nervous system[3-7]. In agreement with their work, it has been demonstrated that a relatively larger amount of methionine (sulphur-35) is incorporated into the grey matter of brain and spinal cord than into the white matter.

Experiments were carried out on eight male police dogs aged two years and adequately fed. Methionine (sulphur-35) was administered intraperitoneally (200 microcurie – 1 millicurie). Twenty-four hours later the animals were killed. The coated method was used for histoautoradiography with an emulsion developed in our laboratory[8].

Activity of sulphur-35 determined in mineralized tissues[1] decreases in the following order: cerebellum, brain cortex, pons, spinal cord, peripheral nerve.

Autoradiography of coronal sections of the brain showed that methionine (sulphur-35) accumulates to a larger extent in the grey matter (Fig. 1). No obvious differences between the activity of the grey matter of the cerebral cortex and of basal ganglia could be demonstrated. The isotope does not accumulate extensively in the areas surrounding the ventricles.

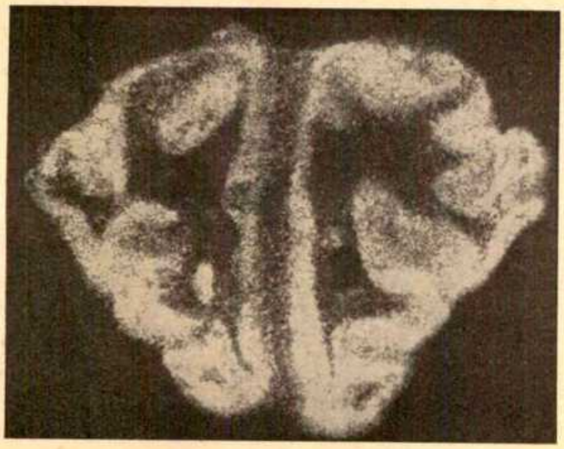

Fig. 1. Coronal section through the brain of the dog, showing greater incorporation of methionine sulphur-35 in the grey matter of the cortex

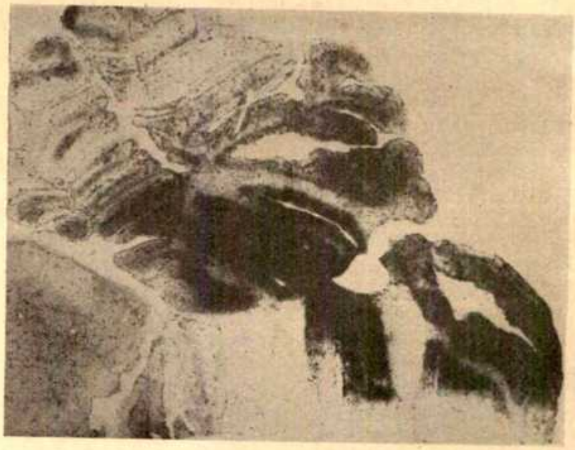

Fig. 2. Incorporation of methionine sulphur-35 into the cerebellum. Higher concentrations are present in phylogenetically older regions of the cerebellum. Unstained. (× 15)

The following areas were historadiographed: gyrus sylvius ant. and post., g. sigmoideus post., g. enterolateralis (occipital pole), basal ganglia, palleo- and neo-cerebellum, pons, spinal cord. In certain cellular structures of the cerebral cortex accumulation of methionine sulphur-35 could not be demonstrated. The same holds good for the grey matter of the pons and basal ganglia. The border-line between grey and white matter is relatively sharp, activity in the white matter being up to twice as low as in the grey matter. In the cerebellum activity

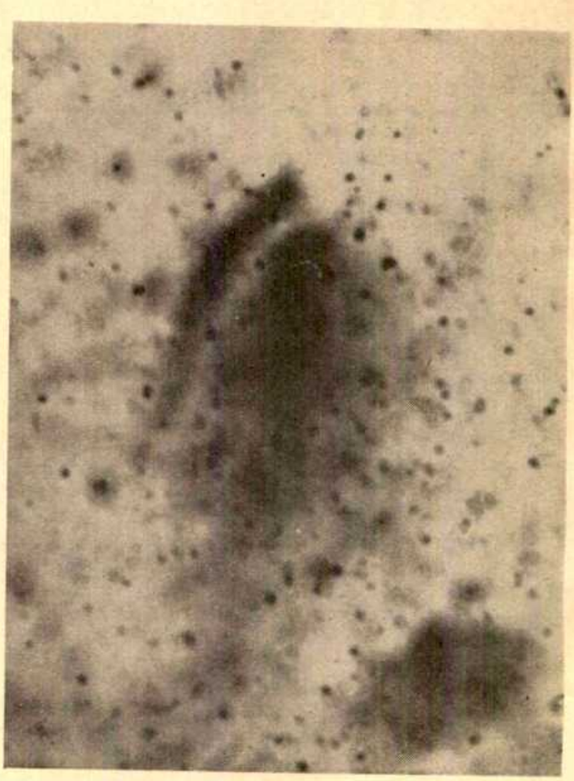

Fig. 3. Concentration of methionine sulphur-35 in motor cell from anterior spinal horn. Coated radioautograph. Hæmatoxylin–eosin. (× 975)

is highest in the medial parts (phylogenetically old cerebellar areas; Fig. 2). Under higher magnification it is possible to demonstrate greater accumulation of methionine sulphur-35 in the granular layer of the cerebellar cortex.

Methionine sulphur-35 is not distributed equally throughout the grey matter of the spinal cord. The largest amount is present in motor cells of the anterior horn (Fig. 3). Even in the anterior horns it is possible to differentiate cells with activity higher than the rest.

Very little methionine sulphur-35 is present in the cerebrospinal membranes. No accumulation of methionine sulphur-35 could be demonstrated in the central nervous system surrounding blood vessels or in the vascular walls themselves.

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Possible Interaction of Anti-diuretic and Sodium-retaining Hormones in the Kidney

While investigating the renal excretion of water and sodium by rats in response to intravenous infusion of isotonic saline[1,2], it became desirable to consider some aspects of the renal tubular re-absorption of these substances[3]. We have attempted to do this by considering a model of the tubules based upon properties of a membrane the characteristics of which have already been studied. Some properties of frog skin have been described by Ussing and Zerahn[4], and it seems that this membrane can act as a 'sodium pump', actively transferring sodium ions; the activity of the 'sodium pump' appearing as an e.m.f. of about 100 mV. across the membrane. The rate of water transfer may be regarded as dependent upon hydrostatic and osmotic pressure differences across the membrane and upon its permeability to water.

For a membrane having these properties the rate of sodium transfer may be shown to be a function of the rate of transfer of water and vice versa. In this case a change in the flux of water across the membrane may lead to a similarly directed change of the sodium flux. Were the e.m.f. developed by the 'sodium pump' controlled by a sodium-retaining hormone and the permeability of the membrane to water by an antidiuretic hormone[5], then there would appear to be an interaction between these two hormones which is, however, a function of the membrane upon which they act.

It is suggested that the activity of the renal tubules in re-absorbing sodium and water from the lumina may show properties not entirely dissimilar from the characteristics of frog skin mentioned above. On this supposition the renal responses to certain physiological stimuli have been deduced and found to agree with observations. In particular, the excretion of a urine initially hypotonic in response to an isotonic saline infusion is explained, as also is the inability of physiological doses of antidiuretic hormone to inhibit diuresis caused by infusing isotonic or hypertonic saline.

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Effect of Fast Neutrons on Different Stages of Spermiogenesis in *Drosophila melanogaster*

From X-ray studies, it is known that the rates of chromosome aberrations vary with the age of the males[1] and the time from irradiation to insemination[2]. Lüning[3] showed that these variations were due to differences in the rates of chromosome breaks in different stages of spermiogenesis and that in spermatids there was a higher rate than in mature spermatozoa. After Baker and Von Halle's[4] observation that there was a difference in the rate of dominant lethals in sperm between the first and second day, this was further studied by Lüning[5] on other types of aberrations. He proposed that this difference was due to a difference in the rate of breaks in 'mature' (the first-day) and 'near mature' (the second-day) sperm. This conclusion ought, however, to be revised as some yet unpublished experiments have shown.

From experiments by Baker and Von Halle[6] with fast neutrons it is known that the rates of dominant lethals were the same in sperm from the first and the second day. This result is difficult to explain on the hypothesis of a difference in sensitivity between sperm of the first two days.

Hence it seemed to us worth while to attack the problem of different sensitivity by means of irradiation with fast neutrons also on other types of aberrations. In this study we used two types of mutations, namely, sex-linked recessive lethals, and II–III translocations. The purpose of this experiment was also to obtain information concerning the effectiveness of the fast neutrons compared with X-rays on the two types of mutations. In order to be sure that the dose and stages in spermiogenesis were the same for both types of mutations, certain precautions have to be taken. In our case we used a 'dual-purpose' stock from which we could take the daughters for tests of recessive lethals and their brothers for translocation tests.

Table 1

Day of mating after irradiation	Recessive lethals		
	X-chr. tested	Lethals	
		Abs n : r	Per cent
1	918	10	1·09
2	953	9	0·94
5–6	1,137	24	2·11
Day of mating after irradiation	II–III translocations		
	II–III chr. tested	Translocations	
		Abs n : r	Per cent
1	1,042	32	3·07
2	1,021	35	3·43
5–6	794	61	7·68

The males were taken from *sp* ; *th* stock, the females from an sc^{S1} *B InS* w^a sc^8 ; *cn bw* ; e^{11} stock. The *X*-chromosome in this is the so-called Muller-5 = *M*5. The males were irradiated in the Swedish uranium reactor when 1–24 hr. old. They were afterwards mated to virgin females and then transferred to new virgin females at the following times after irradiation, 24, 48 and 96 hr. They were discarded 144 hr. after the treatment. Eggs were collected from females mated during the first, second and fifth–sixth day after treatment. The F_1 daughters were mated singly to *M*5 males in vials and the F_2 offspring was then examined for the occurrence of recessive lethals. The F_1 males were mated singly to *cn bw* ; e^{11} females and their offspring was analysed for II–III translocations. The results are presented in Table 1.

A comparison between the first and the second broods shows no differences for both types of aberrations, which is in agreement with Baker and Von Halle's results. The comparison between these first two days on one hand and the fifth–sixth day on the other shows for both types of mutation about twice as high a frequency in the latter as in the former.

These results confirm Baker and Von Halle's observations on dominant lethals, as the same rates of recessive lethals and translocations respectively are induced in the first as in the second brood. Hence one might conclude that the same rates of breaks are induced in the sperm of the two batches. In sperm supposed to have been irradiated in the spermatid stage a significantly higher rate of aberrations of both kinds was induced. This is in agreement with the results after X-ray irradiation and is consistent with the hypothesis of a differential sensitivity of various stages in spermiogenesis. It is, however, not possible to determine whether the degree of sensitivity is the same for X-rays and fast neutrons.

From the experiments presented above we may conclude that fast neutrons induce about the same rate of chromosome breaks in sperm to be inseminated during the first two days but a significantly higher rate in sperm to be ready during the fifth–sixth day mating period.

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Production of Heteroploidy in the Three-Spined Stickleback, *Gasterosteus aculeatus* (L.)

Many data exist on natural and induced polyploidy in Amphibia[1,2] ; but knowledge on the subject still remains scanty in other groups of vertebrates. Spontaneous and experimentally produced polyploidy has been studied in mouse embryos[3-7]. Among fishes, production of triploidy by cold treatment has been reported up to cleavage stages[8]. The present work has been undertaken to induce triploidy by heat and cold treatment of the eggs of the three-spined stickleback and to keep alive the triploids thus produced.

The diploid number of chromosomes of *Gasterosteus aculeatus* as studied from squash preparations of testes, entire embryos and conjunctiva of the eyes of adult fishes is 42 ± 2. The small size of the chromosomes still leaves some doubt whether the observed variation in the counts is due to technical limitations or to an actual variation in the chromosome number of different individuals.

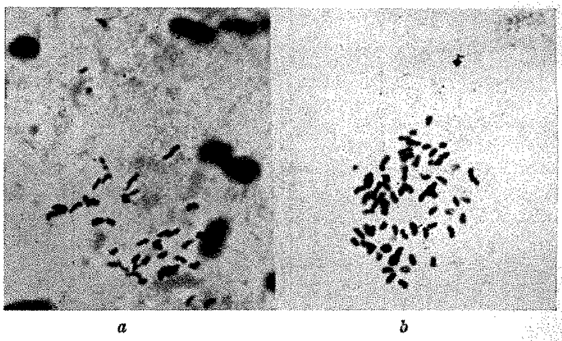

Fig. 1. Squash preparation of the conjunctiva of (*a*) diploid, and (*b*) triploid juvenile fish showing 42–44 and 63–66 chromosomes respectively. (× 1,000)

For the production of triploidy, the eggs, just after insemination, were subjected to heat or cold treatment which probably suppressed the formation of the second polar body and resulted in the fusion of two maternal and one paternal sets of chromosomes. The best temperature for heat treatment was between 32·5° and 34° C. provided the eggs were treated for 5 min. within 15 min. after insemination. However, heat shock always resulted in a high rate of mortality and the production of many abnormalities in the surviving embryos. Therefore cold treatment, which yielded better results, was preferred. It was soon noted that the fertilized eggs can bear a temperature of 0° C. up to 3 hr. ; those treated for 5, 6 and 15 hr. died at cleavage stages. In order to find the best time at which to begin the treatment, the eggs were exposed to the cold treatment for 3 hr., beginning at 3, 5, 10 and 15 min. after insemination. The results obtained are shown in Table 1.

Experiments for triploidy are successful only if the eggs are treated with cold within 5 min. after insemination, 3 min. being the best time. A cold treatment of 3 hr. still causes a very high mortality. The shortest treatment which produces triploidy without causing too high a mortality was found to be 1½ hr. (see Table 2), and hence all later experiments were confined to this treatment.

The construction of a simple apparatus which produced a continuous current of water made easy the

Table 1. RESULTS OBTAINED BY SUBJECTING THE EGGS TO 0° C. FOR 3 HR.

Time of treatment after insemination	Total eggs treated	Survival up to lens formation	Analysable	Haploid	Diploid	Triploid	Mosaic
3 min.	514	42	27	0	1	18	8
5 ,,	465	131	86	0	49	22	15
10 ,,	226	7	7	0	0	0	7
15 ,,	85	45	38	17	14	1	6

Table 2. RESULTS OBTAINED BY SUBJECTING THE EGGS TO 0° C. FOR VARYING PERIODS, ALL BEGINNING 3 MIN. AFTER INSEMINATION

Duration of treatment	Total eggs treated	Survival up to lens formation	Analysable	Haploid	Diploid	Triploid	Mosaic
½ hr.	101	42	40	7	24	0	9
1 ,,	111	36	30	2	18	1	9
1½ ,,	132	40	31	2	3	18	8
2 ,,	55	25	19	1	3	7	8
2½ ,,	96	11	11	0	2	6	3
3 ,,	514	42	27	0	1	18	8

rearing of embryos up to yolk absorption. The young diploid and triploid fish kept in the aquaria have by now reached two-third adult size.

All chromosome counts on embryos were made on squash preparations of whole embryos shortly after lens formation; those of later stages were carried out on squash preparations of the conjunctiva of one eye without killing the fish since the wound heals within a short time.

This work was done under the supervision of Dr. M. Fischberg, to whom I am grateful for his constant help and encouragement.

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Further Observations on the Blood Factor Di^a

IN a previous communication[1] we remarked that the blood factor Di^a promised to be of great anthropological interest: it might prove to be a Mongoloid characteristic. Since then we have, on one hand, found it in a second northern Indian tribe—the Crees of northern Manitoba—three Di(a+) out of thirty-five, and on the other hand in none of thirty-five American Negroes, while Dr. Layrisse tells us that he has tested a number of Nigerians without finding any positive. It looked, indeed, as if Di^a were a Mongoloid 'marker', so it came as a surprise when we found no Di(a+) among 156 Eskimos.

Both the Cree Indians and the Eskimos were patients in tuberculosis sanatoria. Since the frequency of the factor in these Crees was essentially the same as in the neighbouring healthy Chippewa it would not seem that there could be any relationship between the facts that the Eskimos had tuberculosis and that they were all Di(a−). The use of sanatorium populations has the advantage that the patients come from many small populations scattered over a wide area and in this sense represent a random sample of the general population of that area. Laughlin[2] has pointed out the variations that occur in the blood-group gene frequencies in smaller and larger isolates among the Eskimo. We think the sanatorium method of sampling should give a true overall picture. The Eskimos tested were all from the eastern Canadian arctic, which includes Hudson Bay, Baffinland and Labrador. We hope to extend these studies to the western arctic.

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Bacteriological Studies of 'Infected' and 'Uninfected' Chicks in Relation to Antibiotic Growth Stimulation

COATES *et al.*[1] described an infective growth-depressing condition in premises where chicks had been reared for some time. The condition was counteracted by penicillin in the diet, and was not present in clean premises where chicks had not previously been kept. Work on the relationship between *Clostridia* and antibiotic growth stimulation has been critically reviewed by Jukes[2].

In our investigation of the so-called infection, the gut flora of chicks from clean and infected premises was examined during the first few days of life; a gut flora similar to that of adult birds was found in chicks two days after they began to feed[3]. Spores of *Clostridium welchii* type *A* were found in the cæca of chicks from the infected premises one day after feeding, but not in those from the clean environment. Total counts made in series with spore counts showed that *Clostridia* are one of the most numerous components of the developing gut flora of the chick.

In further experiments the infected premises were thoroughly cleaned and redecorated, and the first batch of chicks placed therein was examined. *Cl. welchii* was not found in these birds, but was present in the cæca of chicks from the original clean premises. The chicks from the original clean quarters were infected, that is, their weights were depressed, in comparison with the weights of chicks from the redecorated premises. Subsequent batches of chicks placed in the redecorated premises showed growth depression compared with penicillin-fed controls, and also *Cl. welchii* in their cæca. Thus the presence of *Cl. welchii* in the cæca of chicks one day after feeding indicated 'infection'.

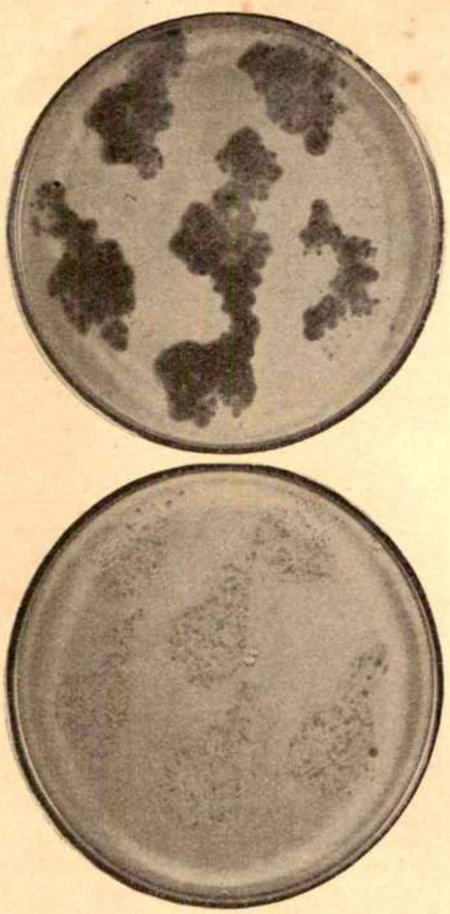

Fig. 1. Differences in lecithinase production on neomycin egg-yolk agar between *Cl. welchii* from 'infected' (top) and penicillin-fed (bottom) chicks

Further experiments were made with birds from infected premises with and without penicillin in the diet, *Cl. welchii* being enumerated by the method of Lowbury and Lilly[4]. In the first experiment of this series, *Cl. welchii* was not found in either group one day after feeding; however, it appeared on the second day in the control group, but not in the group fed penicillin. *Cl. welchii* was not found in the penicillin-fed group in three subsequent experiments on either the first or second day. In another experiment chicks from an alternative source were used, and *Cl. welchii* occurred in both penicillin-fed and control groups in equal numbers. However, Fig. 1 shows that, in contrast with the activity of *Cl. welchii* strains from the control group, lecithinase (α-toxin) production on neomycin egg-yolk agar was markedly less in strains from the penicillin group (lower plate); the dark areas show lecithinase activity. Strains of *Cl. welchii* from this group produced as much lecithinase when subcultured in the absence of penicillin as strains isolated from the control group.

The presence of *Cl. welchii* in the gut of chicks thus appears to be related to the growth-depressing condition. There are distinct differences in the presence and activity of *Cl. welchii* in the first few days of life between chicks from clean and infected premises, and between infected and penicillin-fed chicks. Moreover, the metabolism of at least one component (*Cl. welchii*) of the flora of infected chicks can be altered by penicillin in the diet, the effect for the host being equivalent to elimination of the organism. The experimental details of this work will be published elsewhere.

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Linkage Group XIV of the House Mouse

PRELIMINARY linkage tests with the house mouse mutant 'crinkled'[1] showed a deficiency of recombinations between crinkled and flexed-tail[2] in repulsion inter-cross matings. Owing to a serious shortage of flexed-tail segregants, back-cross matings in coupling and repulsion were set up to estimate the percentage recombination between these loci. Because of the lack of vigour of crinkled flexed-tail homozygotes, these could only be used as male parents. Consequently, the recombination observed refers to that of doubly heterozygous females. Flexed-tail was classified within 24 hr. of birth by the transient anæmia visible at that age, and crinkled at 1–2 weeks of age by the appearance of the coat and tail. The number of offspring from the back-cross matings are given in Table 1.

Table 1

Phase	Normal	Flexed and crinkled	Flexed	Crinkled	Total
Coupling	49	32	17	23	121
Repulsion	54	29	65	95	243

There is a shortage of flexed-tail animals which may, in part, be due to pre-natal losses, but is certainly mainly due to losses after birth and before the classification for crinkled. There is no evidence to suggest that with classification of flexed-tail by the anæmia visible at birth, the deficiency may be due to normal overlapping (see also Grüneberg[3]). To allow for reduction in viability, the data for coupling and repulsion phases were combined by Fisher's method[4]. The estimated recombination percentage between crinkled and flexed-tail is 33·6 ± 2·6 per cent.

Linkage tests of crinkled were made with marker genes in all the known linkage groups except IV for which no suitable marker was available. The results are summarized in Table 2, which shows the estimated recombination percentages and thei standard errors obtained by the procedure of Carter and Falconer[5].

The values obtained show no significant deviation from independent assortment of crinkled with any other marker. In addition, published data[6] provid no evidence that the flexed-tail locus is linked to

Table 2. INDEPENDENCE DATA

Symbol	Mutant locus	Linkage group	Recombination percentage	Standard error
c	Albino	I	50·2	2·6
p	Pink-eye	I	52·4	7·7
d	Dilute	II	45·4	3·7
s	Piebald	III	52·9	4·5
lx	Hemimelia tibiæ (luxate)	III	55·3	6·1
a	Non-agouti	V	51·6	2·3
Sd	Danforth's short-tail	V	58·5	6·2
bt	Belted	VI	48·9	2·9
Ca	Caracul	VI	51·3	5·7
N	Hypotrichosis hypokeratotica (naked)	VI	55·0	6·4
Re	Rex	VII	53·0	5·7
sh-2	Shaker-2	VII	41·1	9·8
wa-2	Waved-2	VII	59·3	9·2
b	Brown	VIII	47·4	2·5
T	Brachyury	IX	56·4	4·8
v	Waltzer	X	46·7	6·8
Mi^w	White	XI	47·6	6·4
je	Jerker	XII	45·5	6·2
ru	Ruby eye	XII	40·4	7·4
fz	Fuzzy	XIII	55·4	6·3
ln	Leaden	XIII	47·5	4·8
—	Sex		47·3	2·0
Va	Varitint-waddler		45·3	6·9

any other mutant locus. Crinkled and flexed thus appear to constitute a new linkage group which has been given the Roman numeral XIV.

I am indebted to Dr. D. S. Falconer for helpful advice and to Prof. C. H. Waddington for facilities kindly made available at the Institute of Animal Genetics.

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A Rare Estuarine Copepod Crustacean, *Enhydrosoma garienis*, found in the Holocene of Kent

AMONG some small organisms including a single ostracod shell, washed from a sample of clay brought to me for identification by Dr. W. A. Macfadyen, was a small tapering object about ⅓ mm. long, terminating in a fine seta. The silty clay, penetrated by fine contemporary rootlets, had been collected from 6 in. below a Neolithic floor by Mr. J. P. T. Burchell at Lower Halstow, Kent. The object, when examined under the microscope, was seen to be a copepod complete with furcal rami and at least some of its appendages. As a zoologist, knowing how difficult it is to sort out these minute crustacea from a few drops of mud and water, I was surprised that anyone could have found so small a specimen in a pound of dried clay and mounted it with gum tragacanth intact on a black cardboard microscope slide.

The minute size of the specimen is indicated in Fig. 1 by comparing it with a fragment of the 'dust' from an electric shaver. Copepods are delicate organisms living in water, and contract and shrivel so badly on drying that no zoologist would think that a recent specimen mounted on card would be worth looking at. Dr. Macfadyen's skill in finding and preserving so small and delicate an object, presumably thousands of years old, however, goaded me into investigating the specimen further.

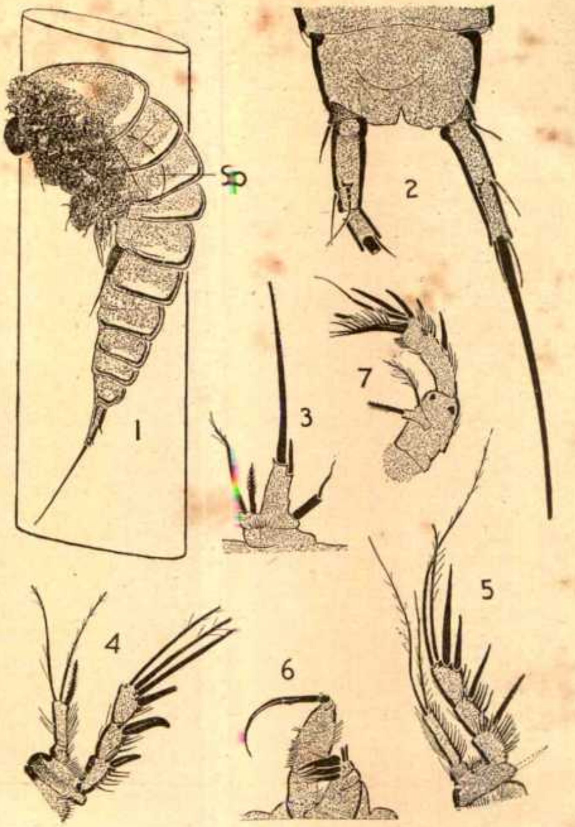

Fig. 1. *Enhydrosoma garienis* Gurney (male). 1, The intact specimen after relaxing and clearing. (*sp.*) spermatophore: outline drawn to the same scale of one day's growth of a human hair on a male chin (× *c.* 140); 2, dorsal view of the last segment of the abdomen and furcal rami; 3, the fifth leg; 4, the third leg; 5, the second leg; 6, second maxilla and maxillipede; 7, second antenna (Figs. 2–7 × *c.* 410)

After being soaked off the black card the object was boiled in a 2 per cent solution of tribasic sodium phosphate in order to soften and relax it. This treatment is recommended by Harley and Ross[1] for reclaiming dried arthropods and nematodes. The specimen was then cleared in lactic acid and some of the debris still adhering to it was removed with needles. The appearance of the specimen is shown in Fig. 1, which is drawn from a photograph taken at that time. The copepod was evidently a male as not only could a swollen first antenna be seen among the extraneous matter still covering most of the appendages but inside the animal could quite easily be seen the chitinous walls of a spermatophore (*sp.*). The fifth leg was still intact and the furcal rami with their setæ practically complete (Fig. 2).

Up to this time, I had thought that the specimen was probably a well-known British freshwater species which had somehow reached the clay. The rather unusual shape of the furcal rami, however, showed at once that it was not to be found in Gurney's monograph[2], nor in Sars's[3], which includes most likely marine species as well. Further progress could only be made by dissection. This was achieved using a Labgear–Harding microdissector[4].

The animal was dissected in lactic acid and the parts mounted in polyvinyl lactophenol, after staining with lignin pink. With the exception of the mandible and first maxilla all the appendages on both sides of the animal, that is, nine pairs, were successfully removed and mounted permanently on a slide, now preserved in the Palæontological Department of the British Museum (Natural History). A selection is shown in Figs. 3–7. Apart from some of their tips, nearly all the setæ are still intact. The outer seta on the basis of leg 2 (Fig. 5) is shown in dotted outline only, as it was absent from the leg drawn but present on its fellow from the opposite side. The corresponding setæ of the third leg (Fig. 4) was missing on both sides.

The species proves to be *Enhydrosoma garienis* Gurney[5] described from Breydon Water, Norfolk, the estuary of the Rivers Yare and Waveney, which Gurney describes as subject to great changes in salinity. It has not been recorded since its original discovery, so far as I am aware, and the specimen from the Holocene clay is only the second male ever to be found, as Gurney had only one male. The prehensile first antenna and the fifth leg (Fig. 3) are almost identical with Gurney's figures. The furcal ramus (Fig. 2) is very different from the furcal ramus drawn by Gurney, which was from a female, but agrees with his description of that of the male. The third leg of the male is also figured for the first time here (Fig. 4).

E. garienis is the only species of the genus which is not completely marine in habitat, so that for an understanding of the earlier conditions of the Neolithic site it is fortunate that Gurney found and described his few specimens of this, the only estuarine species.

I must express my thanks to Dr. Macfadyen for giving me the specimen to investigate.

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Flowering Responses of Some Palestinian Legumes to Photoperiod and Temperature

A LATE autumn outdoor sowing was made of eighteen species of wild-growing leguminous annuals. As soon as the seedlings were big enough to handle, they were potted and grown under fixed photoperiods of 9, 12, 15 and 18 hr., and at natural day-length, in a heated greenhouse in which the temperature was thermostatically maintained above 14° C. A parallel outdoor control series, comprising the genera represented by more than one species, was exposed to lower average temperatures, with minima frequently amounting to only a few degrees above zero. Each treatment lot consisted of five replications. The natural day-length diminished during the experimental period from 11 hr. 15 min. to the annual minimum of 10 hr. 25 min., and then went up again to just under 12 hr. by the time all flowering was over on the greenhouse plants. Observations on the outdoor plants were continued until May 1, when the length of day was 13 hr. 25 min.

The photoperiodic treatments have been tabulated in the order of increasing time-interval from germination to flowering (Table 1). Individual treatment means have been omitted, and photoperiodic indications have been bracketed into statistically homogeneous groups, each group being furnished with the estimate of its mean. Non-homogeneous groups differ significantly at the 5 per cent level.

Table 1. NUMBER OF DAYS FROM GERMINATION TO THE ONSET OF FLOWERING UNDER DIFFERENT PHOTOPERIODIC TREATMENTS

Species	Homogeneous groups	Estimates of means with confidence limits
Trigonella spinosa L.	(15, 18, 12, 9, N*)	81·6 ± 5·0
T. monspeliaca L.	(18, 15); (12, N); (9)	89·5 ± 7·9; 98·5 ± 7·9; 113·0 ± 11·1
T. coelesyriaca Boiss.	(18); (15, 12, 9); (N)	80·0 ± 11·1; 90·7 ± 6·4; 98·0 ± 11·1
Medicago orbicularis (L.) Bartal.	(15, 18); (12); (9, N)	75·5 ± 7·9; 83·0 ± 11·1; 95·5 ± 7·9
M. coronata Desr.	(15); (12, 18, N); (9)	65·0 ± 11·1; 73·7 ± 6·4; 83·0 ± 11·1
Melilotus sulcatus Desf.	(18, 15, N); (12, 9)	89·3 ± 6·4; 104·0 ± 7·9
Trifolium lappaceum L.	(18, 15); (12, N); (9)	82·5 ± 7·9; 110·5 ± 7·9; 128·0 ± 11·1
T. stellatum L.	(18, 15, N); (12, 9)	83·7 ± 6·4; 106·0 ± 7·9
T. purpureum Loisel.	(18); (15, N, 12, 9)	85·0 ± 11·1; 105·5 ± 5·6
T. palaestinum Boiss.	(18, 15); (N, 12, 9)	96·5 ± 7·9; 116·7 ± 6·4
T. scabrum L.	(18, 15); (N, 12); (9)	65·5 ± 7·9; 90·0 ± 7·9; 103·0 ± 11·1
T. vavilovii Eig.	(18, N); (15); (12, 9)	64·0 ± 7·9; 81·0 ± 11·1; 104·0 ± 7·9
T. spumosum L.	(18, 15, N); (12, 9)	73·0 ± 6·4; 100·5 ± 7·9
T. xerocephalum Fenzl.	(18, 15, N); (12); (9)	71·0 ± 6·4; 92·0 ± 11·1; 109·0 ± 11·1
Lotus peregrinus L.	(18, 15, 12, N, 9)	93·2 ± 5·0
Tetragonolobus palaestinus Boiss.	(15, 18, 12); (N); (9)	85·0 ± 6·4; 98·0 ± 11·1; 108·0 ± 11·1
Astragalus hamosus L.	(18, 15); (12); (N, 9)	97·5 ± 7·9; 103·0 ± 11·1; 114·0 ± 7·9
Vicia narbonensis L.	(18, 15, 12, N); (9)	63·2 ± 5·6; 111·0 ± 11·1

* Natural day-length.

The fact that, however tardily, flowering sets in eventually even under the 9-hr. photoperiod and the absence of a photoperiodic threshold defy any traditional photoperiodic classification. It seems that these legumes would be most appropriately classified, according to Chouard[1], as "plantes héméropériodiques préférantes", with *Medicago* possibly fitting in better with this author's "plantes eurypériodiques". It is noteworthy that in the case of *Melilotus sulcatus* and some species of *Trifolium*, the natural day-length, which did not quite attain 12 hr. in the greenhouse series, significantly advanced flowering as compared with the 12-hr. photoperiod. The gradual lengthening of the day apparently exerts a stimulating effect, as distinct from the effect of static photoperiodic values.

On the assumption that the difference in temperature-levels constitutes by far the most essential difference between the outdoor series and the greenhouse natural day-length control, the differences in the number of days from germination to the onset

Table 2. Effect of Temperature on Flowering at Natural Day-length

Species	No. of days from germination to flowering High temperature	Low temperature
Trigonella spinosa	91	160
T. monspeliaca	100	153
T. coelesyriaca	98	154
Medicago orbicularis	97	158
M. coronata	79	140
Trifolium lappaceum	112	154
T. stellatum	88	170
T. purpureum	98	171
T. palaestinum	114	168
T. scabrum	84	170
T. vavilovii	65	156
T. spumosum	80	161
T. xerocephalum	74	158

L.s.d. for temperature effect at $P = 0{\cdot}01$, 50·54.
L.s.d. for temperature effect at $P = 0{\cdot}05$, 36·06.

of flowering (Table 2) can be taken as an indication of the effect of temperature on flower induction.

It appears that in all the species tested, flowering is considerably hastened by high temperature. This response is somewhat at variance with that recorded for related pasture legumes[2] and actually indicates a behaviour diametrically opposed to that attributed to certain species of *Trifolium* and *Medicago*[3].

It is rather interesting that the species investigated, all of which flower in the early spring in a region of a relatively short day, respond readily to such long photoperiods as 15 or even 18 hr., which can be assumed to be entirely outside the scope of their evolutionary experience. It is obvious that, in the absence of a critical threshold, a purely quantitative response to day-length does not in itself constitute the flower-inducing mechanism. The time of flowering would appear to be determined by an interplay of photoperiod and temperature. The gradually increasing day-length coupled with rising temperature in the spring evidently induces flowering when a suitable combination of the two complementary factors is reached.

I thank Mr. S. Zacks for assistance in the carrying out of statistical computations. A fuller account of this investigation, including additional information on the growth and development of the experimental plants, will be published elsewhere.

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Anthracnose Fungi of Olives

In published reports on anthracnose disease of olives, mention is made of only one responsible organism, the fungus described by Almeida[1] as *Gloeosporium olivarum*. I have observed that the causal organism of olive anthracnose in South Africa differs greatly from European and American isolates in spore morphology and cultural characteristics. The spores from Portuguese and South African isolates are much narrower than those isolated in Italy and the United States. The South African fungus develops a pink pigment in the mycelium on potato dextrose agar, as does the Japanese[2] fungus; but isolates from Portugal, Italy and the United States have a grey to olive-green mycelium. The spores from the Italian isolates agree very closely with those of *Colletotrichum gloeosporioides* Penz., and as Ciccarone[3] observed setæ in the fungus from olives it is very likely that the two are identical. Spores from a Californian[4] isolate showed close agreement with the spores of *Glomerella cingulata* (Stonem.) Spauld. and v. Schrenk; they are as broad as, but decidedly shorter than, those of *Colletotrichum gloeosporioides*. The Italian and American isolates differ from the Portuguese and South African forms also in the method by which the conidia are produced. The latter fungi are characterized by the formation of abundant microspores on the mycelium, which are much smaller than the spores formed in the acervuli; in the former, spores are only sparingly formed on the mycelium and they are of about the same size as the acervular spores.

Such wide variation in spore size and cultural features raises doubt whether all the anthracnose fungi of the olive should be regarded as *Gloeosporium olivarum* Alm. In my opinion they should not, for I found that the South African fungus was morphologically and culturally indistinguishable from the chromogenic strain of *Glomerella cingulata* that Dr. M. C. Goldworthy of Beltsville, United States, isolated from apples[5]. The South African fungus could even produce a rapid fruit rot when inoculated into apples. Another reason for considering the South African fungus as distinct from *Gloeosporium olivarum* Alm. is that the former can cause a blossom blight, which has never been reported as a feature of the olive disease in Portugal. The South African fungus is therefore considered identical with Goldworthy's chromogenic strain of *Glomerella cingulata*. However, in respect of spore size and method of spore formation this strain is much more closely related to *Gloeosporium olivarum* than to most other strains of *Glomerella cingulata*. It is felt that this should be expressed in the name.

It is known that *Glomerella cingulata* is extremely variable. Its strains can, however, be grouped in seven different types, two of which have not been known to produce perithecia[6]. Both conidial types (one is the pink chromogenic strain) possess the slender spores which are so typical of the non-perithecia-forming *Gloeosporium olivarum* Alm. Hence it is thought that the slender-spored conidial strains of *Glomerella cingulata* should not be included in this species; but rather that Edgerton[7] should be followed in distinguishing between non-perithecia-forming and perithecia-forming strains of *Glomerella cingulata* and identifying the first with the name *Gloeosporium fructigenum* Berk. The chromogenic strain of *Glomerella cingulata* could then be conveniently called *Gloeosporium fructigenum* Berk. f. *chromogenum* Gorter form. nov. = Goldworthy's chromogenic strain of *Glomerella cingulata* (Stoneman) Spauld. and v. Schrenk *loc. cit.*[5] which apparently not only causes an anthracnose of apples and olives but also of peaches[8]. To bring out the close relationship which exists between *Gloeosporium fructigenum* Berk. f. *chromogenum* and *Gloeosporium olivarum* Alm. from Portugal (cross-inoculations on apple are also possible), the latter should be renamed *Gloeosporium fructigenum* Berk. f. *olivarum* (Alm.) Gorter comb. nov. (= *Gloeosporium olivarum* Almeida *loc. cit.*[1]).

The presentation of this preliminary communication seems desirable as this is the first time that more than one anthracnose fungus has been identified on olives.

The implication is that caution should be exercised in ascribing anthracnose of olives to *G. olivarum* Alm.

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Ætiology of European Foul Brood; a Disease of the Larval Honey-bee

THE cause of European foul brood was originally thought to be *Bacillus alvei*[1] or a mixture of *B. alvei* and *Streptococcus apis*[2]. The causative organism was later named and described by White[3] as *Bacillus pluton*, a lanceolate Gram-positive bacterium. This organism is the first of several which have been found to appear in diseased larvæ. However, White and others failed to culture *B. pluton in vitro* and it was afterwards considered to be a dissociant form of *Bacillus alvei*[4], of *Bacterium eurydice*[5], or of both[6]. Others[7,8] have maintained that *B. pluton* is a separate organism. It has been pointed out that *Streptococcus pluton* would be a more suitable designation than *Bacillus pluton* both on morphological grounds and in the absence of evidence that it forms spores. For these reasons and those given below the organism will be referred to as *Streptococcus pluton*.

Attempts have recently been made, by Prof. L. P. Garrod (St. Bartholomew's Hospital), to cultivate *S. pluton*, from diseased larvæ[9]. A Gram-positive encapsulated, pleomorphic, usually oval coccus which grew in anaerobic conditions on glucose–broth agar, was repeatedly isolated from diseased larvæ. Some evidence was obtained on one occasion that this bacterium grew in honey-bee larvæ and developed into an organism morphologically identical with *S. pluton*, but the disease failed to develop in this and in repeated experiments.

During further attempts to re-isolate the organism on special media, I have recently been able to isolate a bacterium which is probably the same as that previously isolated by Garrod; but its growth is relatively much stronger, and it is now morphologically stable. It appears to be *S. pluton*. The organism can readily be isolated in anaerobic conditions on a medium composed of: 1 per cent yeast extract ('Difco' yeast extract is very suitable); 1 per cent glucose; 0·1 molar potassium dihydrogen phosphate; 2 per cent agar. Adjust to *p*H 6·5 with concentrated potassium hydroxide. Sterilize by steaming or in the autoclave at 5-lb. pressure (108° C.).

The optimum temperature for growth is about 35° C. The optimum *p*H is about 6·5; no growth occurs at or below *p*H 5·5. The colonies are small (never more than about 1·5 mm. in diameter), round, entire and convex. They are transparent and microscopic after 24 hr., just visible and granular after 48 hr., and become very granular and pearly white by reflected light and almost opaque and slightly brown by transmitted light after three days. The organism grows as a lanceolate *Streptococcus* in chains of variable lengths. It has a thick cell wall, is highly refractile in watery suspension and is Gram-positive. Carbohydrate is essential; but only glucose, fructose or, to a lesser extent, sucrose support growth. Neither acid nor carbon dioxide is formed in detectable amounts. Citrate strongly inhibits growth and can be counteracted by magnesium. Marked inhibition of growth is caused if the ratio $[Na^+]/[K^+]$ is greater than 1; virtually no growth occurs if K^+ is entirely replaced (apart from the normal traces in the constituents of the medium) by Na^+. Carbon dioxide stimulates growth. Oxygen is normally tolerated up to a concentration of about 1 per cent; but growth is then weak and apparently involuted with individual cocci poorly differentiated to give chains with a more rod-like appearance.

Invariably, with the numerous isolates made so far of *S. pluton*, there have appeared colonies of *Bacterium eurydice*. The colonies of the latter have always been the first to appear, and its cultural characteristics agree with those given in detail by Gubler[8]. The two organisms will readily subculture together in mixed culture in anaerobic conditions on the medium described above. These mixed cultures (fifth subcultures) have repeatedly produced acute and extensive European foul brood when sprayed on the combs of brood in healthy bee colonies. The two organisms have always been re-isolated from the diseased larvæ of these colonies. Virulence seems to diminish markedly in subculture.

B. eurydice alone does not cause the disease, as previous workers have also shown. *S. pluton* in pure culture also has not usually caused the disease; the bacteria have appeared to grow vigorously in young larvæ but have disappeared in older larvæ after producing forms suggestive of the involuted types obtained in culture in relatively high oxygen tensions. On a few occasions an initially mild attack of the disease affecting very few larvæ has arisen after infection with pure cultures of *S. pluton*. However, *B. eurydice* was also seen to be present in the diseased larvæ and was always isolated, as usual, with *S. pluton*.

No evidence has been obtained to support the theory[5] that *B. eurydice* dissociates into *S. pluton* but it seems that the presence of both bacteria is necessary for the disease to appear. The appearance of *B. eurydice* in those larva which have shown disease after infection with pure cultures of *S. pluton* suggests that it was already present in the bees. Thi supports the findings of Burri[5] and Gubler[8] tha *B. eurydice* can occur in colonies of healthy bees. However, its occurrence does not appear to be widespread; at least not in the locality where the experiments reported here were carried out.

Further work on the symbiotic relationship between *B. eurydice* and *S. pluton* and upon th epidemiology and control of the disease is in progres and will be reported in more detail in due course.

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Intrafollicular Cleavage of Human Ovum

In studies extending over the past four years on nore than four hundred human follicular and tubal va[1], three ova were found to have undergone leavage *in vivo* within the intact follicle, without any possible contact with spermatozoa. There was no evidence of any abnormal stimulation.

Follicular ova were obtained from ovaries *in situ* r immediately after their removal from patients undergoing gynæcological surgery. The unruptured ollicles were grossly normal in appearance and anged in size from 3 to 16 mm. in diameter. Aspiration of the follicles was accomplished with a sterile yringe and 20-gauge needle. The needle was inserted nto the ovarian tissue 3–4 mm. away from the edge f the follicle and then passed into its antrum so as o enter through the base, hence obviating any eakage of the follicular fluid. All normal-appearing ollicles were likewise aspirated in succession with he same syringe and needle, thus pooling the ova rom a given ovary. The fluid was then taken immeiately to the laboratory and expressed as a drop n a glass slide. A petrolatum ring was made around he drop and a cover-glass placed so that it touched he fluid but without direct pressure upon the ova. n order to have a petrolatum ring of uniform hickness, the petrolatum was expressed from a yringe through an 18-gauge needle without bevel. he ova were then studied by means of phase-conrast microscopy and photographed in phase contrast.

The ova which had undergone cleavage in the clear, traw-coloured follicular fluid included a 2-cell stage with two polar bodies within an intact zona pellucida, 4-cell stage with three polar bodies within an intact ona pellucida, and the blastula depicted in Fig. 1. he zona pellucida, completely denuded of the corona adiata and cumulus cells, surrounds a blastula of pproximately fifty cells. The exact number could ot be ascertained because of the difficulty in counting he cells in different focal levels in phase contrast. he cells, which differ in size partly because of synchronous cell division, surround the segmentation avity. Granules may be noted in the zona pellucida. The diameter of the blastula, to the outer surface of the zona pellucida, measured 150 microns.

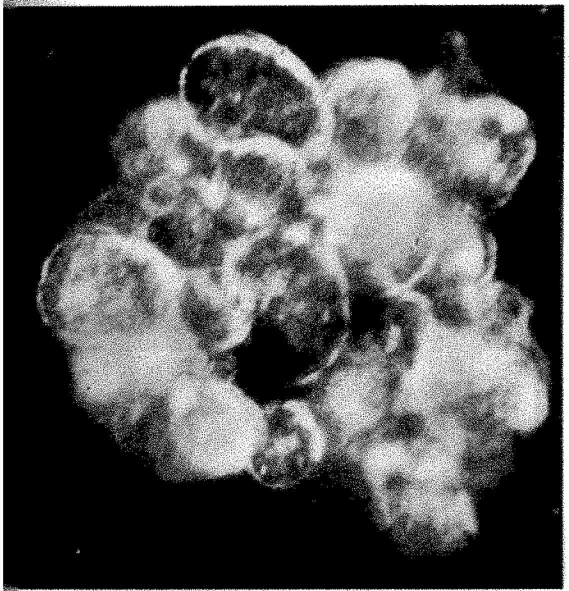

Fig. 1. Blastula stage of human ovum aspirated from intact ovarian follicle. (× *c.* 66)

In that ova from the different follicles were pooled, the exact size of the follicle which contained the blastula is not known. The specimen was obtained during the last half of the menstrual cycle. In comparison with normal human ova fertilized *in vivo* and recovered at pre-implantation stages of development[2], this blastula is approximately four days old.

The extremely rare occurrence of primary ovarian pregnancy in the human conceivably represents intrafollicular development of an ovum. From tissue properly prepared in such cases the haploid or diploid chromosomal content could be investigated. A study concerning the presence or absence of the sex chromatin body in the cells of a primary ovarian conceptus might aid in elucidating the origin of this type of gestation.

Continuing efforts are being made to record other intrafollicular developmental stages of the human ovum. Ascertainment of the chromosomal content is planned for any subsequent specimens.

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Filaments of Silica

In the course of experiments with oxide compounds containing silica, fired in a wire-wound alumina tube furnace in a reducing atmosphere, filamentous deposits were formed.

On examination, they proved to be silica in the form of filaments of varying diameter, some of which were of approximately molecular dimensions. A typical electron microscope photograph is shown in Fig. 1. The filaments exhibited strong electrostatic charges and they would be attracted, from a distance of 1–1½ cm., to any material, organic or inorganic. The

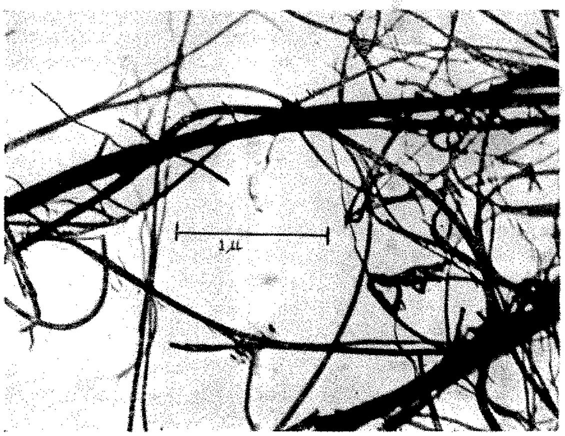

Fig. 1

charges decayed slowly and could not be detected six months later.

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Use of Plastic Tubing in Chromatography

DURING a chromatographic separation of the carotenoid pigments of the starfish *Marthasterias glacialis* (L.) from Madeira, it was found that some pigment disappeared during elution, which was necessarily prolonged in order satisfactorily to separate the relatively large number of pigments present in the total carotenoid extract. Several pigments were lost in this way (presumably owing to oxidation on the column), and further, some of the zones were so small as to make it difficult to isolate them by extruding the column.

These difficulties were largely overcome by using a chromatographic column made in a tube of polyvinyl chloride instead of glass. This plastic is transparent, and during the time of chromatographic separation does not appear to react with the solvents used, such as light petroleum, diethyl ether, ethanol and methanol. The chief advantage of this type of column is that it may be cut easily and quickly with a razor as soon as the bands become distinct, thereby lessening much of the elution and consequent loss of pigment.

When adsorbents, added in a slurry, tend to adhere to the sides of the tube, they can easily be dislodged by tapping the flexible plastic.

By using such tubes, it was possible to isolate eight carotenoids from the aboral integument of this starfish.

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Causes of Eskimo Birth-rate Increase

IN a recent article on "Researches in the Arctic Ocean"[1] dealing with Dr. G. E. MacGinitie's recent zoological work at Point Barrow, Alaska, a paragraph is of particular interest to me as an anthropologist who has spent time, off and on, at Barrow since 1908.

It reads: "The Eskimo birth-rate is increased as much as threefold when the arctic people eat 'white man's food' instead of their traditional pure animal diet of whale, fish and seal. When hunting was the only means of subsistence, Eskimo women became pregnant only once in several years; but with the new diet they bear a baby about every year".

There is no doubt that the Barrow diet has changed, along the lines indicated by Dr. MacGinitie, and that there has been such increase of birth-rate as he says. But another change, which is not mentioned there, has also been suggested as pertinent, namely, that Eskimo mothers used to nurse their children up to ages of three and four years; while now, under white tutelage, they nurse them for only about as many months.

When I was first at Barrow, forty-eight years ago, there was in residence for the Presbyterian Church a medical missionary, Dr. H. R. Marsh, who was ther on his second assignment, having been there severa years before going out on a leave which he spen at medical schools. Dr. Marsh stated the facts abou as Dr. MacGinitie does; but his explanation wa different: That women do not readily conceive whil they nurse their babies; and he believed the previously normal three-year spacing of births had bee reduced to a yearly one chiefly through the adoptio of the white man's style of early weaning.

While my observation as to the usual three-yea spacing agrees with those of Dr. MacGinitie and Dr Marsh, I noted many exceptions to that rule durin the eleven years I spent with Alaskan and Canadia Eskimos. The most striking case was that of a inland couple who looked to me around forty. The told me they were the parents of eleven children, non of whom had been twins; nine of these were stil living, they said, the other two having died at o soon after birth. When I learned this, my chie interest was in the size of the family. It was th largest that anybody had heard of; and, engrosse with this, I neglected inquiring about spacing. Sinc these were 'uncivilized' people, there is no doubt th mother nursed each child until the next came; an she may have nursed her previous along with th current baby, as I often saw done. Neither is ther any doubt that these parents of eleven had produce them while living on Dr. MacGinitie's traditional pur animal diet (which was never strictly pure in norther Alaska after 1880).

Perhaps both Dr. MacGinitie and Dr. Marsh ar partly in the right. Moreover, perhaps other factor than change in eating and nursing habits should b invoked to help explain the undoubtedly higher birth rate; for many and profound have been the change at Barrow since Dr. John Simpson first describe these Eskimos a century ago.

VILHJALMUR STEFANSSON

Dartmouth College,
Hanover,
New Hampshire. July 30.

[1] *Nature*, **177**, 1215 (1956).

"Automation Economics"

MR. AUSTEN ALBU's reply to my protest agains having been misrepresented in his review of my boo "The Economic Consequences of Automation" (Octo ber 13, p. 816) contains two further misrepresenta tions in a single sentence. He attributes to me th view that "all steps taken to increase productio are inflationary"; and states that on p. 84 of m book I claim that "the effect of automation is . . to reduce the extent of inflation". I must emphaticall disclaim having held or expressed these views, bot of which are incorrect.

What I did say was that an increase of productio is inflationary if it means an increase in the *aggrega* cost of production. In quoting me as having sai that automation reduces the effect of inflation, M Albu omitted my all-important reservation "othe things being equal".

PAUL EINZIG

120 Clifford's Inn,
London, E.C.4.

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, November 19

UNIVERSITY OF LONDON (at the Institute of Education, Malet Street, London, W.C.1), at 5.30 p.m—Mr. A. O. Chesters: "The Approach to 'Science for Young Children'".* (Seventh of eight ectures on "Problems of the Junior School". Further lecture on November 26.)

Tuesday, November 20

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p m.—Dr. J. S. Wilkie: "Mendel and Galton: Founders of the Scientific Study of Heredity".*

CEMENT AND CONCRETE ASSOCIATION (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Mr. J. A. Banks: "Allt-na-Lairige Prestressed Concrete Dam".

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENT AND CONTROL SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion on "Data Processing Equipment for Experimental Work; a Review of Techniques and Methods", opened by Dr. M. V. Wilkes.

Tuesday, November 20—Wednesday, November 21

INSTITUTION OF GAS ENGINEERS (at Church House, Westminster, London, S.W.1)—22nd Autumn Research Meeting.

Wednesday, November 21

UNIVERSITY OF LONDON (at the Postgraduate Medical School of London, Ducane Road, London, W.12), at 2 p.m.—Dr. V. Wynn: "Salt and Water Metabolism".*

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. A. Dickson Wright: "Quacks Through the Ages".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. G. D. Nicholls: "Autometasomatism n the Lower Spilites of the Builth Volcanic Series"; Dr. C. D. V. Wilson: "Seismic and Gravity Investigations in the Vale of Clwyd, North Wales".

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS (in the Conference Room, 4th Floor, Waterloo Bridge House, London, S.E.1), at 5 p.m.—Mr. F. C. Mead: "Some Problems Arising in the Technical Education of P.O. Engineering Staff".

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Discussion meeting on "Climatic Change with special reference to the Period of the Instrumental Record".

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Dr. T. Barna: "The Replacement Cost of Fixed Assets in British Manufacturing Industry in 1955".

ROYAL MICROSCOPICAL SOCIETY (at Tavistock House South, Tavistock Square, London, W.C.1), at 5.30 p.m.—Dr. D. Lacy: "Studies on the Neurones of Patella Vulgata by Light and Electron Microscopy".

SOCIETY FOR ANALYTICAL CHEMISTRY, MICROCHEMISTRY GROUP in the restaurant room of "The Feathers", Tudor Street, London, E.C.4), at 6.30 p.m.—Discussion Meeting on "The Micro-Determination f Sulphur".

BRITISH PSYCHOLOGICAL SOCIETY (joint meeting of the MEDICAL and SOCIAL PSYCHOLOGY SECTIONS, at the Royal Society of Medicine, Wimpole Street, London, W.1), at 8 30 p.m.—Symposium on "Anthropological, Psychometric and Psychotherapeutic Aspects of Homosexuality".

Wednesday, November 21—Thursday, November 22

IRON AND STEEL INSTITUTE (at 4 Grosvenor Gardens, London, S.W.1)—Autumn General Meeting.

Thursday, November 22

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. W. B. Emery: "Archaic Egypt—Recent Discoveries at Sakkara".*

UNIVERSITY OF LONDON (at Bedford College, Regent's Park, London, N.W.1), at 5.15 p.m.—Prof. B. C. King: "Some Problems of Igneous Geology in Southern Africa".*

CHADWICK TRUST (at the Royal Society of Health, 90 Buckingham Palace Road, London, S.W.1), at 5.30 p.m.—Dr. P. A. Raffle: "The Health of the Worker"* (Chadwick Public Lecture).

CEMENT AND CONCRETE ASSOCIATION (at the Institution of Strucural Engineers, 11 Upper Belgrave Street, London, S.W.1), at 6 p.m.—Dr. F. W. Gifford and Mr. A. M. Janhunen: "The Design and Construction for the Prestressed Concrete Hangars at Helsinki".

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (at Savoy Place, London, W C.2), at 6 p m.—Discussion on The Presentation and Demonstration of the Theory of Semi-Conductors o Students of Electrical Engineering", opened by Mr. P. Godfrey.

ROYAL AERONAUTICAL SOCIETY (at the Institution of Mechanical ngineers, Birdcage Walk, London, S.W.1), at 6 p.m.—Mr. L. P. oombes: "Aeronautical Development in Australia and Its Potential Value to the British Commonwealth" (Twelfth British Commonwealth and Empire Lecture).

Thursday, November 22—Friday, November 23

BRITISH NUCLEAR ENERGY CONFERENCE (at the Central Hall, Westminster, London, S.W.1), at 10 a.m. daily—Symposium on "The Calder Works Nuclear Power Plant".

Friday, November 23

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6.30 p.m.—Mr. J. R. Whinfield: "New Fibres". (Seventh of ten University Extension Lectures on "Technology and Industry". Further lectures on November 30, December 7 and 14.)

ROYAL AERONAUTICAL SOCIETY, GRADUATES' AND STUDENTS' SECTION (at 4 Hamilton Place, London, W.1), at 7.30 p.m.—Mr. A. W. Kitchenside: "The Effects of Kinetic Heating on Aircraft Structures".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. R. L. Wain: "Plant Growth and Man-made Molecules".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

SENIOR LECTURER (preferably with good academic and research qualifications) IN ORGANIC CHEMISTRY—The Clerk to the Governors, Woolwich Polytechnic, London, S.E.18 (November 24).

BIOCHEMIST (B.Sc.) AT THE WALLACEVILLE ANIMAL RESEARCH STATION, New Zealand Department of Agriculture, to study trace elements and their relation to disease in farm animals—The High Commissioner for New Zealand, 415 Strand, London, W.C.2, quoting Ref. No. A.3/4/59 (November 30)

RESEARCH FELLOW to investigate certain pharmacological or biochemical aspects of cardio-vascular disease—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2 (November 30).

ASSISTANT EXPERIMENTAL OFFICER (with a pass B.Sc. degree or equivalent) IN THE DEPARTMENT OF POTATO GENETICS, for general maintenance of stocks and tests of resistance of tuberous *Solanums*—The Secretary, John Innes Horticultural Institution, Bayfordbury, Hertford, Herts (December 1).

ASSISTANT LECTURER IN VETERINARY MEDICINE—The Registrar and Secretary, The University, Bristol (December 1).

LECTURER, Grade II, IN CHEMICAL PATHOLOGY in the Veterinary School—The Registrar and Secretary, The University, Bristol (December 1).

LECTURER (graduate in medicine or science, and postgraduate experience in some branch of physiology) IN PHYSIOLOGY in the Faculty of Medicine, University of Birmingham—The Assistant Registrar, Medical School, Birmingham 15 (December 1).

RESEARCH ASSISTANT (with a B.Sc. honours degree and a knowledge of either magnetic measurements, mineralogy or crystallography) for research into structures and magnetic properties of substances of geomagnetic interest—The Secretary, Birkbeck College, Malet Street, London, W.C.1 (December 1).

LECTURER (preferably with a major interest in heat transfer, and a knowledge of some aspect of nuclear engineering) IN ENGINEERING (MECHANICAL)—The Registrar, The University, Manchester 13, (December 3).

SCIENTISTS (with a good honours degree in engineering or physics and the ability to handle data and to write clear concise reports) IN THE OPERATION RESEARCH GROUP at London Headquarters, to study problems of production and mechanization—The National Coal Board, Staff Department, Hobart House, London, S.W.1, quoting X/463 (December 3).

LECTURER OR ASSISTANT LECTURER (preferably with special interests in the chemistry of heterocyclic compounds) IN ORGANIC CHEMISTRY—The Registrar, King's College (University of London), Strand, London, W.C.2 (December 7).

ASSISTANT EXPERIMENTAL OFFICER (graduate with mathematical ability and biological interests) to work on the interpretation of data from horticultural experiments—The Secretary, East Malling Research Station, near Maidstone, Kent (December 8).

LECTURER IN FUEL TECHNOLOGY AND CHEMICAL ENGINEERING—The Registrar, The University, Sheffield (December 8).

DEPUTY PRINCIPAL (with a university degree in forestry or equivalent, together with practical and administrative experience in forestry) OF THE AUSTRALIAN FORESTRY SCHOOL, Canberra, Australia—The Official Secretary, Commonwealth of Australia, Australia House, Strand, London, W.C.2 (Australia, December 13).

SENIOR LECTURER IN PHILOSOPHY at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, December 17).

PLANT BREEDER (with a university honours degree in science or agricultural science and two or more years research experience) WITH THE DIVISION OF PLANT INDUSTRY, Commonwealth Scientific and Industrial Research Organization, Canberra, to initiate independent studies in the breeding of pasture plants—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting Appointment No. 130/292 (December 19).

CHAIR OF CHEMICAL PATHOLOGY—The Registrar, The University, Leeds (December 31).

LECTURER (honours graduate in engineering, with practical experience) IN PETROLEUM PRODUCTION ENGINEERING—The Registrar, The University, Birmingham (January 1).

ASSISTANT LIBRARIAN (preferably science graduate, with either a recognized library qualification or experience in library work) at the Imperial College of Tropical Agriculture, Trinidad, B.W.I.—The Secretary, Imperial College of Tropical Agriculture, 40 Norfolk Street, London, W C.2 (January 15).

DIRECTOR (with a good honours degree and considerable research experience in physical or organic chemistry or in technology) of SUGAR RESEARCH, Department of Sugar Chemistry and Technology, Imperial College of Tropical Agriculture, Trinidad, B.W.I.—The Secretary, Imperial College of Tropical Agriculture, 40 Norfolk Street, Strand, London, W.C 2 (January 15).

ENTOMOLOGIST (with an honours degree in zoology and training in entomology, and preferably with experience in the control of insect pests occurring in the tropics, especially those attacking sugar cane)—The Director, Mauritius Sugar Industry Research Institute, Reduit, Mauritius (January 17).

ASSISTANT, Grade B (preferably with a knowledge of zoology) IN BOTANY—The Principal, Medway College of Technology, Horsted, Maidstone Road, Chatham.

ASSISTANTS, Grade B (2), TO TEACH PHYSICS—The Principal, Technical College, Queen Street South, Huddersfield.

BIOCHEMIST or SENIOR BIOCHEMIST TO TAKE CHARGE OF THE ENDOCRINOLOGY LABORATORY concerned with clinical research in the treatment of cancer—The House Governor, Royal Marsden Hospital, Fulham Road, London, S.W.3.

BIOCHEMIST (with a science degree of a recognized university and special experience in medical biochemistry) IN THE MINISTRY OF HEALTH, Gold Coast Local Civil Service, to take charge of the Biochemistry Division of the Medical Research Institute—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.117/13/042.

BRADFORD DYERS' ASSOCIATION RESEARCH FELLOW (with high qualifications in science) to undertake research in tinctorial chemistry, textile chemistry or an allied subject—The Director of Education, Technical College, Bradford.

ELECTRONICS TECHNICIAN (with keen practical interest in electronics, and theoretical knowledge up to higher national or equivalent) to construct apparatus associated with a 2-million volt electron accelerator and other special electronics equipment for research—The Director, Radiobiology Research Unit, Mount Vernon Hospital, Northwood, Middlesex.

ENTOMOLOGIST (with an honours degree in natural science and specialized training and experience in entomology) IN THE MEDICAL DEPARTMENT, Western Region of Nigeria (H.M. Oversea Civil Service) to advise on, and supervise mosquito control measures in towns and rural areas in the Region, and carry out surveys on distribution and epidemiological importance of other insect vectors of disease—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.117/410/07.

GEOCHEMIST (with a good honours degree in chemistry or equivalent and some experience in inorganic analysis, with special reference to rock and mineral analysis) IN THE GEOLOGICAL SURVEY DEPARTMENT, Government of Tanganyika, for the analysis of rocks, minerals and ores, and the supervision of junior staff in routine analytical work—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.105/8/09.

HEAD (with a good honours degree and experience in the direction and administration of metallurgical research, either academic or industrial) OF THE METALLURGY DIVISION, for work in London and Sheffield which includes both fundamental and applied research into the general and physical metallurgy of iron and steel—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting "H.M D".

LECTURER or SENIOR LECTURER IN MATHEMATICS; and LECTURERS or SENIOR LECTURERS (3) IN PHYSICS AND MECHANICS, at Britannia R.N. College, Dartmouth—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting Ref. No. 4641/56/7.

LECTURER (with special qualifications in physical chemistry and preferably with experience and/or knowledge of spectroscopy and colorimetry) IN CHEMISTRY at the Technical College, Bradford—The Director of Education, Town Hall, Bradford.

PHYSICAL and INORGANIC CHEMISTS (preferably with H.N.C (chemistry) or a general degree, or at least H.S.C. (science), Inter B.Sc. or equivalent), to engage in research on a variety of interesting and novel projects which include the chemistry related to reactors and the chemistry of inorganic and organic phosphors—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting 1314/34.

PHYSICIST or ENGINEER (with at least a second-class honours degree or equivalent, and two years' postgraduate experience) for work involving the investigation of engineering problems connected with the deterioration of electrical insulation in service—The Personnel Officer, Electrical Research Association, Thorncroft Manor, Dorking Road, Leatherhead, Surrey.

RESEARCH ASSISTANT (with a good degree in horticulture or botany) for work on the physiology of flowering in carnations—Prof. R. H. Stoughton, Department of Horticulture, The University, Reading.

RESEARCH FELLOW (graduate in physics or engineering) IN THE COMPUTER LABORATORY, for investigations concerned with the input and output equipment of digital computing machines—The Secretary, Birkbeck College, Malet Street, London, W.C.1.

SENIOR LECTURER IN MARKET GARDEN AND GLASSHOUSE CROPS—The Clerk to the Governors, Essex Institute of Agriculture, Writtle, Chelmsford, Essex.

SENIOR TECHNICIAN IN THE ZOOLOGY DEPARTMENT, University of London—The Secretary, Royal Holloway College, Englefield Green, Surrey.

SOIL CONSERVATION OFFICERS (under 45, with a university degree involving specialization in soil conservation, or a university degree in agriculture or related subject, with at least two years postgraduate study or experience of soil conservation) in the Gold Coast Local Civil Service, for duties connected with land-use and anti-erosion measures—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.63/13/04.

TEACHER (with a good degree in physiology, preferably also with experience in pharmacology) IN PHYSIOLOGY in the Department of Biology—The Registrar, College of Technology and Commerce, The Newarke, Leicester.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

The Edinburgh School of Agriculture; Edinburgh and East of Scotland College of Agriculture. Calendar for 1956–1957. Pp. 88. (Edinburgh: Edinburgh School of Agriculture; Edinburgh and East of Scotland College of Agriculture, 1956.) 1*s*. [189

Air Ministry: Meteorological Office. Geophysical Memoirs. No. 95: Wind and Temperature to 50 KM. Over England: Anomalous Sound Propagation Experiments, 1944–45. By R. J. Murgatroyd. Pp. 30. (London: H.M. Stationery Office, 1956.) 5*s*. net. [189

Year Book of the International Council of Scientific Unions, 1956. Pp. ii+84. (London. International Council of Scientific Unions, c/o Royal Society, 1956.) 5*s*. [189

Fulmer Research Institute. Special Report No. 2: Oxidation Resistant Silicon Aluminium Steels. By E. A. Brandes. Pp 40. (Stoke Poges: Fulmer Research Institute, 1956.) 10*s*. 6*d*. [189

Department of Scientific and Industrial Research. Memoirs of the Geological Survey of Great Britain. Chemical Analyses of Igneous Rocks, Metamorphic Rocks and Minerals, 1931–1954. By Eileen M. Guppy. With Petrographical descriptions by Dr. P. A. Sabine. Pp. v+78. (London: H.M. Stationery Office, 1956) 10*s*. 6*d*. net. [189

Building Research Station Digest No 91. The Programming of House-building. Pp. 8. (London. H.M. Stationery Office, 1956.) 3*d*.-net. [189

London and Home Counties Regional Advisory Council for Higher Technological Education. Technical Information Services to Commerce and Industry. Pp. 12. (London: London and Home Counties Regional Advisory Council for Higher Technological Education, 1956) 1*s*. [189

Report of the Interdepartmental Committee on Social and Economic Research. Pp. vi+33. (London: H.M. Stationery Office, 1956.) 2*s*. 6*d*. net. [189

Other Countries

Publications de l'Institut National pour l'Étude Agronomique du Congo Belge. Série Scientifique, No. 65: Les Savanes Herbeuses de la Région de Mvuazi (Bas-Congo). Par R. Devred. Pp. 115. (Bruxelles Institut National pour l'Étude Agronomique du Congo Belge, 1956.) 100 francs. [189

Indian Forest Records (New Series). Entomology. Vol. 8, No. 10: Immature Stages of Indian Coleoptera (26) (Bostrychidae). By Dr R. N. Mathur. Pp. 233–246. (Delhi: Manager of Publications, 1956.) As. 14; 1*s* 3*d*. [189

Forest Research Institute, Dehra Dun. Indian Forest Leaflet No. 139: Application of Gehrhardt's Formula to Abnormally Stocked Deodar Crops in the Himalayas. By G. S. Mathauda. Pp. ii+4. (Delhi: Manager of Publications, 1956.) As. 7; 8*d*. [189

Aligarh Muslim University Publications. (Zoological Series.) On Indian Insect Types. Edited by Prof. M. B. Lirza. 4: The Early Embryology of *Pyrilla perpusilla* Walter (Homoptera), including some Observations on the Later Development. By Dr. Klaus Sander. Pp. ii+62+12 plates. (Aligarh: Aligarh Muslim University, 1956 Rs. 5. [189

Contributions from the New South Wales National Herbarium Vol. 2, No. 4: The Cyatheaceae of Australia. By Mary D. Tindale Pp. ii + 327–362 + plates 9–15. (Sydney: Government Printer 1956) [18

Metropolitan Life Insurance Company. Statistical Bulletin, Vol. 37 July 1956: Age Trends in Poliomyelitis. Pp. 12. (New York: Metropolitan Life Insurance Company, 1956.) [18

United States Department of Agriculture. Picture Sheet No. 25 Sweet-potato Weevil. (Revised edition.) Pp. 2. 5 cents. Home an Garden Bulletin No. 46: Insects and Diseases of Vegetables in th Home Garden. By L. B. Reed. Pp. 48. 25 cents. Technical Bulleti No. 1149: Some Effects of Insecticide Spray Accumulations in Soil o Crop Plants Pp. 36. 15 cents. (Washington, D.C.: Governmen Printing Office, 1956.) [18

Uganda Protectorate. Annual Report of the Forest Departmen for the year ended 31st December, 1955. Pp. vi+65. (Entebbe Government Printer, 1956.) Shs 3/25. [18

Publications de l'Institut National pour l'Étude Agronomique d Congo Belge. Série Scientifique. No. 66: Landscape Evolution in th High Ituri, Belgian Congo. By Robert V. Ruhe. Pp. 92 (7 plates) 90 francs. No. 67: Étude Écologique et Phytosociologique de l Forêt à *Brachystegia laurenti*. Par Dr. R. Germain et C. Evrard Pp. 105+5 planches (Bruxelles: Institut National pour l'Étud Agronomique de Congo Belge, 1956.) [18

Canada: Department of Mines and Technical Surveys. Geologica Survey of Canada Memoir No. 279. Oldman River Map-Area, Saskat chewan. By Donald A. W. Blake. Pp v+52 (4 plates). (Ottawa Queen's Printer, 1955) 75 cents. [18

A Museum is a Point of View: Bernice P. Bishop Museum Annua Report for 1955. Pp. 46. (Honolulu: Bernice P. Bishop Museum 1956.) [18

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Applications are invited for the post of Entomologist. Candidates must have obtained an honours degree in zoology with training in entomology Experience in the control of insect pests occurring in the tropics especially those attacking sugar cane is desirable Terms of appointment· On agreement for three years in the first instance with prospects of permanent employment thereafter Salary according to qualifications and experience in the range Rs.18,000 to Rs 24,000 per annum (£1,350 to £1,800 approximately). Compulsory pension contribution of 5 per cent of salary to the Mauritius Sugar Industry Pension Fund. Free passages on appointment and leave for officer, wife and children up to a maximum cost of three adult passages Six months' vacation leave after three years' service. Applications with proof of professional qualifications and the names and addresses of two referees must be sent by registered airmail to the Director, Mauritius Sugar Industry Research Institute, Reduit, Mauritius, so as to reach the addressee before January 17, 1957.

NEW ZEALAND DEPARTMENT OF AGRICULTURE

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Application forms and conditions of appointment may be obtained on request from: High Commissioner for New Zealand, 415 Strand, London, W C.2, mentioning this paper and quoting reference number A3/4/59. Completed applications to be lodged in London not later than November 30, 1956

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UNIVERSITY OF LONDON, KING'S COLLEGE, will require on January 1, 1957, or as soon thereafter as possible, a Lecturer or Assistant Lecturer in Organic Chemistry, preferably with special interests in the chemistry of heterocyclic compounds. Salary· Lecturer, £700 by £50 to £1,000, £1,050 by £50 to £1,400; Assistant Lecturer, £600 to £650 to £700, with family allowances and superannuation benefits in each case.—Particulars and application forms from the Registrar, King's College, Strand, W.C 2, whom complete application forms must reach by December 7

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Further particulars and information as to the method of application may be obtained from the Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London. W C 1 The closing date for the receipt of applications, in Australia and London, is December 31 1956

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Applicants must complete the official applicati form in duplicate, sending one copy to the afo mentioned High Commissioner's office and c copy to the Secretary, Auckland Hospital Boa Kitchener Street, Auckland, C 1, New Zealan Applications close with the above at noon Monday, December 31, 1956.

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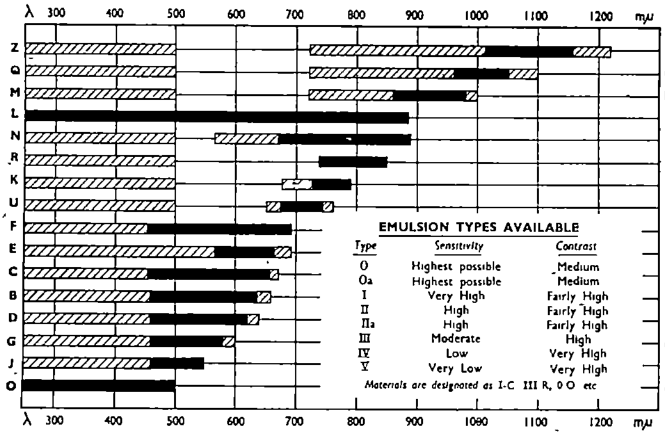

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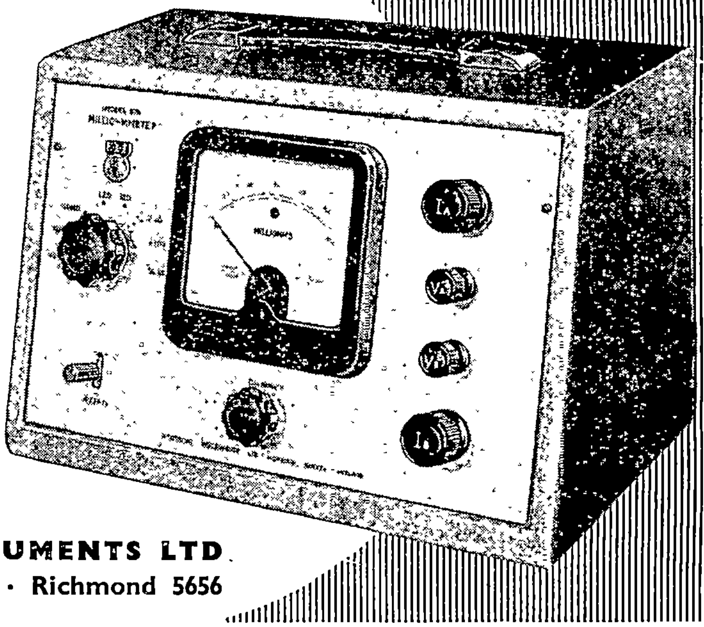

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SOCIAL ADJUSTMENT AND TECHNOLOGICAL CHANGE

A SIGNIFICANT feature of the debate on automation which Lord Macdonald of Gwaenysgor initiated in the House of Lords on October 23 was the emphasis placed on the social aspects of technology. It was clearly recognized that technical change is a social process as well as a technical one, and that if it is to proceed smoothly and the nation is to reap the full benefit that automation can offer, due attention must be given to the social problems involved. Here the greatest problems are, as Lord Hailsham emphasized when replying for the Government on the debate, in the field of education. Lord Hailsham said he doubts whether it has yet been realized what a profound impact the developments represented by automation will make upon the educational system of Britain, and he pointed out that this is as true of general education as of technical education.

What is equally important is that much research s still needed on various social and economic aspects of technical innovation. The report on automation ssued by the Department of Scientific and Industrial Research last May listed a number of specific topics on which research was in progress, many of these projects being financed at least in part by Conditional Aid funds derived from economic aid from the United States. When questioned as to the continuance of such investigations, Lord Hailsham admitted that uch funds are no longer available. He said, however, that it should not be assumed that the researches have also come to an end; but he gave no indication as to the scale on which such investigations would ontinue. This is still under consideration by the Department of Scientific and Industrial Research and by the Government; but it will certainly consort more with the dignity of Britain that work of such mportance should be financed out of her own resources. The Government should be pressed to provide adequate resources and to continue efforts to ensure that adequate use is made of the results already available.

Strong emphasis on the social problems of industry is to be found in the Messel Memorial Lecture which Sir Alexander Fleck delivered to the Society of Chemical Industry on October 12. Messel himself, ke Ludwig Mond, was deeply concerned with the onditions under which the people employed by him worked and lived, and he played an important part, t least on the intellectual side, in making the chemical ndustry contribute to social development. Sir lexander referred to this, and in reviewing the problems now facing the industry, he again placed is main emphasis on what should be done to enable hemical industry to serve more efficiently the social s well as the commercial needs of to-day. While, or example, he believes that we do not proceed so apidly as some other countries from the research tage to production, this may not be a disadvantage, rovided we take full advantage of that longer interval o secure the necessary social adjustment. On the other hand, it is possible that such relatively late production may involve serious loss of income and of profit which can affect the economic strength of the nation. The survival and even the strength of an industrial firm may to-day, as Mr. Tom Burns points out in a study of the social character of technology (*Impact of Science on Society*, September), be a matter of great concern to society as well as to the firm itself.

Here obviously is a field for further inquiry, and Sir Alexander also questioned whether our research is as well aimed as it might be. Still more important is the use the chemical industry makes of its personnel: the improvement in hours of work and working conditions already made do not absolve the industry from the need to keep its methods and conditions of work under constant review. Sir Alexander suggested that, with the continual growth of automatic controls and the tendency for work of a monitoring character to extend, it is a major problem how to maintain in such work both interest and satisfaction for men employed as factory payroll workers.

Here Sir Alexander believes that the development of the trade union system in Britain may provide a solution, though he suggested that real partnership between the less technically equipped members of the industry and the technically qualified requires a developing type of organization which in general has been, and is still, lacking in the different components of our industrial life. We need, both in the management components and in the trade union components, an organization which is flexible, capable of understanding current and impending changes, and willing, so far as lies in its power, to support changes which will be for the good of the industry and of the people employed in it. How far we are yet from such a position is sufficiently illustrated by the attempt to insist that the fireman of the steam locomotive shall be retained on a diesel engine, and by the attitude frequently displayed to the working of lodging turns on the railways. Such attitudes can only be overcome when a great organization takes real care to retain its contact with all its workers, rank and file as well as departmental heads; and shows itself concerned to secure their co-operation, ameliorate their conditions and make their lives more prosperous and content. Time is required to build up effective organization for this purpose; to foster understanding, co-operation and trust; Sir Alexander believes that works councils could do much to help here, all the more as they conform to no rigid pattern but can be adjusted and modified to meet the needs of any particular section of an industry.

Sir Alexander did not conceal the fact that the increase of automatic control and like changes tend to decrease the proportion of factory payroll workers to what is loosely called staff. This clearly of itself involves other problems of adjustment, of education and of change of occupation; and he stressed in conclusion that unless chemical and other industries are to work in a geographical or in a cultural desert, much more care will have to be taken that their operation is constructive and not destructive. To his mind, this can only be secured by sociological advance on many fronts—by profit-sharing schemes, capital participation, cultural participation in art, but above all through a general advance in the educational level of the bulk of the population.

The aspect of service was a dominant note in this striking address, and the sense of social responsibility in it may contribute largely to the solution of the human problems of management which Sir Alexander emphasized afterwards in addressing the Textile Institute on "Change in Industry" on October 26. Discussing the role of the scientist or technologist in industry, he pointed out that while technical judgment is required at all levels of management, there are human problems also; and management must provide leadership and inspiration as well as technical control. The judgment and high qualities of industrial statesmanship required are by no means solely to be found in those with technical qualifications; but he believes that the presence of the technical man in management has been a material factor in the expansion of the chemical industry and one that could contribute increasingly to the conflict of ideas that keep minds awake and receptive of new ideas so that progress is ensured.

It is interesting to note that while the conception of service finds a minor place in the symposium on science and social responsibility which forms the third in the series "Science and the Affairs of Man" appearing in the *Bulletin of the Atomic Scientists* in its tenth anniversary year, the note of responsibility is strongly sounded. It is equally to be found in the article "Science and Our Times" which Dr. J. R. Oppenheimer contributes to the same issue of the *Bulletin* (September 1956). Dr. Oppenheimer points to the grave problems of good and evil which increasing advances in the biological sciences and in our understanding of man's psyche, his beliefs, his learning, his memory and his probable action will involve. Unless we learn to use the new and more certain knowledge of man's behaviour, the danger will remain that we may not only suffer material destruction but also lose much of our human inheritance—much that has enriched our civilization and our humanity.

While Dr. Oppenheimer is hopeful that, despite the opportunities we have already missed, we may find new opportunities of creating honest and viable international communities with increasing common knowledge and understanding, he urges that, if the free world is to remain free, we must maintain the opportunity for a man to learn anything. Indeed, argues Dr. Oppenheimer, we must, in a world in which the changes wrought by the application of science and the din of communication complement the unhingeing effects of the explosive growth in knowledge itself, cherish man's curiosity, his understanding and his love, so that he may truly learn what is new and hard and deep. The world that we study and in which we work is, as he observes, an orderly world; but it has no central chamber of common understanding or common repository of essential knowledge. It is a world united by countless bonds and it may well be the beginning of wisdom to cultivate the virtues, the restraint and tolerance, the sense of fraternity that are asked of us, if in this modern world we are to live not in chaos but in community.

Dr. Oppenheimer was looking to a larger background than Sir Alexander Fleck, but what he says of the impact of science on the modern world as a whole is equally true of its impact on the more limited world of industry, and is remarkably in line with what Sir Alexander urged in his Messel Memorial Lecture. Like Eugene Rabinowitch in his paper, "History's Challenge to Scientists", contributed to the September issue of the *Bulletin of the Atomic Scientists*, Dr. Oppenheimer points to the responsibility of the scientist to contribute by education and persuasion as well as by political action to the rationalization of the behaviour of nations and of mankind; and in so far as industry is looked upon as a social as well as an economic process, the approach and the technique to be used will have much in common The keynote is education, and the sense of respons ibility, the ideal of public service, must be informed and guided by clear ideas not only of what is technically possible and desirable but also of mankind's great heritage. No narrow or partial view of life o of industry is likely to avoid disaster, and whethe or not the scientist finds a solution to his respons ibilities as a citizen in holism or not, as Prof. Alex ander Haddow suggests in his article on the scientis as citizen, the importance of an education in which men are trained to respect, understand and reverenc human values can scarcely be over-stressed at th present time.

It is this factor that Mr. Tom Burns appears inclined to overlook in the article on "The Socia Character of Technology" referred to earlier. H directs attention to two major changes in th social circumstances affecting the introduction c innovations. The first, already noted, is that th increase in the size of firms has made their surviva a matter of greater consequence to society than i ever was before; while the chances of a firm su viving are increased if the technical innovation which might render its processes or products obsolet are developed within it and not outside. The secon is a consequence of the scale of scientific and indu trial activity outgrowing the social institutions i which the industrial revolution originated, and of th departmentalism of science and the development c barriers between pure and applied science, an between science and industry. The production c invention and innovation tends to become randon and scientists and technical innovators have accord ingly tended to become organized in profession groups which overlap teaching and research instit tions, government departments and agencies, an industry. Mr. Burns does not think that eith change is complete; but he does suggest th innovation is the natural outcome of the work of number of professional technologists in applyi pecific techniques to solve the specific problems of a ser, and that it is not in any sense dependent on the fforts of individual entrepreneurs. It will increasingly ake place outside the firm itself; and technology, rganized as a specific social institution, is moving nore and more into a controlling position. Major hanges in the economic structure of society are ikely to be derived more from the expansion in size nd power of the technological system than from vert political strategies.

Mr. Burns's view of technology as a system xtraneous to industry, yet essential to the survival f individual firms, and of the technologist as a nember of a social system, independent of the factory vorkshop, industrial development laboratory, government research establishment and university labortory, in which he is closely integral and professionlly organized, may be challenged on several grounds. t appears to take no account of the extent to which he technical service departments maintained by rogressive firms provide them with targets for esearch and stimulate technical innovation, nor of he extent to which technical innovation may itself lerive inspiration from advances in fundamental cience. He does, however, point to the importance f what is known as operational research and, by mplication rather than by explicit statement, he ppears to regard industry as a social activity the bjectives of which are determined by the needs of he community in which it operates and which it xists to serve. The technologist, as visualized by Ir. Burns, will be working largely in those conditions which Sir Alexander Fleck puts forward as conducive o wide views and open minds, and it will be noted hat Mr. Burns makes a strong plea that the techologist should move much more freely between osts in government, university and industrial establishments, as well as for effective communication not erely between technologists and scientists but also ith the ordinary citizen. This group of papers and ddresses shows how firmly the idea of social esponsibility has already taken hold of the indusialist and technologist; and it also indicates the nportance of greater attention to education at all vels, as well as the need for further inquiry into the any problems of social adjustment that technical nnovation brings and the need for due care in ealing with the social aspects of such developments oth inside and outside industry.

JAMES HUTTON AND JOHN PLAYFAIR

lustrations of the Huttonian Theory of the Earth y Prof. John Playfair. Facsimile reprint with an ntroduction by George W. White. Pp. xix+xx+ 28. (Urbana, Ill.: University of Illinois Press, 956.) 4.50 dollars.

N Greyfriars Churchyard in Edinburgh there is a memorial tablet inscribed: "James Hutton, .D., F.R.S.E. 1726–1797. The Founder of Modern eology". It is obvious that the emphasis in the last phrase is on the "modern", because stones and the Earth as a whole have been objects of study since time immemorial. Before Hutton, much had been written about minerals, rocks, mountains, springs, rivers, earthquakes and volcanoes, by naturalists and miners. The last decades of the eighteenth century saw the emergence of a new approach to these subjects by a few men working independently but contemporaneously—a new approach which, abandoning the idea of mere 'curiosity', sought to link all natural phenomena into a system and so created geology as an organized science. Of these 'founders of modern geology' the three principal were: the 'sage of Freiberg', Abraham Gottlob Werner, bringing order into minerals and rocks; the English surveyor, William Smith, bringing order into strata; and finally the Edinburgh medical doctor, James Hutton, bringing order into geological processes. This order consisted of a framework and of a method. The framework was the geostrophic cycle —the cycle of changes in the Earth, constantly transforming the materials and the surface of the Earth. The method was that of actualism, with its motto: "The present is the key to the past". The geostrophic cycle consisted of successive processes of weathering, denudation, transportation, deposition, consolidation of sediments, metamorphism, magmatism, folding and elevation of strata—this is the essence of Hutton's "Theory of the Earth". An important corollary was that each material was determined by a specific process and each specific process resulted in a certain material. This led to the method of actualism—to understand past formations we must understand modern processes. The frequently mentioned struggle between the Vulcanists and the Neptunists, as associated with the names of Hutton and Werner, is a mere ripple on the surface, a *succès de scandale*, as compared with the fundamental contributions to the science of geology made by these two men.

Unfortunately, all three—Werner, William Smith and Hutton—were clumsy writers and reluctant controversialists, and all three required valiant champions to fight their battles for them. In spite of occasional beauty of phrase, Hutton's "Theory of the Earth" is a difficult book to read and understand. Also, its publication in 1795 happened to fall in a period of reaction provoked by the excesses of the French Revolution. Hutton, in his lifetime and after his death, was violently attacked and accused of free-thinking. Now, we see Hutton in a different light. "My own opinion," writes Sir Edward Bailey, "is that Hutton's chief sin in the eyes of many of his contemporaries was his confident interpretation of God's purpose through thoughtful observation of Nature without accepting guidance from revelation." But the fact was that at the turn of the century Hutton's work was either unknown or derided, whereas Werner's ideas, some of them without any doubt excellent, were all-pervasive among the geologists. But a few decades brought a miraculous change, and Hutton's ideas now animated the infant science of geology. Visibly this transformation was due to the genius of Charles Lyell, whose "Principles of Geology" and "Elements of Geology", published during the 1830's, finally consolidated geology into an organized science. It was clear to some geologists, among them Fitton, that behind Lyell stood Hutton; and at first it is rather difficult to understand how Lyell in his letter to Fitton of August 1, 1839, referring to the latter's review of his "Elements" in which Fitton had given a clear account of the work of Hutton, could write: "It [Fitton's summary of Hutton's work] has been useful to me, as I found it difficult to read and remember Hutton, and though I tried, I doubt whether I ever fairly read more than half of his writings, and skimmed the rest". Later in the same letter, Lyell, while recognizing the value of Playfair in making Hutton's view better known, does not hide his own light under a bushel, for he writes: "yet as an admirer of Hutton all I could have wished is, that your panegyric on Hutton had appeared as aiding and seconding my efforts, since I trust that no book has made the claims of Hutton better known on the Continent of late years than mine".

The fact is that it was Playfair's book that gave Lyell all he wanted to know about Hutton's ideas. Playfair acted as a spokesman for Hutton, and one may say truly that without Playfair the progress of geology would have been retarded by many decades. John Playfair (1748–1819) was a great friend of Hutton. He was first minister at Benvie and Liff and afterwards professor, first of mathematics, and then of natural philosophy, in the University of Edinburgh. He belonged to the brilliant intellectual circle of the Athens of the North in her period of glory. As a great friend of Hutton, he began, after Hutton's death in 1797, to collect materials for writing his memorial, and this led him to a detailed study of Hutton's geological work, which, prompted by the attacks made on Hutton, he published in 1802 under the title "Illustrations of the Huttonian Theory of the Earth". In 1822 this book was republished in the "Works of John Playfair, Esq.". At the present time both editions are extremely difficult to obtain, and thus geologists and historians of science must welcome the newly published facsimile reprint of the Playfair's "Illustrations". It is a handsomely printed and bound quarto volume containing an introduction, a biographical sketch of James Hutton and a biographical sketch of John Playfair (pp. v–xix), all three of them written by George W. White, of the University of Illinois.

The "Illustrations" consist of two parts. The first part contains the illustrations proper or "a general outline of the system in one continued discourse" (pp. 1–140), containing the following sections and chapters: Section I, (1) materials of the strata, (2) consolidation of the strata, (3) position of the strata; Section II, (1) metallic veins, (2) whinstone, (3) granite; Section III, phenomena common to stratified and unstratified bodies. The second part, "Notes and Additions" (pp. 143–528), contains twenty-six notes dealing with various geological topics. They are of great interest, as they mark the extension of Hutton's horizon of experience and contain a certain amount of criticism of his views. It is a great pity that criticism was not applied to the most vulnerable part of Hutton's theory, namely, to his view that heat alone was responsible for the consolidation of strata.

This is not the place to discuss the merits and demerits of the Huttonian theory of the Earth or the interpretation of it by Playfair; but by reading the two authors in parallel, one can see that the success of Playfair's book was due not solely to his clarity of writing but also to a certain amount of simplification and to the elimination of what would be considered by his contemporaries as vague metaphysical background. The part omitted may have little value fo geology as such, but it is of interest to student of the evolution of human thought. Leaving thi aspect out of consideration, let us give only a smal sample of Playfair's clarification and simplificatior The passages quoted below refer to the idea tha great features on the Earth must be the products c great events, a favourite tenet of the school c catastrophists, to which both Hutton and Playfai were opposed. Here is Hutton: "But though, i generalising the operations of nature, we have arrive at those great events, which, at first sight, may fi the mind with wonder and with doubt, we are not t suppose, that there is any violent exertion of powe such as is required in order to produce a great even in little time; in nature, we find no deficiency i respect of time, nor any limitation with regar to power. But time is not made to flow in vain nor does there ever appear the exertion of supe fluous power, or the manifestation of design, nc calculated in wisdom to effect some general end (I, p. 182). And here is Playfair: "Time pe forms the office of *integrating* the infinitesime parts of which this progression is made up; collected them into one sum, and produces fror them an amount greater than any that can b assigned" (p. 117).

The success of Playfair's "Illustrations" wa due also to the presentation of Hutton's theor in such a way that it would conform to the ne scientific tradition, in which arrays of facts woul be used for the formulation of a tentative theory and final causes would have no place at al Looked at in this light, Hutton's achievemer must be valued very highly, especially if we cor sider his contribution to the application of the ide of development or evolution to the Earth. In th respect Hutton stands midway between Kant an Darwin.

All this shows that the present new edition Playfair's "Illustrations" should be welcomed by a interested in the history of scientific ideas. It als indicates an obvious gap in our book list—an easil available Hutton. The interpretation of Huttc being now published, what about the republicatic of the "Theory of the Earth"? The third volun by a strange irony of fate was lost in manuscript f more than a century, and when found was publishe in 1899. It would be most appropriate that tl "Commemorative Volume" of James Hutton, pul lished by the Royal Society of Edinburgh in 195 and the newly republished Playfair book should l followed by a facsimile edition of the "Theory of tl Earth". As an anticipation of the form it shou take, and as minor criticism of the present edition the "Illustrations", I might suggest that it shou have a good index of subjects, authors and localiti mentioned in the text, as well as notes throwing lig on the objects and phenomena described by tl author, some of which are described in such a w that their significance may escape the modern reade For example, Hutton (and Playfair) describe unco formity without mentioning this term, which w introduced in science later. Errata in the origir edition may be mentioned as well. For example, Playfair's book we have *Vinezia* instead of *Venez* (p. 133) and *Palasso* instead of *Palassou* (p. 344). mistake (corrected in the 1822 edition) is also ma in the numeration of the sub-sections—the numb 134 is duplicated (p. 138 and p. 143).

S. I. TOMKEIEFF

THE PHYSICS OF THE SOLID STATE

Solid State Physics

Advances in Research and Applications. Edited by Frederick Seitz and David Turnbull. Vol. 2. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1956.) 10 dollars.

THE second volume of "Solid State Physics" maintains the high standards set by the first. Moreover it contains matter which will be of interest to physicists and chemists who, although perhaps unable to distinguish an exciton from a donor level, wish to know something of the applications of nuclear magnetic resonance and neutron diffraction to structural and dynamical problems.

Six years ago G. E. Pake contributed a pair of excellent expository articles on nuclear magnetic esonance to the *American Journal of Physics*. They are now expanded and brought up to date in the first article of the present volume. The author gives very lear explanations of such vital concepts as line breadth and its associated 'spin-spin' relaxation time as well as the dynamically determined 'spin-lattice' relaxation time. Yet perhaps one can, without being hurlish, deplore the lack of a unified approach which recent theoretical work would seem to make possible. The newer techniques and discoveries are exciting nd are well explained. For example, the treatment given here of Hahn's 'spin echo' methods is much more asily understood than the original papers; this echnique is clearly important for investigating iffusion processes as well as relaxation times. An nteresting new development is that partial polarization of nuclei can be induced by saturating the lectron spin resonance of certain metals. Just as he polarization of electrons produces in any event a ight shift in the nuclear resonance frequency (disovered by Knight), so in turn does the nuclear olarization react on the electronic resonance and hift its frequency. Pake suggests that the latter shift hould be called the 'day shift', since it dawns as the Knight shift subsides.

W. D. Knight discusses his shift in considerable etail in the second article, on nuclear magnetic esonance in metals. The interest here is more pecialized. The effect is proportional to the Pauli usceptibility and the electron-nuclear (or hyperfine) nteraction in the metal. It is therefore closely linked o the problem of electronic structure and is fairly omplex. Considerable progress seems to have been made already, and in due course the phenomenon hould be a useful source of information to the metal physicist.

C. G. Shull and E. O. Wollan present a superb ccount of the structural information so far obtained om experiments on neutron diffraction. The power f the technique can be seen by contrasting the emarkably detailed information it yields about the mmonium halide transitions (p. 155) with the very artial results obtained from nuclear resonance tudies (Pake's article, p. 81). Other important tructures which have been investigated by neutron iffraction include: ice (Pauling was right), some rro-electrics and liquid helium. Scattering of eutrons by phonons gives what is at present rather rude information about the vibrational spectrum. Results from magnetic scattering by unpaired elecons are numerous and precise; the technique is obviously of special importance to students of magnetism.

The theory of specific heats and lattice vibrations is dealt with in a leisurely and lucid way by J. de Launay. A good deal of this material is well known, but there are some fresh results, including some particularly careful comparisons of theory and experiment.

The longest article in the book (140 pp.) is by F. Seitz and J. S. Koehler on the displacement of atoms during irradiation. The authors can scarcely be blamed if outsiders find that this is the least satisfactory article in the book: the subject is intrinsically of great complexity. It may well be that to those working in the field of irradiation displacements the article will serve as a searchlight, because it concentrates on quantitative arguments even when they turn out to be wrong by a factor of 5 or 10. However, this sort of thing is very demoralizing for non-specialists, and one wonders whether it might not have been better to have published the article elsewhere.

R. O. DAVIES

DESIGN FOR STATISTICIANS

Experimental Design

Theory and Application. By Prof. Walter T. Federer. Pp. xix+544+47. (New York and London: The Macmillan Company, 1955.) 77*s*.

AN author who plans to teach the practice of design and analysis of experiments commits himself to writing more systematically and in greater detail than Fisher, yet at a lower level of mathematical sophistication than Kempthorne. However useful his book for reference purposes, he can scarcely expect it to prove attractive for consecutive reading. Despite these difficulties, Prof. W. T. Federer has produced a book that will be valuable to statisticians and experimenters.

Comparison with Cochran and Cox, whose similarly titled book has established a high standard, is inevitable. Federer includes a greater range of designs, especially in respect of factorial sets of treatments and of types of lattice, and his instructions for analysis of these will be widely used. He is less successful in showing relations between designs, his system of classification tending to emphasize distinctions rather than connexions. Disappointingly, but perhaps not surprisingly in view of the difficulty of the problems, the discussion of change-over and rotation experiments is quite inadequate. The Box–Wilson methods of exploring response surfaces receive only a reference that gives no clue to their nature. The lengthy account of alternative significance tests in Chapter 2 is not particularly relevant to design, and, in view of the incomplete discussion of some interesting categories of design, its inclusion seems an error of emphasis.

Many readers will regret the frequency with which ideas and techniques are left undescribed, with no more than a reference to the original publication in a journal. The impressive list of 340 references is of interest for many unfamiliar items, and remarkable for some of the omissions. In so long a book, however, one might expect to find the argument of important papers digested and summarized; too often, all that appears is a statement of conclusions, or perhaps only the title of an unpublished paper or inaccessible report, and a proper appreciation of even Prof. Federer's own work is impeded in this way.

Teachers of statistics, including even those who do not find it suitable as a manual of instruction, will welcome this book. Not only does the text contain detailed working of many numerical examples, but also at the end is a very fine collection of problems for further study. These are largely concerned with agricultural experimentation—indeed, throughout the book there is a curious uncertainty as to whether the intention is to discuss field experimentation alone or a broader range of experimental situations—but they are excellent material for testing the student's understanding. They are not only exercises in computation but also illustrations of the kind of thought needed for experimental planning, and their value is increased by an additional extensive bibliography. Too often, the designing of experiments is regarded as a Procrustean process of fitting the experimenter's wishes to a standard form; this book rightly encourages recognition of the statistician's responsibility for devising a design that is practicable and efficient in answering the questions that concern the experimenter.

D. J. Finney

AN AGRICULTURAL READER

A Textbook of General Agriculture

By James Gillespie and P. Hathaway. Pp. 367+28 plates. (London: Macdonald and Co. (Publishers), Ltd., 1956.) 30*s*. net.

In England and Wales there are three levels of formal education in agriculture. The universities give three- or four-year degree courses and supply the bulk of the research, advisory and other professional workers, though a fair proportion of agricultural graduates finally become farmers. The agricultural colleges give two- or sometimes three-year diploma courses for those intending to become farmers, farm managers or technicians. The county farm institutes offer one-year courses which cater for the sons of small farmers and farm workers, and for others who need a short, mainly practical, training.

As a husbandry text-book, the university student has, for many years, mainly relied on Watson and Moore's "Agriculture: the Science and Practice of British Farming", while the college student has been faithfully served by Fream's "Elements of Agriculture". Although numerically the farm institutes have the greatest output of students, they have not, until now, had the great advantage of a generally accepted and frequently revised text-book. J. Gillespie and P. Hathaway have gone some way to fill this gap, but their contribution will need a good deal of re-shaping if it is to become a standard text-book with a large enough, and a steady enough, demand to justify revised editions every four or five years.

Unfortunately, the title is misleading; the book is not a comprehensive text-book. On the contrary, it is, as the authors claim, "a series of essays that cover a number of features of scientific farming". As such, the book is simple and, on the whole, clearly written and well illustrated. The subjects of the component essays are well chosen. Their range, however, is too narrow. Whether one regards this publication as a text-book or a reader, it concentrates too much on the biological, that is, on the husbandry side of farming. In these days, the three sides of the farming triangle—husbandry, mechanization and business management—are almost equal in importance, so it is rather disappointing to find that Gillespie and Hathaway completely overlook the business side and rather neglect mechanization, though there is a useful descriptive chapter on farm machinery.

These, however, are points which could be put right in future editions. The important thing is that the authors have had the courage to attempt to fil an awkward gap by producing a readable book for a type of student that is often unwilling to read. In later life these students frequently become smal farmers or, say, herd managers, and we must welcome any book which can help to equip them to cope with the ever-growing complexity of modern farming.

A. N. Duckham

CHEMISTRY OF LIVING CELLS

The Chemistry of Living Cells

(Harper's Chemistry Series.) By Prof. Helen R Downes. Pp. x+549. (New York: Harper and Brothers; London: Hamish Hamilton, Ltd., 1955.) 52*s*. net.

This introductory text-book, by one who has taught biochemistry for many years to senior students who major in chemistry or in one of the biological sciences, has a flavour of a kind which is all too unusual in modern text-books of biochemistry The historical approach has been widely used in the belief that students should be introduced to the outstanding scientists in their field and encouraged to give them "a local habitation and a name", and shor biographies of prominent investigators are included as footnotes. Delightfully appropriate quotations from literature, both scientific and non-scientific introduce many of the different sections.

The text is lucid and extremely readable, and the illustrative diagrams apposite and clear. So far as possible, the subject-matter has been presented in conjunction with specific experimental data. Each chapter concludes with suggestions for furthe reading and a score or so of "Study Questions".

The first part of the book, entitled "Some Preliminary Considerations", includes sections on "Biochemical History and Literature", "Some Selected Properties of Aqueous Solutions" and "The Structur of Living Forms". Part 2 is concerned with th organic constituents of cells—carbohydrates, compounds of nitrogen, lipids and enzymes. The thir part, that dealing with "Intermediary Metabolism" is naturally the largest and takes up about one-hal of the whole book. The processes of metabolism in micro-organisms and in higher plants are, whereve appropriate, compared with those in the anima world.

This scholarly work constitutes an excellent ke to modern biochemistry for those who have failed t keep abreast of a rapidly expanding subject, or wh may be meeting it in its modern form for the firs time. Of the author herself, one might perhaps without disrespect quote the lines from Thomas Hobbes "Leviathan" with which she opens the section o History and Literature, "But this is certain; b how much one man has more experience of thing past than another; by so much also he is mor prudent and his expectations the seldomer fail him' The clarity and accuracy which Prof. Downes ha infused into this book result from much experience wide reading and careful writing.

F. G. Young

CAUSES AND CONSEQUENCES OF SALT CONSUMPTION

By Dr. HANS KAUNITZ

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THE addition of salt (sodium chloride) to our food has been curiously taken for granted although there seems to be little physiological evidence as to whether or not we are benefited by this habit. Ever since historical records have been kept, salt has played an amazingly important part in the lives of men. Wars have been fought over its sources, and for centuries its trade was more important than that of any other material, as can be seen from the word 'salary'[1,2]. Homer called it "divine", and it has played an important part in many religious cults, in folk-lore and superstitions[3].

Although there was certainly a great deal of deep wisdom connected with the use of salt in ancient rites, it scarcely seems possible at present to appreciate the meaning of the old cults because we have as yet been unable to free ourselves from many prejudices connected with its use. In our own time, the sharpness of the discussions as to the advisability of salting one's food may still be a reflexion of this tradition, which also makes it understandable that the discussions are so frequently carried on by faddists rather than nutritionists.

For these reasons and because the physician is so frequently approached with the question of whether or not one should use salt, an unprejudiced discussion of this subject seemed desirable. It should be stated, however, that undeniable facts, which should form the basis of this discussion, are indeed scarce. One is forced to be guided all too often by biological nnuendoes and vague clinical impressions; thus the conclusions here set forth should be taken with more than a "grain of salt".

It seems particularly timely to give consideration o the problem of the action of sodium and potassium alts from a point of view other than their conventionally accepted role as regulators of osmotic pressure because, in the present era of cell physiology, the onclusion is inescapable that inorganic materials play an important part in hormonal and enzymatic processes. Therefore, it seems not inappropriate to discuss the role of sodium and potassium salts from this point of view, although at this time the coniderations are largely of a speculative character.

Theories which lay the groundwork for our own oncepts were gradually developed about one hundred and fifty years ago. In a book which reveals a remarkably modern outlook, Lehmann[4], in 1853, came to he conclusion that the adding of salt to natural foodstuffs is unnecessary for man. This view seemed to be supported by the fact that most animals, in freedom and in captivity, do well on natural foodtuffs without addition of salt. Although some pecies (for example, cattle, deer, etc.) consume salt agerly when they are offered the substance or when they encounter it in salt licks, there is no proof that they need it for a healthy life.

Later, however, von Bunge[5] formulated his famous hypothesis that extra dietary salt is needed by populations consuming predominantly vegetable products. The excess salt was presumed to be necesary for the more effective excretion of potassium. Bunge arrived at this conclusion on the basis of anthropological studies which he thought indicated that nomadic societies mainly subsisting on meats do not add salt to their food, whereas, once agriculture is developed, salting becomes necessary. He linked this with his observation that the intake of salt is accompanied by the rapid onset of potassium excretion. However, he emphasized that the large amounts of salt usually consumed are out of proportion to what he thought are biological needs. Osborne and Mendel later showed that salt requirements for growth of experimental animals are indeed low; their animals were able to live on traces of salt[6]. Thus, one might have expected that this theory could never have achieved major importance; but, curiously enough, this has not been the case, and it is still cited without further discussion by current text-books of nutrition[7] and anthropology[8].

Objections to the theory should by now be all too obvious. So far as the increased potassium excretion after salt intake is concerned, such a reaction occurs unspecifically with many injuries and diseases[9]. Bunge himself never offered any proof that the increased potassium excretion is biologically of advantage, although he implied so. Now we might be inclined to the opinion that these potassium losses are disadvantageous.

As for Bunge's anthropological data, he brushed away the objection that some African tribes mainly subsisting on a vegetarian diet use potassium-rich plant ashes rather than salt as a condiment[10]. Even at the present time there exist a considerable number of societies which do not add salt to their food. Important in this respect are studies by Kroeber[11] of the food habits of Indians of the north-west Pacific. In the southern half of the area studied salt was used, but not in the northern half. There was no predominance of plant or animal food in either region.

I have been given recent and direct anthropological evidence dealing with this question by various workers in this field*. I have learned of studies of places as distant as Melville Island in Australia, the Kalahari Desert in South Africa, and Tierra del Fuego which lead to the conclusion that the use or non-use of salt by various tribes is irrespective of the amount of agricultural products they consume. The observation is probably of deep significance[12] that the Siriono Indians of eastern Bolivia, a hunting people, were ignorant of salt until it was introduced to them by an anthropologist. At first, they found it distasteful, but they later developed a craving for it. This indicates that once some people are exposed to salt, they cling to its use stubbornly—as do so many of us to the consumption of alcohol, coffee, nicotine, etc.

When carefully weighing the available evidence, one cannot escape the conclusion that normal metabolic processes are possible without the adding of salt to natural foodstuffs. Why then do we eat salt? Merely to answer that certain societies like its taste whereas others do not would be trite and superficial.

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* I wish to express my gratitude for the invaluable information given to me by Miss Jane C. Goodale, of the University Museum of the University of Pennsylvania, Drs. S. K. Lothrop, Hallam L. Movius, jun., and Mr. John Marshall, of the Peabody Museum of Harvard University, and Dr. Harry Tschopik, jun., of the American Museum of Natural History.

It seems to me that salt intake is probably correlated with emotional stimulation, a fact perhaps more keenly appreciated in the superstitions of the ancients than in our own rational approach. In view of the fact that this stimulation may be consciously or unconsciously pleasurable, it may be a causal factor in the craving for salt.

When we now try to deal with the possible consequences of adding salt to the diet, it must be emphasized that the nutritional essentiality of salt for humans has been firmly established. Only the quantity necessary is much in doubt. For a better understanding of this subject, it seems advisable to review briefly the main trends in studies dealing with the biological effects of sodium chloride.

One involves investigations of its distribution in the organs and the excretion of salt in health and disease. Others deal with the peculiar antagonism of sodium and potassium in living organisms. An important subject of investigation is concerned with why salt is an essential ingredient of any living cell; and another trend centres around the regulatory mechanisms, especially of the higher animals, developed for the maintenance of an optimum distribution in the body.

The high potassium content of the parenchymatous cells as opposed to the higher sodium chloride content of the blood serum has been recognized at least since von Liebig's time[13]. Soon thereafter, many studies were conducted which gradually led to the recognition that, in disease, the low sodium chloride content of the cell increases while the potassium level decreases[14,15]. Speculation as to how the body can maintain the high concentration gradients within the distance of a few microns between the surface of the cell and the blood plasma originally involved the idea of the specific permeability of cell membranes. It was held that the cell membrane is specifically permeable to potassium salts and almost impermeable to sodium chloride under normal conditions and that this is disturbed in disease.

Some investigators recognized the weaknesses of these hypotheses at an early date. Keller, in particular, attacked the idea that the separation of the minerals was due to the function of an 'inert' membrane rather than to the discriminatory power of the whole living cell. He tried to replace this static view with his electrostatic theory, the study of which is still rewarding even after fifty years[16]. Nevertheless, the permeability theory was accepted by most biologists until isotope studies[17–19] proved that the cell membrane is equally permeable to both potassium and sodium salts and that the low sodium chloride content of the cell is due to its rapid expulsion from the cell. This mechanism is now often referred to as the 'sodium pump'[20], a term which might well be improved. Although these studies prove that the removal of sodium chloride from the cell is a dynamic process the disturbance of which leads to the accumulation of sodium chloride within the cell and although many modern physiologists have demonstrated the weaknesses of the membrane theory[21,22], some investigators are not as yet ready to give it up entirely[23].

The modern concept of competitive antagonisms within enzyme systems, which gradually evolved from studies on minerals[24], has proved a useful tool for the understanding of some functions of sodium and potassium salts. In practically all biochemical and pharmacological studies, it has been shown that sodium and potassium have opposite functions. For example, potassium salts favour diuresis; sodium salts do the opposite. Many more examples have been cited[9]. Lately, some evidence has been put forth that this antagonism is particularly important in regard to the action of chloride, the biological effect of which depends upon whether it is accompanied by sodium or potassium[25].

In studies concerned with the question of why sodium chloride is essential for the living cell, tenable ideas are sketchy. It seems important that a number of enzyme systems can only function if sodium chloride is present at certain concentrations[26,27]. In view of the fact that we now believe that the life of the cell is maintained by enzymatic processes, sodium chloride is an integral part of the cell.

These dynamic equilibria are encountered in any living organism. In higher animals they are, to a considerable extent, under hormonal control, and disturbances of the more basic processes become noticeable if the hormonal control breaks down. Thus, one finds that, in many diseases, the sodium–potassium ratio in the tissues is disturbed, which probably interferes with metabolic processes bound to a constant sodium–potassium ratio[28]. It is quite probable that in diseases which are of generalized character and are also accompanied by signs of renal damage, excess dietary salt can enhance the disturbances of the sodium–potassium ratio in the tissues and can thus contribute to the occurrence of metabolic failure[29]; but these conditions are by no means clear, and the influence of dietary salt in health and disease can be better appreciated from its effect on the hormonal mechanisms than from its action on the basic processes.

The regulatory mechanisms of salt metabolism not only involve incretory glands but also every major organ directly or indirectly. One mechanism involving the central nervous system was discovered by Claude Bernard[30], who demonstrated that injury to a certain part of the medulla is followed by the excretion of large amounts of sodium chloride. Although a great deal of thought has been given to the central nervous regulation of mineral metabolism neither its correlation to other regulating mechanisms nor how it is affected by changes in salt intake is clear.

Renal mechanisms in salt metabolism have received considerable attention. In fact, the salty taste of urine attracted the curiosity of people for a long time, and this was the reason for its medicinal use[1] Despite the enormous amount of work done since then on the excretory mechanism of the kidney there is little evidence as to whether the dietary intake of salt eventually interferes with the excretory power. From an evolutionary point of view, it i well to remember that sodium chloride is a scarce material for most animals and is constantly reabsorbed by the kidney. Excess salt intake force the kidney to excrete rather than to reabsorb it which may 'prove too much for it' in the long run. Such a view is supported by the rapid occurrence of histological changes in the kidneys of animals on high dietary salt intake[31].

The regulatory mechanism for sodium chlorid metabolism at present best understood rests in th adrenals. This function of the adrenal cortex wa educed in R. F. Loeb's studies on patients with Addison's disease[32]. It was demonstrated that th low serum sodium chloride values in patients with adrenal insufficiency are associated with continued urinary losses and are accompanied by low potassium excretion and increased serum potassium values. These changes are prevented by the normal secretion of the adrenal cortex involving steroids such as deoxycorticosterone, cortisone and aldosterone. However, these hormones not merely influence sodium chloride and potassium salt metabolism but also play an important part in the regulation of protein metabolism (increased urea excretion in hyperadrenalism), carbohydrate metabolism (diabetes in adrenal hyperfunction; hypoglycæmia in adrenal insufficiency), blood pressure (hypertension in adrenal hyperfunction; low blood pressure in adrenal insufficiency), fat metabolism (changes in fat distribution in adrenal hyperfunction), pigment metabolism (discoloration in adrenal insufficiency). If, then, certain body functions are directly influenced by the adrenal cortical hormones, one might ask whether the intake of sodium chloride affects them because of its intimate relationship with adrenal function.

Abundant proof has been given that the deleterious effects of adrenal insufficiency can be at least partially counteracted by the administration of salt. This is true both for humans suffering from Addison's disease[32] and adrenalectomized animals[33]. On the other hand, salt intake is clinically undesirable in conditions in which the induction of hyperadrenalism is a disadvantage. As is known, the administration of either cortical hormones or salt may lead to similar symptoms in circulatory conditions, hypertension and the like.

There exists by now a considerable body of evidence linking the functions of the cortical hormones to those of salt. Thus, hypertension produced by deoxycorticosterone is enhanced by simultaneous administration of sodium chloride[34]. The kidney lesions[35] and changes in food and water intake brought on by salt are potentiated by cortisone[36]. There exists, furthermore, a considerable similarity in the influence which the adrenal cortex or salt exerts on carbohydrate metabolism. Hyperadrenalism is accompanied by increased deposition of glycogen in the liver and a high blood sugar. On account of the simultaneously increased urea excretion, it was deduced that the increased glycogen formation is due to catabolic processes in protein metabolism[37]. The administration of salt leads to similar changes, namely, increased deposition of glycogen, reduced oxidation of glucose leading to increased blood sugar and increased urea excretion[38]. On the other hand, the reduced intestinal absorption of glucose in adrenalectomized animals can be equally corrected by salt or by adrenal hormones[39,40]. Unless one assumes that this latter finding is only due to improved intestinal blood supply, a more specific salt effect becomes probable, which leads to the conclusion that the effects of salt and of adrenal hormones on carbohydrate metabolism are perhaps interrelated and that the mechanism of this effect is the stimulation of the cortex by salt. The restoration of carbohydrate metabolism in adrenalectomized animals may perhaps be due to the stimulation by salt of tissues which are functionally related to the adrenals. Additional material in support of such a theory will be given below.

Thus, the conclusion is unavoidable that cortical hormones and salt enhance each other's actions. But the question must be asked whether this relationship is important when salt is added to the diet, because one might argue that excess salt leads to a compensatory decrease in adrenal secretion of some of the hormones. This latter seems improbable because it has been shown experimentally that increased salt intake is followed by adrenal enlargement suggestive of adrenal hyperfunction[9]. Clinically, high salt intake is probably related to hypertension[41], again a sign of high cortical hormone secretion.

Such a concept is supported by the effect of sodium chloride in a number of conditions which have in common: loss of sodium chloride by way of one of the body fluids, a drop in serum sodium chloride, and a favourable response to the administration of salt. In addition to Addison's disease, one should mention here heat exhaustion, various uræmic conditions with or without histological signs of kidney disease, and high intestinal obstruction. It is usually believed that the benefit resulting from the intake of sodium chloride in these conditions is owing to the replacement of sodium chloride which has been lost. A more careful analysis indicates a different mechanism.

In profuse sweating, the sodium content of the sweat and urine is rapidly reduced to such an extent that the total salt loss was, within five to eight hours, less than that occurring in the same period without profuse sweating[42,43]; a correlation between the salt content of sweat and adrenal activity has been fairly well established[44,45]. The fact that various uræmic conditions respond favourably to salt administration has been well known for at least thirty years[46,47]. These studies are related to observations on 'salt wasting nephritis'. No balance studies indicate whether these patients actually had a negative salt balance. We were able to carry out such a study on one patient with a rapidly progressing uræmia, profuse vomiting, and a drop in serum sodium chloride. This patient consumed only a little bread and milk and yet had a positive sodium and chloride balance[29]. Similarly, it is known that the amounts of sodium chloride necessary for improving the condition of animals vomiting because of intestinal obstruction are much higher than the amounts actually lost.

The improvement produced by salt in the above conditions cannot be due merely to the replacement of salt losses but must be rooted partly in some pharmacological effect of the substance. The therapeutic effect becomes understandable if one assumes that the pharmacological effect of salt is that of adrenal stimulation, which results in the improvement of the existing 'stress' condition. This theory would be more acceptable if it could be demonstrated that there is some reason for the assumption that a similar mechanism is partly responsible for the salt action in Addison's disease and in adrenalectomized animals. In human adrenal insufficiency, the amount of salt required to produce optimal clinical improvement is high, perhaps 50–100 times what might be considered 'normal' minimum requirements. Whether these high requirements are only due to the high renal losses or whether they are also needed for their adrenal-stimulating effect has not as yet been studied. If the effect were only due to the replacement of losses, one should suspect that the amount just sufficient to bring about equilibrium of the salt balance should allow optimal clinical improvement. Whether the high doses are necessary to give equilibrium of the salt balance or whether this could be achieved with much smaller amounts has not as yet been studied. Some very sketchy information obtained on adrenalectomized rats indicated that the salt requirements for maximal improvement are much higher than those necessary to bring about equilibrium of the balance. This point, however, needs more attention in the future.

Finally, if one asks whether a similar mechanism may also be responsible for the action of salt in adrenalectomized animals, some pertinent data can be uncovered in the literature. As mentioned before, the intestinal absorption of carbohydrate is restored by salt or adrenal hormones[40]. Similarly, fat resorption is improved[48]. Salt or cortical hormones keep hæmoglobin formation at normal levels[49], keep adrenalectomized rats fertile[50], and prevent cytological changes in the pituitary of adrenalectomized animals[51]. Inasmuch as salt has scarcely a hormonal effect *per se*, its action may well be mediated by stimulation of tissues capable of partly replacing the adrenals.

The stimulating effect of salt probably sets in motion adaptive mechanisms involving enlargement of the liver, kidneys and adrenals; this has been found in experimental animals[9]. Similar conditions have been thoroughly discussed in many other 'stress' conditions[52,53].

The possible changes, especially perhaps in the emotional sphere, brought on by the stimulating action of salt are, of course, entirely a matter of speculation. The greater responsiveness of people, if they were so stimulated, could have helped throughout the ages in the accumulation of knowledge. Whether this is one of the roots of the reverence which was accorded salt by the ancients can scarcely be guessed at this time.

It would be of inestimable value if we could be sure how long ago the majority of mankind learned to eat salt. It has been assumed that this took place when peoples went through their neolithic stages, which were accompanied by the introduction of agriculture and which took place for the more complicated civilizations about five to ten thousand years ago. The evidence for the simultaneous introduction of agriculture and salt eating is scant. The first known signs of salt mining were found in the Austrian Tyrol and date back to the late Bronze Age for that part of the world, about 1000 B.C. However, it is obvious that all the more complicated older cultures (Egyptian, Babylonian, Chinese) antedating that period knew the use of salt. One clue as to when tribes became used to salt is that Sanskrit and its daughter languages have no common root for salt and that therefore the Indo-Europeans, when first migrating, did not then know its use[1]. For these reasons, we are still inclined to believe that salt was gradually more extensively used when the tribes went through their neolithic stage.

Is there any reason to assume that the constant use of salt as a stimulant has changed our intellectual capacity? If our previous speculations are correct, one must assume that man in the Upper Palæolithic Period (ten to thirty-five thousand years ago) did not salt his food; yet, Cro-Magnon Man created magnificent art. Intellectually, therefore, he was our equal. He differed from us only in his lack of knowledge. Thus, although salt-eating did not change man intellectually but may have facilitated learning, it possibly was an important historical force.

Are there, finally, any reasons why the physician and public health worker should recommend a certain level of salt intake on the basis of present-day scientific knowledge? There is no question that there is a sound basis for the prescribing of low-salt diets in many diseases, particularly those involving the circulatory system. When it comes to normal people, however, recommendations are infinitely more difficult. It is certainly true that the chemistry of the body does not require the addition of salt to our food. The physician, however, is not primarily interested in the mere metabolic processes but in the general welfare of his patients, and he should consider that the quickened pace of a more complicated society demands persons with a heightened responsiveness. Salt may be one of the ingredients producing this effect.

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PERSONNEL MANAGEMENT

THE struggle for productivity in industry can never be won. Each success leads to a lifting of the sights and a new target is revealed. In each succeeding situation differing relations between various groups of employees—and particularly between management and men—are developed and, unless handled with wisdom and care, lead to clashes in which productivity becomes either static or declines. The importance of good human relations is now recognized to be essential if British industry is to develop, and it is not surprising that the Institute of Personnel Management continues to grow in prestige and authority.

This was reflected in its annual conference which, at Harrogate during October 12–14, attracted almost a thousand people representing all levels of management from industry and commerce, government departments, the armed services and various agencies at home and overseas.

The theme of the Conference was full employment and industrial change and, in the opening address, Dr. Alfred Torrie discussed the limitations of the contribution which social science could make to management. Quoting from experience in the services and elsewhere, Dr. Torrie showed how even senior members of government—as well as many others—are resistant to change and unwilling to try anything new which might involve the emotions. Social scientists, too, find it difficult to get their ideas accepted; they are apt to be remote and impersonal, to be objective about human emotions. The social scientist is keen on studying the group and making the group a more important factor than the individual. But the lesson of history is that the most significant advances in the fields of science and invention came as a result of the lonely searching of individuals. The social scientist is so anxious to find out what adjustments can be made to the norm that he forgets that it is the individual, the unusual, the innovator, the inventor that is the carrier of new ideas. The social scientist wishes to measure and control and treat people statistically; but tough-minded people, the tough-minded individuals, resist such treatment.

The third limitation of social science is that it does not account for the whole of the human being. There are far too many variables present. One variable, which is an external one, is that theories may be formed, research may be done, a theory may be validated and its application to industry proved; but unless some sort of social action occurs, it becomes sterile and void. The social scientist is limited in believing in a man-centred world. Spiritual man may be dismissed; but the spiritual factor is always there, sustaining and inspiring and motivating man's behaviour, giving meaning and purpose to life. Social scientists contest all false judgments; but love, humility, honour, loyalty, justice and mercy, and the ways by which men respond to each other in a social situation cannot be measured.

All great people are unstable, and so they have to be. They are maladjusted to the norm and they are unstable because of the strength of the inspiration, the strength of the ideas within them that they are striving to express, to which they are striving to give birth. If the social selection sieve gets finer and finer, innovators are going to be thrown out and society will be deprived of new ideas in the future. Social science is necessary for understanding, but so is spiritual awareness.

How to integrate social with technological change was examined by Lord Halsbury in a most brilliant and penetrating address. He made it abundantly clear, for example, that advancing technology has nothing to do with employment or unemployment; the latter is an economic phenomenon and is controlled by economic policy. Over the past fifty years productivity has been rising at about 1½ per cent per annum, and, since the war, that rise has increased to 3 per cent per annum. Full employment in 1956 is due not only to advances in technology but also, in a post-Keynesian era, to a high investment rate.

There was also a change in the pattern of skill between 1900 and 1956. Skill is subject to two processes operating in reverse directions. Skill is always being degraded into semi-skill; semi-skill is always being degraded into unskill; and, at the same time, unskill is always being upgraded into semi-skill, and semi-skill to new skills. These can be written as two processes operating in reverse directions, and from society's point of view, is the overall direction of the balance, by way of change, and, from the individual's point of view, how it affects him on the short-term view.

In addition to these transformations of skills, which are continually under way, there is a disappearance of old trades rather than old skills, and an appearance of new trades rather than new skills, and the overall effect, if treated statistically, is an overall increase in skill in the community at the highly skilled end, and the demand for a higher standard of education among the so-called unskilled at the other end of the range. It is a great pity that there is no flow diagram of the human career in better statistical form than is available to us at the present time.

What are the events when a man is displaced by a machine? If the craft is a dying craft, it generally turns out that it is represented by an ageing population. The dying population and the dying craft emerge hand in hand, and as the trade dies, so the recruitment of youths for apprenticeship to it begins to fall off, and there seems to be no great difficulty in matching the one process to the other.

When men are displaced by machines the problem is to minimize the stresses arising out of the various strains, and this leads to the need for retraining the industrially displaced person. The issue here is not how successful the result will be, but how just the attempt will be. It seems just, if a man is displaced by other men—and these include the whole complex of managers, engineers, drawing office engineers and scientists and so on who are responsible for initiating changes in factories—that the man displaced should be the first to be allowed to work the new process, or for him to be restored to full earning power by being retrained. The cost of retraining should be borne by the parties responsible for the displacement as part of the true cost of the new installation.

In the closing address, the Minister of Labour, Mr. Iain Macleod, suggested that if thinking and planning for change are to be effective and if change is to be accepted without great social disturbances, certain assumptions are necessary. First, that our technologists will be able to continue to devise machines at the present rate of development, and perhaps, at an accelerated rate; secondly, that the capital will be available and that the machine tool industry will be capable of producing them; that the people of the world will be able to produce and to exchange the raw materials required for these machines, and by these machines. Thirdly, that there is going to be a demand for the products of these machines, and that the spending power to acquire them will be available. Fourthly, that good relations between workers and management are achieved—relations of such harmony that vast industrial disturbances become entirely old-fashioned. Lastly, that the benefits of this new age will spread throughout the world.

First, however, man must adapt his industrial customs and his outlook to what many people call the new machine age. Secondly, the use to which man will put the rewards of these technological changes must be considered.

The problem of the redeployment of the labour force is the widespread conviction that, unless something is done, the social and the economic cost of industrial change is going to fall upon the individual worker.

What is needed is a new recognition of social responsibility in industry at the level of the individual firm and the application of that responsibility over a long period. The real responsibility for planning must lie at the level of the individual firm. Employers must now accept the moral responsibility for planning the employment of their work-people exactly in the same way as they accept the management responsibility for planning the building of their factories, the installation of machinery as well as development of their markets.

This is not just a matter of paying monetary compensation; it involves a much deeper change of attitudes, and of habits, which can only come about if everyone in industry is ready to face the full significance of technological change.

Industry can also make a contribution to the problem of adapting society to technological change, and that is in the field of training. The main responsibility of training in industry is industry's itself. If industry paid more attention than it does to the establishment of effective schemes of training for new entrants, it would not only save money for itself but it would also make a most valuable contribution to the flexibility and the increased mobility of the labour force that is so essential to the British economy.

For many years there has been a trend towards the breaking down of processes and, therefore, the training of workers on one operation only. There may be a reversal of that process, a tendency towards synthesis and a training of workers to understand any one in a whole chain of operations; if this is so, it will make greater demands on the capacity of workers, and training for new kinds of work will require a new approach.

What about the rewards from technological change? The expectation is that the new era of production will make possible a higher standard of living. It should remove some of the drudgery and the physical exertion that is still existent in industry. It may be that it will bring more leisure, which in itself will bring a problem with it. If leisure is wrongly used it is bound to lead to boredom and to discontent which will sap and rot our civilization.

Other features of the Conference were a series of one-day courses dealing with the training of operatives, industrial pension schemes, selection methods, and the part of work-study in retail staff management. There were also a number of sectional meetings where delegates were given opportunity to consider details of recent developments in the training of managers, to discuss the case for and against the payment by results, to examine new suggestions which could be used as bases for pay differentials, to explore communications within the work force, and to learn of recent developments in the mechanization of office work.

T. H. HAWKINS

PHYSICAL CHEMISTRY OF PROCESSES AT HIGH PRESSURES

A TWO-DAY discussion meeting of the Faraday Society on the general theme of "The Physical Chemistry of Processes at High Pressures" was held in the Chemistry Department of the University of Glasgow during September 20–21. Some 162 British and 58 overseas scientists attended the meeting, and a lively and well-sustained discussion resulted. Many of those present had the opportunity of enjoying a display of Scottish dances and Scottish songs, through the kind hospitality of Imperial Chemical Industries, Ltd.

This was the first Faraday discussion with this general theme; it is evident that for condensed states of matter, the pressure variable has been much less fully explored than the temperature variable. However, high-pressure techniques are becoming easier to develop and to apply, at any rate up to about 5,000 atm. Increased accessibility of operations at high pressures has resulted in a broadening of the range of physico-chemical measurements becoming available for interpretation. For still higher static pressures, equipment is at present too specialized and costly to favour its widespread dissemination in many laboratories; but results important for the thermodynamics of condensed phases are being obtained in a few centres. The use of transient high pressures up to 10^5 atmospheres or more, as developed in shock and detonation waves in solids, was first applied to the measurement of thermodynamic parameters during the Second World War. Increased attention is being paid to the development of such techniques at the present time, though there are still serious difficulties of interpretation, particularly in systems containing a mixture of solids.

Industrial interest in high pressures has received obvious stimulus from the highly successful polymerization of ethylene and the suggestive results in the polymerization of acetylene, and adds to the significance and timeliness of the recent discussion.

The papers presented and the discussion make it clear that systematic theory has not wholly kept pace with present experimental developments, though some of the contributions at this meeting clarified important theoretical problems. The influence of repulsive forces in practically all high-pressure phenomena is widespread. A useful survey by Dr. T. Cottrell (I.C.I., Ltd., Nobel Division) brought out the difficulties in finding high-pressure parameters that are at the same time simple to calculate theoretically and experimentally sensitive to repulsive force-fields. Various contributors discussed the form and characteristics of repulsion potentials. For close molecular overlap a simple inverse power function of molecular separations fails to represent repulsions successfully; an exponential function may be more hopeful, though a composite function with more than one adjustable parameter seems to be required if the range of repulsion potentials under discussion is at all large. The anisotropy of repulsive force fields for non-spherical systems, and additional complications where repulsions arise in a many-body problem, present other obstacles to theoretical progress. From the discussion it was evident that some of the difficulties are only just beginning to emerge clearly. One promise of theoretical advances stems from the much greater diversity of experimental phenomena, where measurements are becoming available from which repulsive force-fields might in principle be calculated. This was illustrated by many of the experimental contributions to this discussion, and permits a greater degree of selection in applying theoretical considerations.

Another broad group of theoretical problems arises from the interpretation of the transport properties of dense gases; these are of very considerable practical as well as theoretical interest. The outcome of many statistical-mechanical calculations which can be formulated with some mathematical rigour is much too complicated to be applied conveniently to experimental examples. For this reason the devising and testing of simpler models which permit some theoretical insight into transport processes in dense gases offers special opportunities for progress at the present time. In this direction, significant contributions to the discussion by Prof. H. C. Longuet-Higgins and J. P. Valleau (Cambridge), and by Dr. E. Whalley (National Research Council, Ottawa) were discussed by a number of contributors.

A third type of theoretical calculation at high pressures refers to properties of compressed gases, the variation of which with pressure can be attributed to attractive forces. Measurement of such properties as a function of pressure, and particularly a combination of several types of measurements, promises to give rewarding information about details of intermolecular attractions which it would be difficult to obtain in any other way. For example, a contribution by Dr. J. A. Pople and Dr. R. A. Buckingham (Cambridge) indicates useful properties the dependence of which on pressure, though not extensively studied hitherto, should yield new information about molecular force-fields.

Though advances in techniques of working at high pressures were not specifically included in this discussion, the increasing range of phenomena which can now be studied conveniently was illustrated by experimental studies such as those on the effects of pressure on the infra-red and electronic resonance spectra of gases, by Dr. B. Vodar and his colleagues (Laboratoire de Haut Pressions, Bellevue). These promise to contribute novel features in our general knowledge of molecular force-fields. A. M. Benson and Prof. H. G. Drickamer (Illinois) made the interesting suggestion that the pressure coefficient of a vibrational frequency could be employed systematically to supplement the actual numerical value of the frequency itself, in correlating spectral energy-levels with modes of vibration and thus with molecular structure.

The meeting also considered various aspects of chemical reactivity at high pressures. It is usual to separate the influence of pressure on the structure of the solvent, from its influence on various activation complexes involved in specific chemical reactions. From observed changes in the dielectric constant of methanol, discussed by Dr. S. D. Hamann and W. Strauss (Sydney), there appears to be a striking influence of pressure on the structure of this solvent. Presumably this is connected with the open network structure of hydrogen bonds in liquid methanol. It would be interesting and important to know if such an influence of pressure on structure is observed generally in the case of hydrogen-bonded solvents. There was considerable discussion about the interesting changes in the properties of such solvents as they approach and traverse their critical points. For example, in water near and above its critical temperature, it may happen that some of the 'anomalous' properties associated with clusters of molecules of H_2O with the tetrahedral ice arrangement are related in a sensitive way to the extension of such clusters in space.

So far as the activation complexes are concerned, relatively simple concepts, as discussed by various contributors, at present suffice to account for much of the observed influence of pressure on the free energy of activation. The influence of pressure on reaction-rate is quite striking for certain fairly complex molecules, as in cases reported by Dr. S. D. Hamann and D. R. Toplitzky (Sydney), where a five-hundred-fold increase in rate accompanies the increase in pressure up to 15,000 atm. On the other hand, expectations that the steric hindrance in specific reaction mechanisms might be reduced or even eliminated as a result of bond deformation at high pressures proved not to be fulfilled, at any rate in the examples presented at this discussion by K. E. Weale (Imperial College, London). Other striking influences of increases of pressure arise in polymerization reactions. For example, in the polymerization of styrene, rates of propagation and of chain termination have been shown to depend in a marked way on the degree of compression of the solvent. In consequence the mean molecular weight is affected by pressure. Rather less seems to be known at present about how far chain-branching for a given size of macro-molecule is affected by the pressure at which it has been formed. In the polymerization of ethylene discussed by various contributors, the reaction-rate likewise depends in a complex way on the pressure, owing to the various ways in which nearest neighbours influence chain-reactions as molecular packing becomes closer.

A group of investigations on physicochemical processes in detonation and shock waves was presented for discussion by various contributors. The systems studied differed widely in complexity. It seems clear that in heterogeneous polycrystalline mixtures, a complex diversity of phenomena can occur which is by no means fully elucidated. This applies, for example, to studies reported by Dr. L. Deffet and Boucart (Tir National, Brussels), by Dempster, and by Dr. W. Taylor (I.C.I., Ltd., Nobel Division). The mixtures of explosive substances they described can only be termed 'solid' by convention; phenomena such as grain erosion in the detonation reaction-zone are of dominant importance and depend on the intercrystalline free space in a complex way. Much stimulating discussion was held about the physical chemistry of the reaction zone in detonations. The importance of the intercrystalline free space is further emphasized by a contribution which described the behaviour of single crystals studied individually. High initial pressures are found to have only a slight effect on the 'runaway temperature' in the self-heating of single crystals of explosives.

Experiments on the homogeneous detonation of acetylene should in principle be simpler to interpret than the behaviour of heterogeneous systems. However, the formation of solid products of detonation leads to complications when attempting theoretical interpretations. It is not clear at what stage the 'carbon' ultimately obtained from the detonation of acetylene is actually formed; it seems unlikely, furthermore, that the crystal structure and heat content of such 'carbon' can be taken as the same as in ideal graphite. The kinetics of pyrolysis of acetylene in shock waves to give carbon offers further information about reactions at transient high pressures, which present complications due to the formation of solid products of variable physical structure and chemical composition. Extensions of such kinetic studies promise to cover ranges of high pressure and high temperature not conveniently obtainable in other ways. The possibility of obtaining conveniently kinetic results at several hundred thousand atmospheres obviously attracts a number of research groups. However, as in other studies of transient phenomena, relaxation effects may complicate any interpretation of the results on the basis of the thermodynamics of high pressures. Detonation and shock velocities can now be measured with very considerable precision. The measurement of detonation and shock pressures still present technical difficulties, though they may become accessible from techniques such as X-ray shadowgraphy and measurements of mass flow. But in the case of detonations and shock waves there are very serious doubts about the applicability of 'temperature' at all as a significant modulus in describing the statistical distribution of various kinds of internal energy among the molecular and atomic species present. Active research in the physical chemistry of matter at high pressures receives still further stimulus from the possibility of observing transitions from insulator to conductor behaviour of various crystals when sufficiently compressed. Preliminary studies of this kind were described at the meeting and added further zest to a very lively two-day discussion.

A. R. UBBELOHDE

OBITUARIES

Prof. J. C. Cruickshank

JOHN CECIL CRUICKSHANK, professor of bacteriology as applied to hygiene in the University of London at the London School of Hygiene and Tropical Medicine, died on October 30 at the age of fifty-seven. Educated at George Watson's College in Edinburgh, he served in the Gordon Highlanders at the end of the First World War, and then proceeded to the University of Edinburgh, whence he graduated M.B., Ch.B. in 1921. He took the D.T.M. at Liverpool in 1923, winning the Alan H. Milne Memorial Medal, and then served in the West African Medical Service in the Gambia for seven years, gaining tropical experience which was of great value to him and to his students later in London.

Cruickshank came to the London School of Hygiene and Tropical Medicine to take the diploma in bacteriology in 1933, and remained there first as demonstrator, then as lecturer in bacteriology. During the Second World War he directed Emergency Public Health Laboratory Services laboratories, first at Horsham, later at Exeter, returning to the School in 1945 as reader in bacteriology as applied to hygiene, to re-open the Department under the part-time direction of Prof. G. S. Wilson, and to start teaching courses again. Cruickshank was a great teacher, whose wide experience of tropical and public health bacteriology fitted him uniquely well to teach in courses for the diploma in bacteriology, the diploma in public health and the diploma in tropical medicine and hygiene. Many hundreds of students will remember his excellent teaching with gratitude. In 1947 he became professor in bacteriology as applied to hygiene.

Throughout the past twenty-five years, Cruickshank had maintained a steady output of research on bacteriological topics, chiefly on brucella infections and on immunity. He acted for some years as expert adviser to the Public Health Laboratory Service on clostridia and on brucella. He served on the Water Pollution Research Board of the Department of Scientific and Industrial Research and its Detergents Committee, and on various other public committees and bodies. He was a member of the Pathological Society, the Society of General Microbiology, and the Medical Research Club. In 1952 he gained his M.D. (Edinburgh) with a gold medal. He was loved and respected by all his colleagues and students and all others who knew him; his early death is a great blow to the School. He leaves a widow, two sons and a daughter.

E. T. C. SPOONER

Dr. John McLuckie

DR. JOHN MCLUCKIE, until recently reader in botany in the University of Sydney, died on September 27 at the age of sixty-six. He was still in harness, for he was asked to come back after his official retirement to take the advanced mycology course. He had given a lecture and a practical class on the day of his death.

McLuckie was born in Killermont, in Dunbartonshire, on August 12, 1890. He was the eldest of a family of seven. His father was a gamekeeper, and as a boy John McLuckie learnt to handle a fishing rod and a gun—skills which he practised with great distinction during his forty years in Australia. From these early days he acquired, too, an intimate knowledge of natural history and a love for the countryside.

He won a bursary to the school which is now Bearsden Academy and proceeded in 1909 to the University of Glasgow, where he was a pupil of F. O. Bower. After graduation in 1914, McLuckie sailed for Australia to serve under Prof. A. A. Lawson (also one of Bower's pupils) in the newly established Botany Department in the University of Sydney.

He devoted his whole career to this Department. His early work was a series of studies in mycorrhiza and parasitism, published in the *Proceedings of the Linnean Society of New South Wales*. Then he turned to ecology; his primary surveys of the Kosciusko and Mount Wilson districts are still standard works, and show how well McLuckie had mastered (with the aid only of an out-of-date handbook of the flora) the perplexities of Australian vegetation. But it is as a teacher that he will be remembered. For forty years medical students, pharmacists, scientists and agriculturists passed through his classes. Some of them arrived under the impression that botany was a 'soft option', but none who survived McLuckie's practical classes preserved that illusion. He took immense pains to ensure that students were given good plant material for their practical work (it was not unusual for first-year students to see fertilization in living *Hormosira*); and having provided good material, he took immense pains to ensure that students observed thoroughly and drew accurately. He was exacting in his demands and he had no patience with a student who did not take botany seriously; but the student who did take botany seriously found in McLuckie an enthusiast who delighted in plants and for whom no trouble was too much. He conveyed to his colleagues an impression of deep loyalty to his subject. On field trips he was at his best, and his students will long remember him striding ahead, under the scorching Australian sun, to show them some rare plant or some characteristic patch of vegetation; and then standing by, lighting his pipe and smilingly awaiting their comment.

Through many changes of staff, and during dislocations caused by the War, the Botany Department depended for its stability and cohesion on McLuckie. On at least five occasions he modestly undertook the duties of acting professor. He was a dedicated teacher, and his massive "Australian and New Zealand Botany", published jointly with H. S. McKee in 1954, is a fitting memorial to his career.

ERIC ASHBY

NEWS and VIEWS

Nobel Prize in Physics for 1956: Dr. W. Shockley, Prof. J. Bardeen and Dr. W. H. Brattain

THE Nobel Prize in Physics for 1956 has been awarded, jointly, to Dr. W. Shockley, Prof. J. Bardeen and Dr. W. H. Brattain for their work on emiconductors. During the years they worked ogether at the Bell Telephone Laboratories they emoved many of the obscurities and much of the mpiricism from semiconductors and founded the ubject of transistors.

Bardeen and Brattain discovered transistor action when they placed two metallic whisker tips on the surface of one small piece of germanium and found that the current passed by one metal-semiconductor contact greatly influenced the properties of the other, f the separation was less than about 0·02 cm. Both current and power gains were demonstrated in this, the first solid-state amplifier (now called a point-ontact transistor). The existing, one-carrier, theories f conduction postulated that the majority of mobile harge-carriers in extrinsic semiconductors were ther negative electrons in the conduction band *n*-type conductivity) or vacancies (holes) in the alence band behaving as positive charges (*p*-type onductivity). Because transistor action could not be explained in terms of majority carriers only, Bardeen and Brattain proposed that minority carriers -injected at the first contact, transmitted through he semiconductor in the presence of the majority arriers without much probability of mutual (hole-ectron) annihilation and collected at the second ontact—were responsible.

Shockley saw that metal contacts were not essential o the action, and in 1949 he analysed the properties f *p–n* junctions within one piece of a semiconductor nd predicted the behaviour of transistors having *-p–n* and *p–n–p* structures. He very quickly btained full experimental confirmation. A theory f the recombination of electrons and holes was roposed and direct measurements made of many roperties of minority carriers. Later he proposed nd analysed another structure—the unipolar transistor—which, though using *p–n* junctions, is ependent for power gain on majority carriers only; again, experiments quantitatively confirmed his predictions. Bardeen and Brattain had meanwhile returned to studies of surfaces of semiconductors; by careful measurements they added to the understanding of the properties of very thin adsorbed layers in the presence of electric fields. Dr. Shockley is now with Beckman Instruments and Prof. Bardeen is at the University of Illinois.

Control Mechanisms and Electronics at the National Physical Laboratory: Dr. A. M. Uttley

THE appointment is announced of Dr. A. M. Uttley as superintendent of the Control Mechanisms and Electronics Division of the National Physical Laboratory, Teddington, in succession to Mr. R. H. Tizard, who has taken up a post at the London School of Economics. The Control Mechanisms and Electronics Division was formed in 1954 to study the automatic control of experimental, industrial and administrative operations and the development of techniques and equipment for data processing and computation. Dr. Uttley graduated at King's College, London, in mathematics and psychology. After some teaching experience he joined, in 1940, the Telecommunications Research Establishment (now known as the Radar Research Establishment), Malvern, Ministry of Supply, where he remained until his present appointment. During the War he was responsible for the design of many of the synthetic trainers used to great effect in the training of operational crews. While thus engaged, Dr. Uttley developed a keen interest in electronic and in electro-mechanical control systems, developing the split-field type of motor for use in such applications. One of the developments was the now well-known servo-motor known as the 'Velodyne'. Dr. Uttley's immediate interest after the War was in the automatic guiding of astronomical telescopes, and he acted as adviser on electronics for the Sir Isaac Newton telescope. Later, he turned his attention to problems of digital computation and was largely responsible for the functional design of TREAC, an electronic digital computer in use in the Physics Department at the Radar Research

Establishment. More recently he has been investigating problems of control involving a human operator, and of visual pattern recognition. He has examined also problems of muscle control and has studied principles and design of systems which 'learn from experience', with a view to their application to process control. It is anticipated that Dr. Uttley will take up his appointment early in the new year.

Commonwealth Mycological Institute :
Dr. S. P. Wiltshire

DR. S. P. WILTSHIRE, who has recently retired from his post as director of the Commonwealth Mycological Institute, entered as mycologist and assistant to the director (Sir Edwin Butler) in 1922. In 1933 he was appointed assistant director and editor, and director and editor in 1940. His quiet and self-effacing manner tends to hide a tenacity of purpose which has been invaluable to the Institute and of great worth to mycology in general. Thus he contrived the regular appearance of the *Review of Applied Mycology*, the initiation of a series of mycological papers and monographs, a series of distribution maps of plant diseases and a *Review of Medical and Veterinary Mycology* during what has been probably the most difficult period for publication ever known. In addition, he planned and supervised the general organization of the excellent new building which was opened last year.

Dr. J. C. F. Hopkins

DR. J. C. F. HOPKINS, who succeeds Dr. Wiltshire, is known mainly for his work on the diseases of tropical plants, first in Uganda, and then as chief botanist and plant pathologist to Southern Rhodesia. He recently published a book on "Tobacco Diseases". On his retirement from overseas in 1953 he was appointed assistant editor at the Institute. As so much of the work there is concerned with the diseases of crop plants of tropical regions, Dr. Hopkins's previous practical experience will stand him, and the Institute, in good stead.

E. F. F. Chladni (1756–1827)

A GREAT pioneer in the science of acoustics, Ernst Florens Friedrich Chladni was born of Bohemian parents at Wittenberg two hundred years ago on November 30, 1756. He graduated Dr. Jur. at Leipzig in 1782; but on the death of his father abandoned law for natural science, being particularly interested in sound and in music and being inspired by the work of Leonhard Euler and of Daniel Bernoulli. He studied the torsional vibrations of a pendulum and the longitudinal vibrations of strings and rods, and applied the latter to the determination of the velocity of sound in solids. He also measured the velocity of sound in media other than air by filling an organ pipe with the medium and taking the pitch of the note produced. Using brass plates clamped at the centre and excited by bowing at one end, and sprinkling sand on the vibrating plates, he obtained 'Chladni's figures', which he exhibited to the French Institute in 1809. Napoleon was so impressed by this demonstration that he gave Chladni 6,000 francs to enable him to have his book, "Die Akustik" (Leipzig, 1802), translated into French. Chladni never held an official position, and he earned his living by travelling in Germany, France, Italy, Holland, Denmark and Russia, where he delivered scientific lectures and gave recitals on an instrument which he had designed and constructed and which he called a euphonium. He wrote numerous papers and treatises, including several on meteorites. He died at Breslau on April 3, 1827, leaving his money to the poor of his native town and his meteorites to the royal collection at Berlin.

New Research Laboratories of Thorium, Ltd.

MR. G. H. BEEBY, chairman of Imperial Chemical Industries, Ltd. (Salt Division), and also of Thorium, Ltd., opened the expanded Research Laboratories of Thorium, Ltd., at Ilford on November 14. Thorium Ltd., specializes in the production of thorium and lanthanon chemicals and in the manufacture of polishing powders for glass and metal. Thorium metal is used mainly in special alloys for aircraft construction. Thorium oxide is used in some types of optical glass, as a refractory and in making incandescent mantles for pressure lanterns, etc. As thorium is a fertile element several times more abundant than natural uranium, it has a potential application in atomic energy production. The lanthanons are difficult to separate, so most of the commercially used materials are therefore mixtures freed from non-lanthanon impurities. The most widely used mixture contains about 50 per cent cerium and is called 'technical cerium'. This is used for making lighter flints, in the metallurgical field for improving the quality of many ferrous alloys and in making special alloys and for improving the luminosity of carbon arc lamps. It also has uses in the chemical and paint industries and is an importan component of the glasses used in welder's goggles Cerium oxide is an excellent polishing material fo glass and metal; materials containing 50–95 pe cent cerium are used to make the polishing powde sold as 'Cerirouge'. 'Didymium' oxide, a mixture o praseodymium and neodymium oxides, is used to produce colours in glass, and pure neodymium oxide is used to give a spectacular red-blue colour to certain decorative glassware. Lanthanum oxide i also used in glass-making to produce special optical glasses. Samarium is used in making phosphors fo fluorescent lamps. The research department o Thorium, Ltd., has a staff of about twenty, the research manager being Mr. R. J. Callow. Research is conducted mainly into methods of purifying and separating the materials produced by the firm, into methods for process control and into the properties of polishing powders. The new laboratories have a floor area of about 7,500 sq. ft., divided into fiv main laboratories of varying sizes, a pilot-plan room and ancillary space such as library, dark room etc. At the opening ceremony, a number of items of work were shown.

New Training School for Apprentices

A NEW craft training school for apprentices employed by British Oxygen Engineering, Ltd., was opened at Angel Road, Edmonton, on November 15 by Mr. Robert Carr, Parliamentary Secretary to the Ministry of Labour. Since 1951, when the Company new apprenticeship schemes were first put into operation, it was felt that there was a great need for training school to be completely separate from the production workshops. It would provide apprentices embarking on a five-year course with the firm with real knowledge and appreciation of basic engineerin craft skills, and would enable them to assimilate more quickly the training they received in the productio workshops and technical offices, so that they could carry out their jobs with maximum efficiency. Th school will also be used for advanced craft training and also for third-year apprentices to ensure that experience gained in the previous two years in the workshops is firmly established in the minds of the apprentices, that misconceptions can be rectified and new developments taught. The school, which provides for forty-five to fifty students, comprises a machine-shop, fitting sections and a lecture room, and the shops are laid out to enable a wide range of work in plant, industrial, medical and aircraft fields to be covered. It can also be used for intensive courses for the up-grading of fitters, machinists and inspectors, and also for the teaching of new techniques to staff in general. The Company works in close association with the West Ham College of Technology, South West Essex Technical College, Enfield Technical College, Harlow Technical College and the University of London in the provision of sandwich courses.

Electrical Energy

THE first issue of a new monthly electrical journal, *Electrical Energy*, appeared in September. This publication is, in some respects, a companion journal to *Electronic Engineering*, as it is published by the same organization and has common editorship (London: Morgan Brothers (Publishers), Ltd. 3*s*.). It is stated in the foreword to the first issue that it is designed for the professional engineer engaged in research, development, design and manufacture. The articles in the first number cover a fairly wide range of subjects; one deals with the solution of electric field problems using a digital computer, another with modern methods of excitation control for large synchronous machines, and a third describes the principles of operation of the magnetic amplifier. The standard of these articles is pitched at a level which should satisfy a reader possessing a good scientific background. There are, in addition, short articles and notes dealing with items of current interest concerning industrial developments and new electrical equipment, and, finally, a group of book reviews. The journal is well produced and attractive. It is, perhaps, rather remarkable that there should have existed, to-day, a gap in the coverage of the general field of electrical engineering which a new journal could be designed to fill. There was, however, a need for a periodical which would deal with electrical power in all its aspects and would provide especially for more detailed theoretical treatments of technological topics than are, nowadays, appropriate to the old-established weekly journals which serve the electrical industry so well. The declared policy of *Electrical Energy* and the quality of its early issues suggest that it will meet this need, and on that ground alone it should be heartily welcome.

Physics in Medicine and Biology

THE first issue of *Physics in Medicine and Biology*, a new quarterly journal in the same format as the *Philosophical Magazine*, is dated for July (edited by Prof. J. E. Roberts. London: Taylor and Francis, Ltd. £3 10*s*. a year). The journal, which is the official publication of the Hospital Physicists Association, is intended for papers on topics in the borderline fields between physics and the biological and medical ciences, which cannot easily be classified for existing periodicals. It will publish original papers and review articles on studies of the physical properties of living matter, and on the applications of physics and physical techniques to problems in medicine, biology and physiology. In addition, it will publish instrument notes, book reviews, letters to the Editor, and notes on work in progress. An important feature, which will take 20–25 per cent of the space in each issue, is the Abstracts Section under the editorship of W. A. Langmead. These abstracts are taken from a very wide range of journals; in the first issue 130 journals were abstracted. The subtitles of the Abstracts Section give a good indication of the scope of the whole journal: radiobiology, radiotherapy, radiodiagnosis, radioisotopes (biological and clinical aspects), radioisotopes (physical and clinical aspects), radiation dosimetry, physiology, general physics and instrumentation. The first issue contains a review of recent advances in electrophoretic separation methods, and papers on dosimeter calibrations, microspectrophotometry, a profile counter, and α-track autoradiography. The instrumental note is concerned with the specifications of nucleonic instruments which have clinical applications. Although with such a very wide field only a limited number of papers will be of interest to any one worker, it seems probable that, if the high standard of the first issue is maintained, the journal will be well received by many of the growing number of workers interested in that field.

Priestley in the United States

THE home of Joseph Priestley has been acquired and is being restored to its original appearance by the Borough of Northumberland, Pennsylvania, U.S.A. This house, started in 1795 and completed in 1797, and owned for many years by the Priestley family, was purchased in 1920 by the Pennsylvania State University and presented this year (1956) to Northumberland. The home is of Georgian architecture, is in fine condition, and occupies an acre of landscaped ground near the Susquehanna River. Under the direction of the Priestley Memorial Association, the widow's walk, kitchen and laboratory are being restored to their original appearance and the rooms refurnished with American furniture of about 1800. The Association desires to gather all obtainable information on Priestley and on his American home. It would like to receive reprints of articles bearing on his work, and it welcomes correspondence with anyone interested in this matter; visitors are welcome. Correspondents should write to Mr. Lewis K. Rich, 464 Front Street, Northumberland, Pennsylvania.

The Division of History of Chemistry of the American Chemical Society is co-operating with the Priestley Memorial Association in the restoration of Priestley's laboratory. To this end a committee including Sidney Edelstein, Claude K. Deischer and Wyndham Miles (chairman) has been constituted. The committee wishes to locate apparatus of Priestley's American period, with the view of acquiring them or having replicas made. It welcomes correspondence with anyone knowing the whereabouts of apparatus, and with scholars interested in this project; correspondence should be addressed to Dr. Wyndham Miles, Edgewood, Maryland.

Science and the Humanities

WHAT is pothenology? Sir Gavin de Beer tells us in his Rickman Godlee Lecture on "Science and the Humanities", delivered on October 25 at University College, London (London: H. K. Lewis and Co., Ltd. 2*s*. 6*d*. net). Much harm is done, in his opinion, by ignoring the essential differences between the collectors of Nature's answers and the compilers of men's thoughts. In a witty survey of the background of these differences, he emphasizes that "the only way to acquire a knowledge of scientific methods is in a laboratory, working with one's hands . . . while the only way to grasp the meaning of the humanities is to study men". He deplores the capture of precocious potential scholarship winners and their premature cramming "like geese". This has two harmful results. The first is the penalizing of the late developer. As he says: "The premium which we place on precociousness works directly against the processes which have made man what he is and may make him into *Homo sapientior*". The second is that general subjects are displaced from the boys' or girls' education, perhaps for ever. The effect of this, in his opinion, bears more heavily on science than on the humanities. Sir Gavin considers that one of the secrets of happiness in life is "the selection of the appropriate carrot to set before one's nose and that of other people". His particular carrot is "pothenology"; and to illustrate what it really means he treats his readers to three of his own pothenological researches: Hannibal's route over the Alps, the origins of the Etruscans and the real cause of Gibbon's death. But does he really believe that Newton and Darwin would not have "won scholarships on our existing system"? That is a most unpothenological statement to make.

Institute of Seaweed Research

SINCE the end of the War a new industry has been built up in Britain using more than forty thousand tons annually of a crop which, until recently, was looked upon as worthless. Whereas a few years ago there was only one very small alginate production unit in Scotland, there are now eight factories solely concerned with seaweed processing, which are served by an additional nine collecting and air-drying units. The current output of seaweed meal and alginates from these Scottish factories, together with the alginates and carragheenin produced in five further factories in England, has a sales value exceeding £1 million per annum. Britain's seaweed industry has now a larger output than that of any other country except Japan and the United States. This development has resulted from the combined efforts of scientists and industrialists, backed by the assistance freely given by government officials and by hundreds of interested individuals from all walks of life. A major contributory factor was the setting up in 1944 of the Scottish Seaweed Research Association "to determine whether the possibility existed of creating a stable Scottish seaweed industry which could compete with those of other countries and at the same time provide a considerable part-time crofter industry in the Highlands and Islands". The work of the Association during 1945–55, which was renamed the Institute of Seaweed Research in 1951, is described in a report which may be obtained from its Secretary at Inveresk, Midlothian, Scotland.

Tobacco and Smoking

IN a well-documented article in *Health Education* (14, No. 3; September 1956), Dr. Horace Joules shows that in 1955, 11,900,000 men aged sixteen and more were smoking an average of 15·3 cigarettes a day in Great Britain; the average consumption of 6,300,000 women smokers was 8·1 daily. Of these, 65 per cent of men and 40 per cent of women more than sixteen are regular smokers; 87·3 per cent of male doctors more than thirty-five years old have similar habits. The present yearly death-rate from cancer of the bronchus of 17,000 in England and Wales is shown to be associated mainly with smoking, especially cigarettes. This disease has caused 100,000 deaths in the past ten years, and reasons are given for suggesting that this is only the early stages of an epidemic which will result in half a million deaths in the next twenty to thirty years. Preventive action by the medical profession and the Ministry of Health it is thought, might be rapidly helpful. The mortality and morbidity from bronchitis are greater in Britain than in any other country where statistics are available. The part played by smoking in these conditions is important. The question is posed: Are there advantages from smoking which compensate for the known ill-effects on health? The answer according to Dr. Joules, must be an emphatic no.

Isotopes Commercially available in North America

"THE Isotope Index" published by the Scientific Equipment Corporation, Indianapolis 19, Indiana (U.S.A. and Canada, 2 dollars; elsewhere, 2.50 dollars), is the first up-to-date (April 1, 1956) complete guide to the isotopes and isotope-labelled compounds available commercially and produced or sold by American or Canadian suppliers. Some two thousand items are listed from more than forty different suppliers. In genoral, the information given has been taken from the suppliers' catalogues or price sheets Radioactive isotopes and labelled compounds of carbon-14, iodine-131, phosphorus-32 and sulphur-35 are dealt with in the first section, with the isotopes arranged in alphabetical order by name of element and then by atomic weight. The half-life, principal radiation, the forms in which the isotope is available and the cost are quoted, together with a reference to the supplier. In the next section stable isotopes and the labelled compounds of carbon-13, hydrogen-2 and nitrogen-15 are listed, followed by information on available radioactive calibration standards, radiographic and therapeutic sourcos, and a complete list with names and addresses, of the suppliers referred to in earlier sections. Finally, a brief section describes the recently revised licence requirements of the Atomic Energy Commission in the United States.

Endocrinology of Invertebrates

IN July 1955, immediately before the International Congress of Anatomy, an informal symposium on the endocrinology of invertebrates was held in Paris This highly successful meeting was organized by Dr. L. Arvy and Dr. M. Gabe, of the Sorbonne, and by Dr. B. Scharrer, of the Albert Einstein College of Medicine in New York, and was attended by some three dozen workers in this field. The communications have now been published (*Ann. Sci. Nat., Zool.* 18 (fasc. 2), 125–337); and they form a most useful cross-section of the recent developments in this subject. The Swedish workers Östlund and Fäng (Lund) describe the isolation in a highly purified state of a chromatophorotropic principle from the eyestalk of the shrimp *Pandalus*. The *Y* organ of Crustace discovered by Gabe has been shown by Echalier another French worker, to control the moulting o decapod crustaceans. Karlson (Tübingen) describe the extraction from the silkworm of the moultin hormone 'ecdyson'. This has now been obtained i crystalline form and proves to be a non-nitrogenou substance with a molecular weight of about 300 Another important contribution is that of Charniaux Cotton (Paris), who has obtained clear evidence that an androgenic gland, quite separate from the gonad controls the primary and secondary male characters of the amphipod *Orchestia gammarella*. Other papers deal with the cytology of neurosecretory cells in many groups of invertebrates, with moulting, metamorphosis, and changes of phase in insects, the possible role of hæmocytes in insect growth, and the part played by humoral factors in the discharge of gametes in certain molluscs.

Iboga

THE stimulant properties of the iboga plant have long been known to various Central African peoples (*S. Afr. J. Sci.*, 53, No. 1; August 1956). The pygmies chew iboga leaves and stalks before certain tribal ceremonies during which they must remain awake for several days when they are continually drumming on their tomtoms. Other tribes use the plant for initiation ceremonies when adolescent boys are left alone to roam the forest for five days, living solely on the iboga plant. Hunters of certain tribes also consume iboga before undertaking particularly long and dangerous treks through the forest. French chemists, who have been carrying out research on the plant over the past ten years, have now succeeded in extracting alkaloids from which they can manufacture a stimulant with very little toxic effect.

The Science Masters' Association : Annual Meeting

THE annual meeting of the Science Masters' Association is to be held during January 2–5 in the University of Cambridge, under the presidency of Sir Alexander Todd, professor of chemistry in the University, who will speak on "The Scientist—Supply and Demand". There will be discussions on "Technical Education and the Schools", introduced by Dr. K. B. Hutton, of Hatfield School, on January 4; and on "The Recruitment and Training of Science Teachers", with particular reference to secondary modern schools, introduced by Mr. W. H. Palmer, of Homerton College, Cambridge, and Mr. C. L. Brereton, warden of Bottisham Village Centre. Lectures to be given include "Science in the Universities and Schools" (Prof. N. F. Mott); "Diseases and Problems of Population" (Prof. A. L. Banks); "Some Recent Advances in the Chemistry of Fluorine" (Prof. H. J. Emeléus); "Botanical Monkeys" (Mr. E. J. H. Corner); "The Silicones" (Dr. P. Sykes); "Radio Astronomy" (Mr. L. Ryle); "Antarctica To-day" (Dr. G. C. L. Bertram); and "The Expanding Universe" (Dr. R. A. Lyttleton). Prof. J. F. Baker and the staff of the Cambridge Faculty of Engineering will be responsible for an evening lecture. There will be the usual exhibitions by members and by instrument manufacturers and publishers, and receptions at the Guildhall and in King's College. The Science and Religion Group of the Association will meet on January 5. The programme of the meeting can be obtained from the Annual Meeting Secretary of the Association, 93 Westbourne Road, West Hartlepool, Co. Durham.

University of Sheffield

THE following appointments have been made in the University of Sheffield: Dr. R. S. Tebble, senior lecturer in physics; Dr. J. F. Wallace, lecturer in mechanical engineering; Dr. R. G. Ward, lecturer in metallurgy. Dr. W. J. P. Neish has been appointed to the James Morrison Research Fellowship, and M. F. Sheff to the John Stokes Research Fellowship. The following members of staff have resigned: Dr. R. C. Cass, lecturer in chemistry; A. R. Curtis, lecturer in applied mathematics and Dr. D. W. Wakeman, lecturer in metallurgy.

The Night Sky in December

NEW moon occurs on Dec. 2d. 08h. 12m., U.T., and full moon on Dec. 17d. 19h. 06m. The following conjunctions with the Moon take place: Dec. 11d. 20h., Mars 5° S.; Dec. 24d. 12h., Jupiter 6° N.; Dec. 29d. 13h., Saturn 0·7° N.; Dec. 29d. 19h., Venus 0·2° S. In addition to these conjunctions with the Moon, Saturn is in conjunction with Antares on Dec. 21d. 17h., Saturn being 6·3° N., Venus with Antares on Dec. 26d. 10h., Venus 5·8° N., and Venus with Saturn on Dec. 26d. 21h., Venus 0·5° S. There will be a partial eclipse of the Sun on Dec. 2, but at Greenwich only a small part of the Sun will be seen to be eclipsed at sunrise, the eclipse ending a few minutes after sunrise. Mercury is an evening star, but conditions for observation are not favourable. Venus is a morning star, rising at 4h. 45m., 5h. 25m. and 6h. 10m. on December 1, 15 and 31, respectively, but it will be rather low for good observation from the British Isles. Mars is visible during the evenings, setting at 1h. 00m., 0h. 50m. and 0h. 35m. on December 1, 15 and 31, respectively; its stellar magnitude decreases during the month from −0·4 to +0·3 and its distance increases from 73 to 97 million miles. Mars is moving eastwards in Pisces, being south of δ Piscium at the end of the month. Jupiter rises at 1h. 10m., 0h. 20m. and 23h. 25m. at the beginning, middle and end of the month, respectively, and is east of β Virginis; its stellar magnitude is −1·6, its distance in the middle of the month is about 510 million miles. Saturn is too close to the Sun for observation. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: Dec. 7d. 19h. 21·3m., ν Aqr. (*D*); Dec. 10d. 20h. 14·3m., ϰ Psc. (*D*); Dec. 20d. 21h. 29·0m., 60 Cnc. (*R*); Dec. 21d. 3h. 29·7m., ϰ Cnc. (*R*). *D* and *R* refer to disappearance and reappearance, respectively. The Geminid meteors are active during December 9–13, with a maximum near the latter date, but conditions are not favourable for observation. Winter solstice occurs on Dec. 21d. 21h.

Announcements

THE Ciba Foundation is offering not less than five awards, of an average value of £300 each, for papers on research relevant to basic problems of ageing. In making the awards, preference will be given to younger workers. The work submitted should not have been published before May 31, 1956, and the paper, which may be in the candidate's own language, should not be more than seven thousand words in length, with a summary in English not exceeding 3 per cent of the paper. Entries must be sent in not later than January 31, 1957, to the Ciba Foundation, 41 Portland Place, London, W.1, from which application forms and further information can be obtained.

IN *Nature* of November 10, p. 1033, an announcement was made of the presentation of the Robert Roesler de Villiers Award to Dr. J. F. Loutit. This award was in fact given for research described briefly in an article in *Nature* of March 10, 1956, entitled "Cytological Identification of Radiation-Chimæras", by Dr. C. E. Ford, J. L. Hamerton, D. W. H. Barnes and Dr. J. F. Loutit, and is being shared between these four authors.

BIOLOGY OF AGEING

A SYMPOSIUM on the biology of ageing was held by the Institute of Biology at University College, London, during September 27–28. Papers covered a wide and heterogeneous field, the first day being devoted to the biological and cytological, and the second to the psychological, industrial, nutritional and genetic aspects of age processes.

Sir Cyril Hinshelwood (University of Oxford) described the changes which characterize the decline of cells in non-proliferating bacterial cultures. Studies of the exchange of radioisotopes between non-dividing cells and the medium suggest that the reversal of synthetic enzyme activities which takes place under these conditions is accompanied by active synthesis elsewhere in the system ; but this re-utilization of the labelled materials is incomplete, and there is a steady leakage of activity into the medium. The near-random decline of such a cell population, which is a possible source of analogy with the behaviour of populations of post-mitotic tissue cells, may be due to the coincidence of a number of periodicities, the death of any one non-dividing cell occurring when several cyclical processes of resynthesis happen to reach a minimum simultaneously.

Dr. O. V. S. Heath (Imperial College, London) dealt with the mechanism of the growth check which accompanies the flowering of some higher plants, and with sequential changes in the composition and shape of leaves produced by meristems, as examples of two age changes in the life-cycle of plants. He described experiments suggesting that the change-over from growth to reproduction, which produces marked checking in most plants, and is fatal in annuals, is not wholly a nutritional effect.

Dr. A. Comfort (University College, London) described the importance of vertebrate vital statistics in the study of the phylogeny and comparative physiology of animal ageing. Actuarial senescence has been studied in laboratory populations of guppies (*Lebistes reticulatus*) under experimental conditions. Survival curves of a great many non-domestic vertebrates tend to approach an arithmetic straight line, the number of deaths being constant in unit time. Some advance has recently been made in compiling life-tables for zoo animals ; but among laboratory mammals they are available only for rats and mice, and search is being made for analysable records to indicate age-mortality relations in birds, marsupials and poikilotherms. Important new information of this kind is being obtained by Prof. F. Bourlière (Faculty of Medicine, Paris), whose paper was presented in his absence, and by his collaborators working on the growth and fertility of vertebrates in the wild, both by means of ringing studies and through the use of techniques of ageing reptiles by inspection—the French workers are particularly concerned with the effects upon the life-span of metabolic factors such as those due to hibernation and climate, and are attempting to compare the longevities of populations in warm and cold latitudes.

Dr. G. H. Bourne (London Hospital) described striking differences in enzyme distribution, revealed by histochemical methods, between tissue cells of young and old rats, with a gross increase in the alkaline phosphatase, particularly of the Purkinje cells, but also in liver, kidney and elsewhere. These changes are not confined to cells the life of which is equal to that of the animal but occurs also in the 'young' cells of old animals. Dr. G. I. M. Swyer (University College Hospital) gave an account of the progress recently made by a number of workers in describing the changes in output of individual steroid hormones with the advance of age in man. Of the α-ketosteroids, the 11-deoxy fraction decreases most regularly with age in both sexes, the 11-oxy-17-keto fraction less, and the 11-oxyetiocholanones least. Although human ageing is quite certainly not a simple consequence of steroid deficiency, the separation of these differently reacting components has already opened the possibility of more effective replacement therapy in the treatment of some consequences of senility.

Dr. H. M. Sinclair (University of Oxford) discussed two nutritional factors in the timing of human senescence—the effects of rapid growth in childhood and of overfeeding in the adult upon length of life, and the possibility that the arterial diseases of human old age are direct or indirect consequences of a deficiency of unsaturated fatty acids due to changes in dietary habits over the past century. He described experiments suggesting that not only the total intake but also the isomeric structure of unsaturated fatty acids in the diet are important determinants of atherosclerosis, and that the requirement of these substances is much higher in men than in women.

Dr. J. Maynard Smith (University College, London) gave an account of genetical research on the relation of longevity to vigour. Although there is a correlation between parental and child longevity, this is much smaller than the sib-sib correlation, and only one-quarter that for stature between parent and child. In laboratory stocks, heterozygosity appears to be the most important single correlate of long life, which is part of the general complex of vigour found in hybrids.

Other papers dealt with the demographic aspects of ageing (Dr. B. Benjamin, Office of the Registrar-General), the functional changes with age in man and their effects on employability (Prof. W. Hobson, University of Leeds), the use of the working life in man and animals as a measure of ageing (F. le Gros Clark) and the psychological changes occurring with age in man (Dr. A. Heron, Medical Research Council Occupational Research Unit, University of Liverpool). The papers and subsequent discussion are to be published later.

FEEDING LABORATORY ANIMALS

THE nutrition of laboratory animals was the subject of a symposium, organized jointly by the Nutrition Society and the Laboratory Animals Bureau, and held at Guy's Hospital Medical School, London, on October 6. It was the 105th meeting of the Nutrition Society and the fifth in the series of Laboratory Animals Bureau symposia. Dr. S. K. Kon (National Institute for Research in Dairying) was in the chair, and nine papers were presented.

In the opening paper, Dr. W. Lane-Petter (director, Laboratory Animals Bureau, Medical Research Council Laboratories, Holly Hill, London) spoke of modern ways of feeding laboratory animals. He traced the development of the currently popular compressed compound diets, and directed attention to their undoubted advantages on the score of convenience for the laboratory worker, as well as their probable drawbacks and the inherent weaknesses of this system of alimentation. The incorporation of all the necessary ingredients for complete nutrition, intimately mixed, in a cube or pellet that will not deteriorate after compounding, is a formidable task—even an impossible one. The suggestion that future diets should contain at least a proportion of unprocessed food—whole cereal grains, for example—points to one possible development in a field still wide open for further investigation.

Mr. J. Cassidy (H. C. Styles (Bewdley), Ltd.) showed what can be expected of the conscientious manufacturer in the quality control of ingredients. In Great Britain, diets are made to published formulæ, and the manufacturer assumes, if sometimes with scepticism, that these formulæ are satisfactory. His job is to compound them and present them in a suitable form; but it does not include devising them or testing their adequacy experimentally. If the total market for such diets were larger and not, as at present, dissipated among several manufacturers, there would be more of the commercial incentive to produce really good diets that make the manufacture of farm animal feeds so competitive.

Some of the difficulties of assessing laboratory animal diets were described by Miss G. G. Weeks (Laboratory Animals Bureau). Growth is of little value as a measure of the adequacy of a diet, because growth can mean so many things. Life-time performance, she suggests, in terms of weight-gain, body composition, reproductive performance and longevity, is the only satisfactory criterion, but in this she begged a vital question. The choice of diet is influenced by the use to which the animals are to be put; some nutritional studies require an animal to have low reserves of, say, vitamin D; reproductive performance is of paramount importance for the breeder; a slow increase of weight over a critical period of growth may be of chief interest to the bioassayist; and longevity may, or may not, be irrelevant.

Dr. W. F. J. Cuthbertson (Glaxo Laboratories, Ltd.) showed that some commonly used diets for rats and mice contain only marginal amounts of certain essential nutrients; indeed, the margin may be altogether too narrow for safety. Semi-synthetic diets might have a wider usefulness than 'natural' feeds if standardization of the diet at optimum levels were the objective, and the cost of such diets might be more than offset by the gain in uniformity and reliability of the product.

In discussing the problems encountered in studying the nutrition of cats, Mrs. P. P. Scott produced some valuable data from her own experimental breeding and raising of cats at the Royal Free Hospital School of Medicine. She finds that satisfactory growth of kittens depends largely on an intake of protein at a very high level. It was clear that much of this evidence came from experiments on animals too small in number to be impressive, but the results of studies so far carried out show that breeding and raising cats under laboratory conditions hold great promise.

Adequate diet is a necessary condition of healthy animals, and Dr. J. S. Paterson (superintendent, Allington Farm (Ministry of Supply), Porton) illustrated this with particular reference to guinea pigs. Apart from the assimilable components of a diet, there may be—and in the case of guinea pigs, there is—a need for fibre or roughage. Deficiency of roughage, which is usually supplied in the form of hay, is often associated with dental abnormalities leading eventually to the mechanical starvation of the animal. However, Dr. Paterson has succeeded in raising a line of guinea pigs, appearing in his colony perhaps by a chance mutation, where fibre requirements are such that hay can be omitted from the diet without ill effects.

In an interesting paper on monkey welfare, Miss F. M. Hume recounted her experiences over very many years at the Lister Institute with the nurture of different species of primates. Cage paralysis, a condition that has disappeared from laboratory animal houses, was formerly due to rickets, and the treatment was sunlight through 'Vita-glass', ultra-violet irradiation, or vitamin D by mouth. Miss Hume's obvious regard for the welfare of caged primates sounded a humane—dare one say cautionary?—note in a meeting in which there was a wide range of attack on a difficult problem.

Dr. G. H. Bourne (London Hospital Medical College) reviewed current knowledge of canine nutrition and also touched on the dietary requirements of other carnivores. He referred to the lipæmia and lipuria of tigers consuming large quantities of fat; the latter condition, by coating the floors of their cages with fat, can be an embarrassment and a danger to the keeper.

Finally, Mr. D. B. Bellis (Food Research Department, Unilever, Ltd.) spoke about the nutrition of the baby pig, which has some promise of usefulness as a laboratory animal, and particularly of the problems raised by premature weaning. Substitutes for sow's milk can produce results comparing satisfactorily with those of suckling.

It would be exceptional for a meeting of this kind to provide all the answers to such a difficult problem as feeding small animals under laboratory conditions, and this symposium was no exception to the rule; but the subject did gain something in clarity of definition. The difference in outlook between the chemists on one hand, and the biologists on the other, was striking. The chemist is satisfied, it seems, to offer the animal whatever most conveniently (for himself) contains nutrients that will make the animal grow, reproduce or live as long as it is required to live, and the animal either eats or starves. A very short time will suffice to persuade it to eat, even without relish, whatever edible material is offered. But the biologist might be forgiven for thinking that the presence or absence of relish is relevant, and that an animal eating food it likes may differ from one eating because it has to. The study of acceptability of food items among animals is notoriously full of pitfalls, especially in animals kept under conditions far removed from the natural; but to ignore it may be to ignore one possible method of investigating what a particular animal really needs to eat to support perfect health. Subject to rigid safeguards—all the more necessary when dealing with creatures of the laboratory and with sophisticated or processed foods—the study of food preferences is not entirely irrelevant.

The diagnosis of perfect health introduces further difficulties. Sub-optimal nutritional states do not necessarily kill or sterilize, and if they do not they may be overlooked. For example, very many colonies of albino rats show porphyrin staining of the fur, particularly on the back of the neck—sometimes called 'red collar disease'—but this is seldom regarded as abnormal for it appears not to interfere either with growth or with reproduction. Yet it must be asked whether such a condition is normal; the fact that it is so widespread does not make it so, for it is not universal. Only the sight of a colony where it is never seen is likely to cause anxiety in one where it is prevalent.

Standardization of diets is obviously desirable; but to give a diet a name and a formula does not automatically achieve this end. It is here that the manufacturers and the consumers can profit each other by much closer collaboration than at present exists. If animals are to subsist on composite complete manufactured diets—and at least one speaker questioned the advisability or possibility of this—then the devising and the compounding of these feeds are interrelated. Nor will chemical standardization secure any useful purpose if the feed, as offered to the animal, is sub-optimal in composition. In this respect strain differences in dietary requirements should be noted and allowed for. The first task is still to provide a diet that gives the animal all that it needs, and if possible a little to spare; when this is achieved, standardization begins to have some meaning.

Finally, there is the humane aspect. We cannot do without our laboratory animals, and many would not wish to be deprived of this source of interest. For both scientific and humane reasons, they must be treated as well as possible, so that their lives, which serve us so well, shall not be a burden to them. Good feeding will help to this end.

The papers presented at this symposium will be published (*a*) in the *Proceedings of the Nutrition Society* and (*b*) in Laboratory Animals Bureau Collected Papers, Vol. 5 (obtainable from the Bureau at the Medical Research Council Laboratories, Holly Hill, London, N.W.3).

SEMICONDUCTORS AND PHOSPHORS

INTERNATIONAL COLLOQUIUM

AN international colloquium on semiconductors and phosphors was held at Garmisch, southern Germany, during August 28–September 1. It had the support of the International Union of Pure and Applied Physics, and was opened by Prof. W. Gerlach. Its scope may be judged from the following figures: ninety papers were read, there were about 450 scientific participants, and nineteen countries were represented, including the U.S.S.R., Eastern Germany, Czechoslovakia, Poland and Hungary.

W. Schottky, in his introductory lecture, distinguished (*a*) papers the main emphasis of which was on states and events which concerned the electrons, and (*b*) papers which dealt with experiments and considerations devoted in the main to the manipulation of substances.

Electronic Properties

The magnetic susceptibility contribution (χ_L) which arises from the current carriers in a semiconductor may be recognized by its dependence on temperature. Prof. G. Busch (Zurich), using a reduced representation in which this quantity is divided by a constant independent of temperature and characteristic of a given specimen, showed that germanium, InSb and $InP_{0 \cdot 2}As_{0 \cdot 8}$ appear to have abnormally low values of $|\chi_L|$ at low temperatures. The origin of this effect remains to be investigated. Since relatively little is as yet known of the effect of impurities on the magnetic susceptibilities of semiconductors, the experiments of D. Geist and T. Hehnen (Cologne) on iron-doped germanium were also of interest. Cyclotron resonance experiments on InSb at room temperatures were reported by H. A. Gebbie (U.S. Naval Research Laboratory), and were found to yield an effective electron mass $m^* = 0 \cdot 015m$, as compared with the value $0 \cdot 025m$ obtained from transport phenomena. Although different averages over the energy surfaces are involved, this difference is not clearly understood. Paramagnetic resonance experiments on silicon carbide crystals were reported from the Philips Laboratory by J. S. van Wieringen, who contrasted the effect of doping with nitrogen, when three resonance peaks are observed, with the effect of doping with boron or aluminium, when only one peak is found. Interesting speculations concerning the nature of the nitrogen impurities in the lattice (namely, that the trapped electron can be in an *s*-state and near a nitrogen nucleus) are possible. In another lecture the appropriate equilibrium probabilities for the trapping of electrons by singly- or multiply-charged defects which have several trapping levels were also discussed.

Transport phenomena. Among the non-equilibrium properties, considerable interest was shown in transport phenomena. Here C. Herring (Bell Laboratories) and J. E. Parrott (A. E. I., Aldermaston) discussed consequences of the fact that phonons of long wavelength are less likely to suffer collisions leading to change of direction than phonons of short wave-length, so that they can contribute strongly to thermal conduction. By exerting a drag on the charge carriers, they are also responsible for an additional term in the thermoelectric power. Good single crystals, low concentrations of impurity and low temperatures are required to show up the effects of these phonons. Considerable interest was also shown in the magneto-resistance ratios. Thus, a negative ratio was found for gallium arsenide below 40° K. (R. Broom, R. Barrie and I. M. Ross, Services Electronics Laboratory), and delicate micromanipulation to measure the effect in graphite was also reported (R. G. Breckenridge, National Carbon Co., U.S.A.). From the R.C.A. Laboratory (M. Glicksman) interesting results on germanium–silicon alloys were described which suggest that pure germanium galvanomagnetic properties occur up to a composition of 10 per cent silicon, and pure silicon galvanomagnetic properties occur above 25 per cent silicon. A paper (H. Weiss, Siemens Schuckert, Erlangen) and discussion on the thermal conductivity of InSb showed that further experimental clarification is required in this difficult field before all experiments can be reconciled with each other. Further work on the photoelectro-magnetic effect was reported by British workers (T. S. Moss, Royal Aircraft Establishment; G. G. Macfarlane and V. Roberts, Radio Research Establishment).

Barrier-layer physics. Some attention was given during the conference to those aspects of transport phenomena which may be grouped under the heading of barrier-layer physics. In a general report, E. Spenke (Siemens Schuckert, Pretzfeld) directed attention to large-area silicon rectifiers, designed by Siemens and ready for production, which pass about 250 amp. at 1 V. forward and 1 amp. at 1,000 V. reverse voltage. The advantages over germanium rectifiers may be traced back to some extent to the larger energy-gap in silicon. The manufacture of very pure silicon by the floating zone method is an essential factor in the production of these rectifiers, and the most suitable reactions for this purpose were reported to be :

$$SiCl_4 + 2H_2 = 4HCl + Si$$

or

$$SiHCl_3 + H_2 = Si + 3HCl$$

Two papers from the University of Reading reported new work on germanium contacts (J. D. Nixon and P. C. Banbury ; D. Hanemann and A. J. Mortlock).

Surfaces. Closely connected with barrier layers are investigations of surfaces. Here, J. Bardeen (Illinois) showed clearly that reasonably reliable methods for determining the distribution of surface states are now available, and that future work must try to determine the chemical nature of the fast and the slow states known to occur on etched surfaces of germanium and silicon.

Life-times of excess carriers. About eight papers dealt with another aspect of typically non-equilibrium properties, namely, the life-times of excess carriers in a semiconductor. A paper by W. Scanlon (U.S. Naval Ordnance Laboratory) seemed to show conclusively that the moving line of light method for the determination of life-times is unsuitable for natural single crystals of lead sulphide, unless they are cleaved in an inert atmosphere. A life-time (τ) of 1 μsec. as obtained by this method (and judged to be the true volume life-time by comparison photoelectric-magnetic measurements) may be raised to many times this value by the admission of other gases. By using an etching solution containing thiourea to reveal densities of etch pits (N), a relation $\tau = \text{constant}/N$ was established, and the conclusion that life-time is independent of conductivity was also inferred. This important contribution will undoubtedly stimulate re-examination of previous work in this field.

Carrier trapping due to dislocations was discussed by H. Kawamura (Osaka, Japan). He inferred 2–3 A. as the effective width of a dislocation in germanium so far as trapping is concerned. The dependence of life-times in silicon on temperature were shown to be in contradiction with simple trapping models by M. Zerbst and W. Heywang (Siemens Halske, Karlsruhe).

Optical properties. If it is borne in mind that excess carriers may end their lives by radiative transitions, the connexion between life-times and optical properties becomes clear. J. R. Haynes and K. G. McKay (Bell Laboratories) spoke about this topic with special reference to the production of radiation in silicon due to processes involving thermal and high kinetic-energy current carriers respectively. Haynes showed that the energy spectrum of recombination radiation at liquid-nitrogen temperatures has a peak at 1·1 eV. (due to interband transitions), and that other peaks exist, the separation of which from this main intrinsic peak yields known impurity activation energies. This was found to be the case for indium, gallium and boron impurities, while doping with boron and arsenic jointly also produced unexplained peaks. The spectral distribution due to recombination processes which involve 'hot' electron and hole gases (that is, gases which are out of equilibrium with the lattice) was shown by McKay to be due to band–band transitions as well as optical transitions in one and the same band. By applying reverse bias to a p–n junction formed on a p-type silicon crystal with a layer (2μ thick) of n-type silicon, it was possible to observe spots of red light near breakdown. The current–voltage characteristic near breakdown had a series of discontinuities and it seemed that at each discontinuity a new spot made its appearance. From a correlation of electrical and optical data the diameter of a breakdown region could be estimated at about 500 A. In germanium the current discontinuities, but not the light spots, have been observed to date.

Phosphors. Discussion of light emission by monatomic semiconductors leads on to the general problems of luminescence and phosphors, which are of technical importance for television screens, advertisements and, possibly in the future, for domestic illumination. W. Hoogenstraaton (Philips, Eindhoven) reviewed the non-electronic energy transport in phosphors. The possible importance of excitons was discussed rather speculatively here, and at various points throughout the meetings. Absorption spectra characteristic of excitons have been reported by H. Masakazu (Japan), E. Gross (U.S.S.R.) and S. Nikitine (France). Though some reserve must be maintained with regard to the interpretation of these spectra, there was lively interest in the properties of excitons. Thus, arguing from photoconductive experiments, the conjecture was even made that the life-time of excitons may possibly be as long as 10^{-3} sec. and their diffusion length as long as 3 mm. in single crystals of cadmium sulphide at room temperature (M. Balanski and I. Brosor, Berlin). A theoretical paper concerning their stationary and non-stationary properties was given by H. Haken (Erlangen).

Manipulation of Substances

In the large group of papers dealing with the manipulation of substances, E. Billig (A.E.I., Aldermaston) gave a review of growth and defects of semiconductor crystals (supported by a short film on crystal growth). A number of problems raised here and in discussion (and also in connexion with a paper by I. P. Penning (Philips, Eindhoven)) concerned the possibility of the motion of a dislocation during etching, the deposition of copper at dislocations, the possible production of dislocations by thermal stress near the crystal – melt interface, etc. In a review of the related problem of the incorporation of foreign atoms in the lattice, a new notation for defects in crystals was suggested (F. A. Kröger and H. J. Vink, Philips, Eindhoven). The diffusion of defects was also considered ; the effect of the surface was discussed by F. M. Smits, R. C. Miller and R. L. Batdorf (Bell Laboratories), the diffusion of activators in zinc sulphide by H. Ortmann (Berlin), and the diffusion of hydrogen in zinc oxide by J. J. Lander (Bell Laboratories).

Bombardment of semiconductors. A group of papers on manipulative techniques included some on the bombardment of semiconductors. H. Y. Fan (Purdue, U.S.A.) discussed recent work in this field, and compared the effects (which are not identical) of electron and α-particle irradiation of germanium, in addition to reporting results on the effects of irradiation on silicon, InSb and InAs. R. Gremmelmaier and H. Welker (Siemens Schuckert, Erlangen) described the use of InP as a detector of neutrons, by taking advantage of an (n,γ)-process due to the reaction of slow neutrons with indium, and subsequent conversion of the indium isotope with the emission of β-radiation. The γ- and β-rays produce electron-hole pairs, so that at an InP p–n junction an e.m.f. is developed the decay of which after irradiation enables one to infer the neutron flux.

Papers on specific groups of materials included a discussion of the mechanism of luminescence in silver halides (Z. Matyaš, Prague). New ternary compounds with semiconductor properties were discussed briefly in two papers, and D. A. Wright (General Electric Co., Wembley) reported on the properties of bismuth telluride, which is suitable for studying the problems of thermoelectric refrigeration. Organic systems were also discussed. H. P. Kallmann (New York) put forward considerations which suggest that the energy transfer in liquid organic systems is by collision rather than by irradiation. He also reported experiments on photoconductive effects in organic crystals in which the motion of holes appears to dominate.

Papers submitted to the colloquium, but not read, included one on the electrical properties of some binary compounds by D. N. Nasledov (Leningrad) and another on the breakdown of p–n barriers by B. M. Wul (Lebedew Institute, Moscow), and participants of the colloquium were glad to be able to discuss with the authors recent Russian work in these and related fields.

It is a tribute to the work of the organizers that the texts of most of the invited papers and the abstracts of most short papers were in the hands of the participants before the meeting. Nevertheless, there was comparatively little discussion in the open meetings; though, if time had been allocated explicitly to discussion, there would have been numerous contributions from the floor, judging from the many fruitful private conversations which were proceeding between meetings.

It is regretted that several interesting papers cannot be mentioned here, but enough has probably been said to indicate that a very wide field was covered. While it is true that no new band structure calculations were reported, and impurity band conduction was touched on only incidentally, it is in fact difficult to think of any other basic topic which was not raised in one or other of the papers submitted. The proceedings will be published early in 1957 as volume 4 of "Halbleiterprobleme" (Friedr. Vieweg u. Sohn), with each contribution in its original language.

P. T. LANDSBERG

EXTRUSION AND ROLLING PROCESSES

THE September conference of the British Society of Rheology held in Sheffield during September 27–28 had as its title "Extrusion and Rolling Processes". The varied interests of members of the Society were fully illustrated by the wide scope of the papers presented. Each had in common some particular aspect of rheological behaviour. The conference, consisting of the presentation of six papers and the attendant discussions, was opened by the president, Prof. J. G. Oldroyd (University College of Swansea).

"Some Applications of Rheology in the Investigation and Practice of Polymer Extrusion" was the title of a paper by W. F. O. Pollett (Henley's Research Laboratories). The simple screw extruder is extensively used in the electric cable industry for the application of dielectric and protective coverings, composed essentially of high polymers. Standard quantitative treatments of the theory of screw operation in conjunction with viscous materials have been based, erroneously, on the assumption that the thermoplastics and rubbers used in the cable industry exhibit Newtonian behaviour. The Ostwald de Waele relationship provides a somewhat closer approximation to practice within certain limits of screw design.

The use of different coloured materials is a standard method for mapping flow-paths in an extruder and can be supplemented by two complementary techniques. Strains can be 'frozen in' many high polymers by a reduction in temperature, and elastic recovery will afterwards occur if the temperature is again raised. The recoverable strains produced in plasticized polyvinyl chloride during its passage through the extruder can be stabilized in this way and their distribution studied by the reheating of suitable samples. Further, the temperature at which recovery occurs depends upon that at which the polyvinyl chloride was deformed. These methods have greatly assisted the correct design of T-heads used for the application of extruded wire and cable coverings. It has been shown that when material emerges from the screw channel, it converges towards the axis of the barrel in consequence of the Weissenberg effect. Unless the boundaries are suitably shaped, this will result in stagnant zones leading to decomposition of the polymer or to premature curing in the case of vulcanizable compositions.

When the conditions at the die are such as to favour the formation of high recoverable strains, there is a tendency for the exudate to exhibit a characteristic type of surface roughness probably caused by the stretching of the surface layers as the velocity gradient existing in the die is dissipated in the vicinity of the die mouth. This effect can often be avoided by an increase in temperature; or, if this is impracticable, by maintaining by special die design a shear-rate of 10^4–10^5 sec.$^{-1}$ for a sufficiently long time.

The determination of extrusion variables and the principal features of press design can be treated theoretically as shown by P. Feltham (University of Leeds) in his paper "A Simple Theory of the Criteria of Press Design and Process Efficiency in the Industrial Extrusion of Metals". In the direct extrusion process, work done by the ram is expended on useful plastic work in reducing the dimensions of the metal from A_0 to A, where A_0 is the cross-sectional area of the billet and A that of the extruded bar. Work is wasted due to friction at the billet/container interface, as well as on plastic work which does not yield a final plastic deformation. Since flow during extrusion is essentially streamlined, useless work of this latter kind is very small and is neglected in the theory. The maximum extrusion pressure can be shown to be: $\sigma_{\text{max.}} = Y_a \, [\ln(A_0/A)] \exp (4 \mu L'/D)$, where Y_a is the tensile yield stress of the fully work-hardened material at the extrusion temperature, μ is the effective coefficient of friction at the billet/container interface, L' is a length slightly smaller than the billet length and D is billet diameter. The strain-rate in the 'virtual die' formed by 'dead metal' near the true die orifice is approximately equal to

$(3V/D)\ln(A_0/A)$, where V is ram velocity. Y_a depends on strain-rate and temperature and can be obtained from high-temperature rheological data for metals at high strain-rates. Extrusion forces calculated from the theory for aluminium, copper and lead using a wide range of extrusion temperatures, extrusion ratios, ram velocities and billet dimensions showed very good agreement with experimental results. The maximum extrusion force $F_{\text{max.}} = A_0\sigma_{\text{max}}$ has a minimum for a given value of A_0 and fixed value of billet volume V. From the condition $\mathrm{d}F_{\text{max.}}/\mathrm{d}D = 0$, an optimum value of billet diameter D can be determined. Such a determination could be particularly valuable when using a press near its maximum capacity. At very high temperatures with high extrusion ratios, the back shear stress at the billet surface due to friction may exceed the tensile shear stress of the metal. When this happens, a thin skin of metal adheres to the contained wall after extrusion, and the maximum extrusion stress then becomes $Y_a[\ln(A_0/A) + (2mL'/D)]$, where $m = Y_b/Y_a$ and Y_b is the tensile shear stress of the billet in the surface region.

In "The Use of Optical Methods in the Manufacture of Plastic Sheet", H. H. Allen (British Celanese, Ltd.) pointed out that optical methods can be usefully employed to obtain information about rheological conditions of both product and process in the continuous production of both cast and extruded plastic film or sheet. The instruments used should be simple and robust, and preferably utilize some projection technique. One instrument recently developed, using a technique based essentially on the schlieren method, can detect normal and abnormal flow lines, 'cold-flow' patterns and any impurities and inhomogeneities.

Anisotropy often exists in thin plastic sheets and is generally caused by stresses due to flow in the extruder die or casting box. Orientation of sheet is of importance because of its general deleterious effect on physical properties. An interesting correlation exists between optical anisotropy and such physical properties as breaking strength and heat shrinkage, and its measurement can be used, therefore, to determine these important properties. Further, since its presence reflects to some extent the rheological behaviour of the process, it can be used to detect changes in operating conditions with consequent greater uniformity of product. Continuous measurement of optical anisotropy can be carried out by comparing on a screen the light transmission of the sheet and each of two pairs of crossed 'Polaroids'. This instrument also determines the direction of orientation. Divergence between extrusion or casting direction and direction of optical anisotropy indicates flow disturbance.

The theoretical aspects of milling and calendering were discussed by E. B. Atkinson (B.X. Plastics, Ltd.) in his paper "Milling and Calendering of Plastics". In the mills and calenders used extensively in rubber and plastics technology, a 'bank' of plastic material is built up at the entrance side of the roll 'nip' and is squeezed through the roll gap as a continuous sheet. The flow regime in the plastic in the region between the rolls and the magnitude of the stresses arising are of considerable interest to the plastics technologist and the design engineer. The theoretical treatments of Ardichvili, Eley and Gaskell were based on assumptions of doubtful validity. Except in the case of a high degree of slip (that is, with heavily lubricated compositions) the flow regime can be regarded as equivalent to the extrusion of plastic material through a slot of varying height, and the pressure distribution, roll thrust, and shaft torque determined by the shear stresses set up at the roll surfaces. Gaskell's treatment is based on these assumptions, but in its original form is not readily applied to non-Newtonian materials. Atkinson and Nancarrow have carried out a similar treatment based on an empirical power-law relationship between shear stress and velocity gradient. In this the pressure distribution, total roll thrust and shaft torque may be obtained from expressions which contain the rheological parameters, roll dimensions and speeds, and from tables of numerically evaluated functions which depend upon the size of the 'bank' of plastic in the 'nip' and the exponent of the power law.

Theoretical treatments of the rolling and extrusion processes are affected by a rise of temperature during the process. A paper on "Temperatures developed during Extrusion", by M. T. Watkins (Mechanical Engineering Research Laboratory, Department of Scientific and Industrial Research), was therefore of great interest. Suitable sub-presses were developed for the direct and inverted extrusion of rod and Hooker tubes and the inverted extrusion of tubular containers. The sub-press was set up for the appropriate extrusion and mounted in a 150-ton up-stroking hydraulic press. The extrusion load and punch stroke were measured by variable capacity gauges of the parallel-plate and concentric-cylinder types respectively. Temperatures within the slug were measured at four positions simultaneously by thermocouples protected by high-tensile steel sheaths, it having been established that these sheaths had little if any influence on the flow pattern. Rods, Hooker tubes and tubular containers of chemical lead Grade A, aluminium 99·5 per cent, copper E.R.H.C. and 70/30 brass were extruded at room temperatures at punch speeds of 1 to 30 in./min. All slugs excepting those used for studies on the effect of slug dimensions were of 1 in. and 2 in. diameter and of heights 1 in. and 2 in. respectively. The major factors contributing to the temperature rise inside the slug during extrusion were the reduction in area and punch speed. The highest recorded temperatures for the extrusion of lead and aluminium rod at 99·4 per cent reduction were 180° C. and 280° C. respectively, the thermocouples being located $\frac{1}{8}$ in. inside the slug. In the extrusion of lead at this reduction, an increase in punch speed from 1 in. to 5·5 in./min. resulted in an increase in observed temperature from 90° to 170° C. With aluminium at 94 per cent reduction under similar conditions, the temperature increased from 65° to 160° C.

The difficulties inherent in the theoretical treatment of hot rolling were emphasized by A. W. McCrum (British Iron and Steel Research Association) in a paper entitled "Theoretical Aspects of Hot Rolling". Despite its great importance technologically, the hot rolling process has received little theoretical treatment. Within the temperature-range of hot working, the frictional stress between the rolls and the stock approaches the yield strength of the material in shear, and as a consequence of this and the geometry of the process, the deformation is complex and in general is three-dimensional with the occurrence of appreciable increase in width (spread). A rigid theoretical solution of even the simplest problem, a rectangular bar between parallel rolls, is at present unobtainable without making many simplifying assumptions. Most of the early theories have been largely empirical, and only the analyses of Ekelund, Orowan and Sims can be said to have a theoretical basis. None of these treatments yields formulæ which can be widely used in practice. Of the many formulæ proposed for the calculation of the spread of a rectangular bar between parallel rolls, that of Ekelund is of reasonable accuracy but too complex for practical utilization. A recent formula derived by Hill combines accuracy with simplicity; but a parameter representing the effect of either friction or the deformation behaviour of the material must be determined in advance. The practical requirements of a satisfactory theory of hot rolling are: (*a*) prediction of roll force and torque to the required degree of accuracy, and (*b*) spread must be predicted so that the final product is within the required tolerance limits. Furthermore, this should be possible for all simple shapes such as diamonds, squares, ovals, etc. The problem is further complicated by the modern use of continuous multi-stand rolling, where a knowledge of stock entrance and exit speeds for a given velocity of roll surface is essential.

D. HARDWICK

THE BRITISH ELECTRICAL AND ALLIED INDUSTRIES RESEARCH ASSOCIATION

ANNUAL REPORT FOR 1955

IT is sad to record that within a few days after the presentation of the annual report for 1955 of the British Electrical and Allied Industries Research Association* to the annual general meeting of that body on May 2, the Association lost by death its director, Dr. Stanley Whitehead. Dr. Whitehead had served the Association for just over thirty years and he had discharged with distinction the duties of director for the past twelve years.

Since the report was issued, the Association's new laboratories at Leatherhead have been completed and with only a few exceptions the researches which were carried on at Perivale have been transferred to the new quarters and are already established there.

In the introduction to the report it is mentioned, under the heading of "Finance", that a quinquennial period covered by agreement with the Department of Scientific and Industrial Research for the award of grant will shortly come to an end and it is known that, in relation to renewal of grant, the new conditions will make the ratio of grant to grant-earning income less than under the present generous terms. With this in view, and taking account of the improved facilities for research provided by the new laboratories, the "Council is giving serious thought to the ways and means of securing the additional income necessary for the effective and efficient pursuit of the Association's functions".

As in previous years, the report gives brief summaries of the year's work in each of the research sections, together with a list of reports which have been issued or prepared during that period. There are also included a list of members of the scientific and administrative staff, the composition of the various standing committees, a list of those engaged in the Association's extra-mural researches and finally a full list of the membership of the Association.

Among the more important of the research items reported may be mentioned the discovery of a new form of intrinsic breakdown arising from mechanical instability in the electrostatic field (see *Nature*, **176**, 1225; 1955). This discovery occurred in the course of a research into the properties of irradiated dielectrics, as a result of which it had been shown that irradiation enables polythene, for example, to retain discharge resistance to a much higher temperature. It is also reported that a long-term investigation has been started on the thermal endurance of insulating materials, in which is included the ageing and hydrolysis of 'Terylene'.

In discharge physics a theory of the arc core has been developed which is based on the variation of thermal conduction with temperature. Further new theoretical work has been done on the electron emission from a cathode of low boiling point and on the motion of the cathode spot.

An improvement in the efficiency of utilization of electric cables should result from the publication during the year of a new rating table for paper and varnished cambric cables. These tables, used in association with a group of reports, enable advantage to be taken of higher temperatures allowed for certain types of cable, of variable loading and of a knowledge of the thermal properties of soil. Corresponding work on installation cables has already been incorporated in the thirteenth edition of the Wiring Regulations issued by the Institution of Electrical Engineers. Under "Circuit-Breaking", it is noted that the survey of rates of rise of re-striking voltage, which has already been made for the British 275-kV., 132-kV., and 66-kV. networks, has been extended to the 33-kV. system. This investigation and others of a similar character have utilized the Association's network analyser, and it is noteworthy that a number of these problems have required for their solution the special facilities which have been incorporated in this equipment.

In addition to the continuation of work on air blast and oil circuit breakers, it is reported that significant progress has been made on the rupture of heavy currents under low pressures and that an experimental continuously evacuated switch has interrupted the full output of the Perivale test plant.

There is increasing interest, arising largely from the chemical and oil industries, in flame-proofness and intrinsic safety. A new sectional committee has been appointed to direct an expanded programme of work in this field, which is being financed by special contributions from makers, users and the government.

A revised Code of Practice on Earthing is now nearly complete, and a survey has been carried out on the ageing of electrical installations in relation to the incidence of fires.

Research on the properties of high-pressure, high-temperature steam continues, and work has been started on the extension of the Callendar (1939) Steam Tables, the first region under investigation being that up to 5,000 lb./in.^{2} and 1,400° F.

A report will soon be published summarizing the results of tests for 10,000 hr. on the creep- and corrosion-resistance of steels for high-temperature service in steam plants.

The heading "Unclassified Researches" covers a group of six subjects which are as follows: astrophysics, fixed resistors, rotating electrical machines, measurement of current and voltage on high-voltage systems, storage and generation of electrical energy and the welding arc.

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* British Electrical and Allied Industries Research Association. Thirty-fifth Annual Report (1st January, 1955, to 31st December, 1955). Pp. 141. (Leatherhead: British Electrical and Allied Industries Research Association, 1956.)

It is reported that work on the hydrogen–oxygen fuel cell has reached the stage at which a cell has been tested for more than 1,500 hr. and full-scale performance can now be predicted with confidence.

In relation to arc welding, it is stated that the surge injection system, a device developed by the Association which stabilizes the arc in the a.c. tungsten arc-welding process without generating radio interference and enables low-voltage plant to be used, is now in commercial production. There is also in this section a reference to the development of a novel method for the measurement of current at high voltage. This is a magneto-optical current transformer based on the Faraday effect.

Towards the close of the introduction, mention is made of a proposal to publish at intervals an *ERA Journal* which would aim at bringing out the actual and possible impact of the Association's researches on industry; the first issue of this journal appeared recently. JAMES GREIG

TECHNICAL INFORMATION SERVICES TO COMMERCE AND INDUSTRY

EARLY in 1955 the steering committee of the Regional Academic Board of the London and Home Counties Regional Advisory Council for Higher Technological Education asked its Librarianship Committee for advice on the feasibility of co-operation between county and municipal libraries in technical colleges, industrial firms and research associations in a given area to provide a scientific and technical information service which would be available to all local industrial and commercial concerns. Since that time the committee has examined schemes in operation, or planned, in the London and Home Counties region and in other parts of Britain.

Among these were the cities of Liverpool and Sheffield, a co-operative scheme between county boroughs in south-east Lancashire, as well as one operated by the Hertfordshire County Council. The committee notes that, from the evidence available, the needs of industrial firms vary from area to area and recommends that the schemes in being at the places visited should be brought to the notice of municipal and county libraries, and to local committees of the British Productivity Council in the region with a suggestion that consideration might be given to the development of similar schemes on individual lines to suit local needs.

The technical colleges themselves can do much to stimulate the use by industry of scientific and technical information services in the following ways: by developing the college library to form a valuable part of the teaching programme; by fuller use of the college library in the teaching programme than is the general practice at the present time; by training students in the use of the library's resources and other sources of information available to them in other libraries. If students are so trained during their years at college it is reasonable to expect that they will continue to turn to sources of information with which they are already familiar, in tackling the problems which face them later in industry and commerce. So, too, the link between the colleges and the industrial world will be progressively strengthened.

It is finally recommended that local education authorities in the region should consider what active steps may be taken to encourage the fuller use of libraries in teaching in technical and commercial colleges and that the teachers' organizations represented on the Regional Advisory Council should also be invited to give urgent consideration to this matter.

MANAGEMENT BY SUPERVISION

IN the world of industrial management it is becoming increasingly fashionable for lectures and articles to consist of exhortations or harangues by senior executives based on long experience in their particular firms. This, though useful, has its limitations, and it is refreshing to read a management journal where observations based upon original investigation are included. In the current issue of *Personnel Management* (38; September 1956), the organ of the Institute of Personnel Management, two articles describe researches which have been carried out by workers with experience in the field of social science. One of these, Nancy Wansborough, of the Acton Society Trust, has examined the effectiveness of internal advertising of vacancies as a means of making a demonstrably fairer system of promotion in industrial organizations. Her general conclusion is that the advantages of internal advertising outweigh the disadvantages, particularly in a firm where relations are already good. But in a firm where morale is low, employees may wonder whether advertisements are genuine or whether they are being used as a smoke-screen. In such circumstances, the introduction of advertising may make the last state worse than the first.

The second article has been contributed by Rensis Likert, director of the Institute of Social Research at the University of Michigan. Since 1947 the Institute has been conducting a series of related studies seeking to find what kinds of organizational structure and what principles and methods of leadership and management result in the highest productivity, least absence, lowest turnover, and the greatest job satisfaction. Studies have been conducted, or are under way, in a wide variety of organizations. These include one or more companies in such industries as the following: public utilities, insurance, automotive, railroad, electric appliances, heavy machinery, textiles and petroleum. Studies have also been made in government agencies.

In general, the design of the studies has been to measure and examine the kinds of leadership and related variables being used by the best units in the organization in contrast to those being used by the poorest.

When foremen are asked what they have found to be the best pattern of supervision to get results, a substantial proportion, usually a majority, will place primary emphasis on getting out production. Other supervisors, whom Likert calls employee-centred, report that they get the best results when they place primary emphasis on the human problems of their workers.

Higher levels of management, in discussing how they want their foremen to supervize, tend to place more emphasis on the production-centred approach as the best way to get results; workers, on the other hand, tend to place less.

But which orientation yields the best results? A variety of studies in widely different industries show that supervisors who are getting the best production, the best motivation and the highest levels of worker satisfaction are employee-centred appreciably more often that production-centred.

Related to orientation of supervision is closeness of supervision. Close supervision tends to be associated with lower productivity, and more general supervision with higher productivity. Low productivity at times leads to closer supervision; but it is clear also that it causes low productivity.

In one of the companies involved in the research programme it was found that switching managers of high- and low-production divisions resulted in the high-production managers raising the productivity of the low-production divisions faster than the former high-production divisions slipped under the low-production managers. Supervisors, as they were shifted from job to job, tended to carry with them and to maintain their habitual attitudes towards the supervisory process and towards their subordinates.

Investigations showed that the closer the supervision the less the productivity. Where supervision was more general, productivity increased, and this was accompanied by shifts in a favourable direction in attitudes, interests and perceptions. Workers became more interested and involved in their work, accepted more responsibility for getting the work done, and their attitudes towards the company and their superiors became more favourable; they accepted direction more willingly.

Where the supervision was close, all these attitudes and related variables shifted in an unfavourable direction. "All the hostilities, resentments, and unfavourable reactions which have been observed again and again to accompany extensive use of the scientific management approach manifested themselves." A fundamental conclusion from this experiment and similar research is that direct pressure from one's superior for production tends to be resented, while group pressure from one's colleagues is not.

Other experiments were concerned with the relationship between morale and productivity. It is generally believed by management that the higher the morale, the higher the production. Substantial research by Likert and others has shown that this relationship is much too simple. Some units have low morale and low production; other units have fairly good morale and low production; still others have fairly good production but low morale; finally other units have both high morale and high production.

Units with low morale and low production tend to have supervision which is *laissez-faire* in character and in which the leadership function has largely been abandoned. Units which have fairly good morale but poor production tend to have supervisor who try to keep people 'happy'. These supervisor are often found in companies in which human relations training programmes have been introduced and emphasized.

In the outstanding firms there is a kind of supervision which results in high production with high morale, high satisfactions and high motivation.

Making a plea for the rapid extension of research into management problems in industry and elsewhere, Likert insists that every research projec dealing with supervision and leadership show how the most able supervisors and managers ar struggling in company after company with trial-and-error methods to discover how to improve thei supervision.

It is possible to wait for this trial-and-error proces gradually to evolve and to make clear what the new organization and management theory and processe will be. It would be faster and much more efficien to use the power of systematic research and experiment to accelerate their discovery and refinement Those companies which support and co-operate i research to discover improved processes of management and to train their personnel will have a distinc advantage over companies which do not. Thos which support research will discover at an earlie date the principles and practices which the successfu companies of the future will be using and in whic their own developing executives and managers shoul be trained. They will not experience the traged and cost of obsolete management which is so commo in industry.

THE FATE OF WILHELM HIS

By DR. LAURENCE PICKEN

The Library, Zoological Station, Naples

> "The experience of many years has taught me that phrases oft repeated finally ossify to conviction and utterly dull the organs of intuitive perception".
>
> (GOETHE: "On the Intermaxillary Bone".)

IT is the fate of certain men of science to have made so great a mark on their century-distant generation that their names add lustre still to a bibliography, though their views (it is agreed), if not erroneous, are at least outmoded. Such names evoke a grateful sense of progress; they may be held up to the young as a warning against being unsound; and of corruption there is no danger—for who would read a discredited though venerable author? Th highly select company includes among others, and varying degrees of membership, Lamarck, St. Hilai and Ehrenberg; for many, Goethe; and unque tionably Wilhelm His, native of Basle, sometim professor of anatomy in the University of Leipzig.

The object of this article is to direct attention to th imperfect manner in which knowledge of the work His has been transmitted—an imperfection due that unmerited indifference, already well establish in his lifetime, of which Needham[1] has considered th historical causes.

"I can well remember", wrote Sir D'Arcy Thom son[2], p. 84, "the harsh criticism and even contem which His's doctrine met with, not merely on the ground that it was inadequate, but because such an explanation was deemed wholly inappropriate, and was utterly disavowed"; and His himself in his letter of 1888 to the Royal Society of Edinburgh[2] well summarized the types of reaction which his approach to embryological problems evoked. The aspect of his work which most offended was his contention (to quote Thompson[1] again, p. 83) "that the foldings of the blastoderm, by which the neural and amniotic folds are brought into being, were the resultant of unequal rates of growth in what to begin with was a uniform layer of embryonic tissue". Later critics have picked on the word 'growth' as vulnerable to attack, without pausing to inquire what His meant by that term; but his contemporaries were distressed by other and very different considerations. "To one it seemed ridiculous to speak of the elasticity of the germinal layers; another thought that, by such considerations, we 'put the cart before the horse'; and one more recent author states, that we have better things to do in embryology than to discuss tensions of germinal layers and similar questions, since all explanations must of necessity be of a phylogenetic nature. . . . The present fashion requires that even the smallest and most indifferent inquiry must be dressed in a phylogenetic costume, and whilst in former centuries authors professed to read in every natural detail some intention of the *creator mundi*, modern scientists have the aspiration to pick out from every occasional observation a fragment of the ancestral history of the living world"[2]. Again[2], "Embryology and morphology cannot proceed independently of all reference to the general laws of matter,—to the laws of physics and of mechanics. This proposition would, perhaps, seem indisputable to every natural philosopher; but in morphological schools, there are very few who are disposed to adopt it with all its consequences".

To his contemporaries His was known not only for his mechanical interpretation of certain facts of development, but also for his support of the theory of concrescence; in his own words[3], "The body of an osseous or an elasmobranch fish arises by the coalescence of two halves previously formed at the periphery of the germinal disk". But it escaped the notice of his contemporaries, as it has of posterity, that in the course of work on such embryos he had established, by measurements of areas of serial sections, that the volume of the germ of a salmon, for example, is practically the same as the volume of the fully formed embryo together with the yolk-membrane. "The embryo has been formed from the segmented germ without any increase in volume, only by displacement of its masses"[3].

It was, perhaps, in his views on the importance of measurement for the understanding of morphogenetic processes that His displayed the greatest originality; and it should not be forgotten that we owe to him the procedure of serial reconstruction. "The ways of determining the forms and volumes of germs and embryos are somewhat longer and more tiresome than the simple inspection of stained sections; but the general scientific methods of measuring, of weighing, or of determining volumes cannot be neglected in embryological work, if it is to have a solid foundation of facts, for morphologists have not the privilege of walking in easier or more direct paths than workers in other branches of natural science"[3].

For such views he was condemned; and as a result of that condemnation he was not read with attention by many of his contemporaries, and he is still not read by some of those who cite him. I have assembled here a few examples of conspicuously imperfect acquaintance with his views, and of the reactions of later generations to some of his ideas, associating them in each case with the actual content of his publications.

Morgan[5] re-examined the formation of the teleost embryo. His bibliography includes three works of His[6-8]; but rather surprisingly he does not include the papers on the development of bony fishes[4,9], contenting himself with His's summary re-statement of 1891[3]. In his paper of 1895, Morgan presents the results of measurements of cell-areas in the extra-embryonic blastoderm, made in order to determine whether the increase in area of individual cells could account for the increase in area of the extra-embryonic region. He had been anticipated in this type of approach by His[4], who already in 1878 had published measurements of area and volume of individual cells of the salmon germ at four stages of development; he had also measured thicknesses and calculated the volume of the germinal disk and of its various regions. Morgan sought evidence that the embryo becomes longer because it becomes narrower[5]: "If it could be shown that the amount of material present in the embryo [that is, initially present] is equal to the material of the fully formed embryo, there would remain no doubt that the elongation of the embryo was due to axial concentration". But His had shown in 1878 that between a length of 1·45 mm. and 4·3 mm. the volume of the embryo had increased from 0·279 mm.^{3} to 0·427 mm.^{3}, so that the increase in length could not be accounted for by axial concentration alone. Furthermore, His was aware of the point made by Morgan, that axial concentration may contribute to the elongation of the embryo backwards, for he gives in that same paper[4] measurements showing that the head elongates somewhat while narrowing—though in his paper of 1891[3], in emphasizing the appositional character of growth in length, he asserted the constancy of head-length. I do not quote His's views and figures believing them to be correct, but only to show his out-of-century approach, and the fact that someone of Morgan's stature, working in the same field, could afford to ignore those of his publications which one would have supposed most relevant.

Vandebroek, in his definitive memoir on morphogenetic movements in the embryogenesis of *Scyllium*[10], twice mentions His: first, as the originator of the theory of concrescence—which strictly speaking, as Morgan pointed out, he was not; the credit for the initial idea must go to Lereboullet. The reference given is to a one-page communication[11] to the Leipzig Natural Science Society, not to the definitive publication on shark development[7]. Secondly, reference is made to a statement by His[12] that the segmentation cavity and the archenteron are one and the same thing; there is no such statement in the paper cited. Vandebroek was presumably unaware that the pattern of surface-movement he had revealed by Vogt's method—though not the deeper gastrulation movement, of which His was ignorant—bears a striking resemblance to the pattern of postulated surface-*forces* illustrated by His[8] (Fig. 1 of that paper) and discussed at length in his paper of 1894[13]. (See in particular Vandebroek's Fig. 32.) Although the theory of concrescence as formulated by His rested on an inadequate analysis of the kinematics of fish-development, it contained a flash of insight from which later views profited. Since Vandebroek's analysis it is evident that, although not in the manner envisaged by His, a great part of the material of the embryo has at some time formed part of the margin of the germinal disk; and imperfect though the formulation was, the conception of His helped to prepare the way for the view of development as a translocation of cells.

In that wonderfully organized book[14], "Principles of Development", Weiss refers to His; once, as the originator of a term 'organ-forming areas'[6]—forerunner of 'presumptive areas'; and again, for the fact that among authors who were "exclusive in the choice of agents they believed to be involved" in nerve development, His "favored a mechanical interpretation". Such a judgment is somewhat harsh and leaves the reader with no hint of the balance which His displayed, nor of the extent to which he anticipated certain of Weiss's own views. "The sensory process of a sensory nerve fiber", wrote Weiss[14] ". . . grows more or less perpendicularly into the dorsal portion of the spinal cord; there it splits into two branches which take a lengthwise course. . . . Although there is no direct proof of it, the assumption is obvious that both the bifurcation and the deflection of these fibers is the result of one and the same condition, namely, the fact that at their entrance into the cord they strike upon the longitudinal structure of the dorsal columns of the spinal cord . . . branching may be considered as a peculiar by-product of the deflection of fibers obtaining under certain conditions".

"The longitudinal deflection of the sensory roots at the surface of the spinal cord and brain", wrote His[15], "can be referred to the fact that fibres reaching this position are unable to continue their advance in the same direction. In the interior of the cord, the spongiosa forms a system of passages which determine the manner of distribution of the intramedullary fibres. . . . Branching itself may be interpreted as a consequence of continued growth of the individual processes against a resistance". Weiss makes amends, however, in a recent review[16] where he refers to his own ideas on 'contact-guidance' as "but a modification and more detailed version of such concepts of nerve orientation as have been proposed by His" and others.

The nature of His's 'mechanistic' outlook is clearly conveyed by the following passage[15]: "If the course of the developing nervous paths is determined now by trabeculae of the spongiosa, now by cartilage or blood-vessels, it may at first sight appear questionable that such chance occurrences should intervene in the development of a system which controls our entire life—body and soul. The problem takes on another aspect, however, when we realize that this is a developmental process, the course of which is predetermined in the act of generation. The totality of partial processes must interact with each other in a strictly ordered manner, once the process is initiated; for—in Leibniz's beautiful phrase—the harmony of organic development is a 'pre-established harmony' ".

Pasteels, in his revolutionary review of gastrulation in the chordates[17], gives as the first source relating to His's conception of concrescence his monograph on oogenesis and egg-structure in bony fishes[18] in which there is no reference to concrescence. Like Vandebroek, he overlooks the significance of His's interpretation of folding in terms of surface movements.

As a last instance of injustice, though from a generous critic, Holtfreter, in the first of his papers on the mechanics of gastrulation[19], wrote: "W. His (1874) in his pioneer work on the causative factors of morphogenesis envisaged foldings, invaginations and epibolic expansions as growth phenomena, picturing them as a result of increased cell multiplication of certain predetermined areas, and an interplay of mechanical forces between the regions of differential growth. . . . Actually, cell divisions in amphibian eggs up to the neurula stage simply reduce the cell size but lead to no increase of the egg substance". This comment is repeated in Townes and Holtfreter[20].

Unfortunately for His, it has escaped the notice of many of his later critics that already in 1878 he had changed his position from that maintained in the monograph on chick-development[21] and in the "Letters to a Scientific Friend: Our Bodily Shape and the Physiological Problem of its Origin"[6]. As a result of further studies on chick- and teleost-development, he had reached the conclusion that it is necessary to distinguish, "much more sharply than I and other investigators have done hitherto, between surface-growth and mass-growth. . . . The thinnest regions are those of most rapid surface-growth"[4]. He continues: "As my last work has confirmed for the chick-embryo[22] also, a surface-expansion occurs independently of mass-growth . . . and it will be for the future to determine how far the one or the other determines the shapes generated". He then proceeds to consider the possible influence of cell division as a contributory factor in surface growth: "In the mere parcelling-out of a mass of material there is no reason for the shape of the mass to change; it is necessary to make a subsidiary hypothesis: that cleavage always proceeds in the same direction, so that the fragments of all the elements belonging to a layer come to lie beside one another. In this way, surface-increase without mass-increase is certainly possible. . . . We may grant the possibility of this explanation, leaving on one side for the moment the question: why this surface division occurs, and ignoring the fact that in the course of development the cells show other than spherical shapes—at times radially extended, at times flattened; but when we face the fact that not only do the layers become thinner, but the number of superimposed cells in them diminishes over a certain period, this explanation becomes untenable . . ."[4].

Holtfreter supposes (and he is not alone in this) that His believed cell-division to be the driving force of his foldings; but clearly by 1878 His held no such view.

"As things are at present, it is impossible to escape from the idea of active cell-participation in attempting to explain the moulding of the embryo; but this is not to be thought of in terms of veritable mass-migrations, but rather as processes of a more local character. . . . The situation can best be accounted for, if one ascribes to the cells a tendency to migrate to the surface in maximum possible extension. Where the layer is thick, underlying cells penetrate between the superficial cells and separate them because of this tendency; where the layer is thin, however, the cells spread themselves out, so that they acquire the largest possible free surface"[4]. How far this view of the importance of individual cell behaviour, and of surface-spreading, in morphogenesis coincides with that of Holtfreter himself it is unnecessary to emphasize.

The most penetrating and just contemporary critic of His was Roux[23], who showed experimentally that the rolling of the neural tube continues after its isolation (by incisions) from the postulated thrust of the surrounding tissue. On this work of Roux's His commented in 1894[13], and in the course of his commentary goes far beyond Roux's recognition of the intrinsic capacity of the medullary plate to fold, anticipating Rhumbler, Moore and Lewis: "Suppose we have a sheet of cells, the elements of which are as wide at their bases as they are at the free surface. If now, as a result of internal forces, the cells are all induced to become thicker at their bases and thinner at their free ends, the result will be that the sheet bends and folds together to form a hollow structure". His goes on to say that he personally favours the view that there is an interaction of external pressure and internal developmental processes—such as those responsible for the change in shape of the individual cells just described.

It is a pleasure to be able to mention at least one modern critic who has done justice to His, namely, Oppenheimer[24], though her comments are restricted to the contents of "Unsere Körperform"[6].

I have assembled these passages not merely in order to direct attention to what appears to me to be a singularly flagrant historical injustice, but also in the hope that some embryologist, and preferably some countryman of His's, with full patience for his leisurely manner and antiquated anatomical and histological views and vocabulary, may be stimulated to examine his total output—which is not large—and to make a critical assessment of his work in the light of modern developments in embryology. I have the impression that between the study of induction, the mapping of presumptive areas and the analysis of prospective fates and cell-properties, something has been lost sight of to which His directed attention in 1888: "The germinal layers are elastic plates under the influence of certain pressures . . ."[3]; mechanical properties cannot be indefinitely neglected.

The quotation heading this note was used by His as motto for his own life-work summary[13], published in 1894, ten years before his death. It applies as well to his personal experience as it did to that of Goethe when, in his thirties, he sought to convince Camper of the presence of the intermaxillary bone in man as in apes.

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PARTITION OF SULPHONAMIDES IN PLANT ROOTS: A FACTOR IN THEIR TRANSLOCATION

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In an earlier paper[1], data were presented on the movement of seven sulphonamides through broad bean plants which had been grown in water culture containing 100 µgm./ml. of a sulphonamide. There was appreciable accumulation of the sulphonamides in the roots, and this was specific for a particular compound. Once a compound had left the root system it was possible to postulate movement in the transpiration stream. To reach the vascular system of the plant, a compound must enter the root tissues and move across the living cells of the cortex.

In the course of the translocation studies, the individual compounds were identified in tissue extracts on paper chromatograms, and it became apparent that there was a general relationship between the rate at which the compound moved in the plant and the R_F value on the chromatogram. This suggested a comparison between movement across the root and movement on filter paper, both of which may be attributed to a partition mechanism.

In addition to the data already published[1], comparable uptake and translocation studies have been made with four additional compounds: two of the sulphonamide type, 2-(*p*-aminobenzenesulphonamido)-4 : 6-dimethylpyrimidine ('Sulphamezathine') and 4-acetamidobenzenesulphonamide, the N^4 acetyl derivative of sulphanilamide; and *p*-aminobenzoic acid and sulphanilic acid, both of which can be determined with the same assay used for the sulphonamides.

The separation of these compounds on paper chromatograms has been followed using *n*-butanol–acetic acid–water, *n*-butanol–ammonia–water and chloroform–ethanol–ammonia–water solvent systems. The proportion of ethanol in the last system was varied to alter the amount of water in the mobile phase. Chromatograms were developed on Whatman No. 1 papers and spots were located by diazotization and coupling[2]. In all systems the organic solvent mixtures were the mobile phase; there was no distinctive separation of these compounds using a mobile aqueous phase on lipoid-treated papers or olive oil as a mobile lipoid phase. In an attempt to simulate conditions which might occur in the plant, the

Table 1. THE EFFECT OF VARIOUS SOLVENT SYSTEMS ON THE RATIO OF SHOOT ACCUMULATION RATE IN BROAD BEANS TO R_F VALUE FOR SULPHONAMIDE-TYPE COMPOUNDS

	Shoot-rate	*pKa* (ref. 3)	Ratios shoot-rate/R_F value Solvent systems 1	2	3	4	5	6
4 : 4′-Diamino-diphenyl sulphone	38 3	—	45	44	39	44	44	41
Sulphanilamide	22·7	10 43	38	40	252	71	40	39
N^4 acetyl sulph-anilamine	25·1	—	33	32	418	55	35	34
Sulphaguanidine	5·5	—	12	13	∞	61	13	34
p-Aminobenzoic acid	0·8	4 68	1	7	∞	80	16	40
Sulphanilic acid	3·3	3·20	24	41	∞	∞	47	47
Sulphacetamide	10 0	5·38	14	56	125	∞	71	50
Sulphadiazine	14·8	6·48	20	62	∞	740	93	33
Sulphathiazole	1·6	7·12	2	3	27	54	8	3
Sulphapyridine	6·0	8·43	8	12	67	32	17	7
Sulphamezathine	9·5	7·37	12	20	136	40	30	12

System	Solvent
1	*n*-Butanol–acetic acid–water (4–1–5)
2	*n*-Butanol–ammonia–water (4–1–5)
3	Chloroform–ethanol–ammonia–water (4–0–1–5)
4	„ „ „ „ (4–2–1–3)
5	„ „ „ „ (4–4–1–3)
6	Chloroform–ethanol–buffer solution (4–2–4) 0·5 *M* KH_2PO_4/NaOH initial *p*H 7·8, final *p*H 7·0

volatile components acetic acid and ammonia were replaced by buffering papers and solvent systems at *p*H 7·8 with 0·5 *M* phosphate buffer. The final *p*H on the papers after development was *p*H 7·0, which is close to the determinations of *p*H made on expressed root sap with a glass electrode (*p*H 6·3–6·8).

In presenting the results of these experiments in Table 1, the model system visualized is essentially a partition chromatogram in which the transpiration water containing the compound under test and other compounds accumulated during passage across the root is continuously partitioned on a column made up of root tissue. It has been shown previously[1] that the early stages of treatment, before the tissues become saturated, are characterized by a constant relation between uptake and transpiration. During this period the amount of compound accumulated in the shoots is directly proportional to the amount of water transpired. Thus the shoot accumulation-rate is essentially a measure of the concentration of the treating compound in the transpiration stream. The concentration of the treating solution was the same in each case (100 µgm./ml.), so that the shoot-rate provides a measure of the partition in the root tissues. If comparable conditions for partition can be established on the paper chromatograms, the ratio of the shoot-rate to the R_F value will be constant for a number of compounds, and Table 1 illustrates an attempt to reproduce these conditions. In this table only the ratios have been included, but the R_F values can be calculated from the appropriate shoot-rates. High ratios indicate poor movement on the chromatograms, and ∞ no movement.

Two main effects have been studied in the experiments illustrated—*p*H and lipoid solubility. The movement of a neutral compound reasonably soluble in both water and lipoids should be little affected by changes in conditions and should, therefore, give rise to a constant ratio in all the systems used. Further, if this constant can be applied to a number of compounds the figure should be generally applicable. The sulphone is a compound which fulfils the required conditions, and it seems that 40–45 : 1 should be the ratio aimed at. Other compounds which might move as the sulphone would be the neutral N^4 acetyl sulphanilamide, sulphaguanidine and possibly sulphanilamide which has a high *pKa* and will, therefore, be largely undissociated under the conditions studied. However, lipoid solubility is also a controlling factor, and sulphanilamide and its N^4 acetyl derivative only move on chromatograms when there is an appreciable aqueous component in the mobile phase. Sulphaguanidine moves readily in systems with a high aqueous content in the mobile phase; but its mobility is reduced with water content and it is possible to devise systems in which the mobility gives the characteristic ratio of the sulphone. The assumption is that with neutral compounds and compounds with a high *pKa*, movement is concerned mainly with the undissociated molecule.

Table 1 contains a further group of compounds which are likely to be in the same state on the chromatogram as they are in plants. These are compounds with a low *pKa* value which are probably highly dissociated in both, namely, *p*-aminobenzoic acid, sulphanilic acid and possibly sulphacetamide. They travel more rapidly in the acetic acid system but give fairly constant ratios in the more alkaline systems, suggesting that in the plant it is the ion that is moving, and this may account for the poor mobility as indicated by the low shoot accumulation-rates. *p*-Aminobenzoic acid provides an anomalous case, and its translocation differs from the other compounds in that there is a very high uptake into the roots and a very low transfer to the shoot.

The remaining four compounds, sulphadiazine, sulphathiazole, sulphapyridine and sulphamezathine, have *pKa* values which lie critically close to those on the papers and probably to those in the plant. Small discrepancies in *p*H might, therefore, be expected to make large differences in the proportion of undissociated molecules present in either system. On the chromatograms, as would be expected, they move more readily when undissociated under acid conditions. With a suitable buffer it has been possible to a great extent to correct the movement of sulphadiazine. The binding of these compounds to proteins has been reported in certain animals[4,5] and it seems likely that the ions are concerned in this binding. Binding of this type may also account for their abnormally low rate of movement in the plant. It has been possible to reduce the R_F values on papers sprayed with albumin, as is shown in Table 2; but the retardation has not been sufficient to give a satisfactory ratio. This is not surprising since the degree of binding will probably depend on the physical state of the protein and the *p*H of the system. Hydrogen bonds and van der Waals' forces may also be involved and their effect will vary with the different compounds.

Further evidence on protein binding was derived from differential extraction of roots of treated broad beans. A large proportion of the sulphathiazole,

Table 2. R_F VALUES OF SULPHONAMIDE-TYPE COMPOUNDS IN AN *n*-BUTANOL–AMMONIA–WATER (4–1–5) SOLVENT SYSTEM ON NORMAL AND PROTEIN-TREATED PAPERS
(10 per cent solution of bovine plasma albumin, Fraction V; Armour Laboratories)

	R_F values Normal paper	Protein-treated paper	Per cent retardation of R_F
4 : 4′-Diaminodiphenyl sulphone	0·87	0·76	12 6
Sulphanilamide	0·57	0·49	14·0
N^4 acetyl sulphanilamide	0·79	0·71	10·1
Sulphadiazine	0·24	0·18	25·0
Sulphathiazole	0·48	0·33	31·2
Sulphapyridine	0·52	0·40	23·1
Sulphamezathine	0·48	0·36	25·0

sulphapyridine and sulphamezathine taken in by the plant was retained in the roots and could not be removed by prolonged washing of root macerates with water and chloroform.

It would thus appear to be possible to adjust the conditions on a chromatogram to show a constant relationship between R_F and movement in the roots of broad beans. The required conditions, which have apparently been achieved for eight of the eleven compounds studied in the system shown in column 6 of Table 1, are a mobile lipoid solvent with a relatively high water content and a pH of the order of 6·8–7·0. The same effect would be produced if the lipoid component was retained on the stationary phase or moved more slowly than the aqueous component. The conditions illustrated in the model system might well exist in the plant since a stream of water passing through the root tissue could accumulate substances such as lipoproteins which would confer a lipoid solubility on the mobile phase, and pH values of root sap are of the right order. The retention of sulphathiazole, sulphapyridine and sulphamezathine in the roots, which is thought to be due to protein binding, has not been reproduced adequately in the model; this can perhaps only be done effectively by using protein material from the roots.

The evidence here presented indicates that most, if not all, of the movement of these compounds through root tissue may be attributed to physical rather than to specific biological processes. Further evidence supporting this conclusion is provided by the observation that the rate of accumulation of griseofulvin in the shoot is unaffected by 2,4-dinitrophenol and sodium azide[6], and the accumulation of sulphanilamide in the shoot is also unaffected by sodium azide[1]. Hylmö[7] claims that the movement of calcium and chloride ions associated with transpiration is unaffected by low temperature, which points to the same conclusion.

Partition will probably play a major part in a physical system of this type and the data presented above suggest a way of assessing its influence.

We are grateful to Mrs. A. Borrow and Mr. B. Langford for technical assistance.

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A RARE VARIETY OF THE HUMAN BLOOD GROUP B

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IN the blood of adults and children over the age of six months the serum always contains the agglutinin, or agglutinins, corresponding to whichever of the A or B antigens is lacking from the red cells. This was originally enunciated by Landsteiner[1], and many extensive series of tests have been made without the discovery of exceptions. Apparent exceptions to this rule are very rare, and on thorough investigation are usually shown to have feeble antibodies demonstrable only at low temperatures[2]. Recently, a sample of blood from a Japanese male, Mr. K., was investigated which at first appeared to be a true violation of Landsteiner's Law, but subsequent investigations show it to be possibly a rare variety of the human blood group B.

Serological studies :

(1) Routine ABO grouping by a tube technique[3].

	Anti-A	Anti-B	Group O (anti-AB)
Mr. K's cells	—	—	

	A_1 cells	A_2 cells	B cells	O cells	Own cells
Mr. K's serum	*V*	*V*	—	—	—

(2) The cells remained unagglutinated by eight selected high-titre anti-B (group A) sera at 4°, 18° and 37° C.

(3) The cells were not agglutinated by selected high-titre rabbit immune anti-A and anti-B sera.

(4) The cells were not agglutinated by ten selected high-titre group O (anti-AB) sera at 4°, 18° and 37° C., in saline, albumin or anti-human globulin techniques.

(5) The serum gave no reaction with a series of fresh group B cells suspended in saline at 4° C.

(6) There was no evidence of incomplete anti-B in the serum, demonstrable by the anti-globulin test or by albumin.

As we had previously found a group A person completely lacking in anti-B agglutinins and who was shown to be suffering from agammaglobulinæmia, an anti-globulin inhibition test was carried out on Mr. K's serum. The gamma globulin concentration[4] in his serum was normal, or slightly above normal. Having excluded agammaglobulinæmia, we now felt that this was possibly a true violation of Landsteiner's Law and that Mr. K's blood was thus $O\alpha -$.

(7) Based on some observations made on the human blood group chimera[5], which will form the subject of a separate communication[6], we then examined the ability of the person's serum to inhibit anti-A (group B) and anti-B (group A) sera. The results obtained are given in Table 1. This demonstrates the presence of B substance in Mr. K's serum.

(8) The amount of B substance present in the serum was compared with the sera from nine group B donors. This was estimated by mixing serial dilutions of each serum with a standard (1/10) dilution of anti-B (group A) serum, leaving the mixture at 20° C. for 1 hr. and then adding 1 volume of a 2 per cent suspension of B cells in saline. The results (Table 2) show that B substance was present in the serum in moderate amounts as compared with the nine group B donor sera.

Table 1

	Anti-A 852			Anti-B 869		
	1/20	1/30	1/40	1/20	1/30	1/40
Mr. K.	*V*	*V*	*V*	—	—	—
Saline control	*V*	*V*	++	++	++	++
	A_2 cells			B cells		

Table 2

	1	2	4	8	16	32	64	128	256
x/12156	(+)	gw	+	+	+	+	+	++	++
x/12157	w	(+)	+	+	++	++	++	++	++
x/12158	w	(+)	+	+	+	++	++	++	++
x/12159	–	w	(+)	(+)	+	+	+	++	++
x/12160	–	w	(+)	(+)	+	+	+	++	++
x/12506	(+)	+	+	+	++	++	++	++	++
x/12507	(+)	(+)	+	+	+	++	++	++	++
x/12508	(+)	+	+	+	+	+	++	++	++
x/12509	–	–	–	–	w	(+)	+	++	++
Mr. K.	–	(+)	(+)	+	+	++	++	++	++

Saline control—anti-B 1/10 + an equal volume 2 per cent B red cells in saline: ++.

(9) Mr. K's serum gave no reactions at 4°, 18° or 37° C. with known A_4 cells[7], suggesting that the serum was not from a group O person.

By the time the investigations reported here were complete, Wiener and Gordon's report[8] was just published of a blood, the red cells of which grouped as O—β, yet the saliva of this person contained A substance. They claim this as a further sub-group of A and propose the name A_m because of serological similarities between the blood they describe and the bloods of certain monkeys[9]. No claim is made that the blood reported here is a new sub-group of B, although indeed it may be. This part of the investigation awaits specimens (blood and saliva) from the relatives of the propositus.

Other possibilities that have to be considered are that this blood is a further example of the type described by Levine *et al.*[10] which was phenotypically *O*, but was proved to be of genotype *BO*, but the gene *B* was suppressed. However, while further investigation is necessary, one major difference between the blood described by Levine *et al.* and the blood here reported is that the former contained anti-H, whereas the blood we have examined did not possess such an antibody. Unfortunately, we did not test Mr. K's cells with anti-H.

An alternative possibility is that this blood is a defective B type in which the alcohol-soluble form of the antigen is lacking while the water-soluble form has developed normally. The defect may conceivably have resulted from the absence of normal complementary genes for the development of the alcohol-soluble antigen system, or from the influence of a modifying gene upon the alcohol-soluble system. This was suggested by Gammelgaard[11] to describe a blood A_x, which had little or no evidence of the A antigen in the red cells and yet the saliva was rich in A substance. Indeed, Gammelgaard's A_x and Wiener's A_m may be identical, and the latter may not be a new form of blood group A as claimed by Wiener.

The blood reported here is not an exception to Landsteiner's Law, providing the presence of the antigens is not confined to the red cells. In further work on the human chimera which will be reported later[6], we have observed that the chimera, although phenotypically *O—A*, possesses no anti-A agglutinins, but possesses A substances in her serum when not pregnant. However, when pregnant her serum possesses no A substances—even though she has A cells in her circulation—and at this time possesses an anti-A agglutinin. It would appear from the observations made on the present blood and on that of the human chimera that the presence or absence of agglutinins in the serum is more dependent upon group-specific substances in the serum than on the group-specific substances in the red cells.

It is hoped to carry out further studies on this blood and on that of members of this person's family, and to give a fuller report elsewhere.

We wish to thank Dr. A. E. Mourant, of the Medical Research Council Blood Group Reference Laboratory, London, for his suggestions.

Note added in proof. Since submitting this report for publication, members of Mr. K's family have been tested and his father and one sister have the identical variety of blood group B.

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'LIVING' POLYMERS

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POLYMERIC molecules are born in an initiation process, they grow by a propagation process, and finally they 'die' in a termination process. This death is regulated by the conditions prevailing in the polymerization process, and thus, the rate of death, the average molecular weight of the polymer formed, and its molecular weight distribution are all well-determined functions of experimental conditions.

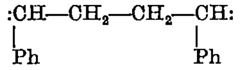
An interesting situation arises when a polymerization process does not involve a termination step. The polymeric molecules then 'live' for an indefinite period of time, and such a system should be profitable in many investigations. A 'living' polymer does not grow indefinitely, nor does its molecular weight increase beyond certain limits. Any growth requires food, and the food for a growing polymer is the monomer. Consequently, if the supply of monomer is exhausted the growth is interrupted, although the living ends are potentially able to grow further if an additional amount of monomer is available.

The exclusion of natural death does not mean immortality either. Reagents may be visualized which convert a living end into an unreactive dead end. Treatment of living polymers with such reagents represents, therefore, a killing process. The difference between the normal termination process—described here as a natural death—and the killing process lies in the unavoidable character of the former reaction, whereas the latter takes place at the time chosen freely by the experimenter. The advantage of such a termination is obvious.

Recently we have succeeded in preparing in our laboratories living polymers by carrying out an anionic polymerization in a non-acidic solvent, such as, for example, tetrahydrofurane. The growing end of an anionic polymer is a carbanion. If the polymerization is proceeding in a solvent which is a proton donor, then the transfer of a proton from the acidic solvent to the carbanionic end of a growing polymer terminates the polymerization. Such a mechanism operates, for example, in polymerization initiated by sodium and carried out in liquid ammonia. However, this termination is impossible in tetrahydrofurane solution.

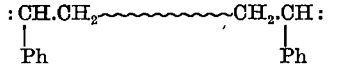
In solvents which solvate poorly the ions formed, the termination may occur by returning an electron from a carbanion to the cation (say Na^+). Such a reaction probably terminates the polymerization initiated by sodium in hydrocarbon solution. However, tetrahydrofurane solvates the ions well, and therefore in this solvent the re-formation of neutral species is energetically unprofitable. Hence, this second termination mechanism does not operate in tetrahydrofurane either.

One assumes finally that the anionic polymerization carried out in tetrahydrofurane solution does not involve any termination step, and in order to examine this assumption the following experiments were carried out with styrene as the monomer. The polymerization was initiated by the intensely green complex naphthalene anion, sodium cation. This initiating catalyst was discovered by Scott[1] and the mechanism of this initiation was elucidated recently in our laboratories[2]; we showed that it involves an electron transfer process from the naphthalene anion to the monomer, for example, styrene. Consequently, negative monomer ions are formed which eventually dimerize into species such as:



$$:\underset{\mathrm{Ph}}{\mathrm{CH}}\text{—}CH_2\text{—}CH_2\text{—}\underset{\mathrm{Ph}}{\mathrm{CH}}:$$

and the latter grow by a carbanionic mechanism until the monomer supply is exhausted. Thus, living polymers of the following structure are formed:



$$:\underset{\mathrm{Ph}}{\mathrm{CH}}.CH_2\sim\sim\sim\sim\sim\sim\sim\sim\sim\sim CH_2.\underset{\mathrm{Ph}}{\mathrm{CH}}:$$

The —Ph.CH: ends of the living polymers are bright red—this is essentially the colour of the negative benzyl ions. Hence, the green colour of the catalyst solution (naphthalene anion) turns red instantaneously when introduced to the styrene solution. In absence of air or moisture the red colour persists for days, without any apparent change of intensity. However, when air or moisture comes in contact with the solution, the red colour disappears —the living ends are killed; for example:

$$\sim\sim\sim\sim\sim\sim Ph.CH:+H_2O \longrightarrow \sim\sim\sim\sim\sim\sim Ph.CH_2+OH^-$$

Hence, the observation of colour is the simplest manifestation of living polymers.

At this juncture one may wonder whether an electron located on a carbanionic end of the polymer may be transferred to the naphthalene molecule. Such a process would be easily recognized. The anionic ends deprived of an electron are transformed into radical ends. The latter undergo an irreversible dimerization process. Consequently, the final result would be the change of the colour from red to green, and an increase in the viscosity of the solution resulting from polymerization of polymers. Neither of these effects was observed, showing that the proposed electron transfer is too slow to be seen. This result reflects, of course, the much higher electron affinity of benzyl radical as compared with, say, naphthalene.

Now, if additional amounts of styrene and of tetrahydrofurane are added to the red solution of a living polymer, further polymerization ensues. If the ratio of styrene to solvent is chosen to be identical to that in the first batch, then the *concentration* of polystyrene formed remains unaltered by the second polymerization. Nevertheless, the viscosity of the solution increases enormously. This increase in viscosity, coupled with the fact that both portions of styrene are converted quantitatively into a polymer, proves that the second batch of monomer polymerized on the living ends of the previously prepared polymer.

This experiment suggests an interesting and novel method for the preparation of block polymers. After completion of the first polymerization process, a second monomer is added to the still living polymers formed from the first monomer. Thus, block polymers of the type *AA...A.B.B...B.A.A...A* are produced. For example, polymerization was initiated in styrene solution. When the reaction was ended, isoprene was added and further polymerization ensued. After killing with water, a polymer was obtained which was shown to contain neither polystyrene nor polyisoprene. Thus, the nature of the block polymer is established.

It is interesting to compare the effect of two killing agents, namely, water and oxygen. If the viscosity of the red solution of living polymers is determined and then a drop of water is introduced, the colour will disappear but the viscosity of the solution remains unaltered. This killing process leads to a transfer of a proton from a water molecule to the carbanionic end of the living polymer, and such a process is not expected to change the molecular weight of the polymer. On the other hand, if oxygen is introduced into the red solution, the colour disappears again, but simultaneously with this effect the viscosity of the solution increases considerably.

It is believed that oxygen represents the class of killing reagents which removes one electron from the carbanionic ends. The high electron affinity of the oxygen molecule favours this reaction:

$$\sim\sim\sim CH_2.Ph.CH:+O_2 \longrightarrow \sim\sim\sim\text{—}CH_2.Ph.CH\cdot+O_2^-$$

Consequently, the living ends are transformed into radicals, and the latter undergo dimerization. (It is possible that the dimerization process involves oxygen bridges due to the action of other oxygen molecules. This, however, does not change the essential characteristic features of the phenomena described here.) Since our living polymers possess two living ends, the dimerization process leads to polymerization of polymers, and consequently, to a considerable increase in the viscosity of the solution.

I hope that these brief comments will show how versatile is the chemistry of living polymers. A detailed description of this work will be published later.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Optical Rotation of the α-Helix in Synthetic Polypeptides

In a communication from this laboratory[1], the belief has been put forward that the polypeptide chains in poly-L-alanine fibres form right-handed rather than left-handed helices; this view is based on the X-ray diffraction pattern. If it is correct, it is to be expected that the same sense of helix will be the stable form in other L-polypeptides. Now the contribution to the optical rotation of an α-polypeptide from the helix alone is considerable; according to Fitts and Kirkwood[2], a right-handed helix of polyglycine should have a specific rotation of about + 130°. In a later communication[3] they have concluded from the change in specific rotation on destruction of the α-helix (in poly-γ-benzyl-L-glutamate and in poly-L-glutamic acid) that in these polymers the helices are right-handed.

The stability and sense of the α-helix can be examined by measuring the optical rotation of a series of polypeptides in which the proportion of D- to L-residues is varied. The addition of a proportion of D-residues, randomly arranged along a chain of L-residues in the α-helix form, will not affect the helix if this has a strongly preferred sense. The optical rotation of a predominantly L-polypeptide should therefore at first move towards higher positive values as the proportion of D-residues is increased, but must ultimately become zero when D- and L- residues are present in equal amounts.

We have measured the optical rotation of a series of D : L-leucine polypeptides in benzene at a concentration of 0·2 per cent (w/v). Films cast from these solutions showed the carbonyl infra-red absorption band in the normal position for the α-form. Since many of these polymers form gels under these conditions (even at 60° C.), small amounts of *m*-cresol (minimum 1 per cent, v/v) were added, and the optical rotation in pure benzene was obtained by extrapolation to zero concentration of *m*-cresol. This procedure was justified by measurements made in pure benzene, when the solubility allowed this. The addition of *m*-cresol lowers the positive rotation of the mainly L-polypeptides. Even with *m*-cresol present, it was found necessary to make measurements at 60° C. to avoid gel formation. It is convenient to express the results in terms of the residue rotation $[R]$

$$[R] = \frac{R}{100}[\alpha]$$

where R is the residue weight and $[\alpha]$ the specific rotation defined in the usual way. The results are shown in Fig. 1.

The expected effect is strikingly apparent, and the increase in rotatory power continues to a lower excess of L over D values than might have been anticipated. The increase in rotatory power is not caused by increasing instability of the α-helix as the proportion of D-residues becomes greater (leading to the formation of a random coil), because conditions which favour a random coil lower the positive rotation[4]. The linear part of the graph is readily accounted for if, over this range, all the polypeptide chains are right-handed, producing a positive rotation from the helix core, with the L- and D-side-chains giving respectively negative and positive contributions. The contribution from the helix core is given by the intercept on the *y*-axis, and corresponds to a residue rotation of + 138°. We may note that the corresponding value for poly-L-leucine in benzene calculated from Fitts and Kirkwood's formula is 70°.

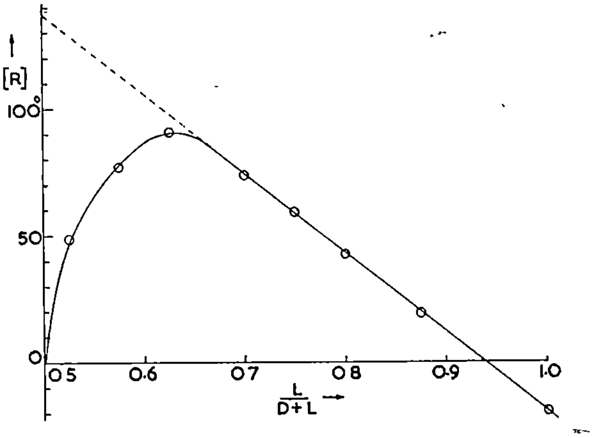

Fig. 1. Residue rotation of poly-leucine plotted against fraction of L-residues in polymer. Concentration 0.2 per cent w/v in benzene at 60° C.; λ = 5893 A.

Our experiments show clearly that, in solution, one sense of helix is significantly more stable than the other for a given enantiomorph. Together with Fitts and Kirkwood's calculation that the form optical rotation is positive for a right-handed helix, the results confirm that L-polypeptides form right-handed helices. The possibility that the optical rotation of an α-polypeptide can be treated as the sum of contributions from the helix core and the asymmetric centres is interesting, and may have applications in the case of proteins such as silks.

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Blood-Group Antigens on Human Epidermal Cells

Recently, Coombs, Bedford and Rouillard[1] reported that the A and B blood-group antigens are present on human epidermal cells. A series of skin samples has now been examined for blood-group antigens other than A and B by the method of mixed erythrocyte-epidermal cell agglutination described by these authors.

Suspensions of isolated epidermal cells were prepared by treating small fragments of stored, thin

Table 1. SERA AND NUMBERS OF SKIN SAMPLES TESTED

Blood group system	Sera (heat inactivated)	Titre of sera against red cells	No. of skin samples tested
Rh	anti-D (Pe)	128–256	8
	anti-D (Ba)	320	7
	anti-D (Wo)	2,000	1
	anti-C (Mi)	32–64	5
	anti-c (Ha)	256	5
	anti-E (Du)	128–256	2
MN	anti-M (Sh 1,325 human)	64–128	1
	anti-M (184 rabbit)	256	1
	anti-M (195 rabbit)	256	4
	anti-N (203 rabbit)	4–8	1
	anti-N (205 rabbit)	32	7
Lewis	anti-Le^{a} (Sh 969)	N	1
	anti-Le^{b} (Ba)	2	2
Lutheran	anti-Lu^{b} (Ro)	4–8	3
P	anti-P (Fl. human)	8–16	2
	anti-Tj^{a} (Pa)	32	3

split skin with crude trypsin[2]. The irregular shapes of the cells in these suspensions make direct agglutination tests unsuitable, and sufficiently large quantities of cells are not easily obtained for absorption tests.

In the tests, the cell suspensions were exposed to an equal volume of a specific grouping serum; the antigen corresponding to this serum was known to be on the skin donor's red cells. After washing to remove uncombined antibody, the epidermal cells were mixed with a 0·5 per cent suspension of red cells possessing the appropriate antigen, and the mixture was centrifuged gently to bring the cells into contact. In this way it was possible to detect the A antigen on epidermal cells, because anti-A formed a specific link between epidermal cells from group A donors and A red cells. No link was formed with B or O red cells. The agglutination is dependent on the theory that antibody molecules are bi- or multivalent, that is, that they have at least two receptors capable of combining with the antigen; in this instance, the antibody receptors combine with an antigen on an epidermal cell and another on a red cell. But, using Rh, MN, Lewis, Lutheran and P antisera and a number of skin samples, as shown in Table 1, it was not possible to demonstrate the presence of the corresponding antigens by means of mixed agglutination.

It should be mentioned that all the skin samples had been exposed to 0·5 per cent crude trypsin solution for one hour, since certain brands of trypsin are reported to be capable of destroying the M and N antigens on red cells[3]. Also, some of the sera available, especially anti-Le^{a} and anti-Le^{b}, were very weak.

Epidermal cell antigens are thought to be concerned in the immunological response to skin homografts; but the evidence suggests that the blood-group antigens may be of little or no importance, since in rabbits, previous injection with red cells failed to affect the response to skin grafts[4]. The inability to detect blood-group antigens, other than A and B, on human epidermal cells strongly suggests that even if surface antigens are involved in the homograft reaction in man, then iso-antigens, other than those common to red blood cells, must be responsible. The recent work of Billingham, Brent and Medawar[5] points to nuclear substances as the source of the antigenic stimulus.

We wish to thank Drs. I. Dunsford, P. L. Mollison, A. E. Mourant, R. R. Race and C. B. V. Walker for the grouping sera used in this work. Also, we would like to record our appreciation to Sister M. J. Davies and the staff of the Ear, Nose and Throat Theatre, Addenbrooke's Hospital, Cambridge, for their most helpful co-operation at all times.

The work was aided by a grant from the Nuffield Foundation and the Agricultural Research Council.

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Some Nitrogen-containing Disaccharides isolated from Human Blood-Group A Substance

IN an attempt to learn more of the detailed chemical structure of human blood-group substances and of the relationship of structure to serological specificity, the products of partial acid hydrolysis of these important biological materials are being examined. Preliminary observations on the isolation of five nitrogen-containing disaccharides from group A substance are reported here.

Human blood-group A substance (15 gm. nitrogen 5·4 per cent, fucose 20 per cent, hexosamine 35 per cent, electrophoretically homogeneous at *p*H 8) was prepared from ovarian cyst fluid (No. 203)[1]. The material was divided and heated as 1 per cent w/v solution at 100° in (*a*) 0·1 *N* hydrochloric acid for 3 hr. and (*b*) *N* hydrochloric acid for 30 min. The acid was removed by treatment with 'Deacidite *E*', the solution concentrated and passed through a charcoal - 'Celite' (1 : 1) column using water and water–ethanol mixtures as eluants. The individual fractions were examined by paper chromatography and the substances present distinguished by R_F values and colour reactions with various spray reagents. The fractions containing disaccharides with closely similar properties were combined and passed through cellulose columns using amyl alcohol/dioxan/water (15 : 3 : 2) as eluant. Homogeneity of the effluent was checked by paper chromatography using mainly butanol/pyridine/water (3 : 1 : 1) as solvent. The individual sugars of the disaccharide units were identified by chromatography after hydrolysis with acid.

Of the disaccharides liberated by the partial hydrolysis of A substance, the following nitrogen-containing materials have been recovered and in two instances completely identified with substances of known structure. The structure of the remaining three disaccharides is not yet fully established.

Disaccharide (1) was identical with the O-β-D-galactopyranosyl - (1→3) - N - acetyl - D - glucosamine (lacto-N-biose I) isolated from the 'Bifidus factor' of human milk[3]. Disaccharide (2) was identified with

O-β-D-galactopyranosyl-(1→4)-N-acetyl-D-glucosamine which had been obtained from meconium[3] and from hog gastric mucin[4]. Disaccharide (3) was composed of glucosamine and galactose and contained the latter sugar as a reducing end-unit. The chromatographic behaviour and general properties of (3) indicated that it was most probably identical with 'lacto-N-biose II' isolated from a tetrasaccharide unit in the oligosaccharide mixture of human milk and was therefore O-β-N-acetyl-D-glucosaminoyl-(1→3)-D-galactose[5]. Disaccharide (4) possessed a high dextrorotation, about $[\alpha]_D + 150°$, and contained galactosamine and galactose. After reduction with potassium borohydride and hydrolysis, compound (4) gave galactosamine and dulcitol. Disaccharide (5) contained fucose and glucosamine and was found to be readily split into its component sugars on heating in *N* acetic acid at 100°.

Under the mild conditions recommended by Wallenfels, alkaline triphenyltetrazolium chloride reagent[6] is rapidly reduced by disaccharides (3) and (4), a reactivity which indicates the absence of a substituent from the secondary hydroxyl group adjacent to the reducing group in each material[7].

On treatment with dilute alkali, disaccharides (1), (3) and (4) gave some free N-acetyl amino-sugar and the corresponding free chromogen[8], whereas (2) remained apparently unchanged; and disaccharide (5) and β-D-galactosyl-(1→6)-N-acetyl-D-glucosamine[9] formed chromogens without being decomposed into their component sugars.

When tested under similar conditions with benzidine–trichloroacetic acid reagent, the disaccharides developed different colours. Substances (1), (3) and (4) produced a very dark brown colour, disaccharide (2) gave a golden-yellow spot, while substance (5) and β-D-galactosyl-(1→6)-N-acetylglucosamine[10] yielded a brownish-red spot.

The chromatographic behaviour and certain general properties of disaccharide (4), therefore, point to it being O-α-N-acetyl-D-galactosaminoyl-(1→3)-galactose, and disaccharide (5) as most probably being L-fucosyl-(1→6)-N-acetyl-D-glucosamine.

Evidence that N-acetylgalactosamine plays a definite part in the chemical structure responsible for A specificity was obtained when it was shown[11] that the agglutination of group A cells by extracts of *Vicia cracca* seeds and lima beans was inhibited by that acetylated amino-sugar and even more strongly by α-methyl-N-acetylgalactosaminide (unpublished observation by Dr. W. M. Watkins). Kabat and Leskowitz[12], using a quantitative precipitation technique, likewise demonstrated that N-acetylgalactosamine partially inhibited the precipitation of A substance by human anti-A serum. It was also shown that an enzyme obtained from *Trichomonas foetus* which destroyed A substance was specifically inhibited by N-acetylgalactosamine and its methyl glycoside[13].

The examination of certain of the materials described above in agglutination inhibition tests using human anti-A serum or lima bean extract has shown that disaccharide (4) is considerably more active than is N-acetylgalactosamine or its methyl glycoside when tested under similar conditions. It seems probable, therefore, that O-α-N-acetyl-D-galactosaminoyl-(1→3)-galactose is a structure more closely associated with A specificity than any that has been identified so far.

We wish to thank Prof. R. Kuhn for specimens of lacto-N-biose I and galactosyl-(1→6)-N-acetylglucosamine, and Prof. P. György for a preparation of β-D-galactopyranosyl-(1→4)-N-acetylglucosamine.

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Extraction of Thyrotrophic Hormone from Human Pituitaries

So far as we are aware, thyrotrophic hormone has not been extracted from human pituitaries although pituitary tissue has been assayed for thyrotrophic hormone activity[1]. The amount of adrenocorticotrophic hormone stored in human pituitaries has been reported previously[2] and in this communication we present our findings with thyrotrophic hormone.

A total of twelve adult human pituitaries, divided into three batches of 3, 4 and 5 glands (see Table 1 for salient autopsy features), were extracted and assayed for thyrotrophic hormone activity. The pituitaries, none of which was from a case of a primary endocrine disorder, were stored whole in deep freeze until sufficient material had been collected.

The glands were cut into small pieces and triturated in a mortar for 10 min. with 0·9 per cent sodium chloride solution pre-chilled to 0° C. and a little coarse acid-washed sand until a fine pasty suspension resulted (10 ml. saline solution to 1·0 gm. wet weight of gland tissue). The suspension was centrifuged at 3,000 r.p.m. for 15 min. at 0° C. A second 0·9 per cent saline extraction of the residue was made and the two extracts combined. The *p*H was adjusted to 4·0 by addition of *N* hydrochloric acid and the slight precipitate was collected by centrifuging. This precipitate showed no thyrotrophic hormone activity and was discarded. Acetone pre-chilled to − 15° C. was added slowly to the supernatant solution to a final concentration of 75 per cent (v/v). After the mixture had stood for 1 hr. in the cold, it was centrifuged and the precipitated material washed with acetone and ether and dried *in vacuo* over phosphorus pentoxide.

The extracts were tested by the thyroid histology method of Junkmann and Schoeller[3] as modified by Heyl and Laqueur[4]. One Heyl–Laqueur unit of thyrotrophic activity is defined as the daily amount required to produce a definite histological change in the thyroid in 67 per cent of immature guinea pigs

Table 1. SUMMARY OF CASES USED FOR THYROTROPHIC HORMONE EXTRACTION

Batch No.	No. of glands	Sex	Age (years)	Autopsy diagnosis	Time of autopsy after death (hr.)
1	4	F	18	Chronic glomerulo-nephritis : cystitis : uræmia	3
		F	60	Mitral stenosis ; auricular fibrillation : auricular thrombus formation : embolism	2½
		F	49	Mitral stenosis (operation – valvotomy) : embolism : pericarditis	6
		M	74	Silicosis : broncho-pneumonia : cor pulmonale : tuberculous pericarditis and lymphadenitis	3
2	3	F	76	Megaloblastic anæmia : primary benign hypertension : gall-stones : empyema of gall-bladder	1½
		F	61	Bilateral renal calculi : bilateral pyonephrosis : uræmia	4
		F	58	Prolapsed disk : diffuse hepatic fibrosis : chronic pyelonephritis	5
3	5	M	57	Carcinoma bronchus : metastases in liver, lymph nodes, brain : purpura (hæmorrhage from stomach)	5
		M	56	Lobar pneumonia	2
		M	38	Carcinoma colon : metastases in lymph nodes and liver : obstructive jaundice	5
		F	16	Mitral stenosis : mural thrombus (left ventricle) : embolism	3
		M	59	Ulceration of rectum (perforation) : acute generalized peritonitis	6

Table 2. THYROTROPHIC HORMONE CONTENT OF HUMAN PITUITARIES

Batch No.	No. of glands	Total weight (mgm.)	Weight of dry powder extracted (mgm.)	Heyl–Laqueur μ/mgm. (approx.)	Total TSH in batch (Heyl–Laqueur units approx.)	Average Heyl–Laqueur units per gland (approx.)
1	4	2,614	205	0·25–0·5	51·25–102·5	13–26
2	3	2,075	110	0·5	55	18
3	5	2,814	81	1·0	81	16

(120–150 gm.) after 72 hr. (1 Heyl–Laqueur unit is equivalent to 1 Junkmann–Schoeller unit and is approximately equal to 0·1 I.U. thyrotrophic hormone). The intraperitoneal injection is divided into two equal daily doses on the first two days.

The results are presented in Table 2.

It would appear that the 'average' adult pituitary stores approximately 18 Heyl–Laqueur units of thyrotrophic hormone (about 2 I.U.) or about half the amount excreted in the urine *per diem* by some hypothyroid patients[5]. It is believed that in man this hormone and adrenocorticotrophic hormone are produced by the basophil cells of the anterior hypophysis, but the evidence for this is of an indirect nature and conclusive proof is still awaited. If thyrotrophic hormone and adrenocorticotrophic hormone are produced by the same cells, it seems likely that the degranulation of the basophils occurring as a result of stress[6,7] must have some influence on the yield of stored hormones from the gland. This is being investigated at present and the findings should add something to our knowledge of the reaction of the pituitary gland to stress.

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Alteration of the Duration of Action of Parathyroid Hormone after Partial Purification

THE earliest methods of assaying parathyroid hormone depended on its ability to cause a rise in the concentration of plasma calcium in normal dogs 16–18 hr. after injection[1]. Recently, Davies *et al.*[2] have described a method of assaying this calcium-mobilizing factor, utilizing the parathyroidectomized rat as the test animal. Following the subcutaneous injection of crude parathyroid extracts (or 'Parathormone', Eli Lilly) into such animals the concentration of plasma calcium begins to increase in 2–3 hr., reaches a peak in 14–18 hr. and remains elevated for a total of 32–40 hr. (Fig. 1). On the basis of these facts, Davies *et al.* suggested that an adequate assay could be achieved by measuring the calcium concentration immediately before, and 18 hr. after, the injection of the test material ; and comparing the change with that occurring in a similar group of animals given a standard preparation.

Using the assay method essentially as they describe, we have been able to confirm their work,

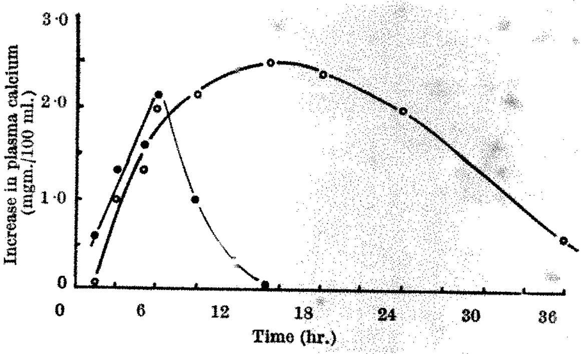

Fig. 1. The changes in plasma concentration of parathyroidectomized rats following the subcutaneous injection of 50 units 'Parathormone', Eli Lilly (○—○), and 0·5 mgm. of a partially purified gland extract (●—●). Each point represents the mean of eight to twelve determinations

and have found it quite adequate for assaying crude extracts prepared in a variety of ways. However, attempts to fractionate these crude extracts by several means resulted in a considerable or total loss of calcium-mobilizing activity when assessed in this manner. These apparently inactive preparations were shown to have considerable calcium-mobilizing activity when the plasma was analysed at 6 hr. rather than 18 hr. after the test injection. An investigation of the time-course of action of such preparations demonstrated that, after their subcutaneous injection, the concentration of plasma calcium begins to rise within 1–1½ hr., reaches a peak at 5–7 hr., and falls to control values in 12–14 hr. (Fig. 1). The duration of action can be prolonged if the material is suspended in arachis oil before injection.

This situation is reminiscent of that encountered in the purification of the corticotropins and is of at least three-fold importance: (1) Assay methods based on the increase in plasma calcium concentration 16–18 hr. after injection are probably unsuitable for assessing the purity of hormonal preparations. (2) The findings of all previous studies based on such an assay method should be critically re-examined since a reported loss of activity may well have been a conversion of a long-acting into a short-acting hormone. (3) Until more is known, comparisons between the calcium-mobilizing to phosphorus-excreting potency of a given preparation are of questionable value, particularly if measured over different intervals of time, as has been the custom in the past.

Our rapidly acting parathyroid extracts have been prepared by several different methods. The most reliable to date has been initial extraction of a fat-free gland powder with 0·2 *N* hydrochloric acid, followed by ultra-filtration through a 'Visking' membrane, and then separation on a 'Dowex' 50 × 4 ion-exchange resin. The activity of such preparations when measured by means of a 6-hr. assay (similar in other details to that of Davies *et al.*) is 75–100 units/mgm. dry powder. The methods of preparation and assay are at present being developed and modified, and a more complete description will be published shortly.

This investigation was supported in part by a grant (*A*.1331) from the U.S. Public Health Service.

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Effect of Acetylcholine and Adenosine on Cardiac Cellular Potentials

WE have been impressed by the similarity of the effects of acetylcholine and adenosine on the membrane-resting and action potentials of guinea pig myocardial fibres. There are a number of reports of the effects of acetylcholine on the membrane-resting and action potentials of myocardial fibres[1-4]; but we have seen no report on the effects of adenosine or of their similarity to those of acetylcholine.

Our experimental method and apparatus were similar to those described previously[5]. Experimental error was reduced by recording from one single fibre throughout each experiment. The electrode remained in the one cell for periods up to 4½ hr. with no significant change in the membrane-resting and action potential. It was possible by this method to observe changes in the membrane-resting potential with an accuracy of ± 1·5 mV. (this limit was set by a combination of amplifier drift and spontaneous variations in the resting potential). The preparations were driven at a constant rate of 240 per min.

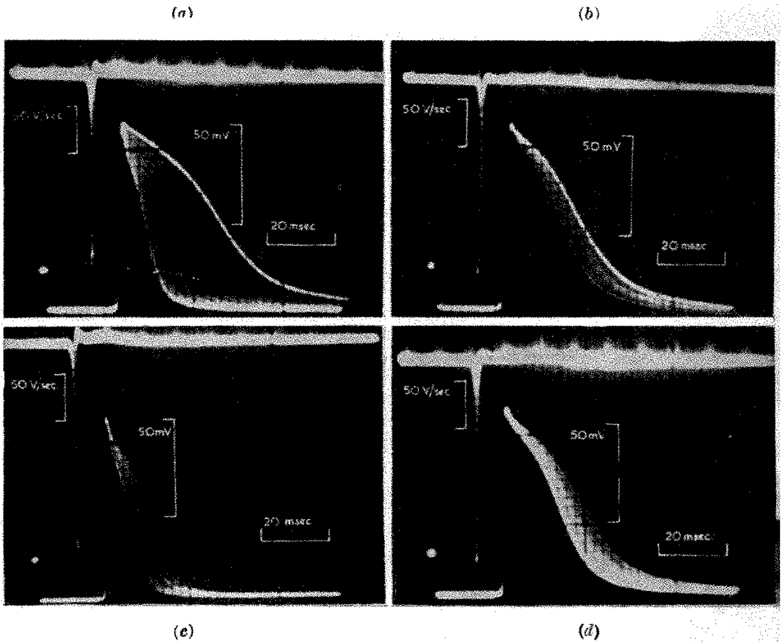

Fig. 1. The effects of acetylcholine and adenosine on the membrane action-potential of a guinea-pig atrial fibre. (*a*) Effect of 0·5 μgm./ml. of acetylcholine; (*b*) effect of 5 μgm./ml. of adenosine; (*c*) effect of 0·5 μgm./ml. of acetylcholine on the action potential already shortened by 50 μgm./ml. of adenosine; (*d*) effect of 50 μgm./ml. of adenosine alone. Upper trace in each illustration: first derivative of the action potential displaced to the left to prevent interference with the lower trace. Lower trace in each illustration: action potential. The above records were obtained from the same fibre and each record is a photograph of several successive action potentials and their first derivatives following the administration of the drug

In the atrium, adenosine (5–50 μgm./ml.) and acetylcholine (0·5–1 μgm./ml.) caused a pronounced increase in the rate of repolarization of the action potential without affecting its maximum rate of depolarization, conduction velocity, or the membrane-resting potential (see Figs. 1*a* and 1*b*). These effects rapidly disappeared after washing out the drugs.

The effects of acetylcholine but not those of adenosine were reversed or prevented by atropine sulphate (1 μgm./ml.). Furthermore, the effects of the two substances did not appear to be additive since the degree of acceleration of repolarization produced by a submaximal dose of acetylcholine was the same whether the acetylcholine acted alone or in conjunction with adenosine. Fig. 1*d* demonstrates the effect of 50 μgm./ml. of adenosine; acetylcholine (0·5 μgm./ml.) further increased the rate of repolarization (Fig. 1*c*) to the same degree as when given alone (Fig. 1*a*). These findings suggest that the two substances have different sites of action on the fundamental mechanisms responsible for the repolarization phase.

In the ventricle, concentrations of adenosine up to 50 μgm./ml. or of acetylcholine up to 2·5 μgm./ml. had no effect on the membrane-resting or action potential.

The effects of acetylcholine that we have found differ from those described by other workers[1,4], who find an increase in the resting potential of atrial fibres, with an increase in the maximum rate of depolarization and a reduction in the conduction velocity[4]. Apart from these exceptions, for which we have no explanation, the effects of acetylcholine which we report are essentially similar to those found by Hoffman and Suckling[2] and Woodbury and Brady[3].

It is of interest to note that Rand and Stafford[6], using the intact guinea pig heart *in situ*, have found a similarity in the effects of acetylcholine and adenosine; both substances block atrioventricular conduction and are potentiated by cardiac glycosides.

This research project was supported by the Life Insurance Medical Research Fund of Australia and New Zealand.

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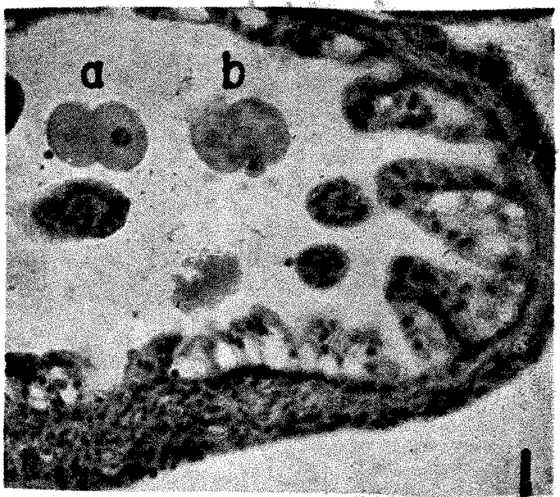
DL-Methionine (Sulphur-35) for labelling Unfertilized Mouse Eggs in Transplantation

IN transplanting mammalian eggs to a fertile female, one can distinguish the fœtuses developed from transplanted eggs among recipient 'native' fœtuses by a genetic marker. The transplanted fœtuses from a brown mouse, *C57BR*, have pigmented eyes, and the fœtuses developed from the native eggs of a Bagg albino (*B4LB/c*) recipient are not pigmented. Such a technique has been used for testing the survival of eggs after various treatments[1]. However, colour of eyes of mouse fœtuses cannot be observed until near the end of gestation. Labelling transplanted eggs with a radioactive isotope would serve as a means of distinguishing these eggs from native ones. The investigator could then determine the effect of any treatment of these eggs *in vitro* upon their fertilizability and early embryonic development after transplantation. Recent results obtained support the application of such a method.

Unfertilized mouse eggs were labelled with DL-methionine (sulphur-35) while they were in the growing follicles. In all instances 30–45-day-old *C57BR* females were donors of eggs. Ovulation was induced by injecting intraperitoneally 2 I.U. of equine gonadotropin 60 hr., and 4 I.U. of human chorionic gonadotropin 13–14 hr. before the eggs were collected. Developing eggs were labelled *in vivo* by an intraperitoneal injection of 25 μc. of DL-methionine (sulphur-35) 4–8 hr. after the female received equine gonadotropin.



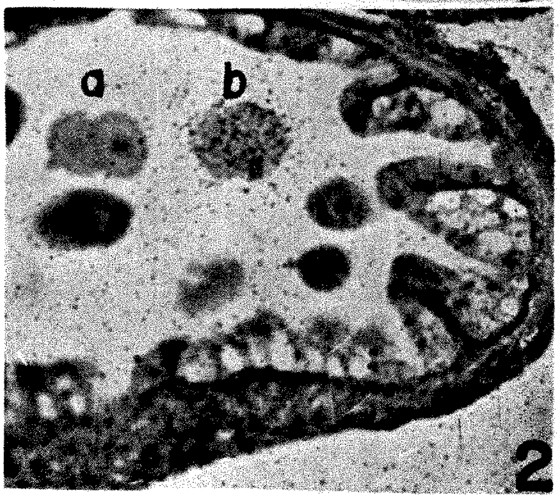


Fig. 1. Section of oviduct of recipient mouse containing two eggs (*a* and *b*) at two-celled stage. (× 185)

Fig. 2. The corresponding autoradiograph. Note radioactivity is present only in transferred egg, *b*. (× 185)

Subsequent to ovulation, tagged, unfertilized eggs were treated as follows: (1) Ampullæ with eggs were excised, fixed and sectioned for autoradiographical examination[2,3]. Radioactivity was found in the cytoplasm of all eggs thus examined and in the granulosa tissue surrounding them. (2) Some eggs were removed from the ampullæ, mounted on a copper planchet, and mixed with a gelatin solution[4] for activity assay in a flowing gas counter. The radioactivity of a dry mount of 35 labelled eggs was 29·1 counts per min. (3) Another group of eggs was recovered from the ampullæ and transferred into the bursa ovarii[5] of fertile Bagg albino females which had been mated 1 hr. earlier. These eggs, fertilized in the recipients, were allowed to develop during the gestation period in order to ascertain whether or not the radioactivity in the tagging technique was detrimental. Such eggs were observed to result in normal progeny. (4) Some eggs were transferred into fertile mated recipients, and their oviducts prepared for autoradiographical examination. Results indicated that, during superovulation, mice can receive 25 μc. DL-methionine (sulphur-35) intraperitoneally with little, if any, effect upon survival of their eggs. Occasionally a radioactive egg was found in a state of degeneration. However, as evidenced by eye colour, nine normal fœtuses resulted from the transplantation of twenty-nine labelled eggs into four recipients. In one case four brown young, which had developed from labelled eggs, were born.

The method described above permits the labelling of unfertilized mouse eggs with DL-methionine (sulphur-35) for their subsequent identification during early embryonic development. Successful application of this method is illustrated in Figs. 1 and 2. Fig. 1 shows a section of the oviduct of a recipient with two eggs at the two-celled stage. One egg, *a*, was natively ovulated and unlabelled, and the other egg, *b*, was radioactive and was transferred from an isotope-treated donor while it was unfertilized. These two eggs can be identified in the corresponding autoradiograph (Fig. 2), in which radioactivity is indicated only in egg *b*.

The assistance of Drs. R. A. Bomstein and J. K. Sherman is gratefully acknowledged.

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Precursors of Embryonic Chick Proteins

WE wish to report some preliminary findings obtained in the course of a rather extensive investigation into the nature of precursors of embryonic chick proteins (for some recent reviews, see refs. 1 and 2). In these experiments, amino-acids, chicken serum globulin and ovalbumin, labelled in their sulphur amino-acids with sulphur-35, were prepared. *Torulopsis utilis* was grown on sulphur-35 sulphate (obtained from Oak Ridge National Laboratory), according to Wood and Perkinson[3]; after extracting the yeast protein with organic solvents[4] it was hydrolysed with a 1 : 1 mixture of 6 *N* hydrochloric acid and 90 per cent formic acid. The humin was removed by centrifugation, and a portion of the neutralized hydrolysate corresponding to 50 mc. of the original sulphur-35 sulphate was injected intraperitoneally into a laying White Leghorn hen in two doses, about five hours apart. Eight hours after the second injection the blood was withdrawn by heart puncture, allowed to clot and serum globulin prepared[5]. The oviduct was removed from the hen and ovalbumin prepared essentially as described by Steinberg and Anfinsen[6]. Both proteins were treated with cysteine at a *p*H of 8·0–8·5 to assure removal of all exchangeable sulphur-35, and were afterwards dialysed. Peptides were prepared by peptic hydrolysis[7] of the ovalbumin and of the serum globulin. Aliquots of the radioactive amino-acids, ovalbumin, ovalbumin peptides, serum globulin or serum globulin peptides were counted as described for proteins, peptides and amino-acids[7]. Others were injected into the yolks of unincubated, embryonated White Rock eggs. The eggs were first swabbed with 70 per cent ethanol at the place to be injected; a small hole was made in the side of the egg, and 0·05–0·1 ml. of the radioactive solution containing 0·3–1·8 mgm. and 6,000–25,000 counts per min. was injected into the yolk. The hole was immediately sealed with paraffin, and the eggs were incubated at 38° C. under conditions of controlled humidity. Two to three dozen eggs were normally injected with one of the protein precursors. Starting with the fifth and ending on the ninth day after the injection, embryos were harvested and a number pooled. The mixture was homogenized for about 3 min. in a Potter–Elvehjem homogenizer in Ringer's or isotonic saline solution, made up to either 10 ml. (fifth and sixth days) or 20 ml. (seventh–ninth days) and precipitated by the addition of 40 per cent trichloroacetic acid, to a final concentration of 8 per cent. Dry protein powders were then prepared and counted to within 5 per cent of standard deviation, corrections for self-absorption and decay being made in each case[7].

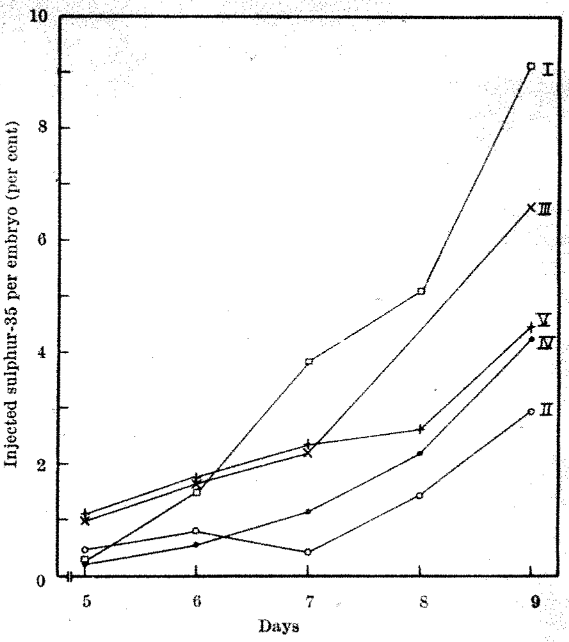

Fig. 1. I, Amino-acids; II, ovalbumin; III, ovalbumin peptides; IV, globulin peptides; V, serum globulin

The results of these experiments are presented in Fig. 1. It is apparent from the curves that over the period investigated there is, within our experimental error, no gross difference (an order of magnitude, or more) in the percentage of the injected protein precursor found per embryo. When one considers, however, that the protein injected is diluted with at least a portion of the yolk protein, approximately 3 gm. total[8], while the amino-acids and peptides are essentially not diluted at all since there are only negligible, if any, amino-acid or peptide pools in the yolk[8], one must conclude that proteins are the preferred precursors of embryonic protein. Furthermore, it is interesting to note that the egg protein ovalbumin is not used to any greater extent than the somewhat more 'foreign' protein serum globulin. This would indicate that these proteins are assimilated by the embryo by pathways having at least some intermediates in common. A similar interpretation might be made with respect to our peptide data.

Free amino-acids, if these were the true intermediates, would be expected to give much higher incorporation values in our experiments with injected sulphur-35 amino-acids than those actually observed. It is therefore tempting to conclude that the intermediates are either 'activated' amino-acids (or small peptides) (which are, on thermodynamic grounds, preferentially derived from protein) or that the processes of breakdown of injected protein and protein synthesis take place at two sites in such close proximity as to preclude any appreciable equilibration with injected amino-acids. The latter interpretation would be in accord with those recently suggested by Lotfield and Harris[9] and by Walter *et al.*[7] for other systems. However, it is not unreasonable to assume that proteolytic activity is largely centred in the yolk[10] and is therefore physically separate from the anabolism taking place in the embryo proper. Thus, our view at present is that the intermediates are activated forms of amino-acids directly derivable from proteins[11] and that added amino-acids and peptides join the common pathways at this junction.

This work was supported by Grant No. *H*2177 of the National Heart Institute, National Institutes of Health.

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Histochemical Appearances of Cholinesterase in the Submaxillary and Sublingual Salivary Glands of the Rat

DESPITE the researches of Babkin[1] and others, no definite conclusions have been reached with regard to the relative part played by the sympathetic and parasympathetic nerve fibres in the regulation of salivary secretion or the exact mode of termination of the fibres in the vicinity of the secretory units of the glands. It was considered that a histochemical study of the distribution of cholinesterase in the submaxillary and sublingual salivary glands of the rat might shed light on the problem.

Twenty-two mature rats were used for the present investigation. Parts of the submaxillary and sublingual glands were processed at the same time under identical conditions. The glands were fixed in 10 per cent formol saline for 6 hr. Frozen sections 10–25μ thick were then cut and washed in distilled water for 12 hr. These sections were then processed using the histochemical technique described by Koelle[2] and modified by Couteaux and Cöers[3]. The sections were incubated with the substrate for 12, 24, 36, 48 and 96 hr. at *p*H 4·2. The cholinesterase appearances in the salivary glands were assessed by studying the concentration and distribution of the copper sulphide precipitate formed. Hæmatoxylin and eosin or toluidine blue were used as counterstains.

In order to distinguish between the cholinesterase group of enzymes and the other esterases a number of the gland sections were treated with incubating solutions also containing 3×10^{-5} *M* concentrations of eserine. An attempt was made to distinguish between true and pseudo cholinesterase by using acetyl thiocholine iodide and butyl thiocholine chloride as substrates. In addition 10^{-6} *M* concentrations of di-isopropylfluorophosphate and 3×10^{-5} *M* concentration of 1-5-*bis* (4 allyldimethylammonium phenyl) pentan-3-one dibromide were used as inhibitors.

In the submaxillary gland, after 12 hr. incubation with acetyl thiocholine iodide, cholinesterase was found to be present in the nerve trunks accompanying the interlobular ducts. In those sections which were incubated for 24 hr. cholinesterase was present in the form of a fine network around the outside of the acini, which in places united with the nerve trunks. No cholinesterase was seen in the acinar cells; but a small amount was present in the nuclei and cytoplasm of many of the duct cells. No cholinesterase was found in the sections of the submaxillary glands incubated with butyl thiocholine chloride.

The inhibitors gave the following results. Eserine completely inhibited all enzyme activity in the submaxillary salivary gland. The sections treated with 1-5-*bis* (4 allyldimethylammonium phenyl) pentan-3-one dibromide showed complete absence of the cholinesterase network around the acini and the concentration of the enzyme in the nerve trunks was considerably reduced. Cholinesterase was no longer visible in the duct cells. The sections treated with di-isopropylfluorophosphate showed complete absence of cholinesterase, indicating that the concentration used completely inhibited both the true and pseudo cholinesterase activity.

In the sublingual gland, after 12 hr. incubation with acetyl thiocholine iodide, cholinesterase was present in the nerve trunks but was less concentrated than that seen in the nerves of the submaxillary gland. In the sections which were incubated for 48 and 96 hr. cholinesterase was seen to be present as a faint network around the acini, which had a similar appearance to that seen in the submaxillary gland; but the concentration of the enzyme was again very much less. No cholinesterase was found in the acinar cells; but a small amount was present in the nuclei and cytoplasm of many of the duct cells. No cholinesterase was found in the sections of the sublingual gland incubated with butyl thiocholine chloride. The effect produced by the different inhibitors was identical to that seen with the submaxillary gland.

These preliminary observations show that in the submaxillary and sublingual glands a small amount of true cholinesterase is present in the nuclei and cytoplasm of the duct cells but is absent from the acinar cells. In addition, they show that true cholinesterase is present in the form of a fine network around the acini of both glands but is much less evident around the acini of the sublingual gland. The fact that the net unites with the nerve trunks would suggest that it is formed of nerve fibres which contain true cholinesterase. Koelle[4] found in the cat, rabbit and rhesus monkey that the concentration of true cholinesterase was higher in cholinergic neurones than in adrenergic and sensory neurones. The present results indicate that the acini of the submaxillary gland of the rat are supplied with a high proportion of cholinergic nerve fibres whereas those of the sublingual gland are supplied with nerve fibres containing a low concentration of cholinesterase and are thus possibly adrenergic.

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Vascular Compartments in the Rat Spleen

INJECTION of radiopaque media either directly into the spleen of the rat or retrogradely into tributaries of the portal venous system, followed by radiography, demonstrates the presence of distinct vascular compartments in the spleen and clarifies certain features of their venous drainage.

Previous evidence for this subdivision in the spleens of other mammals has been based on the following grounds.

(1) *Morphological*—(*a*) the arrangement of the splenic vessels into five or more pedicles which enter the spleen at fairly regular intervals; (*b*) the notched border of the spleen; (*c*) the occasional presence of accessory spleniculi.

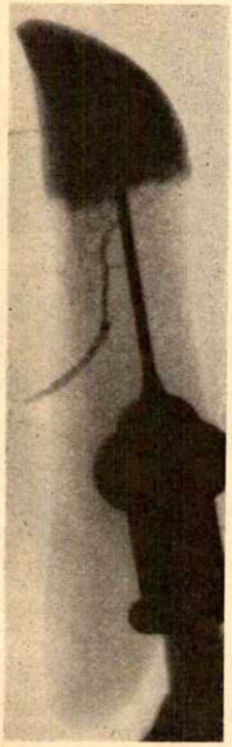

Fig. 1. Radiograph taken immediately after injecting 0·36 ml. 'Thorotrast' into the upper compartment of the rat spleen. (× 2)

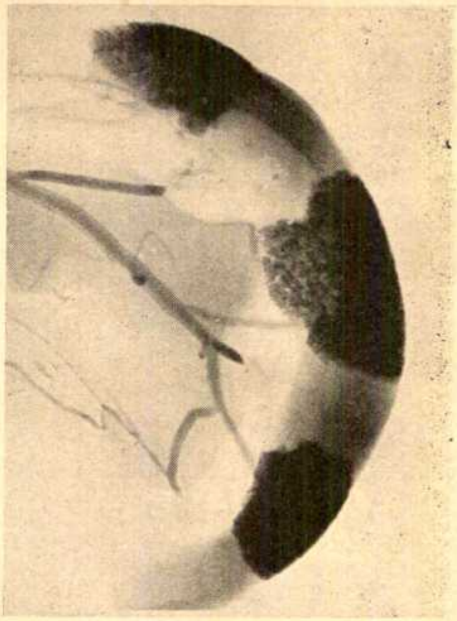

Fig. 2. Radiograph taken 30 sec. after injecting 3 ml. 'Micropaque' into the superior mesenteric vein. Alternate splenic vessels were interrupted before injection. (× 2)

(2) *Embryological*—the fact that the spleen develops from several primordia in the dorsal mesogastrium.

(3) *Stimulation Experiments* (in the dog). Electrode stimulation of one vascular pedicle results in a localized contraction of a single zone.

(4) *Pathological*—the localized areas of infarction following vessel occlusion.

Recently, Dreyer and Budtz-Olsen[1] have suggested that there may be compartments in the human spleen. Their evidence is that a radiopaque medium injected into one zone of the spleen is drained by the nearest vein without diffusion through the splenic parenchyma.

We have studied the passage of media in more than a hundred living rats, taking radiographs during injection and at varying intervals after. To obviate injection artefacts we have also undertaken similar procedures on the spleen of dead animals.

The splenic compartments in the rat vary in number between five and seven, of which the largest is the middle. Each is supplied by a branch of the splenic artery and drained by a tributary of the splenic vein.

Direct injection into the spleen of small amounts (0·06–0·18 ml.) of a radiopaque medium such as 'Thorotrast' or 'Micropaque' (Damancy and Co., Ltd.) is followed immediately by drainage through the vein of that compartment and is complete after 10–15 min. If the compartment becomes overloaded by an excess of injection mass additional drainage is afforded by the intersegmental vein (Fig. 1), which links together the veins of the individual compartments. There is no diffusion between pulp spaces of adjacent compartments for no direct communication exists between them. Obstruction of the compartmental vein is followed by opening up of the intersegmental vein, which constitutes the collateral channel. Interruption of alternate veins followed by retrograde injection into a tributary of the portal vein demonstrates the splenic compartments most effectively (Fig. 2) and indicates their relative sizes.

It is therefore presumed that since each compartment has an independent arterial supply and venous drainage it may be capable of independent activity and only when the blood supply to the spleen is excessive does the organ function as a complete entity. A pre-requisite for such activity is the opening up of the intersegmental vein, which integrates the venous drainage for all compartments.

Preliminary studies on the arterial arrangements strengthen this concept. The results will be published in full elsewhere.

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Biochemical Tests for Malignancy applied to a New Strain of Human Cells

TRANSFORMATIONS of normal cells of rats and mice into malignant strains have been reported to occur under tissue culture conditions on a few occasions[1], and in such cases it was possible to demonstrate their malignancy by inoculation into the appropriate animal strains. During tissue-culture experiments with human cells, an abnormal strain appeared in roller-tubes of liver cells from a 20-week embryo. The new strain showed some of the characteristics of malignant cells, and we had to rely on biochemical tests to obtain further evidence of their malignancy.

We used for the comparative tests human embryonic cells from skin, kidney and lung tissues and three carcinoma strains which originated from human tumours: these latter are the *HeLa* strain and strain *HEP* 1, both of which came from cervical epidermoid carcinoma, and strain *HEP* 2, which came from an epidermoid tumour of the larynx of a man. The new strain (designated *HLM*) is distinguished by morphology, cell mass and protein content from the carcinoma strains. All the cells were grown from cell suspensions in a medium consisting of modified Connaught medium 858[2], 5 per cent chick embryo extract and 20 per cent human serum.

Deoxyribonucleic acid phosphorus was determined, and hæmocytometer counts were made on suspensions of nuclei from the skin fibroblasts, the carcinoma strains and strain *HLM*. The deoxyribonucleic acid phosphorus content per nucleus (Table 1) was of the normal diploid value[3] for the skin cells, but gave tetraploid values for the carcinoma cells and strain *HLM*. Chromosome counts and deoxyribonucleic acid determinations made by other investigators indicate that a tetraploid nucleus may be a consistent feature of human and animal carcinoma cells (cf. ref. 4).

Table 2. COMPARISON OF METABOLIC QUOTIENTS IN TERMS OF CELL NUMBER FOR HUMAN LEUCOCYTES, AND EMBRYONIC AND CARCINOMA CELLS

Cells	Reference	µmoles per 10^9 cells per hr.	
		Q (Glucose consumed)	*Q* (Lactic acid produced)
Normal leucocytes	Beck and Valentine (ref. 8)	140	301
Chronic myelocytic leukæmia		52	127
Chronic lymphocytic leukæmia		31	48
Human embryonic cells	Leslie, Fulton and Sinclair	121	187
Human carcinoma cells		77	70

The metabolic quotients (Tables 1 and 2) have been obtained by relating glucose consumption and lactic- and keto-acid production over 72-hr. growth periods to the corresponding average amount of nucleic acid phosphorus or to the average cell number. The latter values were based on measurements of ribonucleic acid phosphorus and deoxyribonucleic acid phosphorus in sets of replicate tubes sampled at the start and finish of the tests.

Although the embryonic cells are widely different in origin and morphology, their quotients for glucose consumption and total acid production (that is, lactic- and keto-acids combined) are closely similar to one another and considerably higher than the group of values for the carcinoma cells and strain *HLM* (Table 1). That high glycolytic activity is common to both these rapidly multiplying embryonic and malignant cells grown under aerobic conditions is in keeping with the views of Weinhouse[5] and runs contrary to those of Warburg[6]. When insulin was present in the medium at a concentration of 0·1 unit per ml., ribonucleic acid phosphorus formation was stimulated in all cell types, but with embryonic cells the metabolic quotients were decreased relative to the control values, while with the carcinoma cells and strain *HLM* they were larger than the control values. In this connexion, Woods *et al.*[7] have shown that insulin stimulated anaerobic glycolysis in mouse melanoma slices but produced no response in brain slices.

The results in Table 1 clearly show that strain *HLM* belongs to the malignant group. The differences in glycolytic activity are features which distinguish other normal and malignant human cells. This is seen in Table 2, where we have compiled, on the same 'per cell' basis, the values obtained by Beck and Valentine[8] for the glycolytic activity of suspensions of normal and leukæmic human leucocytes in mano-

Table 1. DISTINGUISHING FEATURES FOR HUMAN EMBRYONIC AND MALIGNANT CELLS

Distinguishing features	Experiments	Units	Mean values and standard errors for the different cell types		
			Human embryonic cells	Human carcinoma strains	New strain *HLM*
Deoxyribonucleic acid phosphorus per nucleus	Normal medium	µgm. deoxyribonucleic acid phosphorus per million nuclei	0 69 ± 0·03	1·39 ± 0 04	1·43 ± 0 04
Q (Glucose consumed)	All tests Control Insulin	µmoles per mgm nucleic acid phosphorus per hr.	67·2 ± 2·60 61·8 ± 1·98 57·8 ± 1 00	18 4 ± 0 50 19 1 ± 0·19 26 3 ± 0 42	20·2 20·2 24·9
Q (Total acid produced)	All tests Control Insulin	µmoles per mgm. nucleic acid phosphorus per hr.	108·2 ± 3 9 100·0 ± 5·4 86·0 ± 3·6	16·6 ± 1 31 19·0 ± 1·21 27·2 ± 1·72	22·5 22·5 32·9

metric vessels and those we have obtained with embryonic and carcinoma cells by tissue culture procedures. The rates of glucose consumption and lactic acid production are of the same order for embryonic cells and normal leucocytes and are greater in each case than the values for the corresponding malignant cells.

A detailed account of this work is being prepared for publication. We wish to thank Dr. F. W. Sheffield, Department of Bacteriology, University College, London, and Dr. Alice E. Moore, Sloan-Kettering Institute for Cancer Research, New York, for kindly sending us the *HeLa*, and the *HEP* 1 and 2 strains respectively. One of us (W. C. F.) wishes to acknowledge the award of a grant by the Medical Research Council.

Note added in proof. The transformation of tissue culture lines of human epithelial cells to neoplastic forms has recently been established by cytological and inoculation techniques[9].

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An Apparatus for eluting and concentrating Chromatogram Spots

A MAJOR problem in toxicological analysis is the separation of the poison from metabolites and body constituents that are co-extracted. This problem is especially acute in cases of poisoning by alkaloids. One technique that is of great use in solving this problem is paper chromatography[1-3]. The next step in the analysis is the identification of the alkaloid by such techniques as ultra-violet spectrophotometry, micro-colour tests and observations of the form of crystals obtained with various reagents. Recently, Clarke and Williams[4] have described a technique whereby 0·05 ml. of a solution containing 50 μgm. of alkaloid provides sufficient material for five hundred separate micro-colour and crystal tests. This quantity of alkaloid (50 μgm.) is about the amount most suited for initial purification by paper chromatography. We have, however, found difficulty in eluting the alkaloid from the chromatogram and concentrating the eluate into 0·05 ml. of solution without loss of alkaloid. A simple and highly efficient apparatus for accomplishing this operation is shown in Fig. 1.

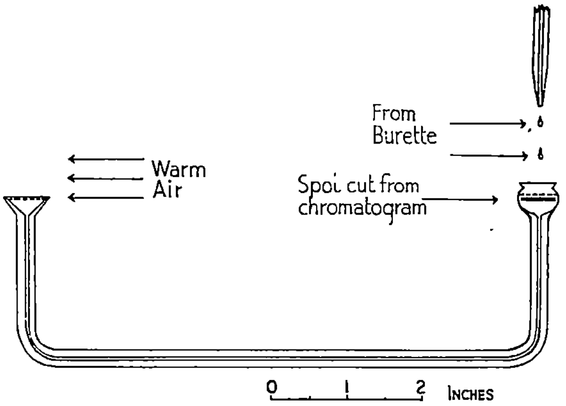

Fig. 1

The apparatus consists of a length of 1-mm. bore capillary tubing the ends of which are blown into small bulbs. The tubing is then bent as shown in the diagram. The spot cut from the paper is put in the larger right-hand cup and alcohol is dropped on to it from a burette, or siphoned on from a constant-head reservoir levelled with the solvent in the apparatus. An electric hair-drier blows a stream of warm air over the left-hand cup and as evaporation proceeds the paper spot is constantly washed by the addition of fresh alcohol. Concentration of eluted alkaloid occurs in the left-hand cup.

Experiments with spirit-soluble dye have shown that back-diffusion is negligible. While 50 μgm. of strychnine from a chromatogram run in butanol–acetic acid was quantitatively recovered and concentrated into 0·1 ml. using this apparatus, only 49 per cent of 50 μgm. of strychnine on a similar spot was recovered by soaking the paper in 5 ml. of alcohol for 5 hr. Quantitative measurements were by ultra-violet spectrophotometry.

Many alkaloids have an extremely low absorption in the ultra-violet. Atropine, for example, has peaks with E (1 per cent, 1 cm.) approximately 5. Nevertheless, if 100 μgm. of atropine can be concentrated into 0·5 ml. then optical density values of 0·1 will be obtained. This apparatus, coupled with paper chromatography and the use of micro cells for ultra-violet spectrophotometry, enables accurate measurements to be made for such alkaloids.

We have found it advantageous to concentrate the eluate in two stages ; first, into a volume of approximately 0·15 ml. and, secondly, using a micro-scale version of the apparatus, into approximately 0·05 ml.

The technique can obviously not be used for alkaloids run on a buffered paper chromatogram[3], but where butanol–acetic acid solvents have been used alcohol is an ideal eluent. The rate of evaporation is such that complete solvent exchange (approximately 1·0 ml.) in the apparatus is achieved in approximately 20 min. The rate of extraction depends on the compound. To achieve complete extraction we find it best to evaporate for approximately three hours, then to allow the paper to soak overnight and to evaporate for a further three hours the following morning.

This technique is obviously applicable to other problems requiring micro-continuous extraction and concentration. We hope to show further uses of it in forensic chemistry.

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Pharmacological Inhibition of Acetylcholine Synthesis

SCHUELER[1] has designated as the "hemicholiniums" a series of quaternary bases[2] which exhibit an unusual kind of toxicity. Chemically they are characterized by the incorporation of a choline (or choline-like) moiety into a six-membered ring through hemiacetal formation. Their most striking pharmacological action is respiratory paralysis: this is central in origin and late in onset, and when the dose is not too large can be prevented by the administration of either eserine or choline. Schueler noted that hemicholinium intoxication presents several features reminiscent of poisoning by botulinus or tetanus toxin, and suggested that it might be due to interference with some cholinergic mechanism. We thought that a substance having such effects might be a specific poison of acetylcholine synthesis, and through Dr. Schueler's kindness we have been able to verify this notion with compound No. 3 of his series, here called *HC*3.

*HC*3 (2×10^{-5} *M*), added to the eserinized plasma perfusing a cat's superior cervical ganglion, did not affect the rate at which acetylcholine was released into the perfusion fluid during repetitive stimulation of the preganglionic nerve trunk for 1–2 min. With more prolonged stimulation, however, the rate of acetylcholine release rapidly declined, and coincidentally the ganglion lost its ability to transmit impulses and also most of its store of preformed acetylcholine. The acetylcholine synthesized by a ganglion during an hour's stimulation at 20/sec. was reckoned by comparing its residual acetylcholine content with that of its unperfused fellow and correcting for the acetylcholine discharged into the perfusion fluid. In five experiments with *HC*3 the amount synthesized was $0{\cdot}10 \pm 0{\cdot}09$ μgm. (mean ± S.D.), and in five experiments without the drug it was $1{\cdot}21 \pm 0{\cdot}17$ μgm. The effects of *HC*3 could be antagonized by raising the choline content of the perfused plasma. When the ganglion was stimulated during perfusion with eserinized Locke's solution instead of with plasma, it synthesized acetylcholine much more slowly, and synthesis was still further reduced if *HC*3 was present, or alternatively, if the concentration of eserine was increased. Evidence that eserine may interfere with acetylcholine synthesis has already been presented by Perry[3] and by Shelley[4].

Analogous results were obtained with *HC*3 in experiments on mouse brain, minced and incubated in eserinized bicarbonate–Locke as described by Mann *et al.*[5]. Under our experimental conditions this preparation synthesized acetylcholine at the rate of about 11 μgm./gm. (wet weight) in 4 hr.; *HC*3 (10^{-4} *M*) diminished the synthesis by at least 75 per cent; choline increased the synthesis and partly (2×10^{-5} *M*) or wholly (10^{-3} *M*) reversed the inhibitory effect of *HC*3. The release of acetylcholine from tissue to medium, which proceeded slowly throughout the period of incubation, appeared to be unaffected by *HC*3 or by choline, except in so far as the level of bound acetylcholine was altered.

*HC*3 was tested for its ability to inhibit the synthesis of acetylcholine by an extract of acetone-dried rat brain powder in a medium containing choline (10^{-2}–10^{-5} *M*), acetyl–coenzyme *A* (2×10^{-4} *M*) and cysteine (2×10^{-4} *M*). In this system it also acted as an inhibitor and its effect was again antagonized by choline; but its action was here so weak (for example, about 50 per cent inhibition by 10^{-3} *M* *HC*3 in the presence of 10^{-4} or 10^{-5} *M* choline) as to seem unrelated to its pharmacological activity. It is unlikely, furthermore, that *HC*3 acts by preventing the acetylation of coenzyme *A*: for (*a*) such an action might be expected to interfere with many essential metabolic processes, whereas the toxic effect of *HC*3 appears to be highly specific; and (*b*) we have found that the ability of homogenized pigeon liver to acetylate sulphanilamide, which depends on coenzyme *A*[6], is well maintained in the presence of 10^{-2} *M* *HC*3. It is conceivable that *HC*3 acts on intact nervous tissue by poisoning choline acetylase (that is, the enzyme that transfers acetyl groups from acetyl-coenzyme *A* to choline), but that the enzyme on being extracted from tissue becomes less susceptible to poisoning by *HC*3. An alternative explanation would be that *HC*3, and other hemicholiniums, may compete with choline for transport by a specific carrier system to intraneuronal sites of acetylation.

This work was supported by grants from the National Research Council of Canada and the Defence Research Board of Canada. We wish to thank our colleague Prof. A. S. V. Burgen for his advice.

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Chromatography and Spectrophotometry of Fused Salts

WE have recently observed chromatographic adsorption on alumina (Merck's reagent grade aluminium oxide) of transition metal cations dissolved in fused salts.

Solutions of Fe^{+++}, Co^{++}, Ni^{++}, Cu^{++}, UO_2^{++} in lithium-potassium nitrate eutectic mixture (lithium-potassium nitrate, 43 mol. per cent lithium nitrate, m.p. 132° C.) were placed in a jacketed 'Pyrex' tube (10 mm. internal diameter, 20 cm. long) filled to a height of 10 cm. with alumina. The temperature of the tube was maintained at 150° C. by circulating silicone oil ('Dow-Corning 710') through the jacket. The solutions were all approximately 0·01 *M* with respect to the transition metals and had been prepared by dissolving appropriate amounts of the anhydrous chlorides in lithium-potassium nitrate. All the transition metal cations listed are adsorbed on the column. They may be eluted with lithium-potassium nitrate containing the complex-forming anions Cl^-, $SO_2^{=}$, or CN^-. We are investigating the elution properties as a function of the particular complexing anion, its concentration and the temperature of operation of the column.

Essentially similar observations have been made using anhydrous ammonium formate (m.p. 118° C.) as a solvent.

In order to gain a better understanding of the nature and stability of the complexes formed, we are carrying out studies with a Beckman spectrophotometer which has been adapted for use at elevated temperatures in the following way: the usual Beckman compartment has been replaced by one through which cooling water may be circulated. The cell holder consists of a brass block with internal channels through which hot silicone oil is circulated from a constant-temperature bath. The usual 1-cm. 'Corex' absorption cells are used for containing the lithium-potassium nitrate solutions, care being taken not to allow the solutions to solidify in the cells to prevent cracking.

Marked changes have been observed in the spectra of the transition metal ions on addition of Cl^-, $SO_2^=$, or CN^-. The interpretation of these data in terms of stability constants for the various complexes formed will be published in detail elsewhere. These studies are being carried out over a range of temperatures to yield information on heats and entropies of formation of the complexes.

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Barbulation induced in Silky Plumage by Thyroxine

A PECULIARITY of 'Silky' plumage in poultry is the absence of barbules in the main vane of the body feathers so that adjacent barbs lie free instead of interlocked, as is the case in the usual breeds. The trait behaves as a simple recessive, occurring only occasionally in other fowl[1]. However, a fairly comparable state of feathering is developed in the common fowl when these are thyroidectomized[2], or if they are treated with one of the goitrogens[3]. In such experimental fowl, the barbules are undeveloped and the individually separate barbs tend to become gradually more delicate and soft. These similarities suggest that the site of effect of the Silky gene is the feather itself, which will not respond at all to the thyroid hormone; or that in the presence of the Silky gene, the thyroid output is inadequate for full control of a possible normal differentiation.

Administrations of thyroxine (thyroxine crystals, Squibb, in distilled water) were made to Silky fowl of both sexes during enforced feather regeneration in test of these questions. Three male and three female Silkies were deplumed regionally and, upon evidence of new feather growth, injected subcutaneously with 0·5, 0·75 and 1·5 mgm. thyroxine, given as a single dose. The first two levels were ineffective; the third gave an evident, although peculiar, response. The barb segments showing an effect were swollen, sometimes forked and barbulated. Some attempts of sporadic barbules to differentiate hooklets were seen; these were atypical, ribbon-like formations. Several difficulties were encountered in the first series of experiments, the regeneration was extremely spotty and slow, and the new plumage was very delicate and readily injured. A later series of tests were made using the same birds and after allowing a rest period of six months. Here a single injection of 0·5 mgm. thyroxine was given to all birds at the time of defeathering; it was followed one week later with a second single dose of 2·0 mgm. With this treatment, regeneration was very prompt and fairly regular, and a good response to the 2·0-mgm. dose was everywhere encountered. The zone of feather barbs growing at the time of the second injection formed barbules that were distally modified in the usual manner. The body feather of the Silky fowl is accordingly capable of a differentiation beyond that characteristically achieved, and it will do so in presence of elevated thyroxine titres.

The male Silkies gave a somewhat better structural feather reaction than did the females; the general condition of all the birds was wholly unaffected to casual inspection and continued good. On a body-weight basis, the Silky fowl, the male especially, seems more tolerant of thyroxine than is the Brown Leghorn; this may be a general condition of which the resistance of the feather is a special instance. However, we know little of the normal thyroid performance in Silkies; it is hoped some observations in this respect may be available when the present material is submitted elsewhere in expanded, illustrated form.

I am indebted to Dr. Mary E. Rawles for a gift of the Silkies, and to Mr. Paul C. Harris for much kind assistance.

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Astaxanthin in the Muscle of Cod

ASTAXANTHIN is probably the most common pigment of marine organisms. It has been found in a variety of species from unicellular algae to fish; it is particularly the typical pigment of the crustaceans.

In fish it is fairly widely distributed in the chromatophores in the skin, but normally occurs in the flesh only of the salmon and related species. It is therefore of considerable interest to report for the first time the occurrence of astaxanthin in the flesh of one specimen of cod (*Gadus callarias* L.). When the number of 'normal' cod caught and distributed for human consumption is considered, the occurrence of pink-fleshed cod must be a rarity.

This particular specimen was bought on the fish market in the town of Drammen, Norway, last September, to be used in a cooking course. It was noted for the bright red colour of the flesh, which resembled the colour of salmon flesh. The fish was taken to the State Research Institute of Home Economics, Stabekk, which submitted it to this laboratory for investigation of the pigment. It has been verified by several zoologists that the fish was a true cod. The pigment was extracted with acetone, and the absorption spectrum of the solution was measured directly in a recording spectrophotometer. The absorption curve is shown in Fig. 1. It agrees well with previous values reported for astaxanthin. The pigment was transferred to ether and washed with a solution of sodium bicarbonate. As no detect-

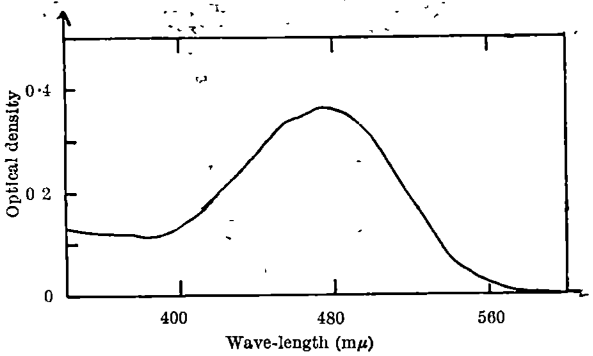

Fig. 1. Absorption spectrum of pigment from a specimen of *Gadus callarias* L. 21 gm. of muscle was extracted with 100 ml. acetone and the absorption measured in a 2-cm. cuvette

able amount of the pigment was removed with the water phase, it was concluded that the astaxanthin was mainly present in the esterified form.

A chemical analysis (performed at Stabekk) of the muscle has given the following results :

Dry matter	21·7	gm./100 gm. wet muscle
Protein	19·9	" " " "
Fat	0·4	" " " "

The data are representative of cod flesh which has lost a little water due to freezing and thawing.

There was nothing else exceptional about this cod than its peculiar pigmentation. The flesh had a good taste.

There is as yet no obvious explanation for this sporadic appearance of astaxanthin in cod flesh, but somewhat similar observations have been made on whales. Occasionally red (astaxanthin-containing) whale-body oils and whale-liver oils are encountered ; in this case pigmentation is taken to indicate an unspecified pathological condition[1,2].

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Bacteriologically Sterile Planarians for Tissue Culture

ADULT individuals of *Planaria lugubris* O. Schm. of 0·7 cm. or more in length have been rendered bacteriologically sterile by treating for 2–3 days at room temperature in the dark with a mixture of 100 mgm. aureomycin hydrochloride, 100 mgm. chloramphenicol crist. and 25 mgm. trypaflavin (the latter against fungi, especially yeasts) suspended in 250 ml. tap-water. If not more than a few animals are treated in one flask (six animals to a 50-ml. Erlenmeyer flask with about 10 ml. fluid), and the trypaflavin concentration of 100 γ/ml. is not exceeded and the animals are shielded from light, the mortality caused by the sterilization procedure itself is negligible. Treated animals transferred to sterile tap-water and shielded from light have not been observed to die. A varying mortality occurred, however, during the test for sterility.

To test the animals for sterility they were transferred singly to flasks with sterile peptone–yeast water (5 gm. peptone B.D.H. and 250 gm. baker's yeast autoclaved in 1,000 ml. tap-water, cleared by centrifugation, adjusted to *p*H 7·2 with 0·1 *N* sodium hydroxide, diluted with tap-water 1 : 1 and autoclaved again for 20 min. at 121° C.). The transfer was performed in subdued artificial light. The flasks were stored away in the dark at room temperature. Animals surviving after five days in clear medium were used for tissue culture. So far not a single infection has occurred in tissue-culture experiments with animals thus tested.

Sterile nylon brushes were used for the transfer of the animals. These brushes were obtained by fastening bundles of short lengths of nylon bristle or fishing line between the jaws of inoculation needle holders.

A few series of tissue culture experiments have already been performed with the hanging-drop technique. Fragments of the lateral regions, 0·3–0·5 mm. in diameter, have been explanted on various mixtures of human blood plasma, human fœtal brain extract and 1 per cent solution of 'Titro-Salz' (Nordmark-Werke, Hamburg) at room temperature. Survival of at least six days has been obtained, but no active outgrowth. However, cell movements and cell migration have been observed. Histological examination of the cultures has shown loss of the original organization, presumably by haphazard movements of the different cell types. On the other hand, there was a certain tendency to form cyst-like structures, notably of epidermal tissue.

Previous attempts by Murray[1] to culture planarian tissue *in vitro* have been made with *Planaria dorotocephala* sterilized by ultra-violet irradiation. The osmotic value of the body fluids of *Planaria dorotocephala* must be considerably lower than that of the body fluids of *Planaria lugubris*, as indicated by the survival of small fragments of the latter species in media with the osmotic value of human blood plasma.

Sterilization of *Planaria gonocephala* Dugès and *Dendrocoelum lacteum* (O.F.M.) by the above mixture has resulted in the death of the animals, perhaps because of the lack of intense pigmentation, which may counteract the photodynamic action of the trypaflavin. Sterilization with the aid of hexachlorophene, 'Bradosol' (Ciba), 'Entero-Vioform' (Ciba), mercurochrome or methylparaben failed also with *Planaria lugubris*. All these substances proved to be lethal in bactericidal (fungicidal) and even bacteriostatic (fungistatic) concentrations.

The tissue culture trials took place in the Laboratory of Cytology and Experimental Histology of the University of Leyden. I am obliged to Prof. P. J. Gaillard, who prepared the first tissue cultures.

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Splenic Hypertrophy in Voles

ENLARGEMENT of the spleen, induced by social stress, has been recorded in *Microtus agrestis*[1] and *M. orcadensis*[2]. Splenic hypertrophy also occurs in natural populations of *M. agrestis* at certain stages of their population-cycle (H. Chitty, personal communication).

The data reported here were obtained from a mixed group of *M. agrestis* which included both stressed and unstressed laboratory-bred animals, and also some from the field. In this group the range of body-weight was 11–40 gm., and of spleen weight 10–660 mgm. It was known from data previously accumulated in the Bureau that in normal unstressed animals, with a similar body-weight range, the spleen weight very rarely exceeded 80 mgm.

Spleens from more than thirty animals have been examined histologically. Enlarged ones are characterized by great congestion, the presence of extramedullary erythropoietic tissue, and large numbers of megakaryocytes. Some erythropoiesis occurs in the small spleens. With increasing spleen size the lymphoid tissue becomes less distinct, and in the largest spleens the Malpighian corpuscles are virtually obliterated. This decrease in the amount of lymphoid tissue in the spleen is consistent with the involution of the thymus reported in stressed animals[1,2].

It was clear from the beginning that the red cell picture was abnormal, and so this has been the main feature studied. The proportion of reticulocytes in the blood has been measured, and for the eighty animals examined, the range was 2–36 per cent. It appeared that a high reticulocyte count was associated with an enlarged spleen, indicating an increased rate of release of immature erythrocytes into the circulation. A preliminary statistical analysis, kindly carried out by Mr. P. H. Leslie, showed that, for a given body-weight, this association between a high reticulocyte count and an enlarged spleen was highly significant.

Hæmoglobin determinations on venous blood ranged from 64 to 115 per cent (100 per cent = 14·8 gm./100 c.c. with oxyhæmoglobin). Low hæmoglobin-levels were in the majority of cases associated with enlarged spleens and high reticulocyte counts.

More than thirty spleens were tested for hæmosiderin; significant amounts were present in only three of the enlarged spleens and in two of the small ones. There was no evidence that any of these animals were suffering from wounds or parasitic infestations sufficient to cause an abnormal blood picture.

There is thus clear evidence of a hæmolytic process in those animals with splenic hypertrophy. This condition is indicated by the large amounts of accessory erythropoietic tissue in the spleen; the high reticulocyte counts, and the low hæmoglobin-levels. However, the exact relationship between spleen size, reticulocyte count, and hæmoglobin content appears to be complex, and depends on the body-weight and sex of the animal, and probably on the particular stage of the condition reached. The ætiology of the hæmolytic process is as yet unknown.

This work would not have been possible without the advice and training facilities kindly provided by Dr. R. G. Macfarlane, Department of Hæmatology, Radcliffe Infirmary, Oxford; in particular I wish to thank Dr. A. A. Sharp for his suggestions and ready help. This is the first part of a fuller study being made in conjunction with Dr. D. Chitty.

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Paromola cuvieri (Risso), a Crab new to the Orkneys, Shetlands and Norway

On June 25, Prof. O. Nybelin brought me for identification some photographs of a large 'spider' crab, four specimens of which had been received by the Natural History Museum, Gothenburg, Sweden, between July 1955 and February 1956. The local fishermen, who had trawled the specimens at four separate localities off the Shetlands and Norway, recognized that they were quite new to fishing grounds with which their families had been familiar for generations. I was not altogether surprised to find that they belonged to a species first recorded from the Mediterranean, namely, *Paromola cuvieri* (Risso), since I knew of another unpublished recent record from the Orkneys. Prof. Nybelin informed me that they had also taken several Mediterranean species of fish in the same waters in recent months. *Paromola*, with a span of 3–4 ft. and a shell 6–8·5 in. long, is not a true spider-crab but a relative of the sponge-crab *Dromia*. It may be recognized by its club-like eyes set on slender stalks and the short last pair of legs, each ending in a curious subchela. It exhibits marked sexual dimorphism of the chelipeds which in the female are very slender and not much longer than the shell; in the male about three times as long as the shell and stouter than the walking legs. The Portuguese call it *aranha do mar*, Algerian fishermen *diable* because of its reddish colour and bizarre appearance.

The distribution of *Paromola cuvieri* is generally given as: Mediterranean (excluding the Adriatic) and the adjacent North Atlantic waters from Cape Bojador and the Azores to Cork; and the maximum depth as 640 m. (about 350 fathoms)[1,2]. Apparently certain British records have been overlooked; Halbert[3] states that specimens were taken by the Irish Fisheries Investigations in September 1907 at a depth of from 627 to 728 fathoms (1,150–1,320 m.), in association with the deep-water coral *Lophohelia*, at 50° 42′ N., 11° 18′ W. He also mentions a shell and two chelipeds found long ago on the shore of Mull (B.M. Reg. No. 1877.1). Halbert was right in thinking that the crab was indigenous to deep water to the south-west of Ireland, and four males and two females were sent to the British Museum from this region between 1911 and 1948 (depth, 130–160 fathoms). He also predicted that *Paromola* would eventually be found in deep water off the west coast of Scotland, and two years later Ritchie[4] recorded a specimen trawled between the Flannan Islands and the Butt of Lewis (depth not given). On January 5, 1951, a female was taken off Stromness, Orkney (depth not stated; specimen in Royal Scottish Museum).

The recent northern records sent to me by Prof. Nybelin are as follows: (1) 150 nautical miles west to north of Sumburgh Head, Shetlands, about 150 fathoms, July 1, 1955. (2) North-west part of fishing ground 'Tampen' to north of Shetlands, 140 fathoms, about end of August 1955. (3) North-west of Utsire, on the west coast of Norway, 135 fathoms, February 1956. (4) On 'Egersundsbanken' off west coast of Norway, 82 fathoms, February 1956. The photographs are of male specimens, which are more often captured than females. That specimens sometimes wander into coastal waters is evident from various records; Orton[5] recorded a male from 15 fathoms off the Cornish coast, and in 1919 another male, now exhibited in the public gallery of the British Museum (Natural History), was taken four miles west of the Lizard in 27 fathoms. The large male found alive in only 2 ft. of water on the Cork coast probably strayed from much deeper water, because Halbert mentions that one of the epizoic organisms, the hydroid *Sertularella gayi* (Lamouroux), is found in fairly deep water. In recent years *Paromola* has extended its range, via the west coast of Scotland, to the waters around the Orkneys, Shetlands and the southern part of the Norwegian west coast.

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Naphthaquinone Pigments in the Tropical Sea Urchin *Diadema antillarum* (Philippi)

In addition to black pigment[1], the sea urchin, *Diadema antillarum*, contains abundant red and purplish pigments.

Extracts of spines, test, peristome, periproct, podia, gut wall, radial water vascular canals and nerve cords, axial complex and amœbocytes of the cœlomic fluid, made by dilute hydrochloric acid under diethyl ther, yielded bright red ethereal solutions showing absorption maxima, when acidified, at 259–62 mμ, 337–42 mμ and 460–70 mμ. Solutions deposited dark red, somewhat unstable, needle-like crystals soluble in benzene, chloroform, acetone, methanol, ethanol, and concentrated sulphuric acid, less soluble in carbon disulphide and light petroleum and slightly soluble in water and hexane. They give a bright reen colour with ferric chloride, and in acid solution re unaffected by hydrogen peroxide, but are rapidly and reversibly decolorized by hydrosulphite. If partitioned between diethyl ether and water, the igment is red and epiphasic when acidified, purplish and hypophasic in the presence of alkali. Neutral or lkaline solutions are unstable. These properties indicate naphthaquinones.

Chromatography is difficult; most of the pigment tered on columns of calcium carbonate, magnesium licate, and to a lesser extent on silica gel, yielding urplish, brownish or black products and eluates with varying absorption characteristics. On powdered ellulose columns (tried at the suggestion of Prof. C. H. Hassall[2]), slow development with light petroleum or enzene produced chromatograms with three or more zones, yielding unstable eluates showing one or more of the above absorption bands, sometimes with varying number of additional maxima between 30 mμ and 400 mμ. Eluates which showed no additional maxima on the first chromatographing usually d when re-chromatographed. The additional maxima disappeared when the solutions were warmed. More rapid development with diethyl ether usually produced chromatograms with a single homogeneous orange zone showing three absorption maxima close to those of the crude extract. Sometimes two zones ppeared, the main one similar to the last, and a much smaller purple zone, which left the column in cid ethanol as an orange solution. Paper chromatography of a crude extract from an individual provided by the Zoological Society of London, recently performed by Dr. T. W. Goodwin, confirmed the instability of the main orange pigment and showed that it changed on the chromatogram to a purple pigment with an absorption maximum in the visible, at about 480 mμ. The latter is eluted from the paper with acid ethanol only with difficulty, while the original pigment is easily eluted with diethyl ether.

The main pigment, purified by chromatography and re-crystallization, shows absorption maxima in acidified diethyl ether at 263–64, 337–39, and 462–63 mμ. It melts at 223° C., sublimes at about 200° C., and does not fluoresce in the ultra-violet in ethereal solution.

Pigment is present in the form of spheroids in the podia, radial water vascular canals, gut wall, axial complex and cœlomic fluid. Some are enclosed in amœbocytes[3], others are free in the tissues, suggesting an origin from amœbocytes. Some pigment is present in the gut wall, in the form of much more minute granules or droplets. The gonads, at least during the summer, contained none of this pigment except in amœbocytes. In the amœbocytes of the cœlomic fluid a reduced precursor of the pigment appears to exist[3].

Much of this work was done in the Zoology Department of the University College of the West Indies, the spectrophotometer being provided by the Rockefeller Foundation. A full account is being prepared.

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An Ecdysial Membrane in the Locust Cuticle

Passonneau and Williams[1] have described in the developing cecropia silkworm an 'ecdysial membrane' situated between pupal and adult cuticles. Richards[2] has studied the fine structure of this membrane, but was unable to demonstrate clearly its nature and origin.

A similar membrane has been found between new and old cuticles of the locust *Schistocerca gregaria* at the time of moulting from nymph to adult and at all the preceding nymphal moults. Its origin has been studied in successive stages of the nymphal-adult moult. No trace of the membrane is seen until after the retraction of the epidermis from the nymphal cuticle, when a few of the innermost laminæ of the endocuticle show properties different from those of the outer laminæ. They are sudanophil, and become detached from the dissolving endocuticle. They do not dissolve, and although at first separate from each other, later become adherent to form a discrete compact membrane. There seems no reason to doubt that the ecdysial membrane represents an innermost sheet of endocuticle which is in some way protected from the action of the moulting fluid.

This conclusion has been verified by subjecting, at different developmental stages, pieces of the last nymphal cuticle to the action of extracted moulting fluid. In the earlier stages, in which the endocuticle has not reached its full thickness, the entire endocuticle dissolved. But in later stages, including those before as well as after retraction of the epidermis, a discrete ecdysial membrane became visible after solution of the remainder of the endocuticle.

The isolated ecdysial membrane is resistant to the action of cold concentrated mineral acids, but dissolves in them readily after treatment with diaphanol. Tests on frozen sections indicate the presence of sterols and of protein, and the isoelectric point of the membrane, about *p*H 5·8, is not changed by the action of the moulting fluid. As a result of experience with the cuticle of *Periplaneta*[3], these observations suggest that the endocuticular laminæ constituting the ecdysial membrane are stabilized, like the outer layers of the cuticle, by impregnation with a lipoprotein complex. The protein moiety is protected by its association with the sterol, and is therefore not removed by the action of the moulting fluid.

Whether the ecdysial membrane has any functional significance is not clear; but its formation may be dependent on the fact that at the time when endocuticle secretion is declining preparatory to ecdysis the epidermis is already in a state of preparation for the formation of the sterol-containing outer part of the new cuticle, so that the last-formed portion of the endocuticle comes to contain material destined primarily for the new cuticle.

This work forms part of an investigation into the locust cuticle carried out while holding a senior research award of the Anti-Locust Research Centre. A full account will be given in due course.

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A Technique for measuring Structural Features of Plant Epidermis using Cellulose Acetate Films

IT is often difficult to peel off areas of plant epidermis which are large enough for accurate determinations of mean cell size and stomatal distribution. Buscalioni and Pollacci[1], and Long and Clements[2] have described a method for counting stomata using collodion films; but these were found to be sometimes difficult to remove from a treated leaf, and to tend to give poor images of epidermal cells because they become opaque in the presence of water. Recently, Bennett and Furmidge[3] have recommended a technique for the study of the distribution of deposits and organisms on plant surfaces using impressions on cellulose acetate or gelatin; structural features of epidermis from some curved surfaces and 'savoyed' leaves, however, cannot readily be observed by this method. An additional technique devised here for the measurement of epidermal cells appears to overcome the disadvantages of the above-mentioned methods for this purpose.

A quick-drying coloured solution of cellulose acetat is applied to the plant organ from which measurements are required. When the dry film is removed i bears an impression of the sculpturing of the epidermis so that areas which were above lateral cel walls are thicker, and thus appear darker, than th rest of the film when viewed by transmitted light The cellulose acetate film seen through a microscop therefore closely resembles the structural features o peeled epidermis.

2 gm. of cellulose acetate and 0·7 gm. night blu or crystal violet are dissolved in 100 ml. acetone The solution is painted on the epidermis with a camel hair brush which is kept immersed in acetone whe not in use. The film dries in a few seconds, and, afte flooding with a strong solution of detergent, can b lifted from the plant. Films are more easily remove from large areas and whole leaves if treated materia is placed in an oven and allowed to wilt before applying detergent. The stripped film is mounted on slide with the surface which faced the plant uppermost, and dried by dabbing with filter paper; it i then immediately ready for viewing dry. Larg areas of film should be stuck to the slide. Whe observed with an orange light source, films coloure with night blue give almost black images which ar very suitable for photographing on panchromati film.

A cellulose acetate film takes a few seconds t prepare, and gives a permanent record from whic measurements can be made at leisure (Fig. 1). Ther is no risk that the cells will shrink during the preparation, or that the picture will be confused by th presence of underlying mesophyll cells—two faults c the 'peeling' method. The technique is suitable f leaves, petals and other organs of many plants excep those which are densely covered with hairs. Not a plants that were tested gave equally well-define films; but satisfactory records of cell size an

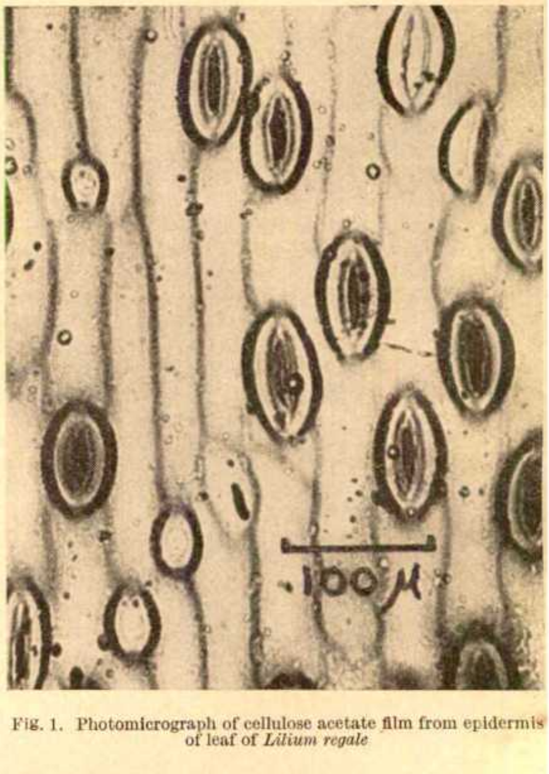

Fig. 1. Photomicrograph of cellulose acetate film from epidermis of leaf of *Lilium regale*

stomatal number were obtained from many species hat were unsuited to the 'peeling' method.

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Possible Use of Sorbic Acid as a Preservative for Corn Silage

MANY types of preservatives such as ground ereals, sugar beet pulp and molasses are employed to reserve silage in the best possible condition. These reservatives are high in fermentable carbohydrates which help to stimulate lactic acid fermentation. Some armers have been using hydrochloric and sulphuric acids to control the protein breakdown which gives an unpleasant smell to silage. The use of ground ereals is uneconomical. Beet pulp and molasses are vailable only in certain places and usually in limited upply. Inorganic acids like hydrochloric or sulphuric re strong acids, and, from the point of view of armers, they have been difficult to handle and distribute in the silo. Likewise, such acids produce deleterious effects on the digestive system of farm nimals. Virtanen[1] reported that there is a need or a suitable and cheap organic acid for silage-naking with acids.

In recent years sorbic acid, a mild organic acid, as been used extensively as a fungistatic agent in he food-processing industries. In cucumber fer-nentation, 0·1 per cent sorbic acid controlled yeast cum formation without interfering with the normal nd desired fermentation by bacteria which produces actic acid[2]. It has also been shown that the sorbic cid is less toxic and a better preservative than odium benzoate[3,4].

Wide-mouth glass jars were used as the experi-nental silos. The corn silage was prepared in them s it would have been in the regular silos. Prior to nsilage, corn plants were chopped into small pieces nd were 'pitched' in the 'silos'. Each layer was acked well. Water was sprinkled on the top of each ayer in the case of untreated (control) silos which vere again packed to remove the air pockets. In the ase of treated silos, sorbic acid solutions were prinkled instead of water. Concentrations of 0·3, ·2, 0·1, 0·05 and 0·025 per cent of sorbic acid on an bsolute weight basis were prepared in tap-water nd were sprinkled on the top of each layer of the nsilage material. Sorbic acid was kindly furnished y the Carbide and Carbon Chemicals Co., New York. ome of the silos thus prepared were covered with ir-tight lids and the remainder were uncovered. The xperiment was conducted in triplicate. Following nsilage and treatments, the silos were stored in card-oard boxes at room temperature for a period of five nonths. After five months, they were weighed to etermine the percentage loss in weight and were pened to inspect the microbial growth on the urface.

It was noticed that the silage was less affected y mould than untreated silage. Higher concentra-ons of sorbic acid were more effective in controlling the mouldy growth than the lower concentrations. However, the concentration 0·1 per cent was quite as effective as that of 0·3 per cent.

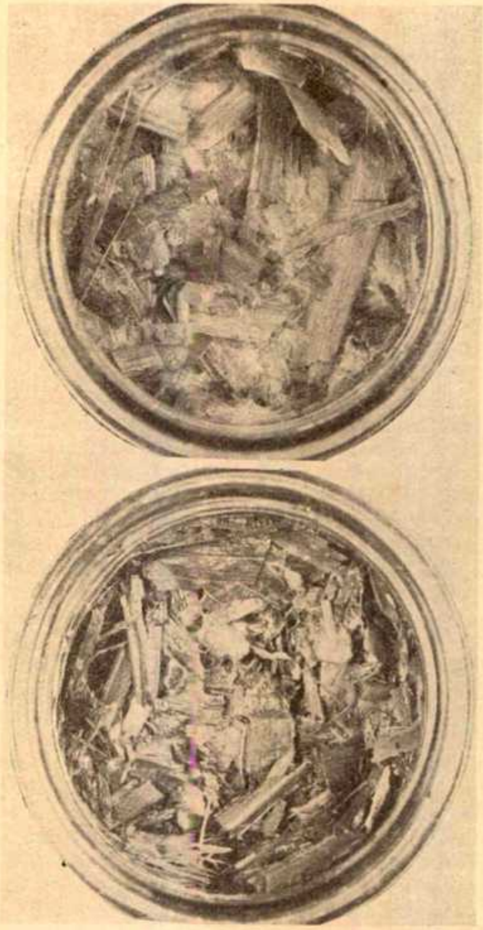

Fig. 1. Top, Growth of mould in profusion on the surface of silage sprinkled with water; bottom, very slight growth of mould on the surface of silage sprinkled with 0·1 per cent sorbic acid solution

Fig. 1 (top) shows the profused growth of mould on the top layer of the silo which was sprinkled with water and Fig. 1 (bottom) shows very little or no growth on the top layer of the silo which was sprinkled with sorbic acid solution at the concentration of 0·1 per cent. Mouldy growth on the silage gives bad odour and flavour.

The occasional spraying of the silage material with harmless sorbic acid solution (0·1 per cent) while the silo is being filled will preserve silage in good physical condition. At the same time a larger percentage of proteins will be preserved which ultimately will be recovered in milk and in meat. The *p*H of sorbic acid (0·1 per cent) solution is 3·6. The preservation of the silage material at such low *p*H produces silage of high quality.

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Growth-promoting Effects of Ethylenediamine Tetra-acetic Acid

THE recent communication by Heath and Clark[1] prompts us to present some of our observations of presumed plant hormone effects of the chelating agent ethylenediamine tetra-acetic acid. Reference to these observations was made in a review on the application of chelation to agriculture[2]. Our interest in this problem developed from observations, made in the summer of 1953, on massive growth response to ethylenediamine tetra-acetic acid by sunflower plants in water culture; metal complexing effects in the nutrient medium were involved, but there was also evidence of a direct effect of ethylenediamine tetra-acetic acid itself on growth.

To investigate possible growth-regulator effects of ethylenediamine tetra-acetic acid, a series of experiments on straight growth of hypocotyl sections of etiolated white lupin seedlings was undertaken late in 1953. Sections 2 cm. long were cut from central portions of hypocotyls 6–7 cm. in length (one section per seedling) from seedlings germinated in the dark at 24°–26° C. under a continuous tap-water spray. For each treatment twenty-five sections were floated on the appropriate solution in a large Petri dish which was then stored in the dark at 25° C. All solutions were made up with de-ionized water without added nutrients. Measurements were made after 24 hr. In preliminary experiments, all treatments included indole acetic acid at $1 \times 10^{-5} M$. It was found that either indole acetic acid at this concentration or disodium ethylenediamine tetra-acetate at $5 \times 10^{-5} M$, or both in combination, caused increases in elongation and water uptake of about the same magnitude, 30–50 per cent. In contrast with the studies using the wheat coleoptile[1], in which growth of controls on water alone gave elongations of about 80 per cent in 19 hr. at 25° C., the lupin hypocotyl sections elongated only about 10 per cent in 24 hr. at the same temperature. The relative magnitude of effects attributable to these compounds thus appears greater with the lupin material than with wheat, presumably because of a lower content of native hormone in this tissue.

When hypocotyl sections were floated on solutions of disodium ethylenediamine tetra-acetate substantial increases in both length and water uptake were observed at concentrations of 3×10^{-4}, 1×10^{-4} and $5 \times 10^{-5} M$, with maximum increases of more than 50 per cent occurring at either 5×10^{-5} or $1 \times 10^{-4} M$. Addition of pH 5 phosphate buffer to the solutions did not influence these results. With disodium ethylenediamine tetra-acetate at $5 \times 10^{-5} M$, respiration was stimulated to the extent of a 50 per cent increase in oxygen uptake.

The experiments with disodium ethylenediamine tetra-acetate are presumed to demonstrate effects of exposure of the plant part to uncomplexed chelating agent, so that responses observed are attributed to its action within the tissues. To study the response to complexed chelating agent in the medium, experiments were carried out with the iron chelate, ferric disodium ethylenediamine tetra-acetate, which at most physiological hydrogen-ion concentrations is the most stable known chelate of ethylenediamine tetra-acetic acid. At $10^{-4} M$ ferric disodium ethylenediamine tetra-acetate, there was a 10 per cent decrease in length and 15 per cent loss of water from the tissues, and more gradual but continued decreases at higher concentrations. Respiration was stimulated about 10 per cent by $5 \times 10^{-5} M$ of the ferric disodium compound, as contrasted with 50 per cent stimulation by the disodium compound at this same molar concentration. It seems evident from these results that growth-stimulating effects of ethylenediamine tetra-acetic acid are associated only with the addition of uncomplexed chelating agent to the growing medium.

The association of growth-promoting effects with uncomplexed ethylenediamine tetra-acetic acid in the medium, but not with the iron chelate, can be interpreted as supporting the concept of growth promotion by removal of calcium from the cell-wall structure. This would presume that uncomplexed ethylenediamine tetra-acetic acid, in passing through the cell wall, forms a chelate with calcium removed from the wall structure, which is thereby enabled to expand.

A further observation of hormone effects exerted by ethylenediamine tetra-acetic acid has been seen in epinastic response of soybean leaves on plants in solution cultures supplied with disodium ethylenediamine tetra-acetate at concentrations of $6 \cdot 7 \times 10^{-5} M$ or higher. The response characteristically took the form of an opening of the angle between petiole and stem and twisting of the leaflets through angles ranging from 90° to 270°.

This investigation will be presented for publication in more detail in a subsequent issue of the *Contributions from Boyce Thompson Institute*. It was supported by grants from the Refined Products Corp., Lyndhurst, N.J., and by Versenes Inc., Dow Chemica Co., Framingham, Mass.

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Seed-coat Structure of Ethiopian 'Rape'

SAMPLES have been obtained of seed described a Ethiopian 'rape', imported into Europe for oil extraction. Plants grown from the seed corresponded with specimens in the Kew Herbarium named *Brassica integrifolia* (West) O. E. Schulz var. *carinat* (A.Br.). This plant is cultivated in Ethiopia and adjacent north-east African territories. Most taxonomists regard this species as a mustard, and som include it in the *B. juncea* complex which contain a number of mustards of commercial importance.

Fig. 1 is a drawing of a cross-section of the testa All layers characteristic of the cruciferous seed-coat are present. The uneven height of the palisade cells i responsible for a distinct reticulation which is show by the whole seed and, also, by surface preparation of the palisade layer. The subepidermal layer although not so distinct as that of *B. nigra*, is ofte quite obvious. So far as the mustards of commercia

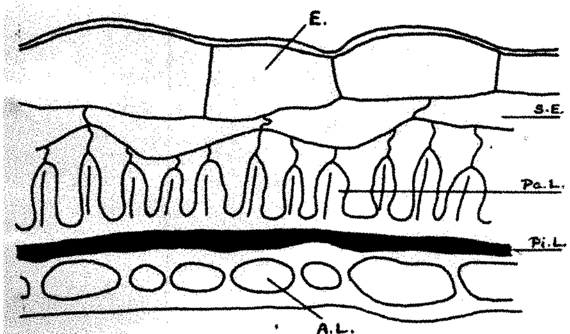

Fig. 1. Drawing of cross-section of testa of Ethiopian 'rape' (× 380). *E*, Epidermis; *S.E.*, subepidermis; *Pa.L.*, palisade layer; *Pi.L*, pigment layer; and *A.L.*, aleurone layer

mportance are concerned, the seed-coat structure of this Ethiopian plant would seem to correspond most closely to that of sarepta or brown mustard *B. besseriana* Andrz). In this connexion, it is interesting to note that, like the Ethiopian species, sarepta mustard is often placed in the *B. juncea* complex.

Although it may not be possible to identify this Ethiopian plant on testa structure alone, the presence of a well-defined epidermis, subepidermis and palisade ayer, consisting of comparatively large cells and with well-marked reticulations, serves to place it in he *B. juncea* complex. Identification on seed-coat tructure is useful in cattle cake analysis, and cattle ake described as Ethiopian 'rape' has been found o contain testa fragments with a structure similar o that described in the previous paragraph.

It is intended to publish the details of this investigaion elsewhere. I am indebted to the Incorporated Oil eed Association and Salamon and Seaber (consulting nalytical chemists) for the supply of material and lso the Central Research Fund of the University of London for the loan of certain apparatus used in this work.

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Nitrogenous Compounds in Plant Xylem Sap

THE predominance of organic nitrogenous compounds in the tracheal sap of apple trees[1] implies hat incoming inorganic nitrogen is largely converted to organic form in the root system. The transpiraon stream then carries to the shoot a mixture of mino-acids and amides among which aspartic acid, sparagine and glutamine are quantitatively the ost important.

That these phenomena are not unique to apples as been shown by chromatographic examination of ylem sap extracted from shoots of a range of cotyledons, monocotyledons and gymnosperms. he plants used were all selected as capable of yielding xylem sap[2]. However, not all species examined ere woody shrubs or trees, as extension[3] of the sap traction technique rendered possible the sampling a considerable number of herbaceous species.

Nitrate was present in saps of less than half the species tested and usually in only trace amounts. In all cases, however, whether nitrate was detectable or not, a range of organic nitrogenous compounds was present. Though no quantitative measurements of individual compounds were made, it was clear that the substances detected in each case would have largely accounted for all the nitrogen in each sap sample.

With most species, either asparagine or glutamine was quantitatively the most important individual compound, glutamine occupying this role in 75 per cent of the species tested. Usually, however, both amides as well as aspartic and glutamic acids were present as well as a range of other amino-acids in lesser amount. In this category, alanine, serine, threonine, methionine and/or valine, and leucine were most commonly present. Examination of some hydrolysed sap samples has revealed the appearance of further compounds, mainly glycine, cystine and cysteic acid, implying the presence of a peptide-like substance in the sap. There was thus in the composition of many samples a striking similarity to the range of compounds already described as present in apple sap[1].

Citrulline was present in the xylem sap from species of twenty-nine families. This compound has not previously been widely recorded in plants; but it has been found in *Alnus*[4] and members of the Betulaceae[5]. While this compound was not widely distributed among the species studied in the present work it was of considerable importance in a number of species of the following genera: *Juglans, Alnus, Nothofagus, Annora, Persea, Diospyros* and *Chamaecyparis*. Citrulline was not detected in any monocotyledon.

Allantoin and/or allantoic acid were present in xylem sap from members of twenty-three families. These compounds have long been recognized[6] as plant constituents; but interest in them as storage and translocatory compounds has arisen only lately[5,7]. In some of the species studied in the present work these compounds were present in low concentration; but in some species of the genera *Persea, Acer, Aesculus, Alectryon* and *Cobaea* allantoic acid was a major constituent of the xylem sap. Neither of these compounds was detected in any gymnosperm and in only one monocotyledon (*Arundinaria*).

It is apparent that the xylem translocation of organic nitrogen is not a phenomenon peculiar to apples. Partial or complete assimilation of inorganic nitrogen must occur before it passes into the transpiration stream. It is of interest that the presence of organic phosphorus compounds has recently[8] been detected in a plant xylem sap.

The course of assimilation of nitrogen in the root must vary just as the compounds in the sap vary, and any description of this process must account for the importance of glutamine and/or asparagine as well as the importance in some species of citrulline or allantoic acid. It is not clear whether the compounds present in tracheal sap are early products from the incorporation of inorganic nitrogen into organic compounds or are products of breakdown of storage proteins. It may be that they result from both processes.

Whatever their origin, it is in the form of these organic nitrogenous compounds that the shoot receives nitrogen from the root system and it is these which are available to the shoot for its further metabolism.

Attention has recently been directed[9] to the metabolic interrelations of root and shoot, but little is known concerning any specific requirement of the shoot for nitrogenous compounds. It may be that all the shoot requres is a bulk supply of inorganic or organic nitrogen, or it may be that all or some of the specific compounds present in xylem sap are essential for shoot development.

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Alloploid Nature of Okra, *Abelmoschus esculentus* (L.) Monech.

Abelmoschus esculentus (L.) Moench. (= *Hibiscus esculentus* L.[1]), commonly known as lady's fingers, okra or bhindi, is an important vegetable crop cultivated in the different countries of the world. The chromosome number of this species has been variously reported as $2n = 130$ [2] and $2n = 72$ [3]; in a number of varieties examined by us[4], the chromosome number was invariably found to be $2n = 130$.

Pal, Singh and Vishnu Swarup[5] described from India a new species, *Abelmoschus tuberculatus* Pal et Singh, related to okra. The chromosome number of this wild species was determined by us[4] to be $2n = 58$.

Meiosis and seed setting in *A. esculentus* ($2n = 130$) and *A. tuberculatus* ($2n = 58$) were normal. The F_1 hybrids ($2n = 94$) obtained from reciprocal crosses between these two species were totally sterile. Chromosome pairing in these hybrids appeared to be interesting from the phylogenetic point of view. Out of 122 pollen mother cells which could be very clearly analysed, 105 showed the chromosomal association, $29^{II} + 36^{I}$, 13 showed $28^{II} + 38^{I}$ and 4 cells showed $27^{II} + 40^{I}$. The most frequent association, $29^{II} + 36^{I}$, strongly suggests that the 65-chromosome cultivated okra is an alloploid comprising two genoms, one with 29 and the other with 36 chromosomes. The former genom is homologous with that of *A. tuberculatus*; the latter genom may be related to any among the species of *Abelmoschus* having $n = 36$ chromosomes.

Among the *Abelmoschus* species of which chromosome numbers have so far been reported in the literature, three have $n = 36$ chromosomes: *A. ficulneus* (L.) Wt. and Arn.[6] (= *Hibiscus ficulneus* L.), *A. moschatus* Medik. (= *Hibiscus abelmoschus* L.[2]), and *Hibiscus esculentus* var. Blue Long *A* [3]. *A. tuberculatus* seems to be the only species so far for which the chromosome number, $2n = 58$, is certain.

A chromosome number approaching that of *A. tuberculatus* was reported for *Hibiscus manihot* ($2n = 60$)[3,7]; however, Skovsted[2] reported $2n = 66$ and Kuwada[8] $2n = 68$ chromosomes for this species. Teshima[3] observed all the chromosomes as univalents, during meiosis, in the F_1 hybrid (*H. esculentus* var. Blue Long *A*, $n = 36$ × *H. manihot*, $n = 30$), and in the F_1 hybrid (*H. esculentus* var. Dwarf Prolific, $2n = 126$–134, × *H. manihot*, $2n = 60$) Chizaki[7] reported the formation of 0–7 pairs during meiosis. Recently, Prof. Kuwada of the Kagawa University, Japan, observed at meiosis in the F_1 hybrid of *A. esculentus*, $2n = 124$, with *A. manihot*, $2n = 68$, the formation of 0–7 bivalents (personal communication). The cytological features of these hybrids are thus distinct from those of the present one, namely, *A. esculentus* × *A. tuberculatus*.

We have so far not met with a form of *A. esculentus* with $2n = 72$ chromosomes, the number reported for the variety Blue Long *A* of this species by Teshima[3]. Should Teshima's observations be confirmed, *A. esculentus* would appear to comprise two chromosomal races, $2n = 72$ and $2n = 130$. While it would then be interesting to study the evolutionary origin of the form with $2n = 72$ chromosomes, it would appear from the present results that cultivated okra (*A. esculentus*, $2n = 130$) may have originated through hybridization between a 29-chromosome and a 36-chromosome species of *Abelmoschus* followed by chromosome doubling in the resulting hybrid.

In this context, it is interesting to note that the F_1 hybrid, *A. ficulneus* ($n = 36$) × *A. tuberculatus* ($n = 29$), studied by us was totally sterile and formed on an average, 1·63 chromosome pairs per pollen mother cell, the frequency being as follows:

No. of pairs per pollen mother cells	0	1	2	3	4	5	6	7	
No. of pollen mother cells	27	14	18	7	8	1	2	1	(= 78

Experiments are under way to synthesize an $n = 65$ chromosome form through chromosome doubling in this hybrid.

Vavilov[9] has suggested, on the basis of phytogeographical studies, an Abyssinian origin for *A. esculentus*. Further studies on the world distribution of *Abelmoschus* species, especially in the Abyssinian region and on their cytogenetic affinities would be helpfu in elucidating the problem.

We are grateful to Dr. B. P. Pal and Dr. S. M Sikka for encouragement and helpful criticism durin the course of these investigations.

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Protective Coloration and Animal Behaviour

Procryptically coloured insects may resemb objects occurring in their environment very closely[1] thus leaf-mimicking butterflies may bear markin resembling veins, holes eaten by phytophagou insects, mildew, etc. This has been held by son authors to invalidate the theory of natural selectic as applied to the phenomena of mimetic protective coloration, since it is argued that avian predators are unlikely to achieve the refinements of discrimination possible for human observers, who are themselves often deceived.

Carter[2] has supported the latter part of this criticism, and has proposed an alternative view. He nterprets the work of Lorenz[3] as showing that birds respond to only a few of the available visual characters of the objects which they perceive: "The conclusion of recent studies of bird behaviour is that very generally, at any rate in those situations . . . in which recognition of the object leads to some course of action, a bird recognizes an object not by its general appearance, as we do, but by some simple and usually single feature possessed by the type of object to which it belongs. This feature may have very little to do with the general appearance of the object". Carter admits that simplicity is not found in studies of problem-solving behaviour, but dismisses such situations as artificial. He proposes that the refinements of imitation found in Nature may have been achieved through selection pressures mediated by a number of different species of predator, each responding nnately to distinct, individual features of the model objects. Such an accumulated selection pressure, contributed by a diversity of sources, would be capable of mediating the production of accurate facsimiles of the superficial appearances of the model objects to which the predator's responses were originally directed. This suggestion has been incorporated nto at least one general discussion of allæsthetic characters[4].

Carter's proposal involves three assumptions: 1) responses of birds to prey-objects are inborn and igidly determined; (2) inborn responses are given o releasing stimuli which commonly possess only one or a very few valent features; (3) different features f the same releasing object may be valent for different pecies of passerine.

It is likely that avian responses to prey-objects are primarily inborn; but the fine details of the orientation of attack[5], and the choice of object[6], may be rapidly modified by learning processes, and it is certain that many features of a variety of edible objects must acquire valence for an experienced predator. The releasing stimuli for some intraspecific responses are simple[7], and possess a few valent features only; but many characters of an object, or class of objects, may be valent for the release of a single unconditioned nterspecific response[8]. The third assumption has not been specifically tested; but experiments comparing the releasing value for passerines in three different families (Fringillidae, Emberizidae and Paridae) of three characters present in a two-dimensional eye-like pattern have not supported it, though they offer no positive disproof[5].

An experienced bird, searching a habitat containing cryptic prey, or confronted with a Batesian or Mullerian mimic, gives a response which may have been appropriately modified as the result of a previous learning process[6,9]. To explain the accuracy of a particular cryptic or mimetic resemblance it is necessary to show that at least one species of predator can achieve discrimination learning of an equivalent refinement. This ability has been demonstrated by de Ruiter in the avian predators of stick-like caterpillars[10], and its converse, for the case of wasp-mimicry, by Mostler[9]. If the responses of the birds are susceptible to learning processes, the nature of the original unconditioned releasing mechanisms in inexperienced predators is largely irrelevant to the selection process.

Certain protective resemblances have been shown to utilize the inborn responses of predators. The eyespot patterns of many insects are exhibited by special displays (Blest, A. D., in preparation) and they release escape behaviour from small passerines. The responses of the latter are almost certainly independent of previous experience of eye-like objects, and are quite certainly wholly independent of previous experience of the birds' own predators[5]. Repeated encounters with a spotted and displaying insect may either reinforce avoidance behaviour, or cause it to wane to extinction. At no point would discrimination learning appear to enter into the situation. It is possible that the hypothesis proposed by Carter might apply to cases of this type, but the existing work on animal behaviour fails to indicate any necessity for such special postulates, either to account for the evolution of intimidating patterns, or procryptic resemblances and orthodox Batesian and Mullerian mimicry.

It remains to re-emphasize that statements concerning the sensory capacities of animals, or their power to achieve sensory discriminations, based on experiments involving the elicitation and measurement of responses from whole organisms, are only meaningful in terms of the precise experimental situations employed[7]. This qualification is often ignored in the more general literature.

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Fossil Frogs from a Lower Cretaceous Bed in Southern Israel (Central Negev)

THE presence of fossil frogs in Israel was discovered in January 1954, when several specimens were found in the Ramon erosion cirque, in the central Negev, about 80 km. south of Beer-Sheba.

The geological formations exposed in the cirque cover the periods from Middle Triassic up to Cenomanian. The fossil frogs were found in a lacustrine continental deposit. The profile of the place is as follows:

Formations	Depth (m.)
Upper basaltic flow	10·00
Lacustrine deposit (Varvy silt containing the fossil frogs together with plant remains)	1·50
Laterite, red-purple	10·00
Tufa, greyish-green	10·00
Lower basaltic flow	5·00
Basal Lower Cretaceous conglomerate	0·50

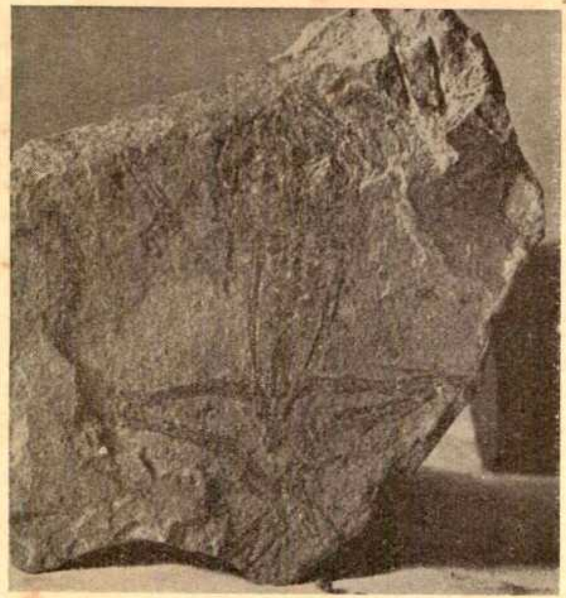

Fig. 1

The age of the formation containing the frogs was determined as Lower Cretaceous, the many plant remains, among them *Weichselia reticulata*, furnishing a fairly safe clue to the period of fossilization. Additional evidence points to an age ranging between Aptian and Albian. In 1955 and 1956, two more visits to the site were made and so far several dozens of fossil frogs and one tadpole have been discovered.

The fossil material underwent various stages of limonitization. This process brings out the whole skeleton of the frogs preserved as an imprint in the soft rock which is secondarily filled with limonite, or as petrified osseous matter.

A first survey revealed the occurrence of three types of frogs. Among them one exhibits some pelobatid features (Fig. 1), such as a distally enlarged sacral transverse process. A second type of fossil frog does not show this enlargement and has a rather pointed head, and teeth on the maxillary bone.

The tadpole (Fig. 2) shows the caudal fin fold preserved as a fairly distinct imprint, and, strangely enough, a series of about twenty free vertebral elements extending through body and tail up to its tip. This state of matters fits nicely with the recent discovery of I. Griffiths[1], who mentions the differentiation of free vertebræ in the larval tail of the recent pelobatid *Megophrys major*. The fossil tadpole found here seems to be the earliest one known so far, since adults only have been described from earlier formations, as, for example, the well-known specimens from the Jurassic of Lerida in Spain and from the United States.

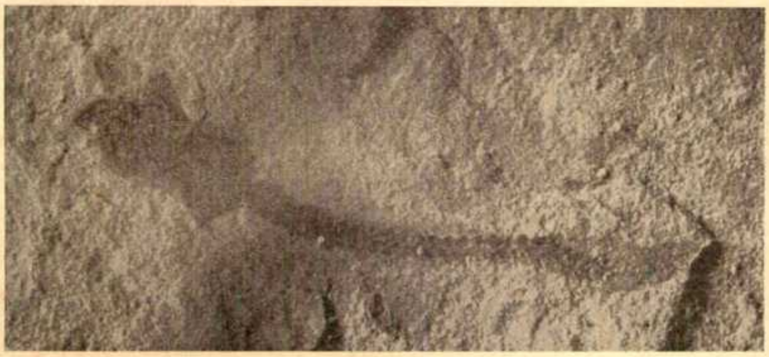

Fig. 2

The presence of free vertebræ in this tadpole contrasts sharply with the differentiation of a typical urostyle in all the adult specimens found, which possess, on the whole, modern anuran features. The presence of free caudal vertebræ in the tadpole seems to indicate that the formation of the adult urostyle differed from that of recent frogs.

The material is under study at the Department of Zoology of the Hebrew University in Jerusalem, under the supervision of Prof. G. Haas. A detailed study will be published elsewhere.

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Structure of Cupric Salts of Monocarboxylic Fatty Acids

IN a previous communication[1] on the structure o cupric formate, acetate and propionate, we concluded that the latter two compounds, both i organic solvents and in crystalline state, consist o dimeric molecules, $\mathrm{Cu}_2(R\mathrm{COO})_2.X_2$, X being a solvent molecule, in which the copper-to-copper linkage might be expected. The following facts were then assume to support the above conclusion : (1) the acetate an propionate show an absorption band of a special kin at about 80×10^{13} c./s., which was ascribed to th possible copper-to-copper linkage ; (2) the absorptio of the special kind is greatly polarized along the direction binding the two copper atoms within a molecule This is the reverse of the polarization property wit the band at 43×10^{13} c./s.

Using the above criteria, we have recently examine the structure of cupric butyrate monohydrate an non-hydrate, valerianate monohydrate, capronate an caprylate. All these in chloroform or ethyl alcoh are found to show absorption spectra which are closel similar to those of cupric acetate and propionate i solution, showing an absorption band of the specia kind at about 80×10^{13} c./s. The dichroism in th visible and ultra-violet of the salts has been determined quantitatively by the microscopic method[1] The crystals of the above compounds show absorption bands a 43 and 80×10^{13} c./s. beside strong absorption in the shorte wave-length regions. The polarization of the band at abou 80×10^{13} c./s. is found to b the reverse of the polarization the band at about 43×10^{13} c./ These relationships bear a clos resemblance to those of cupri acetate and propionate, suggestin the existence of similar dimeri molecules.

It was also found that th water of crystallization does n cause any essential discrepancy i the dichroism. It is most likely, therefore, that the linkage, if any, of the water molecules to the copper atom is not strong in the above type of compounds.

Determination has also been made of infra-red spectra in 'Nujol' of the above compounds, including the cupric formate, acetate and propionate. All of them except the formate show in the region between 1,500 and 2,000 cm.$^{-1}$ and only one absorption at about 1,600 cm.$^{-1}$, which is rather sharp and due to the anti-symmetrical vibration of the COO^- group[2]. This is believed to be further evidence for the existence of the dimeric molecules in the above compounds. The formate tetrahydrate, which was found to involve no dimeric molecules[1], does not show the absorption at the above frequency, although the formate ions are linked to the copper atom. Instead, cupric formate shows a corresponding COO^- absorption at lower frequency, which is considerably broader than the sharp band with the other cupric salts.

Cupric palmitate and stearate in acetic anhydride have been found to show ultra-violet absorption spectra which are closely similar to that of cupric acetate. The infra-red spectra in 'Nujol' have also been measured with the two compounds ; they show one sharp absorption at about 1,600 cm.$^{-1}$. This is identical with the frequency shown by cupric acetate. These facts suggest that the two compounds may also contain the dimeric molecules.

All the above facts lead us to the conclusion that cupric acetate, propionate, butyrate, valerianate, capronate, caprylate, palmitate and stearate contain the dimeric molecules both in their crystalline state and in organic solvents. It is suggested further that the cupric compounds with the homologues of monocarboxylic acids from acetic up to stearic acid consist of dimeric molecules.

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Preparation of Tritium-labelled Derivatives of Benzoic Acid

ISOTOPE exchange methods have long been employed for the study of the reactions of hydrogen atoms attached to aromatic ring-systems, and also, o a limited extent, for preparative purposes[1,2]. Most of the preparations described in the literature were carried out with water of a comparatively low deuterium content. While these methods are not suitable for the preparation of compounds having a high D : H ratio in the labelled groups, they are apart from questions of economy in the use of ritium), in principle applicable to the preparation f tritium-labelled materials, since the tritium content of the starting material (water) is normally much less than 1 per cent. The present communication describes a simple, rapid and direct method for the labelling of *p*-nitro benzoic acid at very high specific activity, with considerable economy in the use of radioactive material. It is also suitable for use with deuterium at high abundance. The two isotopes can, with advantage, be combined in the same preparation : analytical procedures (for example, infra-red spectroscopy) are thereby considerably facilitated.

Tritiated water at specific activities in excess of 220 mc./ml. being a relatively expensive material, it is essential to introduce as little hydrogen as possible from reagents. Unfortunately, the nitro-group has a very marked inhibiting action on the exchange, necessitating the use of very concentrated sulphuric acid (over 85 w per cent)[3]. Other acids, for example, phosphoric, are ineffective[4] or otherwise unsuitable, for example, perchloric. This difficulty is overcome by the use of vapour-phase exchanges in a three-legged vessel (Fig. 1). Into one leg is placed the *p*-nitro benzoic acid (1 gm.), with about 0·1 gm. of concentrated sulphuric acid. Into the second leg is placed 0·6 gm. of fresh phosphorus pentoxide. These legs are then rapidly sealed off. The ampoule of tritiated heavy water (1 curie in 0·2 ml.) is opened, and dropped rapidly into the third leg, which is then sealed off. The pumping-off tube is stoppered to prevent access of atmospheric water vapour. When all the liquid water has disappeared, the vessel is partially evacuated and sealed off. The whole is then heated to 250° C. in an oven for an hour (m.p. of *p*-nitro benzoic acid, 242° C. : b.p. of 88 w per cent sulphuric acid, 250° C.). The phosphorus pentoxide acts as a reservoir for the water (moist phosphorus pentoxide exchanges its hydrogen freely with water vapour and maintains the concentration of the sulphuric acid at the right level). Infra-red analysis (via the pumping-off stem, without breaking the ampoule) indicates that, at this time, the exchange extends to about two of the four ring hydrogen atoms. Very prolonged treatment is needed to cause the remaining two to be exchanged. Published data[5] suggest that these two groups of hydrogen atoms correspond to those which are ortho and meta with regard to the carboxyl group respectively.

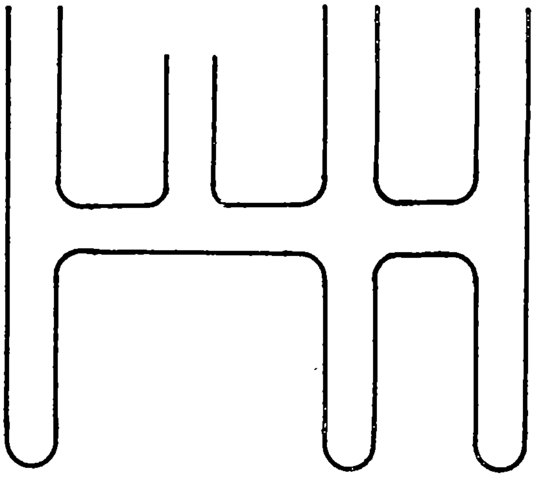

Fig. 1. Reaction vessel for the preparation of radioactive *p*-nitro benzoic acid

Neglecting isotope effects on the exchange equilibria, the radioactive yield $\left(= \frac{\text{useful activity}}{\text{total activity}}\right)$ is about 28 per cent, in the absence of chemical losses, if two ring positions are exchanged, and would be 44 per cent if all four positions came to equilibrium. Since, however, degradation and sulphonation increase with duration of the heating, the radioactive yield into purified p-nitro benzoic acid is likely to be much less than 44 per cent in the second case.

After purification, and removal of the activity from the carboxyl group, the overall yield was about 70 per cent by weight (17 per cent by activity), the specific activity being 230 mc./gm.

Further studies on the use of this material are in progress. A detailed account of the method will be published elsewhere.

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A Surface Contact Microscope for the study of Cell Movements

The importance of the contacts formed by moving cells in controlling their behaviour has been clearly shown in the phenomenon of contact guidance described by Weiss[1] and in contact inhibition described by Abercrombie and Heaysman[2].

In order to study the contacts formed between cells and solid surfaces, it is possible to make use of the slight penetration of light waves into the less dense medium when totally internally reflected at a glass/water interface. The apparatus used for these studies is illustrated in Fig. 1. Light from an intense source S (compact-source mercury arc) passes through the slit T and strikes the upper surface A of the 60°-prism. A cell suspension in water is mounted between an ordinary microscope slide and a coverslip and is sealed with immersion oil on the upper face of the prism (Fig. 2). The incident light now strikes the upper surface of the glass slide at an angle greater than the critical angle and is totally internally reflected at the glass/water interface. In reality the beam penetrates the less dense medium slightly, as shown diagrammatically in Fig. 3(a). If a cell of refractive index greater than water is moving on the surface (Fig. 3(b)), those portions which make close contact with the surface of the glass will enter the penetrating beam and will scatter the light, owing to the presence of minute inhomogeneities in their structure.

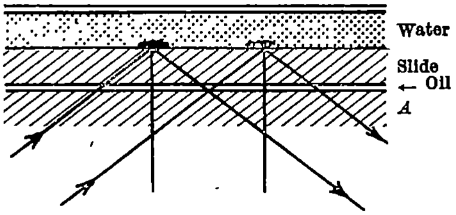
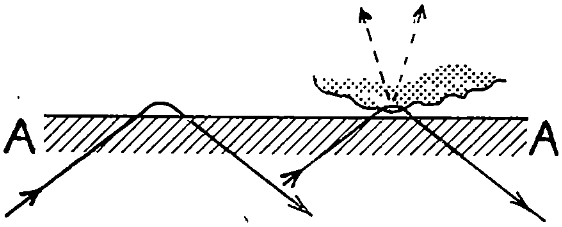


Fig. 2



(a) (b)

Fig. 3

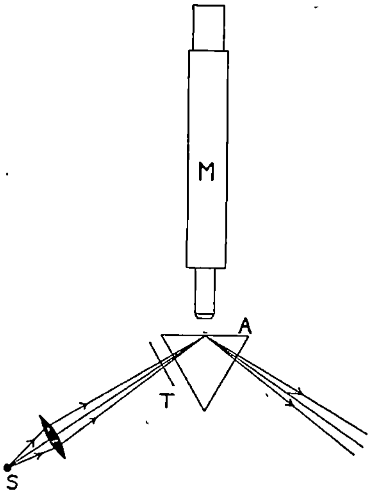


Fig. 1

When seen from above, through the microscope M, the field appears completely dark, provided that the incident light beam has been carefully shielded and the prism faces are clean. But those regions of the moving cells which are in close contact with the glass are brightly illuminated. In addition, the actual contours of the cell surface can be explored by changing the angle of the incident beam. With increasing angle, the degree of penetration of the incident beam is decreased so that the areas of the cell which are illuminated are reduced, eventually to those regions which are almost in molecular contact with the glass surface.

The effect is particularly well illustrated in the case of a filamentous mould kindly provided by Dr. R. J. Goldacre. As the mould moves forward along the glass, bright waves of light can be seen to move rapidly along its length, which are due to continuous changes in the points of adhesion between the lower surface of the mould and the glass surface. Apart from its biological application, the microscope may prove to be generally useful for the study of a number of phenomena, particularly those connected with the forces of cohesion between surfaces.

I am grateful to Prof. A. Haddow for his interest and encouragement in this work. This investigation has been supported by grants to the Chester Beatty Research Institute (Institute of Cancer Research: Royal Cancer Hospital) from the British Empire Cancer Campaign, Jane Coffin Childs Memorial Fund for Medical Research, the Anna Fuller Fund and the National Cancer Institute of the National Institutes of Health, U.S. Public Health Service.

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Adsorption of Uranium on Clay Minerals

In the conventional sulphuric acid leaching of low-grade uranium ores, using 50–200 lb. acid per ton of ore, considerable amounts of uranium may remain in the leach residues, especially with secondary ores where the uranium is in the hexavalent form and should be readily soluble. We have recently been studying the absorption of uranium on clay-like minerals (for example, montmorillonite, vermiculite and halloysite) to investigate the possibility that dissolved uranium may be reabsorbed by an ion exchange mechanism on the clay minerals in an ore, thereby leaving a residue relatively high in uranium despite the usual filtration and washing procedures.

In synthetic mixtures of clay, sand and a uranium mineral, simulating ores containing 0·1–0·2 per cent uranium oxide, we have been able to demonstrate that up to 0·02 m.eq. of uranium can be absorbed on 1 gm. of the above-mentioned air-dry clays under conventional leaching conditions. The results, however, are not consistent with the known cation exchange capacities of montmorillonite, etc., which may be as high as 1 m.eq. per gm. of clay, and are quite different from the values reported by Goldstaub and Wey[1], who found that 0·5–0·6 m.eq. of uranium could be absorbed per gm. of air-dried hydrogen montmorillonite from uranyl nitrate or acetate solutions. As our work was done with a sodium montmorillonite (Wyoming bentonite) in sulphate solutions, and at concentrations and clay–liquor ratios quite different from those used by Goldstaub and Wey, it was not surprising that different results were obtained; but the magnitude of the difference nevertheless seemed excessive. We therefore repeated some of Goldstaub and Wey's experiments with sodium montmorillonite, using both nitrate and sulphate media (0·57 and 0·53 per cent uranium oxide respectively), and leaving 20 ml. of solution at *p*H 1·7–1·8 in contact with 1 gm. clay for 1 hr. in each test. The results, which represented equilibrium conditions, showed a loading of 0·33 m.eq. per gm. clay with nitrate solution, in substantial agreement with the values of Goldstaub and Wey, while the figures for sulphate solution were 0·07 m.eq., being more in line with the lower values obtained in our earlier work.

Confirmation of the unusual properties of sulphate solutions was obtained by repeating the above experiments with the strongly acidic cation exchange resin, *I.R.* 120, instead of clay. The results (Table 1) are expressed for convenience in terms of an arbitrary distribution ratio, namely, uranium oxide per gm. moist resin/uranium oxide per ml. solution.

It is evident that, in sulphate solutions, the ion-exchange capacity of clay for uranium is limited to a value much below that accepted for cation exchange. This phenomenon is consistent with the use of anion exchange resins for recovery of uranium from solution on an industrial scale and suggests that some of the uranium retained in ore residues may be absorbed by anion exchange instead of, or in addition to, cation exchange. Our current interest in the matter lies in devising simple methods for the desorption of uranium from clay-like minerals, in the light of the results reported here.

Table 1. Absorption of Uranium on Cationic Resin

gm. resin / ml solution	Distribution ratio	
	in sulphate solution	in nitrate solution
0·025	16	64
0·25	15	100

P. T. Davey
T. R. Scott

Division of Industrial Chemistry,
Commonwealth Scientific and
Industrial Research Organization,
Melbourne, C.1.
Aug. 2.

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[1] Goldstaub, S., and Wey, R., *Bull. Soc. Franç. Minér. Crist.*, 78, 242 (1955).

A Method for analysing Mechanical Motion

In the particular frequency-range of 10,000–50,000 cycles per second and peak-to-peak amplitudes of the order of 0·002 in. there are several methods, for example, optical, electrical, magnetic, etc., for measuring mechanical vibration. However, in this high-acceleration region of approximately $10^4 g$, certain effects which take place can lead to useful information concerning resonant vibrating members which could not be obtained by other means.

To be specific, assume a right circular cylinder of aluminium of ¼ in. diameter symmetrically driven in fundamental longitudinal resonance at 22,000 cycles per second. Under these conditions there is a loop of motion at either end of the rod, the amplitude being 180° out of phase at one end from that at the other end. There is a node of motion at the centre of the bar. Placing one's fingers lightly along the resonating bar no definite sensation is experienced until a broad threshold of the order of 0·0005–0·001 in. amplitude (peak to peak) is attained at the loops of motion. At 0·001 in. a very definite force acts on the fingers, pushing them toward the node from both loops. It appears as if the static friction between the fingers and the surface of the bar has been reduced considerably since the experience is that of a very smooth feeling. Conversely one experiences resistance, though not of the static friction variety, as the fingers are pushed from node to loop. At the loops of motion the reduced friction effect is greatest, whereas at the node the static friction one observes below 0·0005 in. is in effect.

In order to investigate this phenomenon thoroughly a more quantitative criterion than touch sensation was necessary. Since the surfaces of the metallic cylinder are circular and relatively smooth, a viscous substance, which however has some mass, was required, and a jewellers' abrasive lapping paste mixed with water was used. To specify completely the forces and amplitudes in a vibrating bar one must know the radial amplitude U, which by simple theory is related to the longitudinal amplitude $W = A \cos kx$ by the expression $U = r\sigma W$ [1] (where r is the radius of the bar, σ is Poisson's ratio, and $k = \omega/c = 2\pi/\lambda$). For bars the radii of which are small compared to wavelength, as in the case here, these equations for all practical purposes are borne out by more rigorous theory[1].

The ratio of the maximum radial amplitude to the maximum longitudinal amplitude in a straight bar is $\frac{U}{W} = \frac{r\sigma\omega}{c}$ and for the aluminium bar at hand amounts to 0·207 r. For the same amplitude at the loop the only way to increase the radial amplitude is to increase the frequency or the radius.

Application of the paste in very small quantities to the surface of a bar ⅛ in. radius shows no action below 0·001 in. amplitude at the loop. At about 0·002 in. consistency of a kind is attained. Between 0·001 and 0·002 in. the action is erratic. At roughly 0·002 in. the paste motion is towards the node of vibration from either side of the node although there is a tendency for the gravitational forces to take effect on the paste and roll the paste to the bottom side of the bar, which was held in an attitude parallel to the work table. Increasing the amplitude on this bar to 0·003 in. did not cause any noticeable change in paste motion. By doubling the radius of the bar to ¼ in. the paste motion seemed to be enhanced and a definite change took place by the tripling of the radius to ⅜ in. At this radius the paste moved independent of the attitude of the vibrating element with respect to the work-table. In other words the forces causing the paste motion were higher than the gravitational forces. The velocity of the paste motion was also considerably enhanced.

Since a resonant drive system was used the frequency could not be changed while maintaining the same amplitude of vibration. With the present equipment larger diameter rods could not be driven at sufficient amplitudes to compare with the work done on the three bars, because of the loading effect, since the total kinetic energy of the bar contains two terms, one depending on the cross-section of the bar and the other on the square of the cross-section. In new equipment tests several points will be checked: the effect of frequency, larger amplitudes, temperature, paste, smoothness of surface of bar, etc. Aluminium was chosen as the vibrating member because the alternating stresses involved for 0·002 in. (about 13,700 lb./sq. in.) would be sufficient to generate considerable heat in rod the damping capacity of which is higher than aluminium, the heat affecting the surface tension.

It appears from this work that the ratio U/W above a certain threshold W is a quantity which determines the ability of a paste to respond to certain forces generated in a bar which are sufficiently great in magnitude to compete against surface tension and gravitational forces acting on the paste. At the same time the forces are such that paste tends to be driven from loops of motion and to pile up at the nodes, leading to the belief that this technique may be applied to more intricate shapes and to asymmetrical driving to give information which cannot be derived from theory as yet.

ROBERT H. QUINT

American Cystoscope Makers, Inc.,
1241 Lafayette Avenue,
New York, 59.
Aug. 15.

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[1] Davies, R. M., *Phil. Trans. Roy. Soc.*, A, **240**, 418 (1948).

A Magneto-resistance Displacement Gauge

THE very large Hall and magneto-resistance effects in indium antimonide (InSb) have led to a number of suggested practical applications[1–3]. We report here, briefly, some details of the use of the transverse magneto-resistance effect for the detection and measurement of small displacements.

The principle of the method is that the displacement to be measured causes a small strip of indium antimonide crystal to change its position relative to a permanent magnet, the poles of which are shaped in such a way that there is a strong field gradient in the direction of movement. The mean field over th crystal and hence its resistance are then a function o position.

This simple arrangement would be liable to a larg temperature error, to overcome which it is preferabl to use two crystals rigidly connected together and so disposed that as the field in one increases that in th other decreases. This is shown schematically i Fig. 1. The two crystals form two arms of a Wheatstone bridge, the remaining arms of which consist o equivalent resistances. By adjusting one of these th bridge is balanced in the position of zero displacement

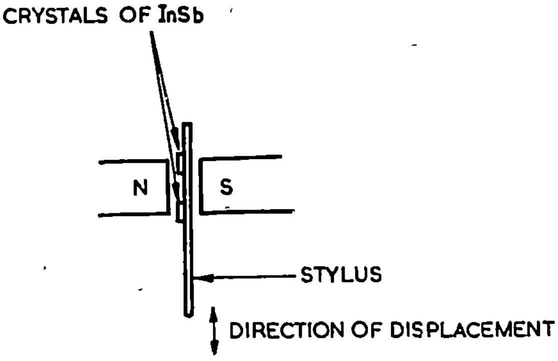

Fig. 1. Schematic arrangement of the specimens relative to the magnetic field

With such an arrangement, fed from a 2-volt cel and using crystals of size $2 \times 2 \times 0{\cdot}25$ mm., we hav been able to obtain a deflexion of 5 mm. directly o a galvanometer (⅛ m.amp. full scale, 6 ohm resistance for 1μ movement of the stylus, that is, a magnification of 5,000 times. The short-term zero stability i better than 0·25μ.

If the bridge is fed with a.c. it is possible to ampli the signal, with a considerable increase in sensitivit the limit to which is set by perfection in the mechan cal mounting and residual temperature effects, rathe than by intrinsic response. It is believed that a increase of 10–100 times should be attainable in th way.

The gauge in its direct form is particularly simp where remote reading, or recording, of results required. For example, it could be used for the co tinuous monitoring of foil thickness. The sensitivit can be quickly altered by switching the feed curren or by inserting shunts across the meter.

Acknowledgment is made to the Admiralty f permission to publish this communication.

I. M. ROSS
E. W. SAKER

Services Electronics Research Laboratory,
Baldock,
Herts.
Sept. 13.

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[1] Hartel, W., *Siemens-Zeitschrift*, **28**, 376 (1954).
[2] Ross, I. M., and Saker, E. W., *J. Electronics*, **1**, 223 (1955).
[3] Willardson, R. K., and Beer, A. C., "Electrical Manufacturin (Jan. 1956).

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, November 26

Institute of Neurology (in the Lecture Theatre, The National Hospital, Queen Square, London, W.C. 1), at 5 p.m.—Prof. S. T. Bok Amsterdam). "The Structure of the Cerebral Cortex as Studied y Quantitative Methods—1".* (Further lecture on November 30.)

Royal Geographical Society (at 1 Kensington Gore, London, .W.7), at 5 p.m.—Mr. B. W. Sparks: "Evolution of the Relief of the Cam Valley".

British Society for the History of Science (in the Lecture Theatre of the Science Museum, Exhibition Road, South Kensington, London, S.W.7), at 5.30 p.m.—Mr. John Fisher: "Electricity in Germany in the Eighteenth Century".

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 6 p m.—Dr. L. E. C. Hughes: First of Three Cantor Lectures on "Engineering Electronics". (Further lectures on December 3 nd 10.)

Tuesday, November 27

University of London (at Bedford College, Regent's Park, London, N.W.1), at 5.15 p.m.—Prof. Harold Richardson: "The Growth of Physical Ideas"* (Inaugural Lecture).

Cement and Concrete Association (at the Institution of Civil ngineers, Great George Street, London, S.W.1). at 5.30 p.m.—Dr. . B. Morice: "The Analysis of Prestressed Concrete Structural Members and the Application of Recent Research".

Institute of Marine Engineers (at 85–88 The Minories, London, .C.3), at 5.30 p.m.—Mr. C. D. Boadle: "Some Safety Considerations of Nuclear Power Reactors".

Research Defence Society (in the Physiology Lecture Theatre, niversity College, Gower Street, London, W.C.1), at 5.30 p.m.—rof. A. A. Miles: "Resistance to Infection—The Experimental pproach". (Twenty-fifth Stephen Paget Memorial Lecture"); followed by the Annual General Meeting.

Royal Institute of Chemistry (joint meeting with the Sir John ass College Chemical Society, at the Sir John Cass College, wry Street, London, E.C.3), at 6.30 p.m.—Prof. R. S. Nyholm: Magnetism and Inorganic Molecules".

Society of Instrument Technology (at Manson House, Portland Place, London, W.1), at 7 p.m.—Prof. J. D. McGee: "Television Technique applied to Observation and Control".

Wednesday, November 28

University of London (at the Postgraduate Medical School of London, Ducane Road, London, W.12), at 2 p.m.—Prof. R. H. S. Thompson: "The Biochemistry of Nervous Diseases".*

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m —Mr. J. S. Hales: "Air Conditioning of Buildings" Alfred Bossom Lecture).

Institute of Fuel (at the Institution of Civil Engineers, Great eorge Street, London, S.W.1). at 5.30 p m.—Dr. R. S. Scorer: "The Cost in Britain of Air Pollution from Different Types of Source".*

University of London (at King's College, Strand, London, W.C.2), 5.30 p.m.—Dr. A. B. Wardrop: "Structural Aspects of Surface rowth in Plant Cells".*

British Institution of Radio Engineers (at the London School Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6.30 p.m.—Dr. G. N. Patchett: "Colour Telesion".

Society for Analytical Chemistry, Physical Methods Group t the Chemical Society, Burlington House, Piccadilly, London, W.1), 6.30 p.m.—Twelfth Annual General Meeting.

Institution of Mechanical Engineers, Automobile Division t 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p.m.—ebate on the motion that "There is no Future for Laminated Plastics Automobile Body Construction".

Society of Chemical Industry, Food Group (at 14 Belgrave quare, London, S.W.1), at 6.45 p m —Mr. G. Clewlow and Mr. W. ixon: "New Aspects of the Evaluation of Biscuit Flour"; Dr. . E. Bender: "The Stability of Vitamin C in a Commercial Fruit Squash".

Royal Institute of Chemistry (joint meeting with the South-West Essex Technical College Chemical Society, at the South-West Essex Technical College, Forest Road, Walthamstow, London, 17), at 7 p.m.—Dr. A. T. James: "Gas-Liquid Chromatography".

Thursday, November 29

University of London (in the Anatomy Theatre, University ollege, Gower Street, London, W.C.1), at 1.15 p.m,—Mr. K. M. arbour: "A New Approach to the Nile Waters Dispute".*

Physical Society, Optical Group (in the Lecture Hall of the ational Physical Laboratory, Teddington), at 2.30 p.m.—Mr. J. W. tes: "Polarimetry: Present Use and Future Aims"; Mr. E. J. llham: "A Precision Photoelectric Polarimeter and Automatic ccharimeters for Industrial Use"; Mr. R. Stanley: "The Belling-m and Stanley Photoelectric Polarimeter".

University of London (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 5 p.m.—Prof. G. F. Marrian: "Some Recent Progress in the Biochemistry of the Œstrogenic Hormones".*

Institution of Civil Engineers (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Dr. W. H. J. Vernon: "Metallic Corrosion and Conservation".

Institution of Electrical Engineers (at Savoy Place, London, W.C.2), at 5.30 p.m.—Prof. R. O. Kapp: "Differences of Opinion about Dimensions".

Society of Chemical Industry, Plastics and Polymer Group (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 6.30 p.m.—Prof. H. F. Mark: "Recent Progress in Heterogeneous Polymerization of Olefines".

Friday November 30

Textile Institute (at 10 Blackfriars Street, Manchester 3)—Dr. F. C. Toy: "The Impact of New Ideas on an Old Craft" (Emsley Lecture).

Royal Society (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Anniversary Meeting.

Physical Society (in the Lecture Theatre of the Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Prof G. D. Rochester and Dr. C. C. Butler: "The Discovery of V-particles and the Properties of Hyperons".*

Institution of Mechanical Engineers, Education Group (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6 p.m.—Dr. H. S. Arms: "The American System of Education and Training of Mechanical Engineers"; Prof. S. J Davies: "The Education of Engineers in European Countries".

University of London (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6 30 p.m.—Dr. W. G. Thompson: "Technologies in the Electrical Engineering Industry".* (Eighth of ten University Extension Lectures on "Technology and Industry". Further lectures on December 7 and 14.)

Royal Institution (at 2[illegible] Albemarle Street, London, W.1), at 9 p.m.—Dr. W. H. Glanville: "Speed on the Road and Related Effects".

Saturday, December 1

Association of Agriculture, and the British Agricultural History Society (at the Institute of Education, University of London, Malet Street, London, W.C.1), at 11 a.m.—Conference.

Mammal Society of the British Isles (at the offices of the Zoological Society of London, Regent's Park, London, N.W.1), at 2 p.m.—Symposium on "Deer".

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Sir John Forsdyke: "The Origins of Coinage".*

British Interplanetary Society (in the York Hall, Caxton Hall, Caxton Street, London, S.W.1), at 6 p.m.—Mr. C. A. Cross: "The Use of Probe Rockets".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Graduate to assist in the Electron Microscopy Section of the Cavendish Laboratory on work in X-ray microscopy and related aspects of electron physics—The Secretary to the Department of Physics, Cavendish Laboratory, Free School Lane, Cambridge (December 1).

Senior Lecturer/Lecturer in Animal Nutrition or Animal Physiology in the School of Wool Technology, New South Wales University of Technology, Sydney, Australia—The Agent General for New South Wales, 56 Strand, London, W.C.2 (Australia, December 14).

Chair of Chemistry—The Secretary, The University, Exeter (December 15).

Farm Demonstrator (with a degree in agriculture, or an honours degree in pure science, followed by an adequate postgraduate qualification in agriculture, together with farming experience) at Cambridge University School of Agriculture—The Secretary, School of Agriculture, Cambridge (December 15).

Lecturer (preferably with a degree in chemical engineering, chemistry or engineering) in Chemical Engineering—The Registrar, King's College, Newcastle-upon-Tyne (December 17).

Senior Lecturer in Psychiatry at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, December 18).

Lecturer in Agriculture (Animal Husbandry) at the University College of Rhodesia and Nyasaland—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (December 21).

Scientific Officer, Grade I (with a first-class honours degree with chemistry as a major subject) in the Defence Standards Laboratory, Department of Supply, Alexandria, New South Wales, Australia, for research into problems associated with the production of protective coatings on metals by electrochemical means and with the evaluation of such coatings for effectiveness and serviceability as corrosion barriers—The Senior Representative (AP.70), Department of Supply, Australia House, Strand, London, W.C.2 (December 22).

PROFESSOR OF GEOGRAPHY at the University of Ceylon—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Ceylon, December 28).

LECTURERS (2) IN VETERINARY PATHOLOGY, and a LECTURER IN CLINICAL VETERINARY PATHOLOGY—The Registrar, The University, Liverpool (December 29).

CHAIR OF APPLIED MATHEMATICS in the University of Malaya—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (December 31).

LECTURER IN SOCIAL ANTHROPOLOGY at the University College of Rhodesia and Nyasaland—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (December 31).

PHYSICS TECHNICIAN (with a good technical background and able to undertake instrumental designs) IN THE RADIOTHERAPY DEPARTMENT, Auckland Hospital, for work which will include the construction of devices of a precision nature in addition to general duties in maintaining deep X-ray therapy units—The High Commissioner for New Zealand, New Zealand House, 415 Strand, London, W.C.2 (New Zealand, December 31).

SENIOR LECTURER IN BIOCHEMISTRY at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, December 31).

SENIOR LECTURER or LECTURER IN GEOLOGY at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, December 31).

SENIOR LECTURER or LECTURER (preferably with a special knowledge of mineralogy, economic geology, or similar subjects) IN GEOLOGY at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, December 31).

SENIOR TECHNICIAN IN THE FACULTY OF AGRICULTURE, University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (December 31).

POSTDOCTORAL FELLOW (with a Ph.D. in physical chemistry, and experience either in high polymer chemistry or in reaction kinetics) IN THE DEPARTMENT OF PHYSICAL CHEMISTRY—Prof. F. S. Dainton, School of Chemistry, The University, Leeds 2 (January 1).

TURNER AND NEWALL FELLOW for research in engineering, inorganic chemistry or physics, at Durham or Newcastle—The Registrar, University Office, 46 North Bailey, Durham (January 5).

ASSISTANT or ASSOCIATE PROFESSOR (with graduate training in physics, and also research and practical experience in the field) OF GEOPHYSICS—The Head of the Department of Physics, University of British Columbia, Vancouver 8, B.C., Canada.

FIELD OFFICER (AGRICULTURE) (aged 30–40, with sound tropical experience of experimental farm management and a knowledge of preparing and recording experiments) IN THE TANGANYIKA GOVERNMENT AGRICULTURAL DEPARTMENT—The Crown Agents, 4 Millbank, London, S.W.1, quoting M.3A/43540/TA.

GEOLOGISTS (with a first- or upper division second-class honours degree in geology) IN THE MINES AND GEOLOGICAL DEPARTMENT, Government of Kenya, for geological mapping, examination of mines and prospects, and the preparation of geological maps and reports suitable for publication—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.99/7/02.

LECTURER (with a university degree in physics or electrical engineering, together with experience in telecommunications, radar, microwave techniques, or allied subjects, and preferably with a knowledge of aeronautical applications) IN THE DEPARTMENT OF AIRCRAFT ELECTRICAL ENGINEERING—The Recorder, College of Aeronautics, Cranfield, Bletchley, Bucks, quoting Ref. ER/L.

LECTURER (with an honours degree or equivalent qualification, and able to teach inorganic and analytical chemistry to Grad.R.I.C. standard) IN THE DEPARTMENT OF CHEMISTRY AND BIOLOGY, College of Technology, Liverpool—The Director of Education, 14 Sir Thomas Street, Liverpool 1.

RESEARCH OFFICER (with an honours degree in bacteriology, and preferably postgraduate experience in virology) mainly for tissue culture work—The Secretary, Research Institute (Animal Virus Diseases), Pirbright, Surrey.

SENIOR LECTURER (with a degree in engineering or in physics and experience in the refrigeration industry) IN REFRIGERATION at the National College for Heating, Ventilating, Refrigeration and Fan Engineering—The Clerk to the Governors, Borough Polytechnic, London, S.E.1

SENIOR SCIENTIFIC OFFICER (with a first- or second-class honours degree or equivalent in engineering, mathematics or physics, and at least three years postgraduate research experience) with the Ministry of Supply at Boscombe Down, near Amesbury, Wilts, for helicopter research—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.293/6A.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Department of Scientific and Industrial Research National Physical Laboratory. Notes on Applied Science No. 15: Application of Spring Strips to Instrument Design. Pp. iv+25. (London: H.M. Stationery Office, 1956.) 2*s.* net. [189

The Story of the Thermal Syndicate Limited. (Commemorating the Jubilee of the Thermal Syndicate Limited, 1906–1956.) Pp. xiv+48+13 plates. (Wallsend: The Thermal Syndicate Limited, 1956.) [189

Planning, Vol. 22, No. 402; Solving Traffic Problems—Lesso from America. Pp. 173–188. (London: Political and Econom Planning, 1956.) 2*s.* 6*d.* [18

Triplex Safety Glass Company, Ltd. Report of the Director a Statement of Accounts for the year ended 30th June, 1956. Pp. 2 (London: Triplex Safety Glass Company, 1956.) [18

British Museum (Natural History). Fossil Mammals of Afric No. 10: Fossil Tubulidentata from East Africa. By D. G. MacInne Pp. ii+38+4 plates. (London: British Museum (Natural History 1956.) 20*s.* [18

University of Cambridge. Report of the Observatories Syndica for the year ending 1955, September 30. Pp. 5. (Cambridge: T University, 1956.) [18

Electrical Energy. Vol. 1, No. 1 (September 1956). Pp. 18+32+ Annual Subscription: Home and Overseas, 36*s.*; U.S.A. and Canad 5 dollars. (London: Morgan Brothers (Publishers), Ltd., 1956.) [18

Report of the City and Guilds of London Institute for the year 1 October, 1954, to 30th September, 1955. (Seventy-sixth Annu Report.) Pp. 112. (London: City and Guilds of London Institut 1956.) [18

Other Countries

Papers and Proceedings of the Royal Society of Tasmania. Volum 90. Pp. viii+204. (Hobart: Royal Society of Tasmania, 1956.) [18

Wisconsin Studies in Medical History. No. 1: Franz Joseph Ga Inventor of Phrenology, and his Collection. By Erwin H. Ackerknec and Henri V. Vallois. (Translated from the French by John Z. Bowers Pp. 86 (2 plates). (Madison, Wisconsin: University of Wiscons Medical School, 1956.) 1.50 dollars. [18

Turkiye Cumhuriyeti Maarif Vekaleti: Basma Yazi ve Resimle Derleme Müdürlügü. Turkiye Bibliyografyasi, 1953, 3, (Temmu Agustos-Eylül). Pp. ii+577–822. (Istanbul: Maarif Basimevi, 195 F. 155 kurus. [18

Académie Royale de Belgique. Classe des Sciences. Mémoire Tome 29, Fascicule 5: Contribution à l'Étude de la Structure Monochlorosilane par Spectroscopie Infrarouge à Grande Dispersio Par André Monfils. Pp. 52. 80 francs. Tome 29, Fascicule 6: Sur l Topologies Définies à Partir d'une Relation d'Ordre. Par Marc Guillaume. Pp. 44. 40 francs. (Bruxelles: Académie Royale Belgique, 1956.) [18

Conseil Permanent International pour l'Exploration de la Me Charlottenlund Slot, Danemark. Bulletin Statistique des Pêch Maritimes des Pays du Nord et de l'Ouest de l'Europe. Rédigé p Arni Fredriksson. Pp. xi+45. (Copenhague: Andr. Fred. Høst Fils, 1956.) 9 kronor. [18

Publications de l'Institut National pour l'Étude Agronomique Congo Belge. Étude Statistique des Pluies Intenses en un Point et s une Aire au Congo Belge et au Ruanda-Urundi. Par Dr. Franz Bult (Bureau Climatologique Communication No. 11.) Pp. 90. (Bruxelle Institut National pour l'Étude Agronomique du Congo Belg 1956.) [18

Groupement pour l'Avancement des Méthodes d'Analyse des Co traintes. Journées d'Extensométrie, 17, 18, 19 Février 1955. (Nume spécial des Mémoires.) Pp. 192. (Paris: Groupement pour l'Avanc ment des Méthodes d'Analyse des Contraintes, 1956.) [24

Netherlands Scientific Film Association. List of Films on Hum and Comparative Parasitology. Third edition. Pp. 94. (Utrech Netherlands Scientific Film Association, 1956.) 10*s.*; 1.50 dollars. [2

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Report of Her Majesty's Astronomer at the Cape of Good Hope the Secretary of the Admiralty, for the year 1955. Pp. 10. (Observ tory, Cape: Royal Observatory, 1956.) [24

Midwest Research Institute. Annual Report of Midwest Resear Institute. Pp. 16. (Kansas City, Missouri: Midwest Resear Institute, 1956.) [24

Mitteilungen aus der Biologischen Bundesanstalt für Land- u Forstwirtschaft, Berlin-Dahlem. Heft 86, Juli 1956: Holzschut Pp. 64. (Berlin-Dahlem: Biologischen Bundesanstalt für Lan und Forstwirtschaft, 1956.) 9.80 D.M. [2

United States Department of Commerce: Weather Bureau. Techn cal Paper No. 15: Maximum Station Precipitation for 1, 2, 3, 6, 1 and 24 hours. Part 16: Pennsylvania. Pp. ii+146. 65 cen Research Paper No. 39: Mesoanalysis—an Important Scale in t Analysis of Weather Data. By Tetsuya Fujita, Herman Newstein a Morris Tepper. Pp. v+84. 50 cents. (Washington, D.C.: Gover ment Printing Office, 1956.) [2

Smithsonian Miscellaneous Collections. Vol. 131, No. 7: T Upper Paleocene Mammalia from the Almy Formation in Weste Wyoming. By C. Lewis Gazin. Pp. iii+18+2 plates. (Publicat 4252.) (Washington, D.C.: Smithsonian Institution, 1956.) [2

New Zealand Forest Service: Forest Research Institute. Forest Research Note No. 6. Estimation of Volume of Forked Trees in Exo Coniferous Stands in New Zealand. By G. Duff. Pp. 10. (Wellingto Government Printer, 1956.) [24

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NATURE

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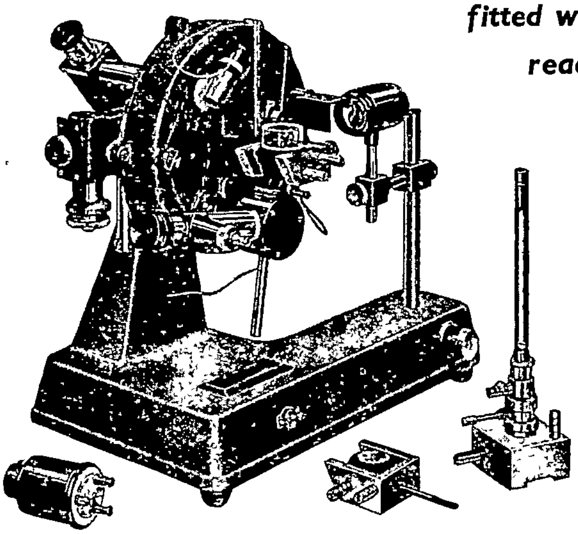

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COST AND PRICE OF *NATURE*

T has been decided that at the beginning of 1957 the price of *Nature* is to be raised from 2*s*. to 2*s*. 6*d*. -an increase of 25 per cent. The decision was taken ith reluctance, and not without considerable eliberation. Certain obvious economic factors have ontributed towards enforcing this step. For example, credible though it may seem, the great increases in aper and printing charges, especially over the past n years, and more especially during the past two three years, have now brought us to the stage when e cost of producing a copy of *Nature* is higher than e price charged. It therefore follows that, with ich a journal as this which has no outside financial ipport or subsidies, those who use it as an advering medium are its strongest supporters financially, at is, apart from the publishers who, throughout e years, have done everything they can to encoure its growth and development. It is not irrelevant point out that though in 1957 *Nature* will cost 0 per cent more to the buyer than it did in 1939, e rates charged to the advertisers have been raised uch more than that mainly owing, of course, to creased costs of production.

There are few scientists to-day who know that at inception and for about the thirty ensuing ars *Nature* was published at a financial loss—a s which was sustained entirely by the publishers io then, as now, willingly undertook certainculiar responsibilities for the advancement of ence.

Other journals, both scientific and otherwise, and newspapers have, since the beginning of the cond World War, found it necessary to increase eir prices (in some cases quite drastically). A large mber, even during the past two years, have raised eir subscriptions from 10 to as much as 50 per it. In many cases (and this applies especially to wspapers, due mainly to paper rationing) the rise price has been gradually accompanied by a luction in the number of pages and consequent ount of text. This has not been the case with *ture* ; in fact, the reverse is true for the amount of t in an issue of *Nature* to-day is well-nigh double it of an issue of 1939 and even more than that of l earlier issues.

In this connexion, Table 1 is of interest. There set out the total number of pages of text matter pearing in twenty-six issues (equivalent to one ume extending over a period of six months) of the irs 1939, 1947, 1955 and 1956. These years are of vious significance. It will be noted that the actual mber of pages in 1947 are less than the corrending six months in 1939 ; yet the amount of t in 1947 was much more, for by then there had n an accumulation of war-time economies, such smaller type, more economic (though essentially attractive) lay-out, and so forth. These economic asures still hold ; therefore, to the figure 1,446 (for 1956) about another 400 pages could justifiably be added for comparison with the figure for 1939. This indicates that in 1956 almost twice as much text is offered per volume as compared with 1939. (We are glad to announce that one war-time economy is to be jettisoned in 1957 in that we shall be returning to the wider page margin though the type-area will remain the same. This will not only add dignity to the journal but also offer a utilitarian advantage to the inveterate note-maker.)

Table 1

Period (June-Nov. ; 6 months)	No. of letters and special articles	No. of columns of letters and special articles	Total No. of pages
1939	313	484	1,086
1947	497	644	904
1955	627	1,071	1,194
1956	833	1,323	1,446

Also in Table 1 are indicated the number of actual letters and special articles and the number of columns devoted to these for the same periods covered. The term 'special articles' here applies to those contributions which are really extended research communications in contradistinction to the general articles, reports of scientific meetings, etc., which are not included in Table 1. These special articles are invariably inserted just before the letters (one to four articles per issue).

The distribution of *Nature* is not without interest in this connexion, though it cannot be too strongly emphasized that circulation figures of a journal such as *Nature* are meaningless, at any rate, to the many readers who bear no financial responsibility in connexion with the journal. So widely known and read is *Nature* throughout the world that it is understandable when a person suggests that its *numerical* circulation must be enormous. But this is not the case. The head of one of our leading scientific institutes once said that he and his colleagues had estimated the numerical circulation from various data which he did not at the time disclose. We wish their estimate had been right ; but they were 800 per cent out in their calculations. At any rate, the estimate did indicate how much *Nature* is used, if not purchased.

Bound up with distribution is contribution, and Table 2 shows those countries from which letters and

Table 2

Great Britain and Ireland
United States of America
Australia
Canada
India, Ceylon and Pakistan
Japan
New Zealand
Czechoslovakia
South Africa
Sweden
Holland
Hungary
Italy
Brazil
Germany (Western)
Anglo-Egyptian Sudan
France
Israel
Belgian Congo
Belgium
Denmark
Egypt
Gold Coast
Norway
Finland
Kenya
Malaya
British West Indies
Nigeria
Poland
Austria
Switzerland
Uganda
U.S.S.R.
Venezuela
Yugoslavia

special articles were published during the immediate past *six months* (a period corresponding to the 1956 period in Table 1)

The countries in Table 2 are arranged in order of number of communications published from them over the six-month period: for example, United States, 162; Canada, 35; Japan, 17; Czechoslovakia, 12; Hungary, 7; Germany, 7; Israel, 5; Denmark, 4; Egypt, 4; Kenya, 3; U.S.S.R., 1. The complete figures are not given, for they would be misleading, because only a short period is covered. Had this period been extended to, say, one year, more countries would have appeared in the list. In fact, over a longer period it would be seen that most countries throughout the world where scientific research is being carried out use *Nature* for recording and discussing their results.

If time and space allowed comparisons of this (1956) period with similar periods during selected years over the past twenty years, other items of interest would emerge. Table 2 alone, for example, if compared with certain previous years, would stress the great scientific advancement which has taken place in Colonial areas during the post-war years due mainly to government and otherwise sponsored research, and also the commendable efforts being made by the newly established Colonial university and other scientific centres. Moreover, there is an indication that the U.S.S.R. is returning to the fold where she used to play a prominent part before sinking into a period of silence behind the Iron Curtain.

At present, however, we are concerned with Table 2 only so far as it is an indicator of the *geographical* distribution of contributors to *Nature*. This distribution is entirely world-wide, and the same applies to the readers and subscribers, though certainly not numerically; for, by and large, there must be very few working scientists in the world who are unable conveniently to read or refer to any copy of *Nature* they require, no matter whether they be subscribers or not. But geographical distribution is not the same as numerical distribution, in that probably *Nature* is more widely distributed geographically than even some metropolitan daily newspapers. For every issue of *Nature* published there are many more readers. It is fair to emphasize this especially since the advertisers, whose rates have been increased much more than the published price, are in a practical way much stronger supporters of the journal than its readers. There are many and various reasons for this. For example, up to as recently as three years ago, more than two hundred copies of each week's issue of *Nature* were subscribed for from within the U.S.S.R. Then this number was suddenly reduced to about a dozen; yet scientists who have recently visited that country can tell us that they saw photocopies of *Nature* at every scientific centre they visited. Elsewhere, especially in Britain and the United States, it is common to hear quite an active and even outstanding scientific worker state, or maybe even complain, that he is unable to get hold of a copy of *Nature* for ten days to three weeks after it has been published because his colleagues must have their turn first with the one issue for which they subscribe. Comparisons are sometimes misleading, sometimes even odious; but the fact cannot be refuted that at present an issue of *Nature* costs, in Britain, about half the price of a packet of twenty cigarettes and much less than most readers would expect to pay for one seat for one performance at a theatre.

There are, of course, especially among the younger scientists, many who cannot be expected to subscribe personally to a general journal such as *Nature* particularly those who must, or prefer to, subscribe to other journals. But *all* contributors, whether they be also subscribers or not, and especially authors o special articles and letters, can do much more than they are doing towards keeping the costs of production down. For example, there is still too much rushing into print, and this does not apply solely to the younger enthusiasts. It is sometimes even followed by a request to cancel a contribution which has most probably already cost several pounds sterling in setting of type and maybe even making of blocks for illustrations. Other contributors all too readily make corrections in their proofs—and such corrections are nowadays very expensive to make For example, it costs about 1*s*. 6*d*. to insert on comma in a proof.

The average weekly authors' corrections, includin cancelled matter owing to articles being withdrawn or revised copies submitted after type has been set up amount to seven columns, or in other words th equivalent of two complete weekly issues is wasted eac half-yearly volume (26 *numbers*). *The entire cost o this is borne by the publishers; the time waste by editors, compositors and readers needs n emphasis.*

In many cases, more care at the initial stages o preparing a manuscript would obviate such expensiv corrections. Moreover, corrections are often made in a wasteful and sometimes futile attempt to improv style. The costs of blocks for illustrations also hav soared, yet on occasions we are asked to discard block in favour of a new one. As one editor of *Natu* pointed out in a lecture before the Royal Society o Edinburgh, it would perhaps be a good idea if ever contributor to *Nature* asked himself the three fo lowing questions before submitting his contribution (1) Have I said exactly what I want to say? (2) Have I said it in the minimum number of words? (3) Is worth saying at all? It should here be emphasize that no charge is ever made to authors for correction or cancellations.

The demand for space in the "Letters to th Editors" section is continually on the increase By and large, of course, this is a very welcom trend; but contributors are asked to keep their communications down to the absolute minimum length.

All this is a matter of economics. *Nature* ha geographically and personally, an almost 100 p cent distribution throughout the scientific world, subscribers are being asked to contribute no mor than their fair share of the costs. This share is comparatively, indeed surprisingly, low.

CHINESE THOUGHT AND SCIENCE

cience and Civilization in China

By Dr. Joseph Needham. With the research assistance of Dr. Wang Ling. Vol. 2: History of Scientific Thought. Pp. xxiv+696+plates 14–20. (Cambridge: At the University Press, 1956.) 80*s.* net.

DR. JOSEPH NEEDHAM devotes this second volume of his monumental work to a survey of hinese thought with an eye to its relevance to cience. According to the author, the philosophy of rganism together with the Hegelian dialectic is more onsonant with modern science than the non-organic hilosophy of the past. (Whether this is so or not is question we cannot enter into here.) Further, such view of the universe can dispense with the notion f a creator by positing a spontaneous inner drive in ll things enabling them to develop with a Leibnizian pre-established harmony'. Dr. Needham's main hesis in this volume is that Chinese thought, with he exception of certain schools, was of this organic ype. From this he concludes that the outlook of ne Chinese was scientific, and, in some sense, nore scientific than that of their European conemporaries.

It is not clear why this should be so. Philosophic-ly, there is a good deal to be said for the thesis that view of the universe is a purely metaphysical natter and has no relevance for science. Even if we ere to eschew this extreme position, the most we an say is that a metaphysical view may have some ractical bearing on science. For example, given the ecessary conditions for the development of twentieth entury science, a metaphysical view—in this case he philosophy of organism—which is consonant with may, through suggesting a new point of view, help bring about this development. On the other hand, is same metaphysical view, coming at a different ncture, might inhibit the original emergence of ience. For, in order to arrive at a scientific explanaon of any natural phenomenon, it is essential, at east in the early stages of science, to be able to treat chain of events as isolable. But on the holistic ew of Nature, this is impossible, as everything is ganically bound up with everything else, and, in der to explain a particular bit of Nature, we would ave to concern ourselves with Nature in its totality. r. Needham seems, at times, not unaware of this. is, therefore, puzzling that he should think that e Chinese world view which did not lead to the nergence of science was more scientific than the ntemporaneous European view which did give rise science. Can it be that when Dr. Needham says at a metaphysical view is scientific, what he really eans is that it is true ? And this, because twentieth ntury science not only necessarily implies the ilosophy of organism but also constitutes the st word in human knowledge ? If that were e case, the Chinese should indeed be given credit r arriving independently and without the aid of odern science at a 'true' metaphysical view of the iverse.

When one takes a closer look at Dr. Needham's erpretation of Chinese thought, one finds a good al which leaves room for disagreement.

In his treatment of the early Taoist philosophers, ich is one of the least satisfactory parts of the ok, he tries to show that they took a scientific erest in Nature. Admitting that they did take a certain interest in Nature, need it necessarily be scientific ? Wordsworth, for example, was not necessarily a scientist because he took an interest in Nature. The interest the Taoist philosophers took in Nature was not scientific but philosophical, or, to be more precise, ethical. They were interested, that is to say, only in the lesson implicit in the Way (*tao*) of Nature for man as to how he should lead his life. Here, as elsewhere, Dr. Needham has not sufficiently stressed the central part played by ethics in all Chinese thought.

Again, Dr. Needham produces little evidence for his re-interpretation of the Taoist advocacy of the abolition of knowledge as confined to Confucian scholastic knowledge. There are no good grounds for departing from the generally accepted view that when the Taoist philosophers advised the rulers to "empty the minds of the people and fill their bellies" they meant exactly what they said.

In the section under discussion, one often gets the impression that the evidence Dr. Needham adduces does not quite support his conclusion—an impression that is to return again and again throughout the book.

In the section on "Fundamental Ideas of Chinese Science", one is surprised that although Dr. Needham dismisses the system of the Book of Changes as detrimental to science, he takes a much more favourable view of the Five Elements theory. This is due, perhaps, to his failure to see the full significance of the underlying similarity between the two theories: both exemplify what he calls "correlative thinking". Under each element, as under each *kua* (diagram) of the Book of Changes, is grouped a large number of things. The explanation of any given thing depends on which element it comes under. What makes this kind of explanation so different from the scientific is this: in any situation that requires explanation, there are bound to be a number of factors which most likely come under different elements, and the choice of the significant factor, and with it the element under which it comes, is arbitrary. Thus this system of explanation can never be shown to be unsound, for, whenever an explanation turns out to be false, one can always say that this is because the wrong factor was chosen as significant. Correlative thinking must have constituted one of the major obstacles to the emergence of science, as it was an ingredient to be found in a good deal of Chinese thought.

The section on Neo-Confucianism is probably the most important, as well as the most successful, part of the book. But even here one feels that Dr. Needham has overlooked certain aspects. Neo-Confucianism was both eclectic and 'scriptural'. It accepted as canonical the Confucian Classics—a haphazard collection of works differing widely in origin and point of view. Thus a multiplicity of 'scriptural' sayings, each of which can be used uncritically as authority, have to be accommodated in an uneasy system of thought. Further, according to Dr. Needham, in the Neo-Confucian system morals emerge only when organisms of a sufficiently complex nature appear on the scene. One would have thought that the starting point of the Neo-Confucians was the moral order of human society, and this they took as a pattern for the explanation of the universe. *Li* are principles which are moral as well as natural. If the Neo-Confucian philosophy is to be interpreted as a philosophy of organism, it is misleading to think exclusively of natural organisms. In fact, the Neo-

Confucian vision of the universe was constructed on a moral basis.

In a work of this length, with so many quotations from Chinese works, it is to be expected that one often feels unable to accept the author's translations. But one cannot pass without comment the section on Mohist logic. Dr. Needham has not given sufficient warning to the reader that, in the majority of cases, the text has been so radically and so extensively emended that the translation is of an exceedingly tentative nature. There are, for example, no good grounds for thinking that proposition Cs 14 (p. 179) is concerned with whether evidence is independent of morals, or that Cs 51 (p. 180) approximates to Hegelian dialectical logic.

Incidentally, there are fairly frequent mistakes in the Romanized readings of Chinese characters.

Although I have dwelt mainly on parts of the book which are more open to criticism, I should like to make it quite clear that this is the most significant work in English that has appeared in this field for many a long year. In fact, it is because the book is so full of stimulating ideas that it inevitably provokes disagreement.

D. C. Lau

THE PHYSICS OF MODERN RADIOLOGY

Radiology Physics

An Introductory Course for Radiologists, Radiographers and Medical Students. By Prof. John Kellock Robertson. Third edition. Pp. xvi+329. (London: Macmillan and Co., Ltd.; New York: St. Martin's Press, Inc., 1956.) 36*s*. net.

IONIZING radiations, in the form of X-rays and nuclear radiations, have been used in medicine for some sixty years, and lately the scope and intensity of their application have been immensely increased. In this time, however, comparatively few text-books have been available which both present to the student the basic radiation physics and show how it is applied to radiological practice. Among them is Prof. J. K. Robertson's "Radiology Physics", first published in 1940 and now in its third edition. The author has extensively revised the earlier editions and has added much new material. The result is an up-to-date book written to the standard required for an introductory course for radiologists, radiographers and medical students.

The first six chapters cover the subjects of alternating currents, production of high voltage, cathode rays, positive rays and isotopes, Roentgen tubes, rectification and diode and triode valves, discussing broadly the physical phenomena leading to, and underlying, the production of X-rays. The next five chapters describe the physical properties of X-rays and their measurement, including the dosimetry of X-rays in radiotherapy and including also a new chapter on the physical principles of X-ray diagnosis. Of the remaining five chapters, one is devoted to natural radioactivity, one to super-voltage tubes and particle accelerators, two to the transmutation of matter and artificial radioactivity, and the last, a new chapter, to uranium fission and nuclear reactors. Radiation protection is dealt with somewhat briefly in an appendix.

Most of the chapters have been revised and contain new material. The substance of two chapters in the earlier editions has been omitted. There i now no chapter on infra-red, visible and ultra-violet radiations, and the material on high-frequency currents has been reduced to two short sections a the end of Chapter 6. Although the omission of thes subjects leaves the book free from material strictl extraneous to radiological physics, I am sorry tha they have gone for, hitherto, "Radiology Physics" ha been one of the few books to which the medica student could turn for simple relevant informatio on infra-red and ultra-violet rays and on so-calle short-wave therapy. The value of the chapter o dosimetry would have been appreciably enhanced if in addition to the detailed description of a well known make of condenser dose meter, more consideration had been given to electronic methods Extension of the section on valve amplification t include an elementary explanation of the principle o negative feed-back could have led to a discussio of modern dose and dose-rate meters using stabl valve amplification.

Prof. Robertson's style is lucid and direct, an physical principles are presented clearly with th necessary mathematical expression where this i required. The many numerical examples worked ou in the text are valuable both as an aid to the student' understanding and as a constant reminder that numerical approach is imperative in the medical us of radiations which must always be regarded a potentially harmful and which possibly can be lethal

The book is well designed to give the basic understanding of radiation and nuclear physics to th student radiologist. It is perhaps more detailed an more quantitative than is required by the othe readers named specifically on the title page; but bot radiographers and medical students will find the ne edition helpful. Physicists teaching the elements radiation and nuclear physics to the increasin numbers of those who use ionizing radiations wi welcome this book as an aid to their work.

F. W. Spiers

PHYSICS FOR NON-PHYSICISTS

Descriptive College Physics

By Prof. Harvey E. White. Pp. x+485. (Princeton N.J.: D. Van Nostrand Company, Inc.; London Macmillan and Co., Ltd., 1955.) 42*s*.

The World of Atoms

An Introduction to Physical Science. By Pro J. J. G. McCue, with the assistance of Prof. Kennet W. Sherk. Pp. xiii+659. (New York: The Ronal Press Company, 1956.) 6.50 dollars.

EXPERIENCE alone can determine whether th needs of a group of non-specialists are bett satisfied by a conventional course in physics adjuste to their capacity, or by a more general approac attuned to their outlook; but one would feel tha either method, if only it can arouse and hold the interest, can achieve success. These two books, eac the work of an enthusiastic and resourceful teache seem admirably suited to the needs of the no scientist students for whom they are intended.

Prof. Harvey White, in selecting material for short physics course for arts students at the Universit of California, Los Angeles, appeals to the spectacul experiment and uses very little mathematics. Neve theless, the elementary mechanics is presente thoroughly and rigorously, and the reader is led on to the later chapters on atomic and nuclear physics with a good grounding in the conservation laws. There are excellently illustrated chapters on colour and spectra, introducing the important part played by the spectroscopist, particularly in the early days of modern physics. The book is a most valuable interpretation of the experimental side of physics, and manages in this way to make the subject attractive and intelligible to the non-mathematician.

Prof. J. J. G. McCue's book, which is written at the same level for the same type of student, takes a wide survey of the whole of physical science and lays more emphasis on the historical and human aspects. Why do we believe in the existence of atoms and sub-atomic particles, and how do their properties determine those of the materials in the world around us? These are the questions he asks and discusses in seventy-one chapters, each centred on a single topic. The book would probably be harder reading but for the author's foresight in concentrating attention on one thing at a time, pausing at intervals to recapitulate and consolidate the material of several chapters. The chemists' contribution to the history of atomic physics is fully described, as is also the impact of modern physics on theoretical chemistry. The closing chapters have the inevitable good account of nuclear physics, but without the usual dramatic emphasis; rather more space is, in fact, devoted a little earlier to organic chemistry. A catholic selection of suggestions for further reading ranges from original papers to biographies and popular lectures; readers interested in Anderson's first report of the positive electron, Fred Hoyle's views on the origin of the cosmos, or Sir J. J. Thomson's descriptions of baseball and American football, are directed with equal precision to the source. This is a well-written book which, in spite of its wealth of detail, holds the reader's attention to the end.

G. R. Noakes

ANTIBIOTICS IN AGRICULTURE

Proceedings First Conference on the Use of Antibiotics in Agriculture

Pp. xx+278. Publication 397, National Academy of Sciences, National Research Council, Washington 25, D.C., 1956. 2.50 dollars.

IT was an excellent idea of the National Research Council of the U.S. National Academy of Sciences to convene an international Conference on Antibiotics n Agriculture (held during October 19–21, 1955, in Washington, D.C.), and so provide an authoritative forum for discussing the many achievements, problems and expectations in the rapidly growing field of application of antibiotics in agriculture. The publication of the full report on the proceedings of this Conference is the culmination of an enterprise which was well worth while.

The leading experts of the United States and twelve other countries touched in their papers and discussion on every aspect of this fascinating topic. The scope f application of antibiotics is continuously widening. Their usefulness as therapeutic agents and as growth-promoting supplements to feeding-stuffs has been stablished beyond doubt, and newer developments oint ot considerable benefits which may be obtained from application in agronomy (promoting growth and combating infection in plants) and food preservation. Our knowledge and experience in these new fields are still very limited, but the potentialities appear to be enormous.

In 1954 about a quarter of the total production of antibiotics in the United States, namely, nearly half a million pounds, was used as supplements to feeds. All species of agricultural animals appear to have benefited from inclusion of antibiotics in their rations, the magnitude of the positive response depending on many factors. The latter were discussed by many of the contributors.

The mode of action of antibiotics as growth promoters was a subject of a very lively controversy, dominated by the general admission that the available scientific evidence does not allow the exponents of the many hypotheses to be too dogmatic. The exponents of the theme that antibiotics promote growth by virtue of their effect on the bacterial population of the digestive tract discussed the many biological pathways which could lead to an explanation of the phenomenon. The antibiotics could act as prophylactic agents guarding against 'sub-clinical' or obvious infections or as therapeutic agents in combating disease. They could function by modifying the nutritional requirements of the animals, or by specific effects on some of the essential nutrients. The experimental evidence with germ-free animals was by no means conclusive, and it added an impetus to some of the hypotheses which postulate that the antibacterial properties are not sufficient by themselves to elicit the growth-promoting effect. One of the hypotheses postulated a direct effect of the antibiotic upon intermediate metabolism of the host, others implicated hormonal systems, and still others the possible changes in the metabolic properties of the flora of the digestive tract. One feels rather sympathetic to the view expressed by one of the contributors: "Certainly there is not just one mechanism of action, but several".

The last section of the report deals with the public health aspects involved. In reviewing this part of the proceedings, one cannot do better than quote a paragraph from the summarizing talk of Dr. S. C. Keefer, director of the School of Medicine, Boston University. "It is important to assess the risk of sensitization or of sensitive reactions from antibiotic residues, and also to assess the significance of altering the oral or gastro-intestinal flora, and the emergence of resistant microorganisms as it is related to public health. Certainly the evidence to date would not lead one to believe that the risks outweigh the great benefits which have flowed from the use of antibiotics in animals, to improve nutrition or to prevent or treat diseases, or for that matter from their use as crop sprays in combating plant diseases or in the preservation of food. In any event, this area of antibiotic residues needs continuing study and research, and a fixed and rigid posture should not be taken without a sound basis of evidence. One must weigh the great advantages against the slight risks or the disadvantages."

The report is very well produced and no doubt will serve as a valuable reference book on this very important subject. There are a few mistakes, which could have been avoided by more careful editing, especially of the parts which report the general discussions. The reviewer cannot help feeling that a verbatim report was not the best way of dealing adequately with the discussion.

R. Braude

Gas Chromatography

By Courtenay Phillips. Pp. x+105. (London: Butterworths Scientific Publications; New York: Academic Books, Inc., 1956.) 25*s*.

INTEREST in gas chromatography has become widespread in the few years which have elapsed since the development of gas–liquid partition chromatography by James and Martin, and it is already a major undertaking to read all the papers which have been published in this field. With this book, the first monograph on gas chromatography to appear, Mr. Phillips has done a great deal to lighten the task of anyone intending to make use of gas chromatography. There is a valuable theoretical treatment of the subject, a carefully documented survey of most of the recent work in the field, and a useful list of references.

An important feature of the book is the wide range of techniques discussed. Although there is understandable emphasis on gas–liquid partition chromatography, there is also a section on gas-adsorption chromatography, and the use of gas chromatography in the determination of distribution functions is discussed. The short section in which the uses of adsorption and partition methods are compared might, with advantage, have been expanded; and the inclusion of some practical examples would have been helpful. All the diagrams are clear, and carefully chosen; it would have been very helpful to have included a diagram of the Martin gas-density balance, however, for it is difficult to follow a purely verbal description of this instrument without a picture.

The book is confidently recommended to all who are interested in the applications of gas chromatography. N. H. RAY

Kant's First Critique

An Appraisal of the Permanent Significance of Kant's Critique of Pure Reason. By H. W. Cassirer. (Muirhead Library of Philosophy.) Pp. 368. (New York: The Macmillan Company, 1954.) 30*s*. net.

THIS book is evidently a very able commentary upon one of the greatest philosophical works of all time. The sub-title is worthy of note, namely, the permanent significance which Kant's masterpiece has for posterity. In the light of his secluded existence at Königsberg and the rigour of his general outlook, it is scarcely to be expected that his successors would find nothing about which to differ. Perhaps to a scientist, the most important point is the justification which the present author finds for the logical dichotomy between the dual aspects of sense-givenness and the impact of the intellect upon what may be presented to it. Kant never thought of them as having a 'really' separate existence. This particular machinery was only introduced in order that some grasp of the nature of perceptual knowledge might follow.

Closely allied to this is the strong case made out by Kant that *a priori* thinking is a pre-requisite for 'knowledge proper'. Dr. Cassirer believes that much is to be gained by an approach of this kind to current problems, rather than by invoking a flood of empiricism. That a fair balance is maintained is illustrated by the writer's rejection of Kant's metaphysical deduction of the categories; but there is probably little need to stress the inacceptable character of his 'supersensible' *Ding-an-sich*, when the mind meets common objects of experience. F. I. G. RAWLINS

The Eighth Plague

By Denys Rhodes. Pp. vii+280. (London and New York: Longmans, Green and Co., Ltd., 1956.) 13*s*. 6*d*. net.

ALTHOUGH described by the author as "essentially a work of fiction", this book includes descriptions of locust swarms and hopper bands, of control operations against them with modern methods and, to a lesser extent, of field research, which must be based on first-hand knowledge, as they are extremely vivid and technically correct. The atmosphere in which this minor war between man and insect is waged in "an anonymous African territory" is effectively conveyed, and the personages —locust control officers, research workers and administrative officials—are very much alive and natural. An applied scientist reading the book will be interested in the attitude of practical field-workers to research workers, which is a mixture of amused contempt and carefully concealed respect. Less clearly brought out is the team-spirit during urgent operations; on such occasions, the author over-stresses individual leadership and makes the personages concerned exhibit heroics out of character. The not unusual conflict between scientists attempting to put their cherished ideas into practice and politicians and administrators who regard a particular approach to a problem mainly in the light of its immediate expediency is well presented. The book deserves attention, as it brings to the notice of a wide public, in a very readable form, a striking example of the kind of human problems arising in the application of science to the development of tropical countries.

Extrasensory Perception

Edited by G. E. W. Wolstenholme and Elaine C. P. Millar. (Ciba Foundation Symposia.) Pp. ix+240. (London: J. and A. Churchill, Ltd., 1956.) 27*s*. 6*d*. net.

THE sceptics are justified in ascribing much of the most interesting evidence in favour of telepathy and clairvoyance to chance; but this explanation cannot be applied to some of the experiments on card guessing, which have given results that would not have occurred by chance even if the whole human race had done nothing but guess cards from the dawn of history to the present day Well-known statisticians have found no flaw in the calculations and the results present a challenge to scientists. In May 1955 the Ciba Foundation collected a number of people who might be able to explain the facts or suggest the next step. Parapsychology and psychiatry, magic and mathematics zoology and the basic medical sciences were all wel represented at the discussions, which lasted three days and have now been published. The resulting book contains much interesting information, not only about extrasensory perception, but also about bird navigation and the homing of bees. Many marvellous things can be done by conjuring, and some remarkable performances have been shown to be due to the subconscious interpretation of sensory clues; bu the experts at this meeting were convinced tha there are some things which cannot be explained in such ways. The main impediment to progress in thi field is the fact that it is difficult to find percipient who can give statistically significant results, and much time is inevitably wasted on negative experiments. J. H. GADDUM

THEORETICAL CHEMISTRY OF METALS

By Prof. N. F. MOTT, F.R.S.
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THE use of electronic computers has made it possible to calculate the electronic wave functions of simple molecules with any degree of accuracy desired. The wave function may be taken as a series of Slater determinants; the one-electron functions contain adjustable parameters which can be found by minimizing the energy. With the increase in the speed of the computers, theoretical chemistry is approaching the point where it can, for example, rival experiment in the determination of the force constants of these molecules.

The study of solids and particularly of metals has not advanced so far. Given unlimited time on the electronic computer, we would not yet know how to set up the wave functions in the form of a series which would converge to the true one as the number of terms increased. There remain unsolved problems in the study of metals, quite apart from those like superconductivity which depend on interaction between the electrons and the lattice vibrations. Even when the nuclei are treated as being at rest, we do not know how to set up an exact wave function. This article is a description of some advances that have been made recently towards a solution of these problems and of some of the difficulties which remain.

Most attempts to set up a wave function for a metal start from the model of Bloch, which is similar to the method of molecular orbitals in chemistry. In this, each electron is treated as moving independently of all the others in a static field due to the nuclei and to the other electrons, the latter averaged in the sense of the Hartree – Fock method. To each wave function is ascribed a wave vector **k**. The determination of these one-electron wave functions is by no means an easy matter, both because of the complicated considerations of symmetry and the labour of setting up the self-consistent field. But there is no difficulty of principle here which cannot be solved, given time and effort, and much progress has been made. The question to be discussed in this article is where we go from there. One needs a wave function to describe the whole system and predict its properties. This wave function in terms of the Bloch model is a single Slater determinant of the one-electron wave functions already described, each with its appropriate spin. However, this is not a very adequate model for quantitative work, neglecting as it does the tendency of electrons of opposite spin to keep away from each other. In early work, particularly that of Wigner[1], a term was introduced into the wave function to describe this tendency, the so-called 'hole' around each electron where another electron would be unikely to be. More recently Bohm and Pines[2] showed how the size of this hole could be deduced from the existence of co-ordinates describing plasma vibrations in metals.

These methods contrast with that usual in theoretial chemistry and described as configurational interaction. In this one adds further Slater determinants in which some of the one-electron wave functions orrespond to excited states, the amplitude of each of these determinants to be determined by minimizing the energy, by perturbation theory or in some other way. This was tried for metals in a well-known paper by Heisenberg[3]; but it is not usually convenient, for the following reason. The concept of the Fermi surface, which follows naturally from the one-electron model, seems to correspond closely to the observed properties of metals; any introduction of excited states destroys the clarity of this concept.

The Fermi surface may be defined as follows in any of the one-electron models, either the single determinant or as modified by Bohm and Pines. Every state of an electron is defined by a wave vector **k** and so is the energy parameter in the one-electron Schrödinger equation. In setting up the Slater determinant which serves as the wave function of the whole system, one uses only the wave functions of occupied states, separated by unoccupied states in **k**-space by a sharp surface of constant energy that we call the Fermi surface. Since such a model must be inadequate in some respects, it is perhaps surprising that there is much experimental evidence that this surface corresponds to some property of the real metal and hence of an exact wave function. Perhaps the most direct are the properties of X-ray emission and absorption bands of light metals. We have to do here with transitions in which electrons in the conduction band made transitions to X-ray levels, or electrons from X-ray levels are excited to states just above the Fermi surface. Both types of spectra show sharp limits in accord with the one-electron theory. This was first shown experimentally by Skinner[4], who in one of his papers also discussed whether interaction between electrons ought to destroy this sharpness of the upper limit, and finds that it should not. His argument is illustrated by Figs. 1 and 2, in which Fig. 1 represents the Fermi distribution of electrons after an absorption process, the electron which has been ejected from an X-ray level being just above the Fermi distribution in the energy-level marked (*a*). Fig. 2 shows the state of affairs after emission of a

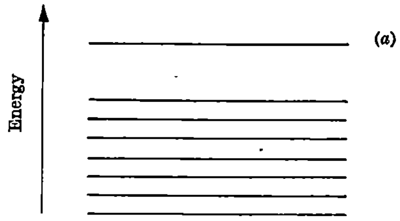

Fig. 1

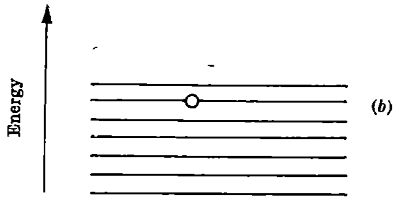

Fig. 2

quantum near the edge, there being a hole in the distribution at (*b*). Skinner shows that both these states will have a long life-time, tending to infinity as the energy interval between (*a*) or (*b*) and the Fermi limit tends to zero. This concept of a very long life-time of a slightly excited electron is confirmed by the most elementary facts about the electrical conductivity of metals; if an electron is set in motion by an electric field, it will at low temperatures in a pure crystalline metal have a very long mean free path, and hence a long life-time in its excited state. This can be terminated by interaction with other electrons, a process not without effect on the electrical resistance (Baber[5]); but the effect tends to zero with temperature and thus with the energy of excitation of the electrons above the Fermi limit.

It thus seems that the exact wave function of the electrons in a metal must have the following properties: it must allow a system of excited states, each carrying a current and with a life-time which tends to infinity as the energy of excitation tends to zero. These states will be described by a wave number **k**, and will be of two classes, as illustrated in Figs. 1 and 2. There will be a sharp dividing surface in **k**-space between the two; this is the Fermi surface.

It is thus extremely convenient to describe a metal by a single Slater determinant, improving the wave function by correlation terms or plasma vibrational co-ordinates and not explicitly introducing wave functions of the excited states which are unoccupied in the one-electron approximation. Such a description gives us a wave function with some of the properties that the exact wave function must have; for example, it retains the concept of a Fermi surface.

The importance of the Fermi surface in the theory of metals lies in the fact that electrons having energies just below it can be excited easily into the unoccupied states above it by thermal fluctuations and electromagnetic fields. Thus these electrons take part in electric, magnetic and thermal processes in metals, so that a determination of the shape of the Fermi surface is basic to any detailed understanding of most of the properties of metals and alloys. In fact, the forces within metals fall into two sharply defined groups. There are the short-range electrostatic and chemical forces, short-range because of the strong screening provided by the conduction electrons, and the effects such as that described above which depend on electrons near the Fermi distribution and can be defined only in relation to large blocks of the crystal. The effects determining crystal structure in many alloys are in the latter class (Jones[6]), though one would guess that the main part of the heat of formation of alloys is in the former.

In the Mond Laboratory in Cambridge two experimental methods are in use of which the interpretation depends on the physical existence of a Fermi surface and by which its form in **k**-space may be determined. These are the anomalous skin effect and the de Haas – van Alphen effect. The de Haas – van Alphen effect consists of the observation at low temperatures of an induced magnetic moment which varies sinusoidally when plotted against the reciprocal of the field. The moment depends on the orientation of the crystal relative to the field. The explanation of the effect in terms of the one-electron model ascribes the fluctuations obtainable with small or moderate fields to 'pockets' of electrons or positive holes, pockets in **k**-space where there is a small overlap into a new zone, or a small unoccupied space at the corner of a zone which is above the Fermi surface. The period of the fluctuations allows the shape of the Fermi surface and the number of carriers to be determined; in some cases it is as low as 10^{-5} per atom. The effective mass can also be determined and is usually low. Experiments are now in progress to study the larger main parts of the Fermi surface by using fields up to 100 kilogauss generated by discharging a bank of condensers through a coil.

That it is physically meaningful in terms of an exact wave function to say that in a given metal 10^{-5} electrons per atom overlap into a given zone is surprising and is not fully understood, though perhaps the explanation will be found along the lines indicated above, depending on the long life-time of excited states. The experiments, however, leave us in no doubt.

The existence and physical reality of pockets of electrons are very useful for the theoretical chemistry of metals. For suppose now that we try to set up the best possible wave function for a metal, starting with a single Slater determinant, using a Hartree – Fock self-consistent model and then taking account of electron correlation in some way. Such a calculation will yield energies of the one-electron states and in particular the energies at the points of particular symmetry in the zones, the corners and the centres of faces. If the de Haas – van Alphen effect shows the existence of small pockets, then these measurements will provide a very sensitive check on the energies of these points. For example, if the metal has a small number of holes and a small number of electrons, then some corner must have energy just above the central point of some face. For metals, therefore, a check on the calculations is available, of a kind not available in molecules or in insulators.

A calculation of this type has recently been carried out in the Cavendish Laboratory for the metal aluminium (Heine[7]), using a self-consistent field, and to determine wave functions by the method of orthogonalized plane waves. The magnetic properties of the metal have been investigated in the Mond Laboratory, and the calculation was undertaken with the view of explaining these properties in detail, locating in **k**-space the 'pockets' responsible for them and obtaining for the first time the detailed electronic band structure of a polyvalent metal. The work was successful in locating these pockets without any ambiguity whatever, though some slight changes in the calculated energy values were, as expected, necessary to fit the facts. The calculations and the experiments between them give a very fair pattern of the whole Fermi surface. They could be repeated for other light metals; for heavy metals the task would be harder.

Some interesting points come out of the calculations One could ask why one finds pockets containing such an extremely small number of electrons, about 10^{-5} This could happen if some zone corners had energies exceeding by a very small amount the energy at the centre of some face of another zone; but this would be an accident which should occur rarely, whereas thes small pockets seem common. The explanation i that the energies of the one-electron states, excep near zone boundaries, are quite surprisingly nea the free-electron values ($W = h^2\mathbf{k}^2/2m$). It appear that the effects of the attractive field near each nucleus and of the oscillations of a 3 *s*-wave function are of opposite sign and just balance. The wave functions themselves are very like plane waves except for these oscillations around each nucleus this has been recognized already for the alkalis. As

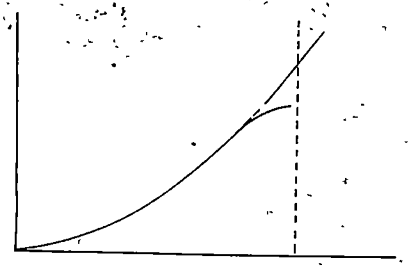

Fig. 3

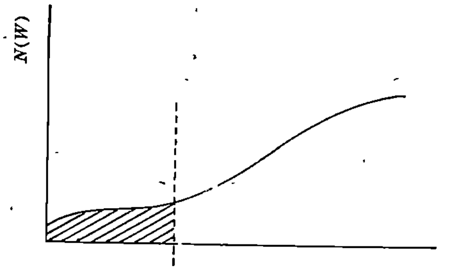

Fig. 4

consequence it has been possible to piece together the reduced Brillouin zones each containing $2N$ states into an extended k-space of the type described by Jones[6] (approximation of nearly free electrons). Since the energies are so close to the value for free electrons, the energy gaps on crossing zone boundaries are small, as shown in Fig. 3, and consequently d^2W/dk^2 is large. This means that the effective mass is small, as shown directly by the experiments, and consequently the density of states is small near one of these points (Fig. 4) This is why the number of electrons in a pocket is so frequently small; it is *not* very sensitive to the position of the Fermi surface, and though it can be changed by alloying another metal which affects the total number of electrons, it is not changed very much.

With the success of work of this kind we may be well on the way to the development of a quantitative theory of metallic properties, with a detailed description of the difference between individual metals. On the other hand, it is still possible that there is something lacking in the present theory, and that the shape of the Fermi surface calculated by refinements of the methods described will not agree with the experiments. Herein lies much of the interest of the work.

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AUTOMATIC FUNDAMENTAL CALCULATIONS OF MOLECULAR STRUCTURE

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IN principle, it is possible to predict the structure and properties of molecules with unlimited accuracy merely from Schrödinger's equation and the numbers and properties of the electrons and nuclei defining the molecule. The complicated mathematical formulation, the very intractable intermediate probems and the extent of the numerical operations have caused this to be both a very confusing and a difficult subject. It does not appear to have been generally realized that the advent of automatic machines has simplified and made practical such calculations, not only as a means for performing the arithmetical operations but also for the carrying out of much of the mathematical analysis of the most formal type. It is hoped that this report and discussion of the results of some prototype calculations of this nature may help to demonstrate the significance and future possibilities of such calculations. The full description will be given elsewhere and will be somewhat lengthy ince it will include some theoretical developments which enable the solutions of the formal mathematical problems to be expressed in the form of procedures uitable for automatic performance. However, these are methods applicable to all molecules and, once stablished, need not be repeated or extended. These methods have been worked out with the facilities of the Mathematical Laboratory, Cambridge, to the Director of which, Dr. M. V. Wilkes, and staff we are much indebted. The procedures are in operation on the EDSAC, but could be applied to any general-purpose machine.

The force constants, etc., given below represent the final stages of some fundamental predictions of molecular properties. Their interest does not lie so much in the magnitudes found, as in the fact that they have been obtained using the EDSAC by procedures of the above type which could be applied to any molecule with unlimited accuracy. The machine has been caused to perform most of the organization of the calculations and a considerable portion of the mathematical analysis, as well as all the arithmetic. It is possible, though not certain, that more effort has been required for the development of these procedures than might have been needed for the calculations without automatic computation, but this initial effort is largely non-recurrent.

In Table 1 the force constant and energy were obtained (S. F. B. and G. B. C.) by evaluating the wave functions for the BH radical at three different internuclear distances. The wave functions were obtained as linear combinations of twenty-three co-detors by the variational method. The term co-detor is used

Table 1. Equilibrium Data for BH Radical

	Calculated	Experimental
Total energy	– 25·105	—
Binding energy	0 055	< 0 13
Bond length	2·33	2 33
Force constant	0·30	0 19

for describing antisymmetric functions in many variables which are formed from a set of elementary three-dimensional exponential polynomial functions ; first, by constructing orthonormal linear combinations of members of the set ; secondly, by using these combinations to form antisymmetric many-dimensional functions of the Slater-determinant type ; and thirdly, by constructing simple linear combinations of these determinants which transform as the irreducible representations of the group symmetry of the molecule under consideration. The method of calculation would converge to the true solution of the many-electron Schrodinger equation as the number of the elementary functions is increased and all co-detors corresponding to these are included.

All quantities are expressed in atomic units. The accuracies of the experimental binding energy and force constant are quoted by Herzberg as uncertain.

The EDSAC was used to calculate the numerical values of all the elementary integrals, to perform the various matrix transformations and linear combinations and to solve the eigenvector equation. This would naturally have been expected, but in addition the algebraic formulæ used for a large number of the most complicated integrals had previously been derived by J. L. Turner and S. F. Boys on the EDSAC. In essence, the machine had been caused to manipulate numbers as codes representing mathematical functions and to combine these according to the non-arithmetical processes corresponding exactly to the processes which one performs with the mathematical functions in the determination of an explicit formula for an integral of this type. The largest class of integrals for which this was performed was that of the so-called hybrid six-dimensional electrostatic integrals, some of which led to final formulæ involving more than five hundred terms. This particular application of the machine serves to emphasize the advantages—and, in many cases, the necessity—of handing over to the automatic computer many of those processes of formal mathematics that would generally be regarded as requiring considerable and unavoidable intellectual effort.

Table 2. EQUILIBRIUM DATA AND FORCE CONSTANTS FOR H_2O

		Calculated	Experimental (ref. 1)
Total energy		– 75·77628	– 76·4641
Binding energy		0·21350	0·3544
O—H distance (R)		1·95	1·85
H—O—H angle		96°	105°
Force constants	A_{11}	1·15	1·07
	A_{12}	– 0·09	+ 0·06
	A_{22}	0·22	0·20
	A_{33}	1 31	1·10

Table 2 shows corresponding data for a subsequent calculation on H_2O (S. F. B. and C. M. R.). This involved the solution of the wave equation at seven nuclear configurations. A total of ninety-six co-detors, formed from eight elementary orbital functions, was examined, but only about thirty of these contributed appreciably to the wave function and were retained for the final parts of the investigation. The total energy of distortion, δE, is given in terms of the O—H distances, r_1 and r_2, and of the H—O—H angle θ radians by :

$$2\delta E = \frac{A_{11}(\delta r_1 + \delta r_2)^2}{4} + 2A_{12}\frac{(\delta r_1 + \delta r_2)\,(R\delta\theta)}{4} + \frac{A_{22}(R\delta\theta)^2}{4} + \frac{A_{33}(\delta r_1 - \delta r_2)^2}{4}$$

The quantities $(\delta r_1 + \delta r_2)/2$, $R\delta\theta/2$ and $(\delta r_1 - \delta r_2)/2$ are convenient generalized co-ordinates.

In the course of this calculation, the use of the machine for carrying out formal mathematical and essentially non-arithmetical analysis was extended to cover a much greater part of the investigation than in the earlier work. The machine was provided with a list of the co-detors in coded form. It then considered every variational element which could arise and worked out its formula in terms of the single- and two-electron integrals. Previously computed numerical values were substituted automatically into these formulæ and the lowest eigenvalue and corresponding eigenvector of the resulting matrix evaluated to give the required energy and wave function.

It will be realized that after the first decisions have been taken concerning the number and form of the elementary functions, the whole calculation of the wave function, although it appears to involve about half a dozen separate mathematical processes, is in fact a perfectly determinate operation with a unique result which is not dependent on any further decisions. It is the aim of investigations such as these to enable automatic machines to perform the whole sequence of operations with the minimum of intermediate reference to the human investigators. Significant progress has been made towards this goal, although the possibilities of improvements are by no means exhausted.

The comparison of the theoretical and experimental results for the molecular dimensions and force constants (see Table 2) is considered quite satisfactory for the present stage of development. The sign discrepancy in A_{12} corresponds to a relatively smaller discrepancy in the direction of the principal axes of the potential energy quadratic form. In neither calculation were the best sets of elementary functions fully investigated, since the main effort was to put into operation the general calculation procedures, and it was considered that the results for any reasonable parameters would be valuable for future work. The binding energies were found as the difference of the total energies from the calculated energies for the separated atoms. For the comparison with experiment it was desirable to evaluate the force constants ; but it should be realized that in this direction the scope of the theoretical method far exceeds the experimental, since it gives directly the energy of distortion to any other configuration, not just the lower derivatives, which are all that can at the present be obtained from spectral analysis.

In the wave function calculation for H_3 (the activated complex of a reaction such as $D + H_2 \rightarrow DH + H$), which led to the values of the 'force constants' given in Table 3, the procedure followed was in principle the same as in the preceding calculations, with the exception of a new particular programme which enabled some complicated integrals to be evaluated about ten times as fast a previously. The whole calculation (by S. F. B. and I. S.) comprised the energy determination for nine different configurations of the nuclei around the transition complex. The activation energy quoted i the excess energy at the 'saddle-point configuration' which was found to be linear, over the calculated energy of a separate hydrogen atom and a hydrogen molecule.

It is valuable to include these results here particularly to emphasize that the type of calculatio which we normally call the determination of

Table 3. DATA FOR THE TRANSITION COMPLEX OF H_3

		Calculated
Total energy		− 1·628
Activation energy		0·025
H—H distance (R)		1·78
Force constants	A_{11}	0·288
	A_{22}	0 023
	A_{33}	− 0·05

molecular wave function is by no means restricted to the determination for an equilibrium configuration of a stable molecule; it is equally applicable to any configuration of atoms whether these represent a stable molecule, a distorted molecule or an arrangement of atoms in the process of reaction. The force constants in the latter case are, just as in the other cases, the co-efficients of a quadratic approximation to the potential energy in terms of relative nuclear co-ordinates. They cannot, of course, be observed experimentally as physical force constants; but they are necessary theoretical data if a prediction of the reaction-rate is to be made.

Here the total energy of distortion, δE, is given in terms of the H—H distances r_1 and r_2 and of the H—H—H angle θ radians by:

$$2\delta E = \frac{A_{11}(\delta r_1 + \delta r_2)^2}{4} + \frac{A_{22}(R\delta\theta)^2}{4} + \frac{A_{33}(\delta r_1 - \delta r_2)^2}{4}.$$

It may be emphasized that although these calculations were made with limited numbers of initial functions (seven for BH, eight for H_2O, six for H_3) and the final convergence is only obtained as these numbers are indefinitely increased, the number of functions in each case was greater than the minimum number which could have been used to give a meaningful result. The procedures would not have required any alteration if larger numbers of such functions were used.

Since the impression seems to be very easily given that the various co-detors used for these calculations correspond to excited states of the system or of some unperturbed system, it may be stated again that this is not so (see Boys[2,3]). Indeed, if functions corresponding, even approximately, to the excited states were used, there would be no ultimate convergence, and the convergence even for small numbers of terms would be very unsatisfactory. This point is illustrated most simply by the fact that the bound-state wave-functions of the hydrogen atom are not a complete system, and that the first few terms are completely unsatisfactory for accurate fitting of functions in the region of the low-energy wave functions. To say, as is sometimes done, that the inclusion of the unbound states would rectify this is not valid, since these do not constitute an enumerable system of functions and so are not applicable to form a complete system of functions in the ordinary mathematical sense, and are even more inconceivable in any practical sense. The situation is that, if the single electron functions are chosen in a manner which would lead ultimately to a complete system of functions (not necessarily orthogonal), then co-detors made from these will also be complete. Direct consideration of this desideratum of completeness, particularly in the physical regions where the wave function is large, is the most effective way which we know at present for obtaining low-energy wave functions (see Boys and Price[4]).

Since the most frequently cited calculations on molecular structure have been by means of the molecular orbital approximation, the relation of this to the present method will be indicated. The molecular orbital approximation signifies in its most exact sense the best approximation to the true wave functions which can be obtained by use of a function of the form of a single Slater determinant, and always retains a definite error. A direct application of this approximation to calculate a wave function involves the evaluation of as many difficult integrals as does the present method, but only obtains a less accurate result. It avoids some of the effort towards the end of the calculations, but this is not a very great economy over the whole calculation. This direct calculation has only been made in four or five cases and then generally with further approximations. On the other hand, the approach which is most frequently described as that of molecular orbitals, and which has been applied very widely, is the use of the approximate formula corresponding to a single determinant in a semi-empirical way in which the quantities on which it depends are not found by calculation, but are adjusted to give the correct answer for some particular molecules, and then these values used to make predictions for other molecules.

The present results must not be regarded as giving the best accuracy which can be obtained with the numbers of expansion functions cited. In fact, most of the effort has been devoted to the development of the general mathematical procedures and to the application of these to give the automatic programmes. In this connexion other workers would probably be interested to know the required machine time. It is very difficult to make any estimate which is not dependent on particular circumstances, but it is probable that, at the present stage of development for a machine obeying a thousand orders per second and having a store of about a thousand words, it would require about forty hours of machine time to produce one wave function for one configuration of the water molecule if a single run without any errors or any checking were possible.

Finally, it may be stressed that the programming of the formal mathematical procedures as well as the associated arithmetical operations offer one of the most stimulating possibilities for the solution of many problems of mathematical physics. This kind of approach appears extremely powerful for problems associated with electronic wave functions, and to have possibilities of even greater value for the complicated problems of nuclear wave functions, particularly for the heavy formalisms of the fractional parentage schemes of functions. On the other hand, the possible application of such methods to the more classical problems, for example, those in which the relaxation methods have been so widely used in desk calculations, should be thoroughly examined. The programming of machines to handle all the theory and arithmetic associated with formal expansions in non-orthogonal complete systems of functions would not be difficult. Such an approach for desk work is difficult owing to the necessary increased strain on the computer working at a higher mathematical level. In an automatic method the increased complication would only enter at the initial stage of making the master programme, and might easily present the more interesting problem.

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INHERITANCE OF ACQUIRED CHARACTERS

THE problem of the inheritance of acquired characters is one that has exercised the minds of biologists since the days of Lamarck. That interest in this aspect of evolution is unabated was shown by the very full attendance at the joint discussion of the subject, between the Linnean Society and the Systematics Association, held in the rooms of the Linnean Society on November 1. The discussion was opened by Prof. H. Graham Cannon, who cited Leonard Doncaster's definition of an acquired character as "a feature developed during the life of the individual possessing it, in response to the action of use or environment". The added qualification that, "as a rule", such acquired characters were adaptive, has led to much of the trouble arising out of attempts to prove or disprove the proposition. There are two types of experiment, depending on the nature of the change in the environment to which the organism is subjected, whether normal, as occurring in Nature, or not. To the neo-Mendelian the distinction does not matter, for as Carter said, "It is easy to imagine a gene doing anything we want it to do". Every organism in equilibrium with its environment must change somehow if external conditions change. The difficulty is to force it to change obviously, and, as MacBride said, if a change from one environment to another causes a change in structure in one generation, a change in the opposite direction should reverse it in an equal time. This is true of adaptive acquired characters. If the acquired character is induced by some abnormal circumstance, it will be an induced mutation and therefore inherited in the normal Mendelian manner. It seems, therefore, that attempts to demonstrate experimentally the inheritance of acquired characters are a waste of time.

It is Lamarck's fourth law that states explicitly that acquired characters are inherited ; but this law is redundant as it is covered by his second and third laws. To Lamarck, it was not a question of a new character appearing in one generation and being handed on to the next. In accordance with his second law, it would appear in any event, because it was required. The present neo-Mendelian theory is based on the idea that, "New hereditary changes occur spontaneously and at random : they are not guided so as to fit the environment". This view was repudiated by Graham Cannon. Mendelian inheritance can go back only as far as the first Metazoa, since it depends on the orderly behaviour of chromosomes. Below that level, there is no true mitosis or meiosis, on which proof of the Mendelian law is based, and, at the best, only *simulacra* of these processes in the Protista. The earliest living matter was an amorphous protoplasm, a chemical mixture in equilibrium with its surroundings and, as such, must have reacted according to the physico-chemical law of Le Chatelier. The result would accord with Lamarck's second law. Protoplasm was able to adjust itself in the optimum manner to changes in its surroundings, and it was unlikely that when cells, sex and chromosomes appeared, this quality disappeared. This homœostatic property of protoplasm applied to the morphology as well as the physiology of the organism. It is the main motive force of evolution.

The problem of inheritance in bacteria was discussed by Dr. A. C. R. Dean. In such micro-organisms, the proportions of enzymes in the cell must attain stable ratios after long-continued growth in a given medium. When the medium is changed, different ratios become necessary and the adjustments are made during the lag phase before growth recommences in the new medium. Considerable growth in the new medium is required, before the ratios settle down again to a new stable value. In bacteria, growth and function are closely linked and response to changes in the environment is automatic. Another interpretation of the lag phase is that it represents the time taken by fully adapted mutants to multiply. Experiments with *Bact. lactis aerogenes* and D-arabinose, designed to test these alternatives, favoured the adaptation hypothesis. Thus, there is an increase of at least 40 per cent in cell mass before cell number increases. No stably adapted strains were obtained by plating out individual bacteria from cultures starting to grow in the new medium. Other tests, with different organisms, indicated that the majority of the cells in a culture undergo adaptation, whether the medium contained a new food material or a drug such as proflavine, streptomycin or chloramphenicol. The stability of an adapted strain depends on how well the training has been impressed on the cells and never seems to become absolute. Even after a thousand generations on drug media, the adaptation, although persisting in some cases for as long as six hundred generations on drug-free media, was eventually lost. The interpretation to be placed on these results is debatable. Dr. Dean inclined to the view that such adaptations represented the development of an existing function, rather than the acquisition of a new one. It is very doubtful to what extent they throw light on the position in multicellular forms.

In attempting to link up the situation in unicellular organisms with that in the higher plants and animals, Dr. R. Melville suggested that the initial changes in the cell were similar in all groups. They depended on the exploitation of existing enzyme systems and alternative metabolic paths. The first result in the higher groups was a phenotypic response, which was not inherited. Environmental changes may set up relentless pressures, and failure to adapt may mean extinction. The probable course of events was that after a variable number of generations, some essential molecule or molecules become attached to a protein molecule, possibly ribose nucleic acid. This may be contained in a cytoplasmic granule and have the properties of a plasmagene. It may pass from cell to cell and be carried over sporadically during fertilization. Afterwards, the plasmagene may be incorporated in a gene and pass into the nuclear mechanism for Mendelian inheritance.

The most critical stage in the suggested adaptive process was probably that leading to the formation of a transmissible particle. As evidence for the occurrence of this process, Waddington's work on the production of pheno-copies for cross-veinless, by subjecting puparia of *Drosophila melanogaster* to a temperature shock, was cited. Individuals inheriting the character were found from the twelfth generation onwards. In plants, it appeared from Darlington's work on male sterility in *Epilobium luteum* × *hirsutum* that plasmagenes restoring fertility appeared after fourteen generations. From knowledge of the physiology of pollen sterility in *Forsythia* and other plants, boron may be an important factor in the fertility mechanism. This linked up with the mineral content of the soil, as an example of an environmental factor that may exert an adaptation pressure. In discussing temperature, Crosby's paper on the "Role of Plasmogenes in Acquired Adaptations" was mentioned, and it was pointed out that no special assumptions were necessary if the applicability of the Le Chatelier principle were admitted. The effects of temperature were stated more precisely by the van't Hoff principle. It followed, that if a process was controlled partly by exothermic and partly by endothermic reactions, any change of temperature would have a differential effect. Applied to morphology, this could affect the shape of leaves or other organs. An explanation of the topocline in leaf shape in *Ulmus coritana* was possible, on these lines.

In the unavoidable absence of Prof. Waddington, his paper was read by Dr. A. J. Cain, who said that although random mutation and natural selection, together, constitute a mechanism or generating states of high *a priori* improbability, many people were not satisfied that this conventional theory contains the whole truth. The existence of environmentally adapted populations within a species could not be wholly irrelevant to the process of evolution. On general grounds, one would expect the capacity of an organism to respond to environmental stress to be under genetic control. Individuals within a population will vary in this respect and natural selection will favour those in which the response is greatest. Conditions for producing, experimentally, a really adaptive change in an organism had not been devised, but artificial selection could be applied to other environmentally induced responses. When *Drosophila* puparia are subjected to a hot shock, some individuals respond by developing abnormalities in the wing venation. After twelve generations, cross-veinless flies began to appear in untreated individuals. When these were bred together, without further treatment, strains could rapidly be built up, in which nearly all the individuals were cross-veinless. The original phenotypic response was now genetically fixed. Similar results were obtained with populations from different sources. In most wild-type stocks submitted to temperature shock, four types of abnormality occurred. If selection is practised on any one of these, its frequency increases, while that of the others does not. In generalizing from these experiments, it seems possible for a response, that was at first only imperfectly adaptive, to be 'tuned' more closely to the requirements of the animal's life. The mechanism revealed operates in a perfectly 'orthodox' Mendelian way. The most important question remaining for discussion is how it comes about that so many responses of animals to environmental stresses are adaptive. The answer may be based on two considerations. First, that development must be epigenetic, involving interactions between parts, so that, for example, changes in the skeleton are associated with changes in musculature, and *vice versa*; secondly, that selection acting on a macro-evolutionary time-scale will tend to favour types of epigenetic interaction that offer the possibility of adaptive response to stresses.

In the general discussion following, Dr. W. B. Turrill criticized Prof. Graham Cannon for his statements that bacteria had "no nucleus, no chromosomes and no sexuality". Dr. M. L. R. Petterson directed attention to the evidence, published in recent text-books, for the existence of genes in both bacteria and viruses, and Mr. P. F. Mattingly mentioned a very beautiful experimental demonstration by certain French workers of the existence of a linear arrangement of hereditary factors in *Escherichia coli*. Prof. Graham Cannon questioned the validity of work with bacteria kept in culture for considerable periods, and suggested that infection by viruses might affect the results. Dr. Dean admitted that the stocks employed had been in culture some years, but their behaviour was always tested in a standard medium before and after experiments with drugs or alternative carbon sources. Dr. S. M. Manton regretted that the discussion had centred so much around single isolated characters. Many characters are intimately correlated for the harmonious working of a whole animal. For example, the control of movement in a centipede involved nearly all parts of the body, and a change in a single character would be ineffective. The number of simultaneous gene changes necessary to account for tergite heteronomy in the centipedes is so prodigious that the concept needs reconsideration.

R. Melville

OBITUARY

Sir Gerald Lenox-Conyngham, F.R.S.

The working life of Colonel Sir Gerald Ponsonby Lenox-Conyngham, who was born at Moneymore, Londonderry, on August 21, 1866, the fifth son of Sir William Lenox-Conyngham, and educated at the Edinburgh Academy and the Royal Military Academy, Woolwich, may be reckoned from the time of his being commissioned second lieutenant, Royal Engineers, at the early age of nineteen. Even after his ultimate retirement sixty-two years later, he continued, until his death on October 27, to be the valued counsellor of his friends. The first half of his long career was in India; the remainder in Cambridge. Throughout he was sustained by Lady Lenox-Conyngham, whom he married in 1890. She was daughter of Surgeon-General Sir A. E. Bradshaw, and there was one daughter of the marriage.

An orderly line of progress throughout may be perceived. Lenox-Conyngham joined the Survey of India in 1889 and was then engaged on astronomical field-work for the next dozen years. During 1894–96, as partner to Burrard (later Sir Sidney Burrard), his senior by five years, he was on deputation out of India conducting observations for the precise longitude of India, then embarrassingly in doubt. These two great men—for they were of great stature and of equally notable ability—became and continued fast friends; but they ever remained to each other just 'B' and 'C'.

The longitude at Karachi which they found was closely confirmed thirty years later by observers of the 1926 International Longitude Project, who had manifold advantages of developments such as wireless telegraphy.

Local arrangements for two solar eclipse parties visiting India in 1898 were entrusted to 'C'. At one of the camps he met H. F. Newall, professor of astrophysics at Cambridge, and formed with him a lasting and fruitful friendship. Then came some years of precise latitude field-observations from which deflexions of the vertical—the *direction* of gravity—are derived. 'B' was then seeking the cause of these and previously found deflexions: extra observational evidence, in the form of the force of gravity, was needed.

Thus in 1902 a gravity survey was planned. 'C' was delegated to Europe to examine, acquire and standardize the best available pendulum equipment; and two years later he took to India a set of four brass von Sterneck half-second pendulums. The next few years, during which I was fortunate in being associated with him, saw the beginning of the series of observations which had nearly covered India and Burma before the Second World War. A great difficulty with brass pendulums in field-survey is finding the temperature of the pendulum shaft. 'C' went far to meet this by his 'dummy' pendulum, the shaft of which contained a thermometer. Later he proposed invar pendulums, but was dissuaded by reason of the magnetic susceptibility of invar. Nevertheless, subsequent pendulums have usually been made of invar.

In 1912 he became superintendent of the Trigonometrical Survey. He was an excellent administrator —a firm but sympathetic and trusting chief. Absence of disorder and steady progress of work in hand were apparent in offices where he was in charge, whether field-party or directorate. The onset of the First World War frustrated his natural promotion to surveyor-general; for the services of Sir Sidney Burrard were extended for the duration of the war. Thus Lenox-Conyngham retired as superintendent in 1920, having been elected a Fellow of the Royal Society in 1918 and received the honour of knighthood in 1919.

In 1898 Prof. Newall had had a close view of the then greatest existing practical geodetic organization; and he felt strongly that geodesy, neglected in Britain, should be promoted. So at a well-chosen time he used his great powers in that direction. Only a month ago, at a luncheon given in Trinity College by friends to Sir Gerald and Lady Lenox-Conyngham to mark their attainment of the tenth decade, Sir Gerald made a remarkable speech; and he recounted how after return to England in 1920 he had received a letter from the then Master of Trinity, Sir J. J. Thomson, asking him if he would accept a praelectorship in geodesy coupled with a fellowship of Trinity, and with what satisfaction he assented.

The formation of a School of Geodesy involved especial difficulties for a newcomer to the University; but his charming presence and shrewd sense inevitably prevailed. The School was formed, and later in 1931 was expanded into the Department of Geodesy and Geophysics. Geodetic and topographical surveying became one of the four subjects for the Geographical Tripos, and the School became the training centre for most of those who later became the principal survey officers of the British Colonial Empire. Meantime, the University created a readership in geodesy and appointed Lenox-Conyngham to it, having previously conferred on him the degree of M.A.

During this second career, he attended all the general assemblies of the International Union of Geodesy and Geophysics, from the first at Rome in 1922 to the sixth at Edinburgh in 1936. He also represented H.M.'s Government at the second and third Pacific Science Congresses in Australia in 1923 and Japan in 1926. The inhabitants of Montserrat, Windward Islands, alarmed at the increasing frequency of earthquake shocks, petitioned the Governor to obtain scientific opinion as to their security. So the Council of the Royal Society, consulted by the Colonial Office, invited Lenox-Conyngham to visit the neighbourhood and to investigate the seismic circumstances; this he did in 1936. He gave some account of this in a Friday Evening Discourse at the Royal Institution on March 12, 1937. He also served on the Council of the Royal Society for the periods 1920–21 and 1934–36.

Lenox-Conyngham had become the father of British geodesy. Recently, he received the affectionate greetings and congratulations of the International Association of Geodesy; and his death, inevitable though it be, is a lively sorrow to a wide international circle.

J. DE GRAAFF-HUNTER

NEWS and VIEWS

The New Scientist

THE interpretation of scientific research and discovery to those who have had no special scientific training and especially to people who have practical interests in the applications and implications of science is now a fundamental need in any country. This need is well met in the United States through *The Scientific American*; somewhat similar journals are published in various countries on the Continent of Europe, and recently one dealing with science for the layman has been launched in India. In this respect, Britain has been backward, although it has several excellent journals of more 'popular' appeal, and frequently newspapers and general popular journals carry excellent interpretative scientific articles. Yet in spite of this there have been repeated calls from industrialists and others, who have realized the need for men and women other than the scientists themselves to understand at least the aims and objectives of research, for a medium which will meet their needs. The very idea, therefore, of such a journal in Britain is welcome, and now it has become manifest in the issue on November 22 of the first number of the weekly periodical, *The New Scientist* (Cromwell House, Fulwood Place, High Holborn, W.C.1).

The aim of this journal is to appeal to all who are interested in scientific discovery and its impact on, and utilization in, industry, commerce and society in general. There are many such people to-day, for the impacts of science are many and profound. It is at last realized that Britain badly needs many more and better trained scientists and technologists; but it can scarcely be expected that such needs will become satisfied or even that the best efforts will be made to meet them until leaders in industry, commerce, politics and even education itself are better informed concerning things scientific. This can only be done by a journal which is free from scientific technicalities and jargon; and this is the style admirably adopted by *The New Scientist.* For the first issue, the Editor has selected some authors who are not only well known among scientists for their contributions to the advancement of science in various fields but are also able to interpret their work in an intelligible and attractive way to readers who have not been trained in scientific discipline. These authors include the President of the Royal Society (Sir Cyril Hinshelwood), Sir Edward Salisbury, Prof. Zdenek Kopal and Dr. N. A. Mackintosh. There are eight such articles, and each is well worth reading not only by the non-scientist but even by scientists themselves. Apparently we are also to be presented with a series of scientific profiles; Sir Edward Appleton figures in the first issue—an apt choice especially since he is giving the present series of B.B.C. Reith Lectures. Among other features of this excellent first issue are science news from the home front, from the United States and from elsewhere overseas; letters to the Editor; book reviews; and city comment. This last section will appeal particularly to city business men who are specially interested in commercial and industrial projects based directly on scientific discovery.

The New Scientist has made a good start. No doubt it will maintain the high standard which it has clearly set itself, thus becoming a very important and welcome addition to British periodical literature.

Numbers of Science and Technology Students in Britain

FIGURES for full-time students taking a course for a first degree in science or technology in institutions in receipt of Treasury grant, given by Mr. H. Macmillan in a written reply in the House of Commons on October 23, indicate that in pure science the numbers increased from 5,897 in the academic year 1938–39 to 13,916 in 1951–52 and thereafter declined slightly to 13,485 in 1953–54. In technology the trend was the same: an increase from 3,836 in 1938–39 to 7,590 in 1951–52 and thereafter a decline to 7,439 in 1953–54. The number of first-, second- and third-year students in pure science in 1938–39 was roughly just over 1,800 in each year, and in 1953–54 was again approximately equal—at 4,100–4,300; but the number of fourth-year students, which rose from 396 in 1938–39 to 1,449 in 1951–52, fell to 755 in 1953–54. In technology the variations between the different years became greater: in 1938–39 for first-, second- and third-year students the figures were 1,391, 944 and 1,193, respectively, and in 1953–54, 2,286, 2,240 and 2,031; fourth-year students rose from 276 in 1938–39 to 1,149 in 1951–52, and the number in 1953–54 was 758. Students taking a fifth or later year in technology numbered 32 in 1938–39, 161 in 1952–53, and 126 in 1953–54. An appendix to the ninth annual report of the Advisory Council on Scientific Policy since issued gives the number of first degrees in pure science in 1954–55 as 4,938 compared with 2,167 in 1938, 5,577 in 1951–52, 5,379 in 1952–53 and 5,096 in 1953–54. Of these, 1,886 were pass degrees; and of the honours degrees 914 were in chemistry, 600 in physics, 494 in mathematics, 403 in biological sciences and 122 in geology and related sciences; for 1951–52, the peak year, the corresponding figures are 2,232; 977; 608; 553; 464; and 144, respectively. First degrees in technology in 1954–55 were 2,314, of which 1,005 were pass degrees; for 1938–39 the corresponding figures were 1,048 and 516; for 1951–52, 2,765 and 1,186; for 1952–53, 2,578 and 1,155; and for 1953–54, 2,336 and 1,036.

Patents Bill

IN moving the second reading of the Patents Bill in the House of Lords on November 22, Lord Mancroft said that when the Patents Act, 1949, was drafted it was envisaged that, on the restoration of normal peace-time conditions, the Patent Office examiner would make his first report about three months after the complete specification was filed, and that nine months would be a reasonable allowance for the remaining steps to be taken. It was hoped that the arrears of unexamined specifications which had accumulated during the War would soon be cleared, and accordingly the average of the pre-war time limit was adopted and the period made twelve months with an optional further three months on payment of a fee. The intake of patent applications, however, is nearly 40 per cent above the pre-war average of about 21,000, and is still increasing; and with the general shortage of science graduates the Patent Office is unable to recruit enough examiners to keep abreast of the intake. The present examining staff of about 340 (compared with 310 before the War) is expected by special efforts to dispose of nearly 26,000 complete specifications in 1956, leaving an excess of at least 3,500 on the year. There are large arrears of unexamined applications, and it is unusual for the examiner's first report on an application to go out until more than twelve months after the complete specification is filed, leaving no time for the applicant to meet any objections raised by the examiner. The Patent Office is using powers conferred on the Comptroller, under the Emergency Act of 1939, to grant extensions, and the new Bill authorizes the Board of Trade to prescribe from time to time the period during which an application must be put in order for acceptance, subject to the limits that this period must not be less than one or more than four years. The Bill also continues the existing provision of the 1949 Act for allowing the applicant an additional three months on payment of a fee. Replying to questions about staff, Lord Mancroft said that action has been taken to attract graduates and undergraduates to a career in the Patent Office. The salary scale has been revised, and recruits now start at £605, on a scale running up to £1,345, and leading after promotion up to £2,000. Lord Mancroft added in conclusion that it is important not to lower the standard of either the examiners or the patent procedure.

Grants from the R. W. Paul Instrument Fund

THE Royal Society announces that grants have been made by the R. W. Paul Instrument Fund Committee as follows: £2,000 to Prof. R. V. Jones and Dr. A. H. S. Holbourn, University of Aberdeen, for continuation of the development of an engine for ruling diffraction gratings in which, in order to avoid the difficulty of making an almost perfect screw, use is made of light waves to determine the grating space; £1,500 to Prof. S. Devons, University of Manchester, for an investigation of the proposed optical system of a new type of reflecting camera incorporating a correcting lens and furnishing increased speed and field of view—a camera which could be used in an investigation of the structure of weak extended sources of light in interstellar space of the Milky Way. The Paul Instrument Fund Committee, composed of representatives of the Royal Society, the Physical Society, the Institute of Physics and the Institution of Electrical Engineers, was set up in 1945 "to receive applications from British subjects who are research workers in Great Britain for grants for the design, construction and maintenance of novel, unusual or much-improved types of physical instruments and apparatus for investigations in pure or applied physical science".

Early Life of George Boole

SIR GEOFFREY TAYLOR, whose mother was one of George Boole's daughters, contributes to *Notes and Records of the Royal Society*, 12, 1, an article on Boole's early life and mathematical studies. Previous accounts have not always been consistent one with another, nor entirely free from unwarranted speculation. Some interest is attached to these questions, since Boole's work on symbolic logic, first expounded in his "Mathematical Analysis of Logic" (1847) and developed more fully in his "Laws of Thought" (1854), is marked by profound originality of concept; it gave one of the earliest instances of an algebra differing substantially from the familiar algebra of real numbers, and thus not only opened the way to a new field of applications, but also contributed largely to the development of modern ideas on the axiomatic foundations of a variety of abstract algebras. It is possible that this originality was fostered by the resolute manner in which Boole taught himself mathematics, and that the months spent in surmounting difficulties which might have been cleared away in a few minutes by contact with a competent teacher were not entirely a waste of his time, but played a considerable part in forming a powerful and precise research mind. In the same issue of *Notes and Records*, W. Kneale discusses Boole's algebra of logic and its place in the history of mathematical logic.

The Physics and Chemistry of Solids

A NEW journal, *The Physics and Chemistry of Solids*, has been added to the international series published by the Pergamon Press (London: Pergamon Press, Ltd., 1956. 42*s*. each part. Subscription rates per volume (4 parts): (*A*) £6; 17 dollars); (*B*) for individual subscribers certifying that the journal is for their private use, £2 15*s*.; 7.50 dollars). Prof. Harvey Brooks is editor-in-chief; in his foreword to the first issue, a combined issue for September and October 1956, he defines the fields of physics and chemistry for which the journal is to cater. They are, first, the electronic structure of solids and those physical and chemical properties deriving from that structure; and secondly, the statistical mechanics of condensed systems. Fundamental studies will be preferred to applications; but papers on borderline subjects will, apparently, be welcomed rather than discouraged. The first issue sets a high standard, and the editors, who are drawn from the United States, the U.S.S.R., Holland and France, will secure a prominent position for the journal if they are able to maintain that standard over the years; the advisory board, which includes the names of many whose contributions have greatly helped the advance of the understanding of the solid state, should ensure a steady flow of papers. The topics most to the fore in the first issue are magnetic properties, the absorption spectra of impurities in silicon, energy band-structure and residual resistivity. Two papers in particular contain good reviews of their parts of the subject—a feature which will be frequently required if the editors' aim of developing lines of communication between physicists and chemists is to be fulfilled.

Archæology in India

THE October issue of *Man* contains an interesting article by Dr. F. R. Allchin on certain stone alignments in southern Hyderabad. Stone alignments are found at many times and in many parts of the world, and there is not necessarily any reason to suggest cultural connexions between them. In Hyderabad they only occur to the north of the Krishna and Tungabhadra Rivers in the Raichur, Gulbarga, Nalgonda, Mahbubnagar and Atraf-i-Balda districts of the State. They consist of parallel lines of standing stones set out accurately. In all cases the lines seem to be oriented on the cardinal points. It is suggested that their age is late B.C. or early A.D. In the same issue is an interesting article by Prof. Robert Heine-Geldern on the coming of the Aryans and the end of the Harappa civilization in India. It is illustrated with a number of drawings of tools and seals. Prof. Heine-Geldern is convinced that the invaders arrived between 1200 and 1000 B.C., a date somewhat later than that usually suggested and much later than the one indicated in the subsequent (November) number of *Man*. The early archæology of the region from Quetta in Baluchistan right across northern India continues to excite great interest, and some day a firm date for the various cultures found will be finally determined.

Alexander Graham Bell Museum, Nova Scotia

THE Alexander Graham Bell Museum, which the Canadian Government has established to illustrate the scientific achievements of the inventor of the telephone, was opened on August 18 at Baddeck, Nova Scotia, where Bell spent his summers for more than thirty years and participated in early aeronautical research. The Museum is sponsored by the Department of Northern Affairs and National Resources, and its purpose is to protect and display the numerous relics of Bell's research that have been given to the Canadian Government. Kites, propellers and other objects indicate the experiments in heavier than-air flight which Bell carried out between 1890 and 1909, while other material illustrates his investigations in medicine and electrical and marine engineering.

The Industrial Research Associations in Grea Britain

THE Department of Scientific and Industrial Research has issued an admirably illustrated accoun of the work of the industrial research associations in the government scheme in a booklet entitled "Combining for Research: the Work of the Industria Research Associations in the Government Scheme" (pp. 32+16 plates; from the Department, London 1956). The booklet outlines the nature of the research associations as well as describing the various types o work carried out, and includes brief notes on th individual research associations. While in no wa critical, and making no attempt to assess the relativ importance or value of the different activities, i indicates very clearly the potentialities of co-operativ research as well as the conditions which must b fulfilled for effective work.

United States Awards for Further Study by Science Teachers

The National Science Foundation, Washington, D.C., is offering a new programme of fellowships for improving the teaching of science, mathematics and engineering in American colleges and universities. About a hundred fellowships will be awarded next March to citizens of the United States who hold a baccalaureate degree or its equivalent, have demonstrated ability and special aptitude for teaching science, have taught full-time at the collegiate level for not less than three years, and who intend to continue teaching. Selection will be based on letters of recommendation, academic records, and other appropriate evidence of professional activity and competence. The value of the fellowships will vary, but the total income must not exceed 10,000 dollars a year; travelling and other expenses will be allowed. Fellows may study for 3–15 months at any accredited non-profit institution of higher education in the United States or abroad. Application must be made before January 14 to the Division of Scientific Personnel and Education, National Science Foundation, Washington 25, D.C., from which further information can be obtained.

University of Hull

It is announced from the University of Hull that Prof. E. B. Castle, professor of education and director of the Institute of Education, has been appointed pro-vice-chancellor for a period of three years. Dr. Paul Galambos has been appointed lecturer in statistics in the Department of Economics and Commerce. Mr. B. Thomas has been appointed to a research studentship in the Department of Physics for work on radiation damage. The Medical Research Council has made a grant of £600 per annum for a period of three years to assist research work on the biosynthesis of the alkaloids of plants in the Department of Botany under the direction of Dr. B. T. Cromwell; Mr. K. Rothwell has been appointed to a research assistantship in the Department to undertake this work. The Research Section of the Shell Petroleum Company has made a grant of £1,000 to finance a research appointment in the Chemistry Department over a period of two years from the ession 1957/58.

University of London

The following announcements have been made by the University of London: Dr. I. M. P. Dawson, ecturer in pathology in the University of Leeds, has een appointed to the University readership in athology tenable at Westminster Medical School. The title of reader in physiology has been conferred on Mr. R. D. M. I.-K. Harkness in respect of his ost at University College, and that of reader in mathematics on Dr. K. F. Roth, in respect of his ost at University College.

Announcements

Dr. O. G. S. Crawford, founder and editor since 1927 of *Archæology*, and formerly archæology officer of the Ordnance Survey, has been awarded the *Verdienstkreuz* (first class) of the Federal German epublic, for his services to archæology.

Prof. T. S. Wheeler, professor of chemistry in University College, Dublin, will be going to the nited States on a lecture tour during January-March 1957.

Mr. George Brearley, a partner of Cremer and Brearley, consulting chemical engineers, and formerly managing director of Brotherton and Co., Ltd., has been appointed director of the Association of British Chemical Manufacturers in succession to Mr. J. Davidson Pratt, who is retiring in June 1957.

The Ministry of Supply announces that Dr. A. W. Lines has been promoted to deputy chief scientific officer and appointed senior superintendent, Research and Assessment Division, Guided Weapons Department, Royal Aircraft Establishment, Farnborough.

The following officers and new members of council for 1956–57 of the Institution of Civil Engineers have been announced: *President*, H. J. F. Gourley; *Vice-Presidents*, Sir Arthur Whitaker, Prof. A. J. S. Pippard, A. C. Hartley, Sir Herbert Manzoni; *New Members of Council*, R. J. Ashby, J. F. A. Baker, F. E. P. Clear, D. K. Duff, J. E. Dumbleton, Dr. L. F. Loder, F. J. Oliver and W. L. Owen.

The Royal Agricultural Society of England offers annually a medal together with an award of one hundred guineas for research work of outstanding merit carried out in the United Kingdom which has proved, or is likely to prove, of benefit to agriculture. Recommendations for the next award, by the heads of university departments, research stations and institutes and other research establishments, must be submitted to the Secretary, Royal Agricultural Society of England, 35 Belgrave Square, London, S.W.1, not later than January 31, 1957.

Prof. V. B. Wigglesworth, Quick professor of biology in the University of Cambridge and director of the Agricultural Research Council Unit of Insect Physiology, will deliver the fourth Middleton Memorial Lecture in the Wellcome Building, 183 Euston Road, London, N.W.1, on December 6, at 5.30 p.m. He will speak on "Insects and the Farmer".

The Institution of Naval Architects is offering the following scholarships, which are tenable for three or four years, according to the length of the course at the university or college selected: Trewent (naval architecture), £175 per annum; age limit, twenty. Parsons and Yarrow (marine engineering), each £175 per annum; age limit, twenty-one. All three are limited to British subjects. Further particulars can be obtained from the Secretary, Institution of Naval Architects, 10 Upper Belgrave Street, London, S.W.1.

The autumn meeting of the Physical Society is being held this year in the Department of Natural Philosophy, University of Edinburgh, during December 17–19, and the general theme is "β- and γ-Ray Spectroscopy and Related Topics". During the meeting, on December 18, Prof. P. I. Dee, of the University of Glasgow, will deliver the eighth Rutherford Memorial Lecture of the Society; he will speak on "The α-Particle".

The first Technical Convention of the Institution of Telecommunication Engineers (New Delhi) will be held on December 30 at the National Institute of Sciences Hall in New Delhi. It will be preceded by the annual general meeting of the Institution on December 29, when Brig. Iyappa, the retiring president, will induct the president-elect, Prof. K. Sreenivasan, head of the Department of Electrical Communication Engineering, Indian Institute of Science, Bangalore.

The Institution of Chemical Engineers has now moved to 16 Belgrave Square, London, S.W.1.

ELECTRON TRANSPORT IN METALS AND SOLIDS

CONFERENCE IN OTTAWA

AN international conference on "Electron Transport in Metals and Solids" was held in Ottawa during September 10–14. The meeting was arranged by Dr. D. K. C. MacDonald, of the National Research Council of Canada, and was supported by the International Union of Pure and Applied Physics, by Unesco, and by the National Research Council. The décor of the meeting—the National Research Council Laboratories, overlooking the wide Ottawa River—was much appreciated by the fifty or so participants. By skilfully rebutting all attempts to include too many persons and too many papers, Dr. MacDonald and his assistants kept the programme within bounds, allowing time for proper consideration of the main topics and discussion of the problems still unsolved. One could wish that all scientific conferences were organized so sensibly, and not made indigestible with a gobble of successive pemmican pellets of condensed yet incoherent discourse.

A full account of the proceedings is to be published as a special number of the *Canadian Journal of Physics*. The following notes summarize (in logical, but not chronological, order) the main subjects.

J. Bardeen opened with a survey of the state of knowledge on interactions between electrons and lattice vibrations, leading to a lively discussion of the causes and effects in the lattice-scattering part of the resistivity of metals. It seems that, with corrections to the Bloch theory, this problem is now understood in principle, but detailed calculations of the resistivity of even simple metals are only now beginning to look reliable. The effects of deviations from equilibrium in the phonon distribution were discussed by E. H. Sondheimer, with reference to recent observations on resistivity and thermoelectric phenomena at low temperatures. G. Borelius pointed out that the resistivity of pure metals at high temperatures can be correlated phenomenologically with other properties; it appears that there may be much to learn from measurements of conductivity of liquid metals. The relation between X-ray scattering and electron scattering by lattice waves was developed by Sir K. S. Krishnan in an ingenious argument.

A review of electrical transport phenomena in alloys, by J. Friedel, brought out the wide variation of behaviour found with various transition elements, both in large and small concentrations, but most of the facts could be correlated reasonably well with theory. More controversial was the discussion concerning the minimum (and sometimes, also, the maximum) in resistance found at low temperatures in metals containing certain impurities. Papers by C. J. Gorter, by R. W. Schmitt and by J. Korringa showed the complexity of the phenomenon and the perplexity of its interpreters. It seems that there may be two distinct mechanisms, one related to an antiferromagnetic ordering in the spins of *d*-electrons in impurities from the transition group of elements and the other, not yet understood, which seems to require some sort of energy-level very near the Fermi surface of the matrix metal.

P. G. Klemens gave an account of the calculation of the electrical resistance due to lattice imperfections in metals. Although some reasonable estimates can be made for the scattering by dislocations, there are still difficulties in explaining the large changes in resistance caused by cold work in metals. An interpretation in terms of scattering by bands of stacking faults was supported by A. Seeger; but in the discussion other speakers found difficulty in believing that this effect could be large.

More fundamental problems concerning the validity of the Boltzmann equation, and the corrections one could make to it, were discussed by I. Prigogine, who outlined recent work on the statistical mechanics of irreversible processes. It is hoped that by starting from the 'master equation', more refined calculations may shortly be possible. Within the framework of the Boltzmann equation, it was shown by J. M. Ziman that there is a close connexion between the thermodynamics of irreversible processes and the variational principle of Kohler, which may be exploited to simplify calculations of transport coefficients. Another variational principle for conduction phenomena in the presence of a magnetic field or asymmetric scattering mechanism was proposed by A. Seeger, and R. Kubo gave a general expression for the conductivity tensor, derived directly from dispersion theory applied to the density matrix.

In reporting measurements on the electrical and thermal conductivity of metals, K. Mendelssohn emphasized the interest of thermal conduction in superconductors, which is effectively pure lattice conduction (although C. J. Gorter pointed out that the two-fluid model could be interpreted in such a way as to lead to an appreciable contribution from a circulation of normal and superfluid electrons) Information from lattice conduction could, as pointed out by P. G. Klemens, supplement electrica measurements in identifying the various types o imperfections in metals. Other experimental data were given by G. K. White, reporting on work in progress at the National Research Council Laboratories.

Nuclear magnetic resonance and the electroni structure of conductors was the subject of a review by N. Bloembergen. It is evident that measuremen of the Knight shift yields very diverse information some of which may be related to band structure o to known transport properties. There seems room for better correlation between this study and measurements of the more traditional transport parameters On the theoretical side, D. Pines brought up to dat the theory of plasmons, showing that in most solid the valence electrons form a plasma the collectiv oscillations of which have important effects. Th calculations are in remarkably good agreement wit experiment. It was suggested that, where there ar present both holes and electrons, as in a sem conductor, there may be new forms of excitation having dispersion properties like those of a soun wave; these 'distinct electron modes' may b literally named 'demons'. The various techniques b which direct information can be obtained about th geometry of the Fermi surface were described b R. G. Chambers. Cyclotron resonance, the anomalou skin effect, and the de Haas – van Alphen effect ca all show up anisotropy, and attempts are being made to interpret the results quantitatively.

Although largely devoted to the study of metals, the conference spent some time on topics related to semiconductors. N. F. Mott presented his theory of the transition to metallic conduction in semiconductors, regarding electronic transport in an impurity band as the jumping from site to site with activation by lattice vibrations. P. R. R. Aigrain, on the other hand, preferred a collective picture, in which the randomness of the distribution of impurity sites plays an important part. He suggested that certain states, although not localized, cannot carry current, and hence explained the low mobility in the impurity band. Experimental data on galvanomagnetic effects in *n*-type InSb at 4° K. were given by H. P. R. Frederikse. By considering valence bonds in various compounds, E. Mooser and H. W. B. Pearson were able to present some rules which allow the prediction of semiconducting properties.

An important contribution was made by A. F. Joffé, who discussed recent Russian work on heat conduction in semiconductors. Besides lattice conduction (which may be reduced very effectively by using mixed crystals so that phonons are scattered by the random distribution of atomic mass), there is a significant electronic contribution, and also a further part which may be due to transport of heat by excitons. This led to considerable discussion, with opinions divided as to the exact interpretation.

J. M. Ziman

GAS TURBINE DEVELOPMENT

The Engineering Department of the North Herts Technical College, Letchworth, arranged a conference on "Gas Turbine Development", which was held during October 20–21. It attracted more than a hundred, most of whom were leading designers or research workers in the appropriate field.

The first of the four main papers was given by Mr. G. B. R. Feilden, engineering director, Messrs. Ruston and Hornsby, Ltd., who offered a brief résumé of the development of the Ruston and Hornsby gas turbine (750/1,000 kW.), since 1946, dealing particularly with the engineering difficulties which were experienced in putting the research designs into working order. At the end of 1,500 hr. running experience with this machine, it was decided to go ahead with a production model capable of 750 kW. and rising to 1,000 kW. maximum output. Improvements were made in the prototype output by raising the maximum temperature, and increasing the length of the turbine blades by 7–8 per cent; production economy being maintained by utilizing tooling for existing blades. It was decided, also, to improve the matching of the components and make minor adjustments to the burners. The completed model had a compressor and turbine practically identical with the prototype, though epicyclic gears had been introduced and the turbine mounting improved. In order to enable the individual components to be serviced easily, however, considerable modifications in layout had been incorporated.

Mr. Feilden illustrated developments in the more recent installations, including one at Milan, which has now been in continuous operation for 10,000 hr. This machine is fired by natural gas, and the arrangement of the combustion chambers with ancillary ducting has proved very practicable for servicing. He also illustrated the installation at Debden, in which the heat exchanger is placed below the set, and the combustion chamber is arranged at an angle downwards. This is a coal-tar fuel-burning set with the ducting arranged upwards. Another slide showed the installation at the Admiralty Test House at Pyecroft, which was made to exacting specifications, the air inlet in this installation being at an unusual angle, and the ducting was woven through the installation. The turbine is to be fitted with a heat exchanger made of corrugated steel plates in the near future.

Mr. Feilden concluded his address by comparing the overall efficiencies of various plants required to produce both power and process steam. The Diesel is the most efficient power producer, and, for a 1,000-kW. electrical output, used in conjunction with an exhaust heat boiler, it gives better figures than any other plant for outputs of process-steam up to 7,500 lb. per hr.; above that requirement, the gas turbine is better. An exclusively steam plant, even with a highly efficient steam turbine and a high-pressure water-tube boiler, is far behind in overall efficiency, and only begins to be competitive if a very considerable quantity of steam (more than 20,000 lb. per hr.) is asked for.

Discussion revealed that problems of servicing under varying climatic and atmospheric conditions have been extremely interesting. While the installation at Kuwait has to digest large quantities of sand, this appears to have no adverse effect upon the turbine blades. The sodium sulphate in airborne particles presents an entirely different problem with the Milan installation, and it is necessary to wash the blades every 200–300 hr. with a solution of 'Teepol' and water; the turbine has now done 3,000 hr. non-stop.

"The Marine Gas Turbine" was the subject of the second paper, by A. W. Pope, chief gas turbine engineer, Messrs. W. Allen, Sons and Co., Ltd. Mr. Pope showed that there are two distinct applications of the marine gas turbine—naval and merchant-marine. In connexion with naval applications, there are many differing requirements. Naval can be divided into two categories: (*a*) protection of convoys, and (*b*) task forces. The former duty is performed mainly by frigates, a comparatively new class of ship of which there are various types (fast escort, anti-submarine, anti-aircraft and air direction). The task force duties are undertaken by aircraft carriers and cruisers. The varying requirements mean that aircraft carriers spend much of their time at full power, whereas frigates spend very little. On one such ship, it was found that 70 per cent of full power was used for only 1 per cent of the ship's life. There is here an obvious application for gas turbines (known as boost turbines) to provide the extra power when required. Already two British ships have been provided with such turbines, and an American ship is powered by 9,000 steam h.p., and 21,000 gas turbine h.p., with a saving of 20 per cent on engine weight.

Gas turbines are also being used for electrical generation. There are two types of generator set, namely, emergency and base-load. In emergency sets, fuel consumption is unimportant, and the gas turbine correspondingly simple. Mr. Pope gave an example of the development of such a turbine, detailing various changes in design to give greater efficiency.

Of base-load generator sets, he said that these will undoubtedly become standard practice in the Navy, possessing as they do several advantages over diesel sets, to which they are preferred above 350 kW. Mr. Pope then gave details of a 1,000-kW. base-load generator set and of a 500-kW. set.

On merchant marine applications, Mr. Pope remarked that engines for this purpose operate their whole life at full power, and, due to the cost of running, only one experimental set has so far been built. He gave figures, however, to prove that maintenance costs are much lower than those for diesel engines, and possibly than those of steam turbines. There is, he said, a certain amount of interest in emergency gas turbine generator sets for the merchant marine. One such machine has been developed; it was first run only 21 months after the initiation of the project, and was delivered after only 26 months.

"Air Development" was the theme of an address by Dr. A. W. Morley, head of Forward Projects Investigations Department, Messrs. D. Napier and Sons, Ltd. Dr. Morley traced the development of the gas turbine engine, dating from Dr. A. A. Griffiths (1926), who applied Prof. Frankel's theory of circulation, to the turbo-prop and jet engines which are known to-day. The piston-engine transport, he said, belongs to the past, and he showed a short film of the conversion of the piston-engine transport to the turbo-prop transport (Convair 340). The reasons for the conversion became evident as the lecture developed; namely, it provided a saving of weight and an increase of power, so that the cruising speed went up as well as the pay-load. This conversion utilized the Eland turbo-prop engine, and Dr. Morley justified the title of his lecture by describing in detail the principles and development of the above engine, including the control system, fuel metering system and torque meter. He also dealt with some of its safety aspects, detailing the maximum torquemeter, and overspeed governor, stressing the fact that the ideal design is such that if one part fails something else comes into play.

Dr. Morley then showed how the introduction of new conceptions brings about new machines, as for example in the Fairey Rotodyne (rotor, 90 ft. diameter), Rolls-Royce "Flying Bedstead" and in helicopter development.

Applications to the motor vehicle were dealt with by Dr. J. H. Weaving, chief research engineer, Austin Motor Co., who described the main steps in development, with slides showing the calculations and results represented in graphical form.

The importance of the heat exchanger was emphasized, and it was shown that there is no point in having high compression ratios if a heat exchanger is used. Dr. Weaving compared the efficiencies of the gas turbine with heat exchanger, petrol and diesel engines at full load; it is possible to achieve efficiencies with gas turbines comparable with the diesel engine if a thermal ratio of 0·9 is used, and comparable with the petrol engine if a thermal ratio of 0·7 is used.

Dr. Weaving stated that research is continuing on rigs to improve the efficiency of individual components. A centrifugal compressor has been on test, and axial compressors of single, two and three stages have been tried. A two-stage compressor giving ratios of 4 to 1 and 6 to 1 without overstressing has been used, and a three-stage compressor is now in service. Research into the design of burner and combustion chamber is being carried out by J. Lucas and Co., Ltd.

Dr. Weaving foreshadowed great developments in the regenerative types of heat exchangers, and concluded his address with illustrations of the result of researches in Great Britain, the United States and on the Continent. The installation of the Austin turbine in the "Princess" saloon was shown, also the *G.T.* 302 "Whirlfire" and its novel installation with twin-disk regenerative heat-exchanger as fitted in the General Motors "Firebird".

SUMMER SCHOOL IN PHYSICS IN THE UNIVERSITY OF MEXICO

LAST summer the University of Mexico held, for the first time, a summer school in physics. The subject on this occasion was theoretical nuclear physics, and the course extended from July 9 until the end of August. The twenty-eight members of the school were mostly graduate students or senior staff in theoretical physics, but also included some experimental physicists. Apart from members of the University of Mexico there were visitors from the Argentine (2), Brazil (3), Cuba (1), Britain (1), France (2), Germany (1), India (1) and the United States (9).

Unesco provided for the travelling expenses of some of the members, others had grants from their own national institutions, and in addition a good deal of local expenditure was borne by the University of Mexico.

The meetings, which were conducted in English, were held in the Physics Department of the University (director, Prof. C. Graef Fernandez) and the programme was designed and arranged by Dr. M. Moshinsky, professor of theoretical physics.

The idea of such a summer school bears some relation (and no doubt has received some inspiration) from the successful summer schools that have become regular institutions in Les Houches (France) and Varenna (Italy); but the Mexican Summer School differed from these older institutions by being rather more specialized. The five lecture courses provided all dealt with parts of nuclear theory; their subjects were: collective motions in nuclei (M. Moshinsky); theory of nuclear reactions (R. G. Thomas); electromagnetic reactions with nuclei (J. S. Levinger); the nuclear shell model (B. Stech); and nuclear forces (R. E. Peierls). Thus they covered specialized and well-defined sections of the subject, and with about twenty-four lectures in each course it was possible to present each topic in fair detail. The lectures were given on three mornings and two afternoons each week. In addition, there was a weekly seminar in which the topics ranged rather more widely, and by request of the members of the School a short series of lectures by Prof. Graef Fernandez on general relativity.

One of the obvious functions of such a course was to give some inspiration and encouragement to the young, but growing, group of theoretical research workers at the University of Mexico, and one had the impression that the members of this group appreciated the opportunity of taking part in a live discussion of modern topics from a variety of points of view. They took part in the lectures and discussions with great enthusiasm, in spite of the language difficulty, which must have demanded of some of them as great or greater effort than the technical difficulties of the subject. The meetings also met with an enthusiastic response from the experimentalists associated with the new nuclear physics laboratory, and both in seminars and outside the lecture rooms there were many occasions when one heard of the fine work done on the Van de Graaff set of the laboratory, and discussed the relations of these results with the theoretical principles that were the main subject of the course.

For the foreign members of the Summer School it was a most stimulating experience to be in Mexico, both because it is always interesting to become acquainted with a new and vigorous research school, and also because they had the chance to see around them so much of beauty and interest. The new University City of Mexico is world-famous for the breath-taking beauty of its buildings and its setting, and there was time enough to see this as a particular example of the achievements of Mexican architecture, which is without comparison in its imaginative use of form and colour, and in the unique way in which it exploits modern building techniques and modern trends, while it remains firmly based on old traditions in art and an impressive sense of continuity of æsthetic values.

For the foreign members there was indeed so much to see outside the Science Institute, and outside Mexico City, that it is a tribute to the programme of the Summer School and to the sense of duty of its members that sight-seeing trips and archæological excursions were normally confined to week-ends or postponed until after the end of the course.

In principle, one might argue that summer schools should not be held in places so attractive as Mexico, and which offer so many alternative interests, or that they should not be held at the sponsoring University, where the local staff have their normal business to attend to. But in this case there was no sign that either of these factors was allowed to divert attention from the activities of the School.

A similar Summer School for 1957 is now under discussion and the subject is likely to be experimental nuclear physics. If the University of Mexico, and the members of the physics staff in particular, are willing to continue to carry the burden involved in the organization of a summer school, and of the generous and friendly hospitality which was provided, the School will undoubtedly establish itself as an important feature in modern physics, which can provide another forum for serious discussion and a focus for the interests of physicists in Latin America.

R. E. Peierls

MYXOMATOSIS IN AUSTRALIA

On September 18 the Commonwealth Scientific and Industrial Research Organization of Australia held a conference in Melbourne to plan the country's myxomatosis campaign for the season.

The conference included representatives of the Organization, the State Departments of Agriculture and of Lands, the Commonwealth Department of Commerce and Agriculture, the Graziers' Federal Council, the Australian Wool and Meat Producers' Federation, the Australian Primary Producers' Union, Commonwealth Serum Laboratories, the Walter and Eliza Hall Institute for Medical Research, and the Australian National University. Sir Ian Clunies Ross was chairman.

Reports from all the Australian States indicated that rabbit populations are extremely low. Myxomatosis has been largely responsible for the reduction in rabbit numbers, but other factors have also contributed; the widespread and organized use of the poison '1080' has been particularly important in Tasmania and Western Australia. Climatic conditions, too, and especially very heavy rainfall, have adversely affected rabbit breeding.

In Tasmania poisoning with '1080' has been most successful. Rabbit numbers have been reduced to an extent which compares favourably with results achieved by myxomatosis in the eastern States.

Prof. F. Fenner, of the Australian National University, reported on his examination of more than 150 strains of myxomatosis virus, including strains from Europe and America.

In Australia, strains of the virus with reduced virulence appeared in the field soon after the initial release of myxomatosis in 1950. These less-virulent strains have become dominant.

In Europe the less-virulent strains did not appear as rapidly but they are now the dominant strains there also.

The conference recommended that further large-scale inoculations with the standard (high-virulence) strain of the virus should be carried out during the coming season to prolong the period of effective use of myxomatosis by allowing fewer rabbits to survive and breed.

If existing low-virulent field strains are allowed to develop without some competition from the standard strain of the disease there will be a much bigger reservoir of survivors to provide genetically resistant progeny.

A high incidence of myxomatosis in the coming spring and summer is predicted. To take maximum advantage of these favourable conditions, a campaign for the general release of the standard (high virulence) strain of the virus has just begun.

Experiments aimed at introducing the 'French' strain of the virus indicated that it did not survive in competition with the existing dominant field strain of low virulence. A warning was given against further introduction of the 'French' strain. It appears that this strain has given rise to much less virulent forms of the virus.

Experiments undertaken by Dr. I. D. Marshall, of the Australian National University, and Dr. W. R. Sobey, of the C.S.I.R.O. Animal Genetics Section, have confirmed that rabbits can inherit some degree of resistance to myxomatosis. Observations in the field have indicated that rabbits are, in fact, inheriting resistance to the disease, but further investigations will be necessary before the degree of this inheritance can be assessed.

The conference was told that it was believed that the European rabbit flea was a major factor in the spread of myxomatosis in the United Kingdom. The Australian Agricultural Council agreed at its meeting in July 1956 to a recommendation that the European rabbit flea be used for myxomatosis experiments in Australia. The conference agreed that such experiments would be valuable, subject to tests to confirm that the flea is harmless to Australian fauna.

The conference urged all landholders to use poison '1080' and all other effective methods after the current myxomatosis season ends. Advantage should be taken of low rabbit numbers to kill off all survivors. The aim must be to eradicate the rabbit from Australia.

DUTCH – NORWEGIAN JOINT ESTABLISHMENT FOR NUCLEAR ENERGY RESEARCH

REPORT FOR 1954–55

THE fourth annual report of the Dutch–Norwegian Joint Establishment for Nuclear Energy Research (J.E.N.E.R.) covers the period from July 1, 1954, to June 30, 1955*, and reports that at Kjeller the natural-uranium heavy-water research reactor, JEEP, has completed its fourth year of operation, yielding 50 MW.-days of heat during the year. A great variety of research work has been done, both in connexion with the design of reactors and of a more fundamental nature, but the principal task of the Establishment is research in the field of nuclear power.

The original design for a pressurized heavy-water reactor, using natural uranium as fuel and heavy water as moderator and coolant, as a power demonstration reactor has been shelved, and instead work has been concentrated on a boiling heavy-water reactor running on slightly enriched uranium and delivering 10 MW. of heat. The Norwegian organization, Institut for Atomenergi (I.F.A.), which together with the Dutch organization, Stichting voor Fundamenteel Onderzoek der Materie (F.O.M.), operates the Joint Establishment, has proposed to the Norwegian Government to build this reactor at Halden, in Norway, 100 km. south of Oslo. The site is on the premises of a paper-pulp plant, Saugbrugsforeiningen, which is interested in the future possibilities of supplying process steam by nuclear reactors, the area being far away from reserves of hydro-electric power. The firm will buy the steam generated in the experiment and will support the project in general. The reactor, except for the control room, will be entirely underground in an artificial cave in the mountainside.

Sales of radioisotopes produced in JEEP increased by 85 per cent more than the previous year. 579 shipments were made, and an additional 262 irradiations were carried out for use within the Establishment. Some radioisotopes, such as labelled compounds and isotopes requiring a high neutron flux which are not easily produced at Kjeller, were imported mainly from the United Kingdom Atomic Energy Authority. The Isotope Department continued its radioisotope service for industry, and a number of new technical applications have been carried out, some of which are briefly described in the annual report.

The neutron diffractometer described in the report for 1953–54 has been improved by the addition of a neutron monitor so that it now gives the number of neutrons scattered by a crystal in a certain direction for a given number of neutrons incident from the reactor, instead of for a given length of time. The angular resolution has also been improved, and a second 'two circle' instrument especially designed for studies of single crystals has been recently put into use. Most of the research work on crystal structures, using neutrons, has been concerned with the determination of 'light' atoms in the presence of 'heavy' atoms, and the substances investigated include CuH, Al_2Th and $Ca(H_2PO_2)_2$. The fission process, the basic process underlying the operation of reactors, has been the subject of experimental and theoretical studies during the year under review, and the angular correlation of fission products, the high-energy gamma radiation from fission fragments and the hazards which might arise from the continuing heat generation from fission products in the event of an accident to a pressurized boiling-water reactor system are some of the topics discussed in the report. A large liquid-scintillation fast-neutron detector, consisting of an aluminium tank, 30 cm. diameter and 30 cm. high, containing an organic scintillator into which cadmium or boron is introduced and viewed by four photomultipliers with 5-in. diameter photocathodes, and a time-of-flight spectrometer have been constructed for studies of fast neutrons.

Work in the Chemistry and Metallurgy Departments has continued on the study of plutonium chemistry and the reprocessing of spent fuel rods, the nuclear properties of uranium oxide fuel rods and full-scale corrosion tests on fuel elements under dynamic conditions. The Health Physics Department has kept constant control of radiation hazards; of the 111 individuals exposed to radiation, not one received a radiation dose greater than half the permissible working dose recommended by the International Commission on Radiological Protection. Five reports and two publications of the Establishment were issued during the year. 300 books, 25 periodicals and 8,500 reports were added to the library, including a technical library consisting of about 6,500 reports (4,900 on microcards), twenty-eight bound volumes of the U.S. Atomic Energy Commission's "National Nuclear Energy Series", a complete set of *Nuclear Science Abstracts* and other material presented by the Commission.

The final sections of the report deal with the accounts of the Establishment for the period under review; the personnel in the various departments; and the various scientific meetings and conferences attended by members of the staff of the Establishment.

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* Fourth Annual Report, July 1954–June 1955, of the Dutch–Norwegian Joint Establishment for Nuclear Energy Research. Pp. iii+34. (Kjeller, near Lillestrøm: J.E.N.E.R., 1956.)

MECHANISM OF INSECT FLIGHT

FLIGHT by means of flapping wings demands a higher rate of energy consumption than any other known activity in the animal kingdom. But in no single bird, or bat, or insect has the aerodynamics of the process been closely analysed. Indeed, some authors have claimed that the observed movements of insects would not permit flight in accordance wit ordinary aerodynamic principles. This subject is now being studied with all the care it deserves by T Weis-Fogh and M. Jensen, and their first four papers have been published under the general title o "Biology and Physics of Locust Flight" (*Phil. Trans Roy. Soc.*, B, 239, 415; 1956). Dr. Weis-Fogh is a entomologist and physiologist (a student of the lat August Krogh, who took an active part in the earl stages of the work); Dr. Jensen is an engineer wit a special knowledge of the aerodynamics of aircraft Two of the papers are under joint authorship, an the other two by each author alone.

From a critical review of the available informatio the authors conclude that natural flight is almos certainly based on conventional aerodynamic principles, even in such small insects as mosquitoes. Th energy account of a wing stroke comprises at leas three independent terms: an aerodynamic term du to the wind forces on the wings, an inertial term due to acceleration of the wing mass, and an elastic term caused by the elastic deformations of the thorax. In addition, there may be some extra-muscular damping within the thorax.

In order to analyse how the various wing-stroke parameters are related to the *lift* and the forward *thrust*, the locust was suspended from a complicated balance and flew against a uniform wind the speed of which was automatically adjusted to the point where the thrust was equal to the drag of the body, thus indicating the flying speed. This speed averaged 3·5 m./sec., but might be as much as 4·5–5·0 m./sec. during the first minutes of flight. The power necessary to overcome the drag of the body was only 1–3 per cent of the total metabolic rate; and changes in the inclination of the body up to 20° had no effect at all on the lift, in striking contrast to the effect of pitch on an aircraft. Most of the parameters of the wing stroke are remarkably constant, such as the stroke angles, the stroke plane angles, the middle position of the wings and the time course of the angular movement. Even the stroke frequency showed a maximum increase of 8 per cent during the most active lift. It is therefore concluded that, by analogy with a variable-pitch propeller, the great variations in lift must be caused by differences in *wing twisting*. It is rather remarkable that over the whole range of temperature (25–35° C.) at which flight occurs, the standard wing stroke is completely independent of temperature.

In a detailed analysis of the aerodynamics of locust flight it was found that the calculated vertical lift force, when averaged over an entire wing stroke, equalled the average reduction in body-weight as measured directly on the flight balance. Likewise, the average thrust of the wings as calculated, corresponded with the measured drag of the body. The hind-wings are responsible for about 70 per cent of the total lift and thrust, about 80 per cent of the lift being produced during the down-stroke.

As already noted, the wing stroke of locusts is extremely constant and independent of external conditions. The question arises whether the rhythm is imposed by the central nervous system or peripherally. In the fourth paper of the series, Weis-Fogh discusses some of the sensory mechanisms concerned in locust flight. As is well known, flight can be initiated by the 'tarsal reflex'—sudden removal of contact with the legs; but this causes only about five seconds of flight, or about a hundred wing strokes. Sustained flight is dependent upon the blowing of air over the wind-sensitive hairs on the head. The direction of the air current is immaterial, and, since static bending has no effect, the adequate stimulus is probably minute vibrations of the hairs. A new receptor system is also involved in the maintenance of flight. The adequate stimulus is the rhythmically changing wind-pressure on the wings. The receptors perhaps reside in the wing-hinge, but they have not yet been identified. Finally, in addition to the wing-stroke movements being strikingly constant, there is a very accurate control of the lift; this presupposes a system of lift-sensitive receptors (probably campaniform sensilla at the wing-hinge) which control reflexly the wing-twisting angle.

This important work is still incomplete; six further sections are in preparation.

ENZYMIC AND CHEMICAL SYNTHESIS OF THE ALPHA-1 : 2-GLUCOSIDIC LINKAGE

Enzymic Synthesis

WHEN the dextran-producing organism *Betacoccus arabinosaceous* is grown on a medium containing sucrose and an appropriate second sugar (to serve as an acceptor of transferred glucose units) oligosaccharides are produced in appreciable quantities[1]. A particularly interesting example is the formation of the 'branched' trisaccharide, O-β-D-galactopyranosyl-(1→4)-O-[α-D-glucopyranosyl-(1→2)]-D-glucopyranose, from a mixture of sucrose and lactose[1]. It is now shown that, as was envisaged earlier[1], cellobiose behaves in an analogous fashion to lactose and gives rise to the 'branched' trisaccharide, O-β-D-glucopyranosyl-(1→4)-O-[α-D-glucopyranosyl-(1→2)]-D-glucopyranose. The preliminary chromatographic evidence upon which this work is based was obtained by our former colleague, Dr. R. W. Bailey.

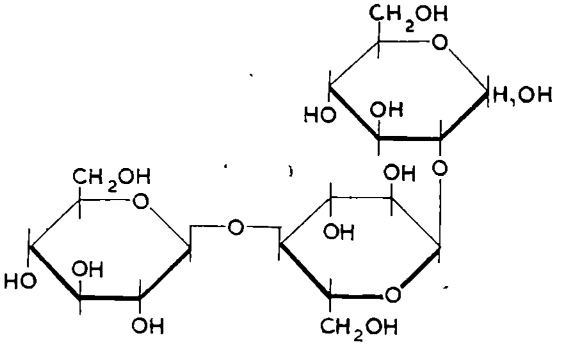
The new trisaccharide was isolated by the charcoal column method[2] from a culture of *Betacoccus arabinosaceous* (Birmingham strain), which had been grown on a medium containing yeast extract, inorganic salts, sucrose (10 per cent) and cellobiose (30 per cent).

The molecular size was confirmed by oxidation with hypoiodite[3] and by ionophoresis of the benzylamine derivative in formic acid[4]. Acidic hydrolysis gave glucose as the only product detectable by filter-paper chromatography and by ionophoresis in borate (*p*H 10)[5]; partial hydrolysis yielded components corresponding to glucose, cellobiose and a second disaccharide (*Y*). The reducing power of the trisaccharide towards the Shaffer–Hartmann copper reagent[6] was only about 2·5 per cent of that of glucose, a discrepancy which is shown generally by 2-O-substituted glucoses[1]. Moreover, the trisaccharide and disaccharide *Y*, in common with the analogous trisaccharide derived from lactose, were not developed by alkaline triphenyltetrazolium chloride, which detects all reducing glucosaccharides except those with a 2-O-substituent[7]. Further evidence that the reducing unit of the trisaccharide was linked through position 2 was obtained when treatment with phenylhydrazine acetate yielded a mixture of two osazones, similar to cellobiosazone and glucosazone on microscopic examination.

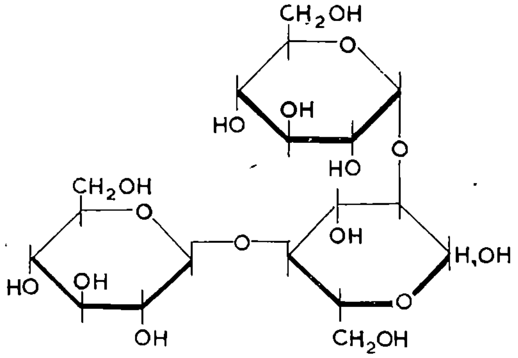
That one of the glycosidic linkages in the trisaccharide was α and the other β was shown (*a*) by its $[\alpha]_D$ value (+93° equil.; conc. 1·00 in water) and also that of the alcohol derived from it (+89° equil.; conc. 1·00 in water), (*b*) by its infra-red absorption spectrum, which displayed a peak at 840 cm.$^{-1}$ (α-linkage) in addition to those given by cellobiose[8], and (*c*) by its conversion to glucose and disaccharide *Y* with almond β-glycosidase.

This enzymic hydrolysis proceeded much more slowly than with β-linked disaccharides. The products were separated on a charcoal–'Celite' column and a sample of disaccharide *Y* was thus obtained. A disaccharide (*X*) was prepared from the lactose-derived trisaccharide in a similar manner. The earlier conclusion[1] that *X* was 2-O-α-D-glucopyranosyl-D-glucose and the above indications that *Y* was identical with it were confirmed (*a*) by paper chromatography and ionophoresis in borate, *p*H 10 [M_G 0·32 (eliminates 1 : 3- and 1 : 6-linkages)[5]], direct comparison eliminated maltose as a possibility ; (*b*) by molecular weight determinations using ionophoresis in formic acid and oxidation with hypoiodite ; (*c*) by their low reducing power (about 12 per cent of that of glucose) towards the Shaffer–Hartmann reagent (*cf.* sophorose[6]) ; (*d*) by 96 per cent conversions into glucose with acid ; (*e*) by their high $[\alpha]_D$ values (+133° equil. ; conc. 0·94 in water) ; (*f*) by their infra-red absorption spectra, which displayed peaks at 840 cm.$^{-1}$ (α-linkages) but not at 894 cm.$^{-1}$ (β-linkages[8]) ; (*g*) by their resistance to almond β-glycosidase and (*h*) by the similarity of their stains (aniline hydrogen phthalate spray) with that of sophorose. Direct comparisons with a sample kindly supplied by Dr. Whelan (see following communication) were made by infra-red analysis, paper chromatography, ionophoresis of the benzylamine derivatives and ionophoresis in borate (*p*H 10) and identical results were obtained. Thus *X* and *Y* were both 2-O-α-D-glucopyranosyl-D-glucose (kojibiose[10]).

Two possible structures remained for the cellobiose-derived trisaccharide ; these are shown in (I) and (II). The former was considered unlikely when the method of synthesis was taken into consideration and was eliminated also when the sugar consumed 3·90 mol. of periodate with the production of 1·75 mol. of formic acid and no formaldehyde (theoretical value : II, 4, 2, 0) and when its alcohol consumed 5·02 mol. of periodate, giving 1·92 mol. of formic acid and 0·85 mol. of formaldehyde (theoretical values : I, 6, 3, 1 and II, 5, 2, 1). Thus the trisaccharide was O-β-D-glucopyranosyl-(1→4)-O-[α-D-glucopyranosyl-(1→2)]-D-glucopyranose. It is possible that the trisaccharide which was isolated by Buston and Khan[11], following treatment of cellobiose with an extract from *Ch. globosum*, is analogous to our trisaccharide ; indeed, these authors noted certain similarities between their trisaccharide and sophorose.



(I)



(II)

We thank Dr. R. W. Bailey for valuable assistance in the preliminary investigations of the trisaccharide.

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Chemical Synthesis

The formation of 1 : 2-linked polymers of α-D-glucopyranose has been examined as part of our investigations of the chemical synthesis of sugar polymers[1]. The problem had an added interest since the occurrence of the α-1 : 2-glucosidic linkage in Nature has only been recognized very recently and the linkage has not previously been synthesized by chemical methods. The previous communication reports the enzymic synthesis of this linkage, and Shibasaki[2] has described the presence of a diglucose (kojibiose) believed to contain the α-1 : 2-linkage, in a mixture of disaccharides synthesized from glucose by *Schizosaccharomyces pombe*.

The method of synthesis was suggested by the observation[3] that α-glucosides are formed when 1 : 2-anhydro-3 : 4 : 6-tri-O-acetyl-α-D-glucopyranose (Brigl's anhydride[4]) is heated with a suitable molecule containing a hydroxyl receptor group. In this way maltose, sucrose and αα-trehalose were synthesized[3]. It occurred to us that heating the Brigl anhydride alone might cause it to polymerize, with the formation of a polymer of α-1 : 2-linked glucose units. When the anhydride (m.p. 60°) was heated at the temperature of boiling butan-1-ol (b.p. 118°) the initially thin colourless liquid began to darken and thicken during 2–3 days and after a week had set to a hard syrup. Paper chromatographic fractionation of the deacetylated material revealed glucose and a series of benzidine-reducing oligosaccharides, which had the linear R_M value/DP relationship characteristic of a polymer homologous series[5]. The disaccharide component was isolated. Although it migrated as a single zone on a paper chromatogram it proved to be a mixture of three substances. This was revealed when, after treatment with cold phenylhydrazine acetate, paper chromatography resolved the substance into three zones. Two were coloured yellow (phenylhydrazones); the third, occupying the original position, was due to a non-reducing sugar, identified as αα-trehalose. The two coloured zones were separated and reconverted into the free sugars. The sugar from the faster-moving zone may be a 2 : 2-linked disaccharide; the other has been identified as O-α-D-glucopyranosyl-(1→2)-D-glucose.

The evidence of identification is as follows: (*a*) Acid hydrolysis gave rise to glucose as the only product (paper chromatography). (*b*) Hypoiodite oxidation indicated a disaccharide and confirmed the presence of a reducing group. (*c*) The $[\alpha]_D$ value of +140° (conc. 0·06) suggested the presence of an α-linkage, an inference confirmed by the infra-red absorption peak at 840 cm.$^{-1}$ (α-linkages), but not at 894 cm.$^{-1}$ (β-linkages) (see previous communication). (*d*) The M_G value of 0·32 in borate buffer, *p*H 8·7, shows that the linkage cannot be 1 : 3 or 1 : 6 and the R_F value in butan-1-ol–pyridine–water (3 : 1 : 1) was different from that of maltose (α-1 : 4-link) as well as from nigerose (α-1 : 3) and isomaltose (α-1 : 6). (*e*) Unlike the three last-named disaccharides the new sugar does not react on paper with alkaline triphenyltetrazolium chloride, a property suggestive of substitution at C–2 of the reducing glucose unit[6]. (*f*) Further indication of C–2 substitution is the copper-reducing value of less than 2 per cent as glucose (Somogyi reagent[7]). Sophorose (O-β-D-glucopyranosyl-(1→2)-D-glucose) has the same reducing power. Nigerose, maltose and isomaltose have approximately 50 per cent of the copper-reducing power of glucose. (*g*) Oxidation of the borohydride-reduced disaccharide with a limited amount of sodium metaperiodate (5 molecular proportions) yielded 1·36 mol. prop. of formaldehyde. Treated in the same way, reduced maltose gave 2·20 mol. prop. of formaldehyde.

All these properties are consistent with the assignment of the structure O-α-D-glucopyranosyl-(1→2)-D-glucose to the synthetic disaccharide and confirm the expected manner of polymerization of the Brigl anhydride. The fact that other disaccharides were formed, and, indeed, that disaccharides were formed at all is explicable on the basis of a chain-terminating reaction being caused by traces of moisture. Water should react with the anhydride to form 3 : 4 : 6-tri-O-acetyl-α-D-glucopyranose, which could in turn react with anhydride to yield either αα-trehalose or the α-1 : 2-disaccharide.

As mentioned earlier, the name 'kojibiose' has been applied by Shibasaki and co-workers[2] to a new glucose disaccharide, believed to contain the α-1 : 2-linkage. We are informed by Drs. Shibasaki and Matsuda that they have confirmed its supposed identity. We therefore propose to apply the name kojibiose to the α-1 2-linked diglucose.

This work was begun at the University College of North Wales, Bangor, and our thanks are due to Prof. Stanley Peat for his encouragement. We also thank Mr. P. M. Grant for the infra-red data, and Dr. S. Hestrin for information about the triphenyltetrazolium chloride spray.

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CYTOPLASMIC CHANGES ASSOCIATED WITH ADAPTATION AND DIFFERENTIATION

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RECENT investigations have shown that cytoplasmic changes accompany the growth, differentiation and ageing of homocaryon colonies of a number of species of the *Penicillia* and *Aspergilli*. Variation in the behaviour of colonies derived from single asexual spores of a homocaryon colony has been attributed to the unequal distribution of cytoplasmic elements at spore formation[1,2]. This variation among spores has been used as the basis of selection experiments, by which marked differences in phenotypic behaviour, of purely cytoplasmic origin, have been established.

Induced cytoplasmic changes, obtained by alteration of the medium on which the fungus is grown, have now been investigated in *Aspergillus glaucus*, the cytoplasmic nature of the changes being confirmed by the methods of Jinks[1,2].

Two cytoplasmic changes have been investigated: first, the change induced by transfer from normal medium to medium containing mercuric chloride, and secondly, that induced by transfer to medium in which galactose or xylose had been substituted for the sucrose normally used.

Mass hyphal transfers from normal medium grew on medium containing up to 9 μgm./ml. of mercuric chloride, with no reduction in vigour and at a steady rate, following lag periods of up to fourteen days (during which growth did not occur or was negligible).

Asexual spore transfers from normal medium showed that some of the spores, but only a small proportion, were also capable of growth on mercuric chloride medium, after varying lag periods. No spores were capable of growth on concentrations exceeding 3 μgm. mercuric chloride/ml. Spores of a uniform age from any one colony were found to be markedly heterogeneous for the level of poison on which they were capable of growing.

Hyphal transfers from adapted colonies (that is, colonies growing on the mercuric chloride medium) to mercuric chloride medium grew with no significant lag.

The behaviour of the asexual spores from adapted colonies on the mercuric chloride medium was, on the other hand, very little different from that of the spores from an unadapted colony. Spores from adapted colonies showed the same heterogeneity in concentration of poison tolerated and in lag period of survivors on any one concentration as did spores from unadapted colonies. As with spores from unadapted colonies, concentrations greater than 3 μgm. mercuric chloride/ml. were completely toxic.

Table 1 gives the distribution of toleration of various levels of mercuric chloride in a sample of asexual spores from a colony on 5 μgm./ml. mercuric chloride. The variation in age among the spores of the sample was less than 48 hr. The cytoplasmic heterogeneity is thus almost entirely due to unequal distribution of cytoplasmic elements at spore formation, the effect of mycelial and spore ageing being very small.

Table 1

Level of mercuric chloride	Percentage of spores in random sample
0·0–0·5 μgm./ml.	3·4
0·5–1·0 ,,	1·8
1·0–2 0 ,,	83·6
2·0–3·0 ,,	9·5
3·0 ,,	1·7

Only on concentrations just below toxic, that is, about 3 μgm./ml., was there a significant difference in the behaviour of spores from adapted and unadapted colonies on the mercuric chloride medium. On these sub-toxic concentrations, spores from adapted colonies of most lines gave a higher percentage survival, and a shorter mean lag period of the survivors, than spores from unadapted colonies. This difference is illustrated in Table 2.

Table 2

Homocaryon line	Percentage survival of spores From unadapted colony	Percentage survival of spores From adapted colony	Difference in mean lag period
1_1	4 4	7·8	22 hr.
1_2	2 2	20 2	150 hr.
1_3	0·0	0·0	0 hr
2	4·6	25·1	42 hr.

When the behaviour of mass hyphal transfers on the galactose and xylose media was investigated, growth was found to start after a lag period of a few days, during which little or no growth occurred.

Samples of asexual spores of uniform age, from different homocaryons raised on sucrose, when plated on to sucrose, xylose and galactose, showed significant variation in ability to grow, both between homocaryons and between sugars (Table 3). The variation on xylose and on galactose was about three times that on sucrose. Similarly, the variation in the lag period on the new sugars was significantly greater than on the sucrose medium.

Table 4 compares the behaviour of asexual spores taken from single colonies grown on the three sugar media when placed on the same and different media. For each colony the highest survival rate of the spores is taken as 100, the shortest lag period as 0 hr.

Table 3. THE RELATIVE PROPORTIONS OF ASEXUAL SPORES FROM SINGLE COLONIES OF TWO LINES ON SUCROSE MEDIUM CAPABLE OF GROWTH ON SUCROSE, GALACTOSE AND XYLOSE

(Highest survival-rate for each line taken as 100, lowest mean lag period as 0)

Line	Medium	Percentage of asexual spores giving a colony	Mean lag period
1_3	Sucrose	100·0	0 hr.
	Galactose	92 4	44 hr.
	Xylose	81 8	48 hr.
1_4	Sucrose	100·0	0 hr.
	Galactose	100 0	34 hr.
	Xylose	87 5	24 hr.

From Table 4 it can be seen that, for any one sugar, a greater percentage survival, smaller mean lag period, and less variation in lag period, is obtained on transfer to the medium to which the parent colony is adapted than to a different sugar.

Table 4

Medium to which mycelium adapted	Medium on which spores plated					
	Sucrose		Galactose		Xylose	
	Survival	Lag period	Survival	Lag period	Survival	Lag period
Sucrose	100	0 hr.	100	34 hr.	87·5	24 hr.
Galactose	52·9	0 hr.	100	0 hr.	23·5	47 hr.
Xylose	54·9	3 hr.	36·8	16 hr.	100	0 hr.

Jinks has shown that it is possible to select for cytoplasmic differences among the cytoplasmically heterogeneous colonies obtained from large numbers of single asexual spores[2]. Selection for any one character, for example, growth-rate, or perithecial density, was invariably accompanied by a correlated change in all the other characters investigated. It has now been found that selection for these characters is accompanied also by a change in the behaviour of the asexual spores from the selected colonies on the mercuric chloride medium. Cytoplasmic variants of various lines, selected for high growth rate, were found to give survival rates varying between 14 and 30 per cent on concentrations of mercuric chloride just below 3 μgm./ml. compared with a survival rate of 2–3 per cent for spores from unselected colonies. The change in survival rates of the spores brought about by selection in the complete absence of mercuric chloride is equal to, if not greater than, that brought about by prior adaptation of the parent colony to the mercuric chloride medium.

It is evident from these observations that the asexual spores of a colony show heterogeneity, of cytoplasmic origin, in their ability to grow on the media tested. Furthermore, there is a difference in the behaviour of hyphal and asexual spore transfers to the adaptive medium, hyphal transfers in general being more successful. This is most marked in the case of the mercuric chloride adaptations, where, even after adaptation of the parent colony, only a small proportion of the spores are capable of growth on the mercuric chloride medium.

The observations made here are in keeping with those made earlier on cytoplasmic differences affecting growth rate, perithecial density and other characters, in which asexual spores of a single homocaryon colony showed marked cytoplasmic heterogeneity, and colonies derived from asexual spore transfers and hyphal transfers differed in mean cytoplasmic content.

I am indebted to Dr. J. L. Jinks and Mr. L. G. Wigan for guidance and criticism.

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AGE AND OXIDATIVE PHOSPHORYLATION IN RAT LIVER AND BRAIN

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THE scanty literature concerned with the ageing process in relation to enzymatic activity does not contain any systematic study of oxidative phosphorylation. Such a study is of considerable importance, because oxidative phosphorylation is generally regarded as the primary metabolic process in aerobic cells for the generation of adenosine triphosphate[1]. Recent experiments in the Laboratory of Tropical Diseases demonstrated an uncoupling of oxidative phosphorylation in particulate preparations of albumen gland correlated with decreased fertility in aged snails[2]. These findings suggested similar research with mammalian tissues. Concurrent studies in the Section on Ageing had shown no decline in the respiration of fortified rat brain homogenates associated with age[3], and it became of interest to study oxidative phosphorylation in these preparations. The availability of a colony of inbred rats especially maintained to study ageing facilitated a joint investigation in the two laboratories.

Sprague–Dawley rats, grossly free from disease, were killed by decapitation; the brain and liver were removed simultaneously, and immediately chilled in cold 0·25 *M* sucrose.

Mitochondria were isolated from liver tissues in 0·25 *M* sucrose essentially by the procedure of Schneider[4]. The mitochondria were washed once; each ml. of the final suspension represented 0·5 gm. of original tissue. The supernatant fluid which remained after the mitochondrial sedimentation was centrifuged at 20,000 *g* for 30 min. at 0° to obtain a clear, soluble fraction for the glycolytic experiments. Oxidative phosphorylation was studied in the liver mitochondria with the use of β-hydroxybutyrate as substrate[5]. The oxidation of this substrate was determined by colorimetric estimation[6] of the acetoacetic acid formed.

It may be seen in Table 1 that the amounts of phosphate esterified and β-hydroxybutyrate oxidized (formation of acetoacetate) were significantly lower —30 per cent—in the mitochondrial preparations of old rats as compared to those obtained from the younger (control) animals. In a few experiments, the preparations from animals only a few days old had a lower activity, while those from animals 8–20 days old displayed a higher activity than the preparations from the control group. On the other hand, in all age-groups, the phosphorus/acetoacetic acid ratios remained essentially the same. Thus, in the case of liver tissue, there was observed no uncoupling of phosphorylation from oxidation but a definite decrease in the level of both activities associated with age. No sex differences were noted. Independent tests revealed that the adenosine triphosphatase activity of freshly prepared mitochondria from the old rats was low and responded to uncoupling agents (latency effect) in the same manner as mitochondria from the control rats. Since all the data in Table 1 were calculated on a nitrogen basis, the reduced level of oxidative phosphorylation found in the older rats cannot be ascribed to the addition of less mitochondrial nitrogen to the reaction flasks. In fact, there was little difference in the amount of nitrogen found (micro-Kjeldahl) in the mitochondrial preparations from the older animals (average value, 1·42 mgm. nitrogen/ml.) as compared with the control preparations (1·45 mgm. nitrogen/ml.).

In contrast to these findings were the observations of glycolytic phosphorylation. As seen in Table 1, there was no decline in the anaerobic uptake of phosphate, nor was the glycolytic activity reduced in liver preparations from the old rats. These findings are analogous to our experience with snail tissue where glycolytic phosphorylation also did not decline with age.

Oxidative phosphorylation was measured in brain homogenates with succinate as substrate[7]. 10 per cent homogenates were prepared in 0·25 *M* sucrose

Table 1. EFFECT OF AGE ON OXIDATIVE AND GLYCOLYTIC PHOSPHORYLATION IN CELL-FREE FRACTIONS OF RAT LIVER*

Oxidative phosphorylation (mitochondria)

Age	No. of exps.	P uptake (μM/mgm. N)	Acetoacetate (AA) formed (μM/mgm. N)	P/AA
3 months (control)	14	16·8 ± 1·42	6·0 ± 0·68	2·8
24–37 months	10	11·8 ± 1·55	4·0 ± 0·70	2·9

All t ratios are significant, $p < 0·001$

Glycolytic phosphorylation (supernatant fraction)

Age	No. of exps.	P uptake (μM/mgm. N)	Lactate formed (μM/mgm. N)
3 months (control)	6	4·2 ± 1·97	4·3 ± 1·16
24–37 months	6	5·0 ± 1·39	5·2 ± 1·20

* Figures are mean values ± one standard deviation

Oxidative phosphorylation. Each flask (main compartment) contained in a final volume of 2·0 ml. $4·0 \times 10^{-2}$ glycylglycine buffer, *p*H 7·4, $2·5 \times 10^{-2}$ *M* DL-β-hydroxybutyrate, 1×10^{-2} *M* potassium phosphate, *p*H 7·4, $2·5 \times 10^{-3}$ *M* adenosine diphosphate (Pabst), $1·2 \times 10^{-3}$ diphosphopyridine nucleotide (Pabst), $1·5 \times 10^{-5}$ *M* cytochrome *c*, $2·5 \times 10^{-2}$ *M* glucose, 0·4 mgm. hexokinase (Sigma), 5×10^{-3} *M* magnesium chloride, $1·5 \times 10^{-2}$ *M* sodium fluoride (added last) and 0·5 ml. of mitochondria (added at zero time). The flasks were transferred immediately to the Warburg bath at 30°. At the end of 20 min. 0·2 ml. of 25 per cent perchloric acid was tipped in from the side arms to stop the reaction. See ref. 5 for additional details.

Glycolytic phosphorylation. Each flask contained in the main compartment $1·25 \times 10^{-2}$ *M* potassium bicarbonate, $2·0 \times 10^{-3}$ *M* fructose diphosphate (Schwarz), 5×10^{-3} *M* magnesium chloride, 5×10^{-3} *M* potassium pyruvate, $1·25 \times 10^{-3}$ *M* adenosine diphosphate, $2·5 \times 10^{-2}$ *M* glucose, 0·4 mgm. hexokinase, $4·0 \times 10^{-2}$ *M* nicotinamide, $1·2 \times 10^{-3}$ *M* diphosphopyridine nucleotide, $1·0 \times 10^{-2}$ *M* fluoride (added immediately prior to enzyme) and 0·5 ml. of supernatant fluid obtained as described in the text. Each side arm contained 1×10^{-2} *M* potassium phosphate which was added at zero time. Final volume 2·0 ml. Gas phase: 5 per cent carbon dioxide and 95 per cent nitrogen. Incubated 20 min. at 30°.

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Table 2. Effect of Age on Oxidative Phosphorylation in Brain Homogenates*

Age	No. of exps.	O_2 uptake (μatoms/mgm. dry wt.)	P uptake (μM/mgm. dry wt.)	P/O
3–8 months (control)	10	0·66 ± 0·06	1·08 ± 0·09	1·64
22–33·5 months	10	0·65 ± 0·10	1·05 ± 0·16	1·61

* Figures are mean values ± one standard deviation.

Each flask contained in a final volume of 3 ml. $1\cdot2 \pm 10^{-2}$ *M* potassium phosphate, *p*H 7·4, 1×10^{-2} *M* sodium succinate, $1\cdot2 \times 10^{-2}$ *M tris*† buffer, *p*H 7·4, 5×10^{-3} *M* magnesium chloride, 2×10^{-3} *M* adenosine triphosphate (Sigma), 5×10^{-4} *M* diphosphopyridine nucleotide, $1\cdot5 \times 10^{-5}$ *M* cytochrome *c*, 2×10^{-2} *M* glucose, 0·5 mgm. hexokinase, 2×10^{-2} *M* potassium fluoride and 1 ml. 10 per cent homogenate. 0·2 ml. 10 per cent potassium hydroxide in centre well. Incubated in air for 30 min. at 30°. For details see ref. 7.

† *Tris* (hydroxymethyl) aminomethane.

and aliquots immediately added to chilled Warburg vessels containing all other components. As seen in Table 2, and in contrast to the liver studies, no decline was found in the oxygen consumption or phosphate uptake in homogenates from the old rats as compared with the controls. However, the lack of decline in oxygen consumption is in accord with previous respiration studies[3]; and in addition, the phosphate findings suggested that the coupled phosphorylation also is not depressed with age in the brain tissue. These results, together with the liver studies, indicate that in neither organ is there a change in the phosphorus/oxygen ratio with age. On the other hand, the lower absolute level of substrate oxidation and of the coupled phosphorylation found with liver, but not with brain, may be a reflexion of differences in tissue susceptibility to senescence.

Although the activity of some enzymes may increase with age[8], a general concept of ageing is one of progressive decline in the metabolic activities of the cell. If the *in vitro* experiments reported here with liver tissue are a valid reflexion of hepatic metabolism *in vivo*, then the decline in the absolute level of oxidative phosphorylation strongly supports this concept. It is of interest that studies with rat liver homogenates[9] did not show any significant correlation between age and oxygen consumption. The possibility exists that in cell-free homogenates, amply supplied with substrate and co-factors, age differences in metabolic behaviour which may be operating *in vivo* are masked to some extent *in vitro*. Perhaps isolated mitochondria represent a more subtle tool, because of their unique morphology and fragility, for investigating the ageing process. The studies with liver suggest the possibility in some tissues of a shift in phosphate metabolism from oxidative to glycolytic exergonic reactions accompanying senescence. Work is in progress to explore this possibility as well as other facets of the relation of ageing to enzymatic activity.

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COSMIC-RAY INTENSITY AND GEOMAGNETISM

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In a series of papers, E. and O. Thellier[1] have measured the remnant magnetism of ancient bricks. By comparison of the original magnetic moment of a sample with the moment acquired by heating above the Curie point and cooling in the present Earth's field under proper conditions, they have deduced the magnitude of the total Earth's field in ancient times when the bricks were fired. The results are summarized in Table 1.

Table 1

Source of sample	Date	*H* (gauss)
Caule Sainte-Beuve	1933	0·456
Palais Rihour–Lille	1465	0·56
Gallo-Roman remains	≈ A.D. 200	0·71

During the past two thousand years, the total field intensity in France appears to have dropped 65 per cent. We should like to point out that, if such a decrease has been general over the Earth's surface, the incident flux of cosmic rays and the rate of production of radio carbon must have increased during this period. The change in the carbon-14 inventory may be estimated as follows:

(1) Assume that the rate of production of carbons 14 is proportional to the *particle* flux of cosmic ray over the Earth's surface. This implies that the production per primary does not depend on energy, that is, at higher cosmic-ray energies the energy goes predominantly into mesons rather than an increasing flux of nucleons per primary. In Table 2 we compare the measured total primary flux at each latitude[2] with the neutrons absorbed in a column of the atmosphere 1 cm.^{2} in cross-section at each latitude[3]. The neutron captures per primary particle (column 4) are reasonably constant up to the latitude of the 'knee' (≈ 58°).

Table 2

Geo-magnetic latitude	Primary flux (No./cm.^{2}-sec.-ster.)	Neutron captures/cm.^{2}-sec.	Neutron captures/primary particle	$\left(\frac{Pc}{e}\right)$ min. (gauss-cm.)
0	0·021	0·48	3·6	$5\cdot0 \times 10^7$
20	0·025	0·64	4·0	$3\cdot86 \times 10^7$
28	0·033	0·88	4·3	$3\cdot02 \times 10^7$
41	0·053	1·35	4·1	$1\cdot62 \times 10^7$
51	0·095	1·80	3·0	$0\cdot78 \times 10^7$
58	0·15	2·05	2·2	$0\cdot39 \times 10^7$
90	0·15	2·15	2·3	0

(2) Assume that the primary integral number-rigidity spectrum has the form:

$$N\,(>E) = C\Big/\left(\frac{Pc}{e}\right)^n \quad \infty > \frac{Pc}{e} > \left(\frac{Pc}{e}\right)_0 \tag{1}$$

C is a constant and n is the power law exponent. The integral spectrum is constant for $\left(\frac{Pc}{e}\right) < \left(\frac{Pc}{e}\right)_0$ corresponding to the knee observed in the latitude effect of primaries, and there has the value $C\Big/\left(\frac{Pc}{e}\right)_0$. From the data in columns 2 and 5 of Table 2, we find that $n = 0{\cdot}93$, $C = 4{\cdot}03 \times 10^5$ and $\left(\frac{Pc}{e}\right)_0 = 0{\cdot}39 \times 10^7$ gauss-cm. at $\lambda = 58°$. To facilitate the further computations, we assume $n = 1$.

(3) Assume that the average minimum $\frac{Pc}{e}$ at any latitude is that corresponding to a vertically incident particle. The solid angle available to particles of $\frac{Pc}{e} > \left(\frac{Pc}{e}\right)_{\text{min.}\,(\lambda)}$ is $\Omega = 2\pi$.

The flux over the entire Earth's surface in particles per second, Φ, is then given by:

$$\Phi = \Omega \int_0^{\lambda'} C\Big/\left(\frac{Pc}{e}\right)_{\text{min.}\,(\lambda)} 2\pi\, a^2 \cos\lambda\, d\lambda + \Omega \int_{\lambda'}^{\pi/2} C\Big/\left(\frac{Pc}{e}\right)_0 2\pi\, a^2 \cos\lambda\, d\lambda \tag{2}$$

where λ' is the geomagnetic latitude of the knee.

From geomagnetic theory we know that the critical value of the Størmer variable r_0 for the vertical direction is $r_c = \frac{\cos^2\lambda}{2}$. Since by definition $r_0^2 = a^2\Big/\frac{eM}{Pc}$, where a is radius of the Earth, M is magnetic moment of the Earth, if we set $r_c = r_0$ then,

$$\left(\frac{Pc}{e}\right)_{\text{min.}\,(\lambda)} = \frac{\cos^4\lambda}{4} \cdot \frac{M}{a^2} \tag{3}$$

By substituting (3) in (2) we obtain:

$$\Phi = \frac{A}{M}\left\{\int_0^{\lambda'} \frac{d\lambda}{\cos^3\lambda} + \frac{1}{\cos^4\lambda'}\int_{\lambda'}^{\pi/2} \cos\lambda\, d\lambda\right\} \tag{4}$$

$$A = 8\pi\, a^4\, \Omega\, C$$

$$n = 1$$

The integrals in the brackets are functions of M as the limits contain the cosmic ray 'knee', λ'. At the 'knee' $\cos^4\lambda' \,.\, M =$ constant, from (3). Calculations show that the dependence of Φ on M given by (4) may be well represented by the relation $\Phi = \frac{C_1}{M^{0\cdot 52}}$, and then the rate of production of carbon-14 by

$$P(t) = \frac{C_2}{[M(t)]^{0\cdot 52}} \tag{5}$$

remembering that the magnetic dipole moment is dependent on time. The differential equation for the carbon-14 inventory over the Earth is then:

$$\frac{dI}{dt} = P(t) - \lambda_1 I \tag{6}$$

where λ_1 is the decay constant for[4] carbon-14 $= \frac{0{\cdot}693}{5568}$ years^{-1}.

To carry out the integration of (6) the function $P(t)$ must be known over all past time, whereas the experimental magnetic field data only extend back for two thousand years. Therefore, to estimate the *minimum* effect consistent with these data, we make the following assumption:

$$P(t) = P_0 = \text{const.} \quad t < 0$$

$$P(t) = P_0 \exp(\lambda_2 t) \quad 0 < t < 1933 \text{ years A.D.}$$

The values in Table 1 are well fitted by the exponential if we make $\lambda_2 \frac{1}{7950}$ years^{-1}. Also $P_0 = C_2/M_0^{0\cdot 52}$

The integration of (6) then yields:

$$I = \frac{C_2}{M_0^{0\cdot 52}\,\lambda_1(\lambda_1 + \lambda_2)} \cdot (\lambda_2 \exp(-\lambda_1 t) + \lambda_1 \exp(\lambda_2 t)) \tag{7}$$

We then find that the relative carbon-14 inventory at $t = 0$ and $t = 1933$ is

$$\frac{I\,(1933)}{I\,(0)} = 1{\cdot}018$$

From the radioactive decay equation as given, for example, by Libby (ref. 4, p. 9), we find that an object about 2,000 years old would be dated too old by 240 years. This is scarcely outside the errors in the dating process even for a good sample, and probably would escape detection (see, for example, ref. 4, Fig. 1).

It is clear, however, that if the magnetic field has been decaying for longer periods of time than the two thousand years covered by the Thellier data, much larger discrepancies in carbon-14 dating might arise. If the decay were exponential with the same constant $\lambda_2 = \frac{1}{7950}$ years^{-1} for four thousand years, samples of this age should exhibit a specific carbon-14 activity too low by an amount corresponding to an age 1,000 years too old. This seems to be outside the errors indicated by Libby.

One important consideration is that the Thellier data apply locally in France and may not be representative of the overall dipole field. The secular analysis of Vestine[5], for example, extending over forty years, shows that local rates of change are large enough to produce such variations if they persist sufficiently long. This would require harmonic components in the secular variation with periods longer than a hundred years. However, in past geological history there is good evidence for very large changes in the magnitude of the dipole field and its orientation, including complete reversals[5,6]. Certainly one might anticipate that major changes have occurred in the Earth's magnetism in the period covered by the carbon-14 dates. The considerations brought forward here will have greater significance if knowledge of the ancient magnetism of the Earth could be extended to earlier times.

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LETTERS TO THE EDITORS

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Attenuation of Host Reaction to Ovarian Homografts

GRAFTS derived from ovarian tissue which has been treated with glycerol and frozen to, and stored at, − 79° C. are endocrinologically active but contain comparatively few oocytes[1]. The oocytes which survive freezing and thawing can mature and undergo ovulation even in subcutaneous grafts[2]; but it is not yet known whether they are capable of normal fertilization and development. An approach to this problem involves orthotopic grafting at the ovarian site of the ovariectomized or sterilized recipient and, ideally, the use of a graft from a genetically distinguishable donor so that the source of any offspring produced is not in doubt. With the animals at present available at this Institute the latter requirement implies interstrain ovarian homografting and has led us to consider possible methods of attenuating or suspending the immunological reaction evoked by such grafts.

Several different procedures have been found to modify host reaction to homografts of various kinds[3]. The most attractive one from the present point of view is based on the observation that the growth of certain homologous grafts is enhanced by the previous intraperitoneal injection of the host with suspension of killed tissue of the same genetic composition as the prospective graft. This effect of such pretreatment, discovered and extensively studied in relation to tumour tissue[4], was not found by Kaliss and Spain[5] to occur with normal tissues; but Billingham, Brent and Medawar[6] have recently reported slight prolongation of survival of skin homografts following the pretreatment of the host with lyophilized tissue from the donor strain.

Two strains of rats, albino and hooded, are available at this Institute. With both of these, intrastrain ovarian homografts take and persist readily, while interstrain homografts are frequently accepted but persist less readily[7]. In particular, ovarian tissue from 'hooded' donors grafted into albino hosts usually ceases to function within a month, and this combination was therefore chosen for work on pretreating the recipients.

Ovaries of the hooded strain were homogenized in Ringer solution, frozen and thawed, once or repeatedly, and the suspension injected intraperitoneally. In an early experiment a suspension equivalent to a total of five pairs of ovaries was given to each albino recipient on days 14, 13, 12 and 4 before grafts were made from hooded donors. After 28 days, the grafts were still functioning in 7–10 of the pretreated recipients as compared with 7–27 of untreated but otherwise similar recipients for which records were available at the time. Afterwards, pretreatment was by a single intraperitoneal injection equivalent to four pairs of ovaries, groups of ten pretreated recipients and ten untreated recipients being used for each test. The first variable examined was the time of treatment before grafting, intervals of 1, 3 and 7 days being chosen in the light of the work of Kaliss and Day[8] on tumour grafts. Suggestive results were obtained with the recipients treated 7 days before the grafts were made, and three replications of this experiment were therefore carried out. In each, more grafts took and many more persisted in pretreated than in untreated recipients. The final result was that the grafts became active in 20–39 of the untreated recipients and remained active for 28 days or more in 7–39, the corresponding figures for the pretreated recipients being 31–40 and 24–40. The difference at 28 days is highly significant ($p = 0{\cdot}001$) and leaves little doubt that the pretreatment had had a significant effect upon the survival of the graft. The effect may be prolonged as continued observation in the first two experiments showed that active grafts were present in 0–20 untreated and 9–20 treated recipients at three months after grafting. Further experiments suggest that freezing of the suspension is not necessary, except perhaps to prevent the formation of ancillary grafts on the peritoneum. Suspensions subjected to ultrasonic vibrations are equally or even more effective. Work with other tissues and on component parts of the suspension is in progress, with the view of applying the technique to the extension and development of orthotopic ovarian grafting and the study of oocyte survival in frozen and stored tissue.

My thanks are due to Dr. J. H. Humphrey for much helpful information and advice, to Miss M. V. Mussett for the statistical analysis of the results, and to Miss M. P. Moylan for technical assistance.

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Corneal Homografts

IT has now been established that homografts of cornea and cartilage behave quite differently from skin homografts and can survive for long periods. The clinical success of the corneal graft has been known since 1878 [1], and there is ample evidence from histological and autoradiographic studies of experimental corneal homografts to confirm that they remain viable long after homografts of tissues such as skin are destroyed by the host tissues[2–4].

We have now examined more than a hundred corneal homografts implanted subcutaneously into guinea pigs and have found preservation of the corneal epithelium after two months, while at the end of three months the ground-substance survives unvascularized.

Experiments have recently been completed to test for any host sensitization. In fifteen guinea pigs a corneal homograft was inserted into the left lateral body wall, and four weeks later a second corneal homograft from the same donor was placed in a corresponding position on the right side of each animal and the grafts left in position for a further two weeks. Twenty-four hours before removal of the grafts the host animal was given 5 mc. of sulphur-

35 sulphate. First and second set homografts were then removed, sectioned, stained and prepared for autoradiography.

There was preservation of the corneal epithelium of both first and second sets of grafts, and no apparent difference in the uptake of sulphur-35 sulphate by the ground-substance compared to autoradiographs of 'control' cornea from host animal, indicating a normally functioning tissue. Thus there is no evidence of the sensitization of the host to corneal tissue which would be expected if the first grafts had produced a host-immune reaction.

It is our opinion that in both cartilage and cornea the mucopolysaccharides of the intercellular material are the specific substances responsible for the acceptance of these grafts by the host animal. A full account of these results will be reported elsewhere.

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Sialoadenectomy and the Metabolism of Calcium-45 in Bone and Soft Tissues of the Mouse

IT has been reported that there are substances extractable from salivary glands which, when administered to animals, lead to a reduction of the plasma calcium[1]. Further observations[2] indicated the extracted proteins to be capable of promoting the calcification of hard tissues. Sialoadenectomy has been reported to reduce markedly the total ash, calcium, magnesium and phosphorus of the bones of the rat[3]. Our observation[4] that sialoadenectomized rats and mice exhibited reduced rates of growth, plus the study of Mari[5], who observed an increased growth-rate in chick embryo femurs, suggested that we study the metabolism of calcium in intact and sialoadenectomized animals.

The animals used in these studies were adult males, 25 ± 3 gm. The sialoadenectomized animals were prepared and treated as described previously[6]. There were not less than 8 and not more than 12 mice in each experimental group. Calcium-45 chloride was administered intraperitoneally dissolved in isotonic saline. The radiation dose was maintained at 5 μc. per 25 gm. body-weight. The specific activity of the calcium-45 was 102 μc. per mgm. calcium. The calcium-45 content of the tissues was determined 2 hr. after administration of the isotope. Animals were killed by exsanguination, tissues removed, washed with cold saline, blotted dry and samples therefrom weighed and digested by wet oxidation[7]. The clear digests were diluted to convenient volumes and aliquots plated on to tared glass planchets and dried. Radioassay was performed with the aid of a gas-flow counter and counting was extended in time to give a 2 per cent statistical error. Conventional corrections for decay, dilution and self-absorption were applied as required.

The calcium-45 incorporation into bone and nearly all the soft tissues (thymus and lung excepted) was greater in the sialoadenectomized mice (Table 1). The bones (femurs) of the sialoadenectomized animals concentrated calcium-45 1·64 times more than did the intact controls, liver 1·44, kidney 1·20, brain 1·31, spleen 1·36, heart 1·30, lung 0·87, muscle 1·23, thymus 0·68, thyroid 1·39, adrenal 1·21, testes 1·56. The generally higher uptake of calcium by the sialoadenectomized mice suggested that the animals were depleted in calcium and that a calcium-balance study was desirable A three-day balance was performed on intact and sialoadenectomized mice using a finely powdered commercial grain ration, the calcium content of which we found by analysis to be 1·02 per cent. The results of the balance study (Table 2) show a reduced intake by the sialoadenectomized mice, a higher fæcal output and a lower urinary output, indicative of decreased absorption of dietary calcium. The reduced urinary excretion was investigated with calcium-45 and found to be 38 per cent of control values in a 24-hr. test. The balance study on dietary calcium indicated a 52 per cent difference, but this discrepancy is obviously due to the different routes of administration and consequently the degree of absorption.

Table 1. DISTRIBUTION OF CALCIUM-45 IN INTACT AND SIALOADENECTOMIZED MOUSE TISSUES 2 HR. AFTER INJECTION OF 5 μc. ^{45}CaCl$_2$
(Results expressed as counts/min. per mgm. of tissue)

	Group	
	Intact	Sialoadenectomized
Femur	675 ± 35*	1,106 ± 111
Thyroid	229 ± 55	317 ± 53
Adrenal	80·1 ± 15·5	96·9 ± 14·1
Thymus	97 3 ± 18 2	67·0 ± 7·5
Skeletal muscle	48 3 ± 4 4	59 2 ± 6·1
Lung	52·8 ± 8 3	46·0 ± 5·3
Heart	33·0 ± 1 6	43·3 ± 3·2
Spleen	28·2 ± 3·3	38·2 ± 8·1
Kidney	31·6 ± 2 6	37·7 ± 3·5
Testes	20·3 ± 1·5	31·7 ± 2·9
Brain	16·8 ± 1·3	22 0 ± 9 0
Liver	9·8 ± 1·1	14·1 ± 1·5

* Standard error of the mean.

In a single experiment, the 2-hr. uptake of strontium-89 was measured in intact and sialoadenectomized animals. The activity of the sialoadenectomized animal femurs was 175 per cent of control values. This we feel to be indicative of a mineral depletion resulting from the sialoadenectomy. It is interesting to note that the difference in calcium-45 uptake and strontium-89 uptake between intact and sialoadenectomized animals is of the same order of magnitude.

The interpretation of the observed differences in the calcium metabolism of sialoadenectomized animals is at present difficult to explain. The results presented here suggest interference with the absorption of calcium from the digestive tract. Also, previous studies indicated that sialoadenectomy inhibits thyroid activity in a manner involving the hypophysis[8]. Since the thyroid has been shown to be related to calcium absorption, and further, since the growth hormone of the hypophysis regulates the function of new bone tissue and also influences the digestive secretions[9], these current observations indicate that the physiological function of the salivary glands needs re-evaluation.

Table 2. CALCIUM BALANCE ON SIALOADENECTOMIZED AND INTACT MICE, *ad lib.* FEEDING
(Results expressed as mgm.kgm./24 hr.)

Group	(*A*) Calcium intake	(*B*) Fæcal calcium	(*C*) Urinary calcium	(*D*) Calcium balance (*A*–*B*–*C*)
Intact	261·3	147·9	7·8	+ 105·6
Sialoadenectomy	232·2	158·7	4·1	+ 69·4

We wish to acknowledge the technical assistance of Mrs. Nancy Fogel. This study was sponsored in part by grants-in-aid from the National Institutes of Health.

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Some Metabolic Effects of Poliomyelitis Virus on Tissue Culture

A DESIRABLE experimental condition for the study of metabolic effects of viruses on living organisms is that all or nearly all the cells be infected and that they be infected approximately simultaneously so that any metabolic changes can reasonably be expected to take place at about the same time throughout the cell population. This condition can readily be achieved with bacteriophages and their hosts, and a great deal of valuable work has been done with this system[1,2]. It has been virtually impossible to approximate to the necessary conditions with animal viruses and their intact hosts. The closest approximation has been achieved in the work with eggs; but complications introduced by host influences must be considered. As a result, our knowledge of metabolic changes induced in animal cells by animal viruses is limited. With the present emergence of tissue-culture techniques as an almost standardized procedure and the availability of animal virus suspensions of high titre, it has become feasible to undertake quantitative metabolic studies with animal viruses, and to relate any observed effects with virus growth. The present preliminary report is a summary of work on the effect of Type III poliomyelitis virus (Saukett strain) on some aspects of the metabolism of monkey kidney tissue culture; specifically, the effects of the virus on glycolysis and on the uptake by the tissue of glycine-2-carbon-14.

Two-ounce or thirty-two-ounce bottles of trypsinized monkey kidney tissue culture with lactalbumin hydrolysate or 199 medium were used in all the experiments[3]. Type III poliomyelitis virus (Saukett strain) was the infecting agent. It had a titre of about $10^{8.0}$ 50 per cent tissue culture infectious doses per 0·5 ml. The design of the experiments was as follows: the growth medium was poured off a number of two-ounce or thirty-two-ounce bottles of tissue culture, the cells washed with new medium, and new medium was added to the bottles. To half the bottles enough virus, in tissue culture medium, was added so that approximately seventy 50 per cent tissue culture infectious doses were present for each cell in the bottle. The other half of the bottles served as controls. Instead of the virus suspension, they received an equal volume of growth medium previously exposed to metabolizing cells. At intervals, beginning at the time of addition of the virus and continuing for 22 hr., groups of control bottles and groups of infected bottles were removed for analysis. Thirty minutes before a given batch of bottles were scheduled to be removed for analysis, glycine-2-carbon-14 was added. When the bottles were removed (after 30 min. of contact with the glycine-2-carbon-14) the fluids were poured off and analysed for lactic acid by the method of Barker and Summerson[4]. The cells were washed repeatedly with saline, scraped off the bottles, and the weight of the cells, as well as their radioactivity, determined. The quantity of lactic acid found at the start of each interval was subtracted from the amount of lactic acid found at the end of that interval, so that, in Fig. 1, the effect of virus on the rate of formation of lactic acid is presented, rather than the cumulative amount found.

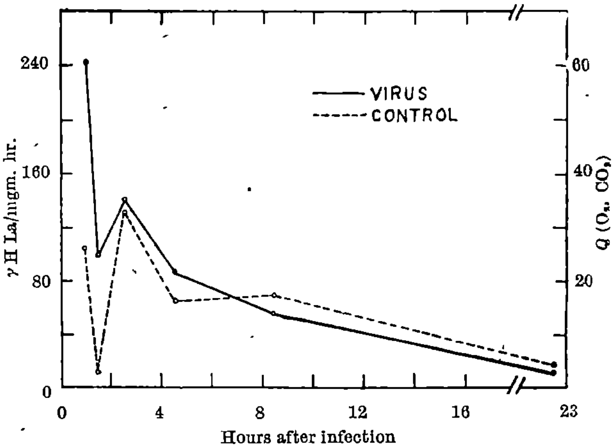

Fig. 1. Effect of poliomyelitis virus on aerobic glycolysis of monkey kidney tissue culture

It will be seen that within $\frac{1}{2}$ hr. (in some experiments 1 hr.) there was a marked increase in the rate of lactic acid production in the infected cells as compared to the control cells. This increased rate continued during 6–12 hr., by which time the glycolytic rate in the infected cells had generally fallen to a level below that of the controls. In other experiments the virus was partially purified by a few cycles of differential centrifugation in order to reduce the likelihood that some constituent of the infecting medium other than virus was responsible for the observed effect. That the stimulation of glycolysis was actually due to the virus is strongly suggested by the fact that such partially purified virus caused an effect similar to that shown in Fig. 1.

Two other cytopathogenic substances, thimerosal and diphtheria toxin, at concentrations of 10 μgm./ml. and 1·5 Lf. units/ml., respectively, were tested for effect on glycolytic rate of monkey kidney tissue culture. It was found that while the thimerosal had no effect, the diphtheria toxin caused a greater increase in the glycolytic rate than did the virus, followed by a fairly rapid decline.

It might be noted that the glycolytic rate of normal monkey kidney tissue culture is extremely high. Such rates have generally been reported only for highly malignant tumour cells[5].

The effect of infection on the rate of uptake of the radioactivity of glycine-2-carbon-14 is shown in Fig. 2. The datum at each point represents the counts per minute of carbon-14 taken up in the preceding 30 min. by each milligram dry weight of tissue.

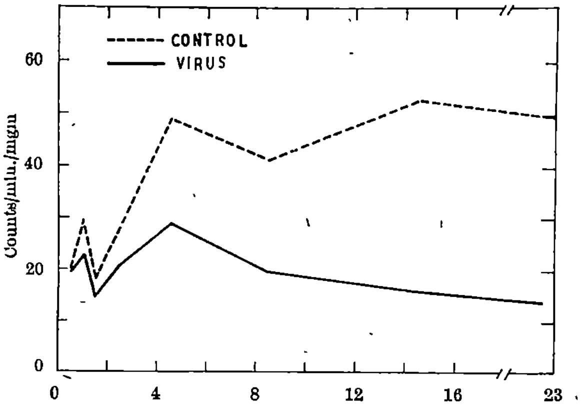

Fig. 2. Effect of poliomyelitis virus on uptake of glycine-2-carbon-14 by monkey kidney tissue culture

It will be seen that infection causes a significant and early depression of the rate of uptake of radioactivity. The partially purified virus described in the section on lactic acid produced the same effect. The other toxic agents tested (thimerosal and diphtheria toxin) both caused more rapid and marked depression of radioactivity uptake than did the virus, the uptake of the tissue after two hours of exposure to thimerosal being only 7 per cent of that of the controls.

In summary, exposure of monkey kidney tissue to high concentrations of Type III poliomyelitis virus leads, within an hour or less, to a stimulation of aerobic glycolysis and to a decrease in the rate of uptake of radioactivity from glycine-2-carbon-14. Two other cytopathogenic substances, thimerosal and diphtheria toxin, exert effects that have some qualitative similarities, as well as differences from those of the virus; but the markedly different quantitative aspects suggest the possibility of a difference in mechanism of action. A more detailed report will be published later.

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Action of the Hypophysis and of Dietary Protein on the Calcifying Tissues

IT is well known that protein deficiency causes considerable interference with endochondral calcification in growing rats, the growth of the epiphyseal plate and the formation of calcified trabeculæ ceasing, the face of the plate being finally sealed off with bone[1,2]. Similar changes are seen after hypophysectomy[3]. In the case of the continually erupting incisor tooth of the rat, protein or amino-acid deficiency causes very slight changes, chiefly an interference with the calcification of the dentin[4-6]. Hypophysectomy induces very marked changes in the incisor, the chief defect being caused by the processes of eruption and incremental growth being differently affected. As a result, there is a relative overgrowth of dentin, the pulp cavity becomes smaller and later the formative end of the tooth is thrown into folds. Other degenerative changes also occur[7,8].

In recent experiments[9,10], young growing rats were put on diets containing 9·3 per cent protein, for from 10 to 117 days. Very marked abnormalities were seen in the epiphyses of the long bones, similar to those described above; they were completely prevented by raising the protein content of the diet to 18·8 per cent. The incisor teeth of the rats on the low-protein diet showed no significant changes in shape or rate of dentin formation or size of the pulp cavity, nor were the effects described by Hunter[4] and Bavetta *et al.*[5,6] seen, probably because the dietary conditions were less stringent than in their experiments.

The literature is not clear about the part the hypophysis plays in the changes which occur in bone during protein deficiency. Follis[1] says the question has not "been satisfactorily answered". Frandsen *et al.*[2] do not think the results in their experiments are due to reduced action of the gland. In view of the striking effects that occur in the teeth after hypophysectomy and the complete absence of such changes in protein deficiency, I conclude that the fundamental actions of the hypophysis and of protein on the hard tissues must be completely unconnected.

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Synthesis of Phosphocreatine by Enzymes from Heart and Skeletal Muscle

THE transfer of phosphate from high-energy phosphate compounds of glycolytic origin (such as phosphoglycerylphosphate and enol-phosphopyruvate) to creatine has been considered possible only through the adenylic nucleotides[1]. Direct proof of this has been given so far only for enol-phosphopyruvate[2]. In the case of the acyl-phosphate, examination of thermodynamic data[3] shows that a direct transphosphorylation from phosphoglyceryl phosphate to creatine is possible and that an equilibrium constant of about 10 might be expected.

In order to test this possibility, a reconstituted system capable of phosphoglyceryl-phosphate genera-

Table 1. Final concentration of the components in a volume of 2 ml.: 0·025 *M* potassium phosphate buffer, *p*H 7·4; 0 0025 *M* magnesium chloride; 0·01 *M* potassium pyruvate; 0·0005 *M* diphosphopyridine nucleotide; 0·05 *M* creatine; aldolase 0·5 mgm. protein/ml.; triosephosphate dehydrogenase 0·5 mgm. protein/ml.; lactic dehydrogenase, 0·25 mgm. protein/ml.; 0·0025 *M* fructose diphosphate ('direct' activity) or 0·01 *M* adenosine triphosphate (adenosine triphosphate–creatine phosphokinase).
Heart or skeletal muscle enzymes were assayed at levels between 0·3 and 4 mgm. protein/ml. Results are expressed in μmoles of phosphocreatine synthesized per mgm. of protein in 20 min. at 37°

	Type of enzyme preparation	Skeletal muscle		Heart muscle	
		'Direct' activity	Adenosine triphosphate–creatine phosphokinase activity	'Direct' activity	Adenosine triphosphate–creatine phosphokinase activity
A	Crude dialysed extract 1	0·02	0·002	0·006	0 08
	Crude dialysed extract 2	0·09	0·07	0	0·02
	Precipitation with ammonium sulphate up to 90 per cent of saturation	1·6	3·8	0	4·2
	Precipitation with ammonium sulphate between 40 and 90 per cent saturation	0·84	1	0	1·4
B	Precipitation with ammonium sulphate between:				
	(*a*) 0 and 25 per cent of saturation	0·09	0 01		
	(*b*) 25 and 50 per cent of saturation	1·7	1·9		
	(*c*) 50 and 75 per cent of saturation	3·1	1·3		
	(*d*) 75 and 85 per cent of saturation	1	10 4		
	(*a*) 0 and 45 per cent of saturation	0·3	0		
	(*b*) 45 and 65 per cent of saturation	2 4	1·2		
	(*c*) 65 and 85 per cent of saturation	1	11 5		

tion was assayed for phosphocreatine synthesis in the presence of enzyme preparations obtained, on one hand, from skeletal muscle, where glycolysis is an important source of high-energy phosphate compounds, and on the other, from heart muscle, which is known to depend mainly on aerobic phosphorylation mediated by the adenylic nucleotides. Preparations of the transphosphorylating enzymes were obtained from extracts of rat heart or skeletal muscle by repeated fractionation with ammonium sulphate; nucleotides were removed by treatment with charcoal and 'Dowex 1'.

In experiments designed to detect in these preparations the existence of a system capable of directly transferring phosphate from phosphoglyceryl phosphate to creatine, the acyl phosphate was generated in the same tube from fructose diphosphate by means of aldolase, triose phosphate dehydrogenase and lactic dehydrogenase in the presence of diphosphopyridine nucleotide, orthophosphate, magnesium and pyruvate. These three enzymes were also treated with charcoal. Commercial fructose diphosphate was purified by barium precipitation and charcoal treatment. Diphosphopyridine nucleotide was purified by anion-exchange chromatography. Hexokinase from the Sigma Chemical Co. was further purified with alumina gel and charcoal. Spectrophotometric analysis of the mixture for adenine nucleotides gave negative results.

The appearance of phosphocreatine after incubation for 20 min. at 37° C. was measured. The initial values were always zero.

Table 1 shows that the synthesis of phosphocreatine with fructose diphosphate as substrate occurs in the presence of enzyme preparations from skeletal muscle without adding any adenylic nucleotides. (This reaction will be referred to as 'direct' reaction.) Preparations from heart muscle, on the contrary, are devoid of such activity, although they are quite able to synthesize phosphocreatine if offered adenosine triphosphate. The possible existence of two separate enzymes for these two activities in skeletal muscle is suggested by the different patterns of fractionation (Table 1*B*).

Absence of catalytic amounts of adenosine diphosphate from the system was shown by using glucose in presence of hexokinase as phosphate acceptor instead of creatine. No inorganic phosphate is esterified in the absence of added adenosine diphosphate; a concentration of 10^{-5} *M* nucleotide allows an esterification of 1·5 μmoles in 20 min.

Synthesis of phosphocreatine from fructose diphosphate is enhanced from 3·9 to 4·8 μmoles in 20 min. by the presence of 2 × 10^{-5} *M* adenosine diphosphate, whereas 10^{-6} *M* nucleotide is ineffective. Since the skeletal muscle preparations contain the enzymes responsible for the transformation of 3-phosphoglycerate to enol-phosphopyruvate, this stimulation may be due to transfer of phosphate from the latter compound through adenosine diphosphate to creatine. Proof of this is the fact that 3-phosphoglycerate may be utilized for the synthesis of phosphocreatine only if 10^{-4} *M* adenosine diphosphate is present. This absolute requirement for the nucleotide may also be taken as a proof of its absence from our system.

The absence of adenine nucleotides is also confirmed by the fact that hexokinase does not inhibit the 'direct' synthesis of phosphocreatine. If this process is stimulated by 10^{-4} *M* adenosine diphosphate, a strong inhibition can be achieved by hexokinase. This would again point to a pathway where there is no competition for adenylic nucleotides.

Table 2 may also be interpreted in a similar way. Adenosine triphosphatase does not interfere with the 'direct' pathway of phosphocreatine synthesis, whereas it completely masks the adenosine triphosphate–creatine phosphokinase, the activity of which appears only after removing the adenosine triphosphatase.

Table 2. Results, conditions and concentrations for phosphocreatine synthesis as in Table 1. Adenosine triphosphatase assayed under the same conditions, but omitting creatine and using 0 05 *M* adenosine triphosphate. Activity is expressed in μmoles of 7-min. phosphorus hydrolysed per mgm. of protein in 20 min. at 37°

Type of enzyme preparation	'Direct' activity	Adenosine triphosphate–creatine phosphokinase activity	Adenosine triphosphatase
Fraction from skeletal muscle precipitated with ammonium sulphate at 40 per cent saturation	0·91	0 02	4·5
Same fraction after treatment with 0·25 volume of calcium phosphate gel of 1·8 per cent dry weight (ref. 5)	1·8	0·04	4 3
Same fraction after treatment with 0·5 volume of calcium phosphate gel	6·4	2	0

Preparation of phosphoglyceryl phosphate[6] enabled us to obtain a more direct proof of phosphate transfer from the acyl phosphate to creatine. This reaction occurs in the presence of enzyme from skeletal muscle, requires magnesium and is not inhibited by hexokinase. Since the acyl phosphate had also been treated with charcoal, these results strongly suggest the existence of a mechanism not linked to the adenylic nucleotides.

This investigation was partially supported by a grant from the Rockefeller Foundation. We are indebted to Dr. George Hodgson for helpful discussion.

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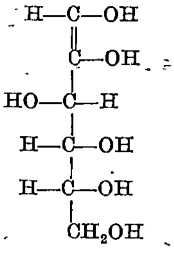
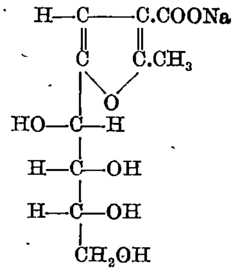
Occurrence of 1:2 Dienol Glucose in Normal Blood: its Reaction with Alloxan and Chromatographic Identification

IN 1922 when Winter and Smith[1] published results indicating for the first time that glucose in the blood of normal animals and men occurs in a form which is different from the ordinary α- and β-glucose. Lungsgaard and Holboll[2], from their polarimetric studies of blood, also concluded that a new form of glucose always occurs in the blood of normal human beings, but they could not say anything about its chemical nature or physiological significance.



(I)

1 : 2 Dienol glucose



(II)

Condensation product of glucose and acetoacetate

It has been reported by West and Rinehart[3] that one molecule of an endiol compound reacts with two molecules of ninhydrin to give rise to hydrindantin ($C_{18}H_{10}O_6$), and it has recently been shown by us[4] that 1 : 2 dienol glucose (I), which is formed on hydrolysing the condensation product of glucose and acetoacetate (2-tetrahydroxy butyl 5-methyl 4-carbethoxy furan) (II), reacts with alloxan, which shows a structural resemblance with ninhydrin, at pH 7·2, and gives rise to the non-diabetogenic alloxanic acid.

It was thought that normal blood might also contain some such active principle, which might be able to combine with a small amount of alloxan in order to transform it to a non-diabetogenic product before it could reach the pancreas to bring about damage to the β-cells, and that diabetes might occur only when this reactive substance was completely depleted. This prompted us to examine normal blood to see if it also contains glucose in the endiol form which can react with alloxan, and to find out whether diabetic animals show the absence of such glucose in their blood.

For this, 2 c.c. of blood each from normal rabbits, deproteinized with 10 per cent trichloroacetic acid and brought to pH 7·2, was allowed to react with alloxan (4 mol. proportion per 1 mol. sugar) at 30° C. and the reducing sugar was estimated periodically by Hagedorn and Jensen's method[5] (Table 1).

Blood samples from a number of rabbits (six) injected with a diabetogenic dose of alloxan (collected 15 min. after the injection) were treated as above with alloxan; none gave any indication of reaction, thus showing that glucose occurring in more reactive form might have already combined with alloxan in the animal system.

Although the other reducing substances such as ascorbic acid and reduced glutathione are known to combine with alloxan, none of these has been found to interfere with the estimation of sugar by Hagedorn and Jensen's method. Hence the diminution of the reducing sugar as shown in Table 1 is due to its combination with alloxan.

It should be pointed out here that although the blood samples collected from different normal persons and from normal rabbits showed the presence of reactive glucose, ordinary glucose D never showed any change in its value when treated with alloxan under identical conditions. Nath *et al.*[6] have also observed that the hydrolysed condensation product combines with ninhydrin to give rise to a coloured compound, hydrindantin, thus giving additional

Table 1. PERCENTAGE OF BLOOD SUGAR REACTED WITH ALLOXAN (*in vitro*)

(*A*) Normal rabbits

Animal No.	I	II	III	IV	V	VI	VII	VIII	IX	X	Average value and mean deviation
Per cent glucose reacted in ¼ hr.	6·2	5·0	9·0	3·7	9·6	2·1	4·8	3·0	8·3	4·3	5·6 ± 2·6
Per cent glucose reacted in ½ hr.	6·2	5·0	11·1	11·0	17·0	6·4	8·5	5·1	14·8	5·6	9·1 ± 4·4

(*B*) Normal human subjects

Case No.	I	II	III	IV	V	IV	VII	VIII	Average value and mean deviation
Per cent glucose reacted in ¼ hr	8·0	2·3	13·0	8·5	13·3	3·2	6·2	2·0	6·4 ± 4·3
Per cent glucose reacted in ½ hr.	10·2	4·0	26·7	8·5	13·3	5·0	8·0	6·2	10·2 ± 6·8

No further change in glucose was observed after ½ hr.

evidence for the formation of 1 : 2 dienol glucose from the condensation product. Further, glucose in aqueous solution, during incubation at *p*H 7·2 for 24 hr., has been known to be partially transformed to 1 : 2 dienol glucose[7], and this incubated glucose has also been found to react with alloxan.

The results in Table 1 also account for the conversion of alloxan to alloxanic acid in the blood, when injected into normal animals, as observed by Seligson and Seligson[8]. It was shown by Meyer[9] that all endiols take up bromine instantaneously with intermediate formation of dibromoenol, which forms labile bromoketones. These bromoketones can oxidize hydrogen iodide and liberate iodine. This test was found to be positive with all the three substances, namely, glucose incubated at *p*H 7·2, hydrolysed condensation product (after removal of the ethereal extract) and deproteinized blood (after removal of the ethereal extract), thus showing definitely that blood contains dienol compounds. Since one important dienol compound, ascorbic acid, is also known to be present in blood, attempts were made to see if any confirmatory evidence for the occurrence of any other dienol compound in the blood could be made available, and if so in what form.

The technique of circular paper chromatography as used by Giri and Rao[10] was followed. Chromatograms with glucose, ascorbic acid and hydrolysed condensation product as well as with blood deproteinized by trichloracetic acid were obtained in duplicate on Whatman filter paper No. 1 of 18·5 cm. diameter, fitted with a wick at the central hole in Petri dishes placed in a closed chamber with solvent mixture containing butanol/acetic acid/water (40 : 10 : 50), the top layer being used. A special reagent, specific for endiol compounds, was found for the development of the chromatograms. It has been shown by Feigl and Cardoso[11] that certain reducing agents, which are without effect in acid solutions towards molybdate ions or which are only slightly active, reduce the latter immediately when phosphate ions, which produce complex phosphomolybdate ions, are present. Although glucose cannot reduce this compound in the acid medium to molybdenum oxide or 'molybdenum blue', ascorbic acid, which is a dienol compound, can do so. Ammonium phosphomolybdate reagent has been found by us to be reduced by 1 : 2 dienol glucose and was therefore selected for developing the chromatogram. The procedure is as follows: the paper chromatogram is immersed in 20 per cent alcoholic phosphomolybdic acid, allowed to drain and dried in a current of cold air; it is then washed in a 20 per cent ammonium nitrate solution acidified with a few drops of nitric acid, washed with water and dried by hot air.

Triphenyl tetrazolium chloride, which is commonly used for developing chromatograms with reducing sugars and sugar derivatives, was also used to develop another set of chromatograms with all the reducing compounds used previously as well as deproteinized blood.

While comparing the bands on the chromatogram with ascorbic acid, hydrolysed condensation product and deproteinized blood developed by the special phosphomolybdate reagent, ascorbic acid shows a band with R_F 0·52 and the blood shows the presence of a new dienol compound having its R_F value as high as 0·92 and similar to that with 1 : 2 dienol glucose. Ordinary glucose does not show any band with this reagent. Human diabetic blood also does not show any development of colour with the phosphomolybdate reagent, thus showing the absence of any endiol glucose.

The chromatogram developed with triphenyl tetrazolium chloride has a band with R_F 0·92 corresponding to 1 : 2 dienol glucose, which is liberated from the condensation product of glucose and acetoacetate on acid hydrolysis. Ordinary glucose has a much lower R_F value, which is in the neighbourhood of 0·32, and that for ascorbic acid is 0·52. The multiple-spot chromatogram with deproteinized blood shows clearly that a large portion of the reducing sugar resolves itself in the same region as that shown by 1 : 2 dienol glucose. The circular bands for ordinary glucose and ascorbic acid were also developed.

It is thus evident that a portion of the glucose in the normal blood occurs in the reactive endiol form which can easily react with alloxan and has the R_F 0·92 (against 0·52 for ascorbic acid) on a circular paper chromatogram when developed with a special reagent for endiol compounds only.

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Release of Adrenaline and of Noradrenaline from the Adrenal Gland of the Cat and the Subsequent Resynthesis of these Amines

SEVERAL workers[1] have shown that there are various ways of causing a release of sympathomimetic amines from the adrenal medulla, for example, splanchnic nerve stimulation, insulin and nicotine. Few, however, have studied the subsequent resynthesis of these amines. It was thought possible that such an investigation might help to reveal the route by which adrenaline is synthesized biologically. Thus a study of the cat adrenal glands depleted by acetylcholine, the natural mediator of the splanchnic nerve[2], has been made.

The adrenal glands of atropinized, adult cats were depleted of their amine content by repeated, intravenous doses of acetylcholine. In all experiments one gland of each animal was used as a control and the depleted gland was compared with it. Also, control experiments were performed. The adrenaline and noradrenaline content of the glands was determined biologically, using the cat blood pressure and the cat nictitating membrane as separate test preparations. The results were calculated by a formula devised by Bulbring[3]. A qualitative chromatographic analysis also was made, in order to determine whether any other catechol amines were present.

Using acetylcholine, it was found that there was a similar percentage loss of adrenaline and of noradrenaline and that this was irrespective of the degree of depletion. The range of depletion was 7·1–86·5 per

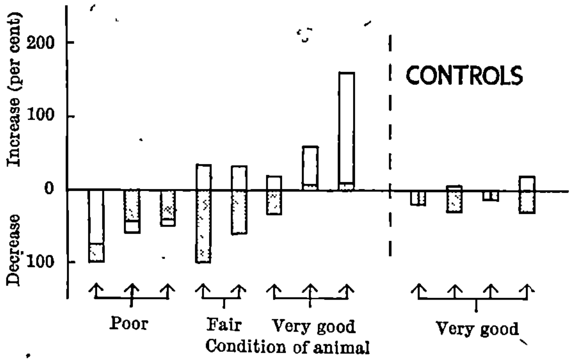

Fig. 1. Adrenaline and noradrenaline content of the second adrenal gland of the cat 2–3 days post-operatively. Adrenaline is shown by the stippled and noradrenaline by the white columns

cent. Correlating the amines lost from the depleted gland with the amines in the plasma obtained from the adrenal venous effluent, it was found that the percentages of noradrenaline in both the control gland and the depleted gland and in the plasma were the same. The total amount of amine in the plasma was equal to, or a little less than, the amines lost from the depleted gland. Hence there was no re-synthesis of the amines while the gland was being stimulated by the acetylcholine.

In an attempt to determine how long it would take for the depleted gland to replace the amine that it had lost, the animal was left on a warm operating table for as long as 17 hr. after the depletion of the glands. However, there was no increase in the amine content during that time, and if there was a gradual decline in the blood pressure, instead of the amine being replaced more was lost. This loss was prevented by the denervation of the gland; but, in spite of this, little or no resynthesis could be obtained. Thus in a further series of experiments, the animal was allowed to recover from the anæsthetic, following the depletion of both glands and the removal of one. After a period of several days the second gland was removed. It was found that 2–3 days post-operatively there was a small increase in the amine content, providing that the animal was in good condition (Fig. 1). After 6–7 days, unless the animal was in poor condition, when again there was a further loss of amine, there was a marked increase in the amine content. By this time, although the total amine had returned to its initial level, there was now an alteration in the proportion of adrenaline to noradrenaline present. Although the adrenaline content had increased by only a small amount, the noradrenaline content was many times its depleted level (Fig. 2). Thus it may be concluded that noradrenaline is synthesized at a much faster rate than adrenaline, under the conditions of these experiments, and it may be inferred that adrenaline is synthesized from noradrenaline.

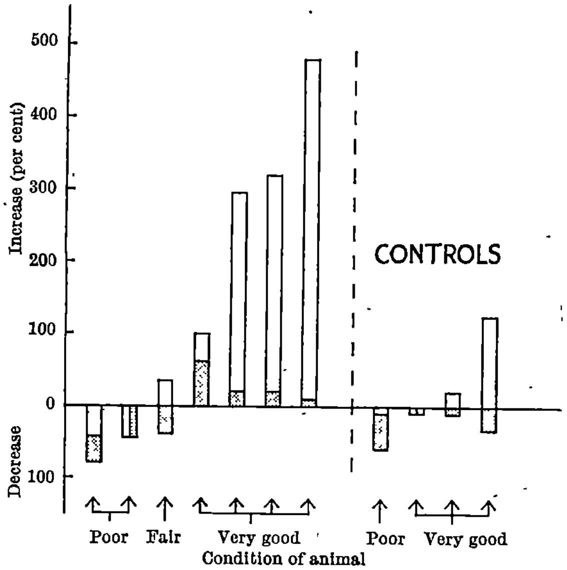

Fig. 2. Adrenaline and noradrenaline content of the second adrenal gland of the cat 6–7 days post-operatively. Adrenaline is shown by the stippled and noradrenaline by the white columns

Experiments are now in progress on the proportions of the two amines present in the gland after a re-synthesis period of one month. This work will be reported in detail elsewhere.

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Hereditary Defects of Temperate Bacteriophage

SEVERAL mutations of temperate bacteriophages are known which can be carried by the prophage of the lysogenic cell but bring about almost complete failure to release infectious particles when the cells are exposed to radiation[1-4]. One such group is known to be transmissible through all parts of the life-cycle including extracellular phage[2]; among these are the defects *i*1 and *i*2 of the bacteriophage *lambda* carried by *Escherichia coli K*-12.

The phenotype of a double lysogen (a bacterium carrying two prophages) containing both a defective ($i = i1$ or $i2$) and a healthy (i^+) prophage is like that of a normal lysogen: the cell liberates healthy phage on induction. This suggests an analogy between the phage defects and the recessive lethals of higher organisms. If the analogy is valid, it would be expected that different loci would be involved in independently derived defective lysogens. We report here a single experiment upon recombination between *i*1 and *i*2 which demonstrates both the expected difference in the gene loci and a difference in the physiological consequences of the respective mutations to defective lysogeny.

To prove that the defects are not allelic, it is necessary to show that healthy phage can be derived by genetic recombination between *i*1 and *i*2. For this purpose, cultures of *lambda-i*1 or *lambda-i*2 lysogens were induced by small exposure to ultra-violet light. The cells almost all lysed 1½ hr. later, releasing a very small number, about 10^{-5} per cell, of i^+ phage and a rather larger number of i phage. Any remaining bacteria were killed by shaking the lysate with chloroform. The lysates were partially

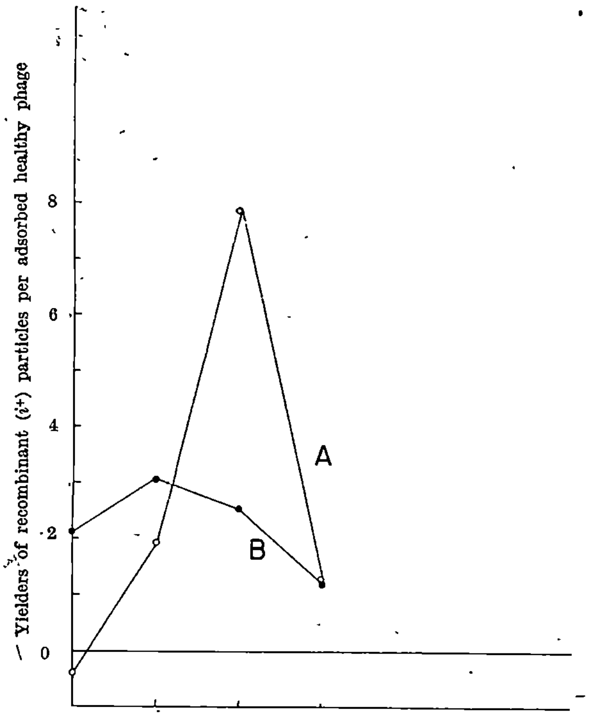

Fig. 1. Variation with time post-induction of the number of yielders of recombinant (i^+) particles per adsorbed healthy phage in infections of strain *C* 112 ($\lambda\, i2$) with $\lambda\, i1$ (curve *A*) and strain *C* 112 ($\lambda\, i1$) with $\lambda\, i2$ (curve *B*). The number of healthy phage yielders per adsorbed phage in homologous infections (*i*1 on *lambda-i*1 lysogens and *i*2 on *lambda-i*2 lysogens) was always less than 1 0 and this value is represented by the base line marked as 0

purified by differential centrifugation. A sample of phage from each lysate was now permitted to infect both a *lambda-i*1 and a *lambda-i*2 lysogen at various times, *t*, after these had been similarly induced. After allowing twenty minutes for phage adsorption, the induced infected cultures were assayed before lysis for yielders of infectious i^+ particles. After eliminating unadsorbed phage there are three sources of these particles in the induced infected cultures : (1) induced cells in which a reversion $i \rightarrow i^+$ has occurred ; (2) cells which have been infected by an i^+ phage present in the infecting lysate as a result of a reversion $i \rightarrow i^+$ in the culture from which it was made ; (3) in appropriate infections, cells in which a recombination between *i*1 and *i*2 has given rise to i^+ phage.

(1) and (2) were counted by separate assays of the uninfected induced culture and the infecting lysate. When *i*1 lysates infected induced *lambda-i*1 lysogens, or *i*2 lysates infected induced *lambda-i*2 lysogens, the total number of yielders of i^+ phage never significantly exceeded (1) + (2) at any time, *t*. Similarly, timed heterologous infections (*i*1 on *lambda-i*2 lysogens and *i*2 on *lambda-i*1 lysogens) were also carried out and the fraction by which i^+ yielders exceeded (1) + (2) was plotted as a function of *t* (Fig. 1).

From Fig. 1 we conclude that : (1) Genetic recombination between *i*1 and *i*2 occurs. Therefore, two different loci, *i*1 and *i*2, are involved. (2) The situations (*A*) in which an *i*1 lysate infects an *i*2 lysogen, and (*B*) in which an *i*2 lysate infects an *i*1 lysogen, give rise to entirely different curves of recombination as a function of time. Therefore, *i*1 and *i*2 are physiologically dissimilar. (3) In (*B*) the yield of recombinants drops steadily when *t* exceeds 10 min., after a small initial rise ; in (*A*) there is a very considerable and unexpected rise in recombination between $t = 0$ and $t = 20$ min. We conclude that if an *i*1 phage infects an induced cell too early, it is unable to wait within the cell for a later increased chance of fruitful recombination, that is, that the intracellular vegetative (recombining) form of *i*1 phage is unstable. For this concept we have independent evidence which will be published in detail elsewhere.

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Sodium and Potassium Changes occurring in the Hæmolymph of Insects at the Time of Moulting and their Physiological Consequences

AN insect is in an extremely vulnerable condition during a moult, so that its behaviour must be completely adapted for the time being to the special problems associated with the moulting process. Ordinary reflexes and locomotor activity must be suppressed. It may even be harmful for some of the muscles to contract at this time while the cuticle is soft, for if they do so they will effect permanent distortions in the drying exoskeleton. The means by which the muscular activity is modified or suppressed are not known.

When a nymphal locust approaches the moult it ceases feeding and becomes progressively less and less active. For a few hours before the moult and for a few hours again afterwards, it is almost motionless, except when it is seeking a suitable position in which to moult. Reflex movements of the limbs can still be evoked at this time but the mechanical responses are extremely feeble. The weak muscular contractions may be partly due to the softening of the exoskeleton, and to internal changes in the muscle fibres, but electrical records obtained from the leg muscles of nymphal locusts with intracellular electrodes suggest that a partial neuromuscular block is present. The block is analogous to that produced by raising the potassium concentration in the tissue fluid[1]. The resting potential of the muscle fibres is low and the fast-fibre responses consist largely of junction potentials. About 24 hr. after the moult has been completed the muscle contractions are much greater, though they do not achieve their full power until about the third or fourth day after the moult. At this stage neuromuscular transmission is normal.

An analysis of the hæmolymph of moulting fifth instar nymphs of *Locusta* and *Schistocerca* showed that in each case the potassium concentration is considerably greater than normal. It was decided to study the time-course of the potassium changes leading to the increased level and also any changes in sodium concentration occurring at the same time.

The time of moulting was anticipated by weighing marked hoppers daily and following the progress of

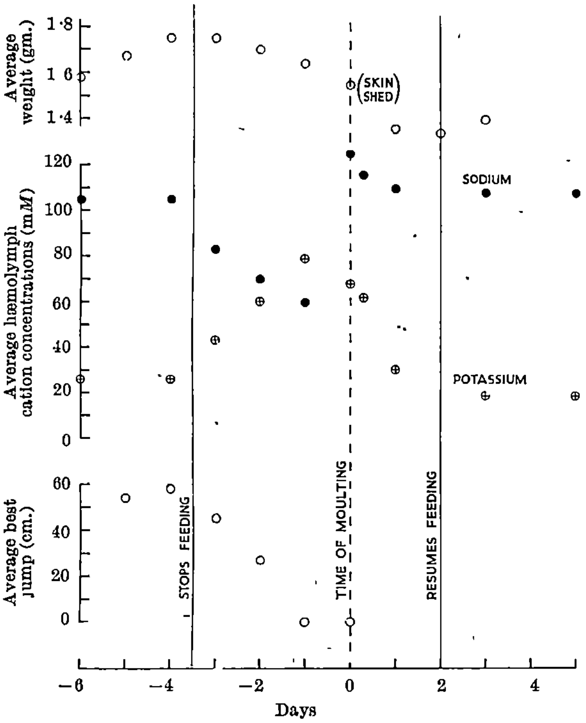

Fig. 1. Physiological changes occurring in fifth-instar nymphs of *Locusta* at the time of moulting. Top, changes in weight; centre, changes in hæmolymph sodium and potassium concentrations; bottom, changes in muscular power indicated by length of jump

each individual graphically. The weight of a hopper rises steadily, increasing by about 0·1 gm./day until eventually the animal ceases feeding. Thereafter the hoppers lose weight at the rate of about 0·6 gm./day, until after about three and a half days following the cessation of feeding the moult occurs. By following the changes in weight it is possible to ascertain approximately the time at which a hopper will moult.

It was found to be possible to follow the progress of a batch containing as many as 40 hoppers. A few individuals were removed from the batch at times estimated to be 4, 3, 2, and 1 days before their moult, during the moult and 6 hr., 1, 3 and 5 days following the moult. 2 c.mm. of hæmolymph was withdrawn from each hopper after making a small puncture behind the pronotum. The sodium and potassium contents were determined with the aid of a flame photometer. Blood was withdrawn from each hopper once only before the moult. Before being returned to the cage each animal was made to jump and the longest jumps were measured.

In Fig. 1 the results of the analyses of the hæmolymph of a group of gregarious-type fifth-instar hoppers of *Locusta migratoria migratorioides* R. and F. are plotted against time in relation to moulting. The average weights, average best jumps, times of cessation and resumption of feeding and the time of moulting are all indicated on the same time-scale. The time of moulting, which was known accurately in many cases or to within not more than 12 hr., was taken as a fixed point. Other points are subject to an error of the order of ±8 hr. in relation to the indicated time of onset of moulting.

The results show that starting at about the time when feeding stops, the potassium concentration in the hæmolymph rises steadily to a peak value of about 80 m.mol./l. while at the same time the sodium concentration falls to about 60 m.mol./l. During this time the sum of sodium plus potassium concentrations remains constant at about 140 m.mol./l. At the moment of moulting both the sodium and the potassium values are extremely variable, but it is evident that there is a fairly abrupt increase in the sodium level, values greater than 200 m.mol./l. having been obtained. There is a corresponding, although smaller, fall in potassium level at about the same time. Thereafter sodium and potassium soon attain the normal adult concentration.

The rise in potassium concentration is adequate to account for the depolarization and partial neuromuscular block which occurs and is probably responsible for much of the inactivity and weakness of the pre-moult hoppers. Potassium ions may therefore play an important part in the achievement of the behaviour changes associated with moulting. Preliminary investigations, now in progress, show that a rise in hæmolymph potassium concentration occurs before moulting in other insect orders.

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Change in the Metabolism of Micro-organisms grown on Irradiated Culture Medium

O. Wyss *et al.*[1] report that the growth of drug-resistant pathogen micro-organisms grown on culture media irradiated with ultra-violet rays increased strikingly without the micro-organisms themselves being exposed to the action of irradiation. The experiments demonstrated that mainly in cultures containing protein, under the action of ultra-violet rays the oxidation-reduction potential showed an average decrease of 300 mV., whereas under that of X-rays the decrease was 100–110 mV.; at the same time the value of the redox capacity increased too. In order also to find an energetic explanation for the change of the metabolism of the micro-organisms cultured on irradiated medium the following tests were carried out on aerobic cultures of *Serracia marcesens* strains. The strains examined were inoculated into the medium irradiated with ultra-violet rays of a quartz mercury lamp for 3 hr., and simultaneously the increase of the cell count, the oxidation-reduction potential and prodigiosin production were measured.

It was established that the growth of the cultures only started when the strain had completely exhausted the redox capacity, which had increased on the action of the irradiation of the medium with ultra-violet rays. Afterwards the growth of the cells and the oxidation-reduction potential of the cultures corresponded approximately to that of the controls; the prodigiosin production, however, decreased significantly.

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Electrophoretic Evaluation of the Serum Proteins in Malignant Disease

It is well known that many diseases produce a marked alteration in the level of the total serum protein. Furthermore, it has been shown by electrophoretic analysis that certain diseases bring about distinctive changes in the relative concentrations of the different serum proteins. In early active tuberculosis[1] there is a rise in the γ-globulin fraction of the serum protein and a corresponding fall in the albumin-level. As the disease progresses the α^2-globulin concentration also increases and in advanced tuberculosis all the globulin concentrations are raised. In contrast, patients with nephrosis[2] show an increase in the α^2-globulin concentration which is usually associated with a decrease in the γ-globulin fraction.

In malignant disease there is an excessive protein demand by the rapidly growing tumour cells, which can only be met by utilizing the host's dispensable protein and the labile serum proteins. This drain on the body's store of protein is bound to be reflected as a change in the concentration of the different serum proteins. Mider *et al.*[3], using the Tiselius electrophoresis apparatus with a veronal buffer *p*H 8·5, found that the total plasma protein-level in malignant disease was below normal, the albumin-level was reduced but there was a significant rise in the level of the α-globulins ; the β- and γ-globulin fractions also rose but the change in concentration was much less. Peterman and Hogness[4], using a similar method, found that in patients with carcinoma of the stomach the albumin-level was low, the α-globulins were raised, but the β- and γ-globulin-levels were normal. Gross and Snell[5] reported that there was no significant difference between the serum γ-globulin-levels of patients with malignant disease and those of healthy controls.

The present report concerns the results obtained from an electrophoretic evaluation of the serum protein-levels of twenty-four patients from the Dartford Group of Hospitals, Kent, suffering from malignant disease, which had been verified by histological examination. The patients were chosen at random, and their ages varied from thirty-one to seventy years. The majority of the tumours were situated in the genital or intestinal tracts and were at different stages of development, some being localized while others had metastasized widely. Blood samples were taken from each patient on admission and only the blood from those patients having normal temperatures, total and differential leucocyte counts, erythrocyte counts and hæmoglobin-levels were used. Blood samples were also taken from twenty-one healthy females of the same age-group to serve as controls.

The protein-level of each of the sera was estimated by first separating the different fractions by paper electrophoresis at *p*H 8·5 using a veronal buffer. The filter paper strips were then treated with bromphenol blue and the optical density of the protein dye complex was measured by means of a photoelectric cell. In this manner the percentages of the different proteins in relation to the total protein in the serum could be assessed.

The results showed that the sera of the patients with malignant disease had no distinctive electrophoretic pattern. The difference between the α^1-, α^2- and β-globulin-levels of the patients with malignant disease and those of the healthy controls was not statistically significant. The level of the serum albumin, however, was lower in the patients with malignant disease than in the controls. Although these findings are not in complete agreement with those of other workers it must be appreciated that only those patients having normal temperatures and blood pictures were used for the present investigation and the stage of development of the malignant tumour in each case was not taken into account.

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Intracellular Site of Developing Herpes Virus

A study of the early hours of multiplication of herpes virus in chick embryo cells[1] showed that some 90 per cent of the virus present in the cells at the beginning of incubation could not be detected 3 and 6 hr. later. The method of cell homogenization employed in this work to extract virus for titration left the cell nuclei intact, and the findings of Gray and Scott[2] suggested that the virus lost in the early hours of incubation might have made its way into the nuclei, and so escaped detection. This possibility was investigated.

Chorio-allantoic membranes of 10-day fertile hens' eggs were infected with herpes virus. After 2, 4, 6, 8 and 10 hr. incubation, membranes were excised, washed and put in diluted anti-herpes serum overnight at 4° C. The membranes were then washed, homogenized and diluted. Fixed and stained smears of diluted homogenate showed intact cell nuclei stripped of cytoplasm. The nuclei were deposited by centrifugation and the virus titre of the supernatant 'cytoplasmic fraction' measured. The nuclei were repeatedly washed, then half were suspended in dilute rabbit serum with 0·85 per cent sodium chloride and half in dilute rabbit serum with 6 per cent sodium chloride. These two suspensions were left overnight at 4° C. and then centrifuged, the supernatant containing 6 per cent sodium chloride being regarded as the 'nuclear fraction' and the other as a control. The virus titres of both were measured. Stained smears of the deposits showed that the 6 per cent sodium chloride solution had removed all basophilic material from the nuclei, leaving none intact except for a very few from erythrocytes ; in the control, intact nuclei were numerous. The results of the virus assays, made by the pock-count method on chorio-allantoic membranes, are shown in Table 1.

It will be seen that at each interval the nuclear fraction contained more virus than the control, but less than one-tenth of that found in the cytoplasm. In three repetitions of this experiment the distribution of virus between the fractions has been the same as in this instance. If all the virus lost from infected cells soon after the onset of incubation[1] had entered nuclei these should contain up to nine times as much as the cytoplasm.

Table 1. DISTRIBUTION OF VIRUS IN CHORIO-ALLANTOIC MEMBRANE CELL FRACTIONS IN THE HOURS IMMEDIATELY AFTER INFECTION

Fraction of chorio-allantoic membrane assayed	Number of lesions caused by 0 05 ml. of assayed material from membranes incubated for 2 hr.	4 hr.	6 hr.	8 hr	10 hr.
Cytoplasmic fraction	60	120	50	80	1,000
Fifth wash of deposited nuclei	0	0	1	1	16
Control extract of nuclei	0*	0*	0*	1*	4*
6 per cent sodium chloride extract of nuclei (nuclear fraction)	3*	3*	1*	4*	90

* Average of eight eggs inoculated with undiluted material.

We may conclude, therefore, that the part of the initial uptake of herpes virus which is no longer demonstrable in the infected cells after 3 or 6 hr. of incubation has not entered the cell nuclei. Other hypotheses accounting for its disappearance are discussed elsewhere[1].

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Detection by Phenylalanine Tolerance Tests of Heterozygous Carriers of Phenylketonuria

PAULING introduced the term 'molecular disease' for the hereditary condition of sickle cell anæmia, in which the clinical signs in both the heterozygous carriers with the sickling trait, and the homozygous patients with the anæmia, are explained by the fraction of abnormal hæmoglobin molecules present[1]. Only a part of the total hæmoglobin is the abnormal type in the heterozygote with one abnormal gene, whereas nearly all the hæmoglobin is the abnormal type in the homozygote with two abnormal genes. An extension of this concept of molecular disease leads to the prediction that in hereditary diseases associated with the loss of activity of an enzyme, the asymptomatic heterozygotes should be identifiable by having less than the normal amount of the enzyme primarily involved in the disease[2].

The molecule the dysfunction of which is responsible for the hereditary disease of phenylketonuria is the liver enzyme concerned with the oxidation of phenylalanine[3]. Inactivity of this enzyme results in the high blood-levels of phenylalanine, the excretion of phenylpyruvic acid, and mental deficiency. Genetic studies have established this condition to be completely recessive, and no related mental or biochemical abnormalities have been found in the heterozygous parents or siblings of the patients[4]. The above considerations suggest, however, that the fraction of enzyme arising from the abnormal gene in the heterozygotes should be defective. This prediction is supported by the present findings from phenylalanine tolerance tests that known heterozygotes of phenylketonuria have lower capacities for metabolizing phenylalanine than do normal people.

Plasma-levels of L-phenylalanine were determined one, two and four hours after oral doses of 0·1 gm. of L-phenylalanine per kgm. body-weight, given after an overnight fast, in nineteen heterozygous individuals (parents of proved phenylketonuric patients) and an equal number of normal adult controls. L-Phenylalanine was measured by a modification of the bacterial decarboxylase method of Udenfriend and Cooper[5]. The fasting plasma phenylalanine-levels taken before the test in all individuals were within the range of 0·03 – 0·16 μmol./ml. The phenylalanine-levels in the heterozygotes during the test were on the average about twice those of the controls at each of the hourly intervals. The distinction between the groups was particularly clear at the fourth hour and by comparison of the sum of the three hourly levels used as an index approximating the area under the tolerance curve. The test was repeated on several individuals from each group with highly reproducible results. The means and standard deviations and the range of the values found are given in Table 1.

Table 1. PLASMA L-PHENYLALANINE LEVELS AFTER INGESTION OF L-PHENYLALANINE

Values given are the means ± the standard deviation, and the ranges, in μmol. per ml. of plasma, found in 19 adult controls and 19 parents (heterozygotes) of known phenylketonuric patients

	Hours after dose 1	2	4	Sum of hourly levels
Controls	0·55±0·186 (0 30–0·90)	0·55±0·168 (0 29–1·02)	0 30±0·076 (0 21–0·50)	1·41±0 366 (0 87–2 19)
Heterozygotes	1·14±0·187 (0 84–1 44)	1 03±0 187 (0 72–1·44)	0 76±0·292 (0·45–1·62)	2 93±0·458 (2·10–4 02)

Comparison of the two groups on the basis of age, sex, weight, intelligence, or dose per square metre of body surface failed to reveal discrepancies which could account for the observed differences between the phenylalanine plasma-levels of the groups. The possibility was exceedingly small that such a difference could have occurred by chance ($P < 0{\cdot}0001$). The excretion of phenylalanine during the nine hours following the oral dose was determined in about half the individuals. The amounts excreted were not different in the two groups and were insignificant in relation to the amounts disappearing from the blood during the test period. Phenylpyruvic acid in the urine during the same period was never found in the controls, and only in one heterozygote, who also showed the highest observed plasma-levels of phenylalanine. The most probable interpretation of these results is that the heterozygotes as a group have significantly less than the normal phenylalanine-oxidizing enzyme activity.

The test was also of value in distinguishing the phenotype of single individuals. The results in only a small fraction (about 15 per cent) of the individuals tested fell in the zone of overlap between the two groups. With more or less certainty, the remainder of the individuals could be clearly distinguished as belonging to one or the other group on the basis of the phenylalanine-tolerance test alone. The probability that an individual in one group might have levels at the mean for the other group was less than 1 in 20,000. This ability of the test to identify heterozygous individuals was examined in six normal siblings of proved phenylketonuric patients. Three gave results in the heterozygote range (four were expected on a statistical basis) and three were clearly normal. In addition, a typical heterozygote type of curve was obtained and confirmed in one individual whose direct and collateral relatives over four generations did not include any cases of phenylketonuria or mental deficiency. Normal liver function was assumed for this individual on the basis of a negative history and physical examination and a bromsulphthalein test. Although phenylketonuria occurs rarely (1 in 25,000–40,000 people)[4], the heterozygous carriers are very much more common (half the square root of the frequency, or at least 1 in 100 people). In the absence of liver disease, heterozygosity for phenylketonuria is therefore the probable explanation for the high levels found in unsuspected individuals.

While the results in a single individual must be interpreted with caution, the abnormal values found in a group of known heterozygotes establish the decreased ability to metabolize phenylalanine as the phenotypic expression of a single phenylketonuria gene. This finding provides confirmation for the view that lack of the active phenylalanine-oxidizing enzyme is the primary lesion in phenylketonuria. Finally, the presence of part of the enzyme in an inactive form in the heterozygote with one abnormal gene, and nearly all the enzyme inactive in the homozygote with two abnormal genes, extends the concept of hereditary molecular diseases, based until now on the abnormal hæmoglobins, to those diseases called by Garrod[6] "inborn errors of metabolism".

This investigation was aided by a grant from the Playtex Park Research Institute; Grant *A* 567 from the National Institute for Arthritis and Metabolic Diseases, United States Public Health Service; and United States Atomic Energy Commission contract *AT*-(30-1)-901 with the New England Deaconess Hospital.

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Seeds of Pure Beta-ray Emitter (Yttrium-90) for Radiation Hypophysectomy

Pituitary ablation has recently been advocated for certain forms of advanced malignant disease with metastases, notably carcinoma of the breast. Such an ablation could be produced by irradiation, and gamma-ray emitters have been used interstitially by some workers[1,2]. For example, 10–20 mc. of radon in gold seeds has been implanted in the gland via the nostril and sphenoidal sinus[1], and seven out of twenty-five patients were reported to have benefited. In some cases, however, it was reported that defective vision ensued, possibly as a result of over-irradiation of the optic nerves or chiasma[1]. Small grains of unscreened radioactive gold metal have also been used[2] and in a series of fifty patients treated over eighteen months no damage to the optic nerves or chiasma was reported. However, with gamma-emitting materials, the danger is always present; it will be considerably less if a pure beta-ray emitter can be used. Colloidal beta-emitting solutions have been injected into the gland[3,4], while other workers[5] have used pellets of yttrium-90. This note is a preliminary account of the radiation properties of similar seeds now in use in this Hospital. They are cylinders of 3 mm. length and 1 mm. diameter and are inserted with a cannula via the nostril using an X-ray image intensifier as a visual aid.

Yttrium-90 is a pure beta-ray emitter with a maximum energy of 2·2 MeV. corresponding to a maximum range of 1 gm./cm.^{2} and having a radioactive half-life of 61 hr. It can be prepared as sintered rods of oxide which are cut to size. The seeds are irradiated in the atomic pile at the Atomic Energy Research Establishment, Harwell, at a high pile factor for a period of several days, the specific activity produced for a six-day irradiation at a pile factor of 12 being about 220 mc./gm. The average mass of the seeds is about 0·0074 gm., so that seeds of total activity of between 1 and 2 mc. are used; the effective activity available for external irradiation will, of course, be much smaller due to self-absorption in the seed.

Each batch of seeds is tested for uniformity by measuring the ionization current produced when the seed is held in the centre of a large ionization chamber. The radiation dose-rate and depth dose from a seed have been determined photographically. Determinations of beta-ray depth dose with film have been reviewed favourably[6]; it has been shown that they reproduced those made with an extrapolation chamber[7] and that they are independent of energy above about 1·5 MeV. maximum beta-ray energy[7,8]. The seed was held on the top of a stack of about 25 pieces of Kodak *K.S.*5 single-coated film which were compressed together in a jig of 'Perspex' and tissue-equivalent wax ('Mix D')[9] so as to give full back-scatter. From the densities observed on each film a depth–dose curve can be drawn; in order to obtain a measurable density on each film in a stack it was necessary to use several different exposure times varying from 20 to 120 sec. Each set of films was calibrated with exposures to a strontium-90 surface applicator of known beta-ray intensity; these also serve to standardize the photographic processing conditions.

The yttrium seeds have been found to give a dose-rate of 3,500 ± 200 rads/hr./mc. at a distance, in water, of 1 mm. from the centre of the cylindrical surface of the seed. Fig. 1 (curve *a*), which is the mean of eight separate determinations, shows the percentage depth dose in the film stack referred to the dose-rate at 1 mm. while (*b*) shows the corresponding derived curve in water which is regarded as equivalent to tissue. Curve (*b*) has been evaluated by measuring the intensity fall-off from the seed in air: from this, together with curve (*a*), the beta-ray absorption in film was calculated; the absorption was then corrected for the difference in density between film and water. The total dose delivered throughout the decay of the seed is 320,000 rads/mc. at a distance of 1 mm in water.

Attempts have been made to deliver a minimum dose of 100,000 rads to the gland by distributing

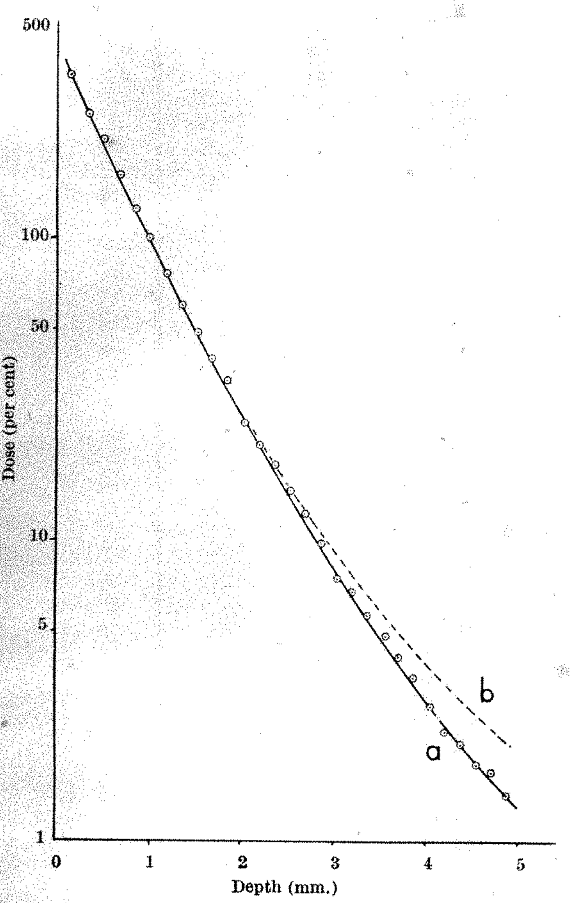

Fig. 1. Curves of dose against depth (100 per cent at 1 mm. depth): (*a*) in film; (*b*) in water

throughout its volume six seeds of average total activity about 9 mc. We are, for the moment, assuming a spherical distribution of dose around the seed.

So far, five patients have been treated, and in due course a more complete account of this technique will be published. We are indebted to Dr. Morrison of the Radiotherapeutic Research Unit and Dr. Russell Fraser of the Department of Medicine, who have carried out the treatments. We are also grateful to the Morgan Crucible Co., Ltd., London, S.W.11, for developing the sintering process.

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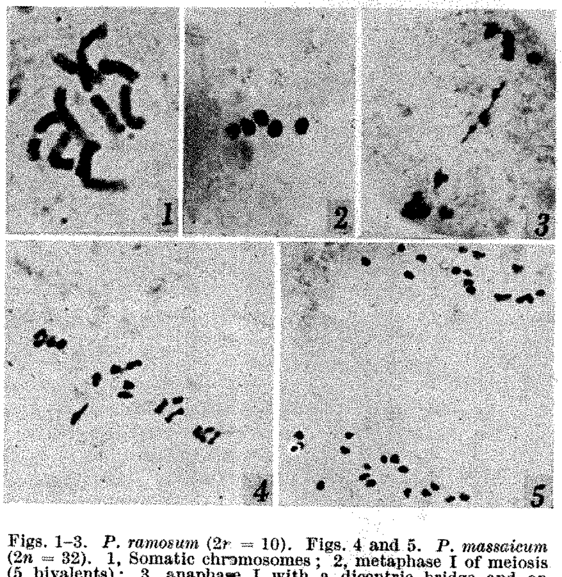
Two New Basic Chromosome Numbers in the Genus *Pennisetum*

Two basic chromosome numbers, 7 and 9, have so far been reported for members of the genus *Pennisetum*, which belongs to the tribe Paniceae of Gramineae[1]. We recently recorded the somatic chromosome numbers 10 and 32 in the species *Pennisetum ramosum* C. Sm. and *P. massaicum* Stapf., which suggests two additional basic numbers, 5 and 8, for this genus. Both *P. ramosum* and *P. massaicum* are natives of tropical Africa and are perennials with profusely branched culms. Both possess all the key characters of the genus *Pennisetum*. Thus, the spikelets are solitary and are surrounded by an involucre of bristles that are free except at the very base. The first glume is shorter than the spikelets; the second glume is almost equal to the sterile lemma in size and the fertile lemma is smooth with a thin margin enclosing the palea.

In the somatic complement of *P. ramosum* one pair of satellited chromosomes was seen and the centromeres in all the chromosomes were either median or sub-median (Fig. 1). At diakinesis and metaphase I of meiosis in microsporocytes, there were five bivalents (Fig. 2). One plant was heterozygous for an inversion leading to the formation of a dicentric bridge and an acentric fragment at anaphase I (Fig. 3). Pollen and seed fertility were high (more than 95 per cent) in all the other plants. Hrishi[2] has considered this species to be synonymous to *P. polystachyon* Shult. ($2n = 54$). From the present data, this view would seem to be untenable.

Besides normal bivalents, quadrivalents, trivalents and univalents occurred at diakinesis and metaphase I of meiosis in *P. massaicum*. The mean frequency per cell of such configurations at metaphase I was $0{\cdot}85_{\mathrm{IV}} + 0{\cdot}125_{\mathrm{III}} + 13{\cdot}625_{\mathrm{II}} + 0{\cdot}975_{\mathrm{I}}$ (average of forty cells). The maximum number of quadrivalents per cell was five. Various irregularities like unequal disjunction of chromosomes, second-division restitution and sporadic abnormalities were observed during the subsequent stages of microsporogenesis. 74 per cent of pollen was stainable.



Figs. 1–3. *P. ramosum* ($2n = 10$). Figs. 4 and 5. *P. massaicum* ($2n = 32$). 1, Somatic chromosomes; 2, metaphase I of meiosis (5 bivalents); 3, anaphase I with a dicentric bridge and an acentric fragment; 4, metaphase I (2 quadrivalents and 12 bivalents); 5, metaphase II with 16 chromosomes at either pole

Seed setting was poor. It seems likely that this plant is a segmental allo-tetraploid.

The existence of a *Pennisetum* species with $2n=10$ suggests that 5 is the original basic number in this genus and that 7, 8 and 9 have all been derived from it since. The results would further support the view that 5 is the primary basic chromosome number for all Gramineae.

We are indebted to Dr. B. P. Pal and Dr. S. M. Sikka for their interest and advice.

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A Mutation to Caracul in the House Mouse

IN an inbred line containing no hair-waving factors, but segregating for polydactyly (*py*), leaden (*ln*), and jerker (*je*), mating 19/291 threw one phenotypically wavy animal (19/291.488*b*). She appeared in the first litter and was classified as *py ln je*. As there is no source of this combination of factors in the Department other than line 19, her genotype precludes the possibility of accidental misplacement from some other wavy-bearing stock.

Mating 19/291 continued to breed, producing a total of twenty-three offspring, all of which segregated as expected for the line factors. Their coats and vibrissæ were carefully examined and, with the exception of 488*b*, were found to be completely normal (straight). Thus there is nothing genetically unusual in the mating save the production of the mutation; it seemed most probable that this was dominant and that it occurred in one or other member of the mating and not in a more remote ancestor.

The mutant doe was mated to a buck from another inbred non-wavy stock, and produced seven wavies and eight normals, confirming the dominance of the mutation.

These fifteen progeny and their descendants were used in various crosses (Tables 1 and 2).

Table 1. SEGREGATION OF THE MUTANT GENE

	Wavy	Normal	Total	χ^2
Backcrosses	68	53	121	$\chi^2 (1:1) = 1{\cdot}8595$
Intercrosses	22	10	32	$\chi^2 (3:1) = 0{\cdot}6667$
Outcrosses	57	0	57	

Table 2. LINKAGE TEST WITH NAKED (*N*)

Repulsion backcrosses: wavy/*N* ♀♀ × + + ♂♂

Wavy +	+ +	Wavy Naked	+ Naked	Total	Recombination fraction
40	3	1	46	90	4·4444 ± 0·0217%

The ratios in Table 1 show as a whole a satisfactory agreement with those expected from the segregation of a single dominant factor. However, the intercross ratio is nearer a 2 : 1 than a 3 : 1. This suggests that the mutant gene is lethal when homozygous. To test this possibility several wavies from the intercrosses were mated with normals. Two of them produced no normals out of fifty-seven (see Outcrosses in Table 1). These must have been homozygotes and thus their non-lethality is demonstrated.

The test with Naked (*N*) (Table 2) proves the mutation to be closely linked with it, the recombination fraction being 4·4444 per cent. This is not in good agreement with the value for the linkage of Caracul (*Ca*) and Naked obtained by Mallyon[1] for female gametogenesis, namely, 1·5200 ± 0·0062 per cent. In spite of this discrepancy, which may be due to environmental or to genetic differences between Mallyon's and my own stock, it appears likely that the mutation is, in fact, Caracul. But the possibility that it is a closely linked mimic is being tested.

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A New Mechanism for Amide Hydrolysis

PREVIOUS work on acid-catalysed amide hydrolysis has indicated that the reaction is bimolecular: in the rate-determining step the conjugate acid of the amide is attacked by a water molecule[1]. This conclusion is derived from three types of evidence. It has been shown that in concentrated aqueous acid solutions the rate of hydrolysis of a number of simple amides increases with the proportion of water in the solvent[2]; that polar substituents in the acyl part of the amide molecule have very little effect on the rate[3]; and that the rate is substantially diminished by groups, for example, *ortho* substituents in benzamides, which shield the reaction centre from attack by other molecules[3,4].

To determine whether or not there exist conditions under which unimolecular hydrolysis occurs, we have hydrolysed suitably substituted amides in an acid solvent (95–100 per cent sulphuric acid) which possesses good ionizing properties but contains little free water, and which is therefore favourable to unimolecular, but unfavourable to bimolecular, hydrolysis. A selection of the amides studied, together with the kinetic results, is given in Table 1.

Table 1

Result	Amide	Solvent	Temperature	First-order rate constant (10^3 min.$^{-1}$)
1	Acet-3.5-dinitroanilide	100 per cent sulphuric acid	65°	6·0
2	,,	97·2 per cent sulphuric acid	65°	4·5
3	,,	94·9 per cent sulphuric acid	65°	3·3
4	,,	100 per cent sulphuric acid	60°	3·5
5	Propion-3.5-dinitroanilide	,,	60°	9·6
6	Chloracet-3.5-dinitroanilide	,,	90°	<0·1
7	Benz-2.4-dinitroanilide	,,	8°	6
8	4-Nitrobenz-2.4-dinitroanilide	,,	50°	4·4
9	2-Nitrobenz-2.4-dinitroanilide	,,	8°	6

These results have exactly opposite features to those obtained for the amides previously studied first, the rate of hydrolysis decreases as the proportion of water in the solvent is increased (cf. results 1 2 and 3); secondly, polar substituents in the acy group greatly affect the rate (cf. results 4, 5 and 6 7 and 8); and thirdly, *ortho* substituents cause steri acceleration (cf. results 7, 8 and 9). The results are however, completely consistent with the unimolecula mechanism:

$$R'\mathrm{CONH}R + \mathrm{H_2SO_4} \overset{\text{Fast}}{\rightleftharpoons} R'\mathrm{CO}\overset{+}{\mathrm{N}}\mathrm{H_2}R + \mathrm{HSO_4}^-$$

$$R'\mathrm{CO}\!-\!\!\overset{+}{\mathrm{N}}\mathrm{H_2}R \xrightarrow{\text{Slow}} R'\mathrm{CO}^+ + R\mathrm{NH_2}$$

he slow step being followed by rapid conversion of he amine to its conjugate acid, and of the acyl ion o the corresponding carboxylic acidium ion[5].

A fuller account of this work will be published later.

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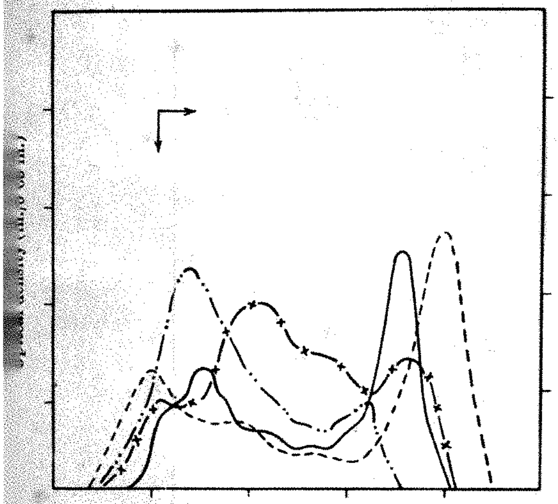
Detection by Paper Electrophoresis of the Protein Denaturation in Heat-inactivated Serum for the Complement Fixation Reaction

In seeking the mechanism to explain an apparent rocomplementary activity to canine complement of anine serum activated at 56° C. for 30 min., it as observed that the same serum was anticomple- entary if inactivated at 62° C. instead of 56° C.

Wiggin[1] suggested that the anticomplementary ction of serum depends on the relationship between e protein ratio in the serum being tested and that in e serum being used as a source of complement. ince in the above case both the serum and comple- ent originated from the same animal, experiments ere designed to find out whether serum inactivation 62° C. affected the protein ratio.

Hæmoglobin-free sera which were obtained from ealthy adult dogs were used throughout the present ork. The sera were clarified by centrifugation at 500 r.p.m. and pooled. Fresh or heated (at 56° C., 2° C. or 65° C.) samples of the serum-pool were plied in 0·01 ml. amounts to Whatman No. 1 ter paper strips for electrophoretic separation of the proteins. The electrophoresis equipment in use was *X*118 'EEL' (Evans Electroselenium, Ltd.). The buffer solution was 30·0 gm. sodium barbitone, 19·5 gm. sodium acetate (hydrated) and 205·0 ml. N/10 hydrochloric acid (these were made up to 3 litres of distilled water). The electrophoresis proceeded in two baths (total 12 strips) for 29 hr. at a current of 0·75 m.amp. per strip. Paper strips were stained with 0·25 per cent bromphenol blue and 95 per cent ethanol saturated with mercuric chloride. Quantitative evaluation of proteins on the paper was by direct photometry of the strip.



ig. 1. Paper electrophoresis of canine serum either fresh (full ne) or heated for 30 min. at different temperatures (broken lines): – – –, 56° C.; —×—×, 62° C.; – · – · · · 65° C. Arrows indicate site of application and direction of run

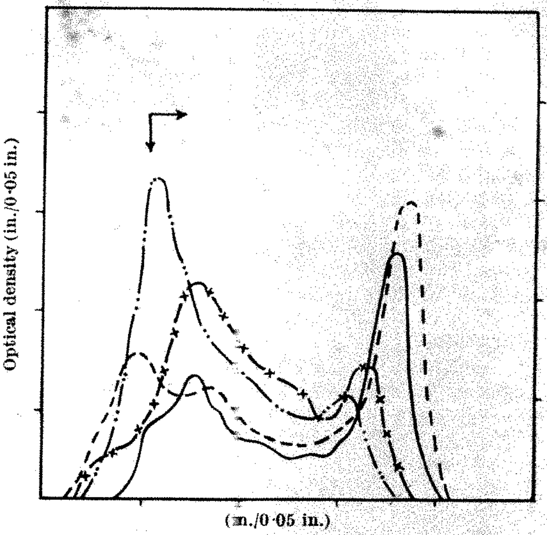


Fig. 2. Paper electrophoresis of canine serum either fresh (full line) or heated for 1 hr. at different temperatures (broken lines). — — —, 56° C.; —×—×, 62° C.; —·—·—·, 65° C. Arrows indicate site of application and direction of run

Fig. 1 shows that heating of canine serum markedly affected electromigration of the protein particles. It is apparent that after heating serum at 56° C. for 30 min. the protein particles migrated faster if compared with unheated serum. Heating of serum at 62° C. or 65° C. for 30 min. reduced considerably the electromigration. Here the protein was strongly adsorbed in the paper and formed patterns which were entirely different from those obtained with unheated serum. The protein denaturation, as shown in Fig. 2, was more marked in samples of serum which were heated at the above temperatures for 1 hr. instead of 30 min.

These experiments suggest that the serum protein can be denatured by temperatures which are commonly used for inactivating serum for the complement-fixation reaction. Detection by paper electrophoresis of protein denaturation at these temperatures has not hitherto been described. Secondly, it seems that, as a function of the serum protein, the procomplementary or anticomplementary activity probably depends on the electric charge on the protein particle in the serum being tested.

A full account of these and related experiments will be published elsewhere.

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Sept. 20.

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A Light Source for locating Œstrogens on Chromatograms

As part of an investigation at this Station into the reproductive physiology of sheep, a suitable light source was required for detecting traces of œstrogens on paper chromatograms of blood extracts. Œstrogens have an absorption maximum near 280 mμ, and light near this wave-length gives maximum contrast when used for photographing them on filter paper. The mercury-vapour lamp is commonly used for this purpose, but its emission in this region is weak and a train of filters is required.

On the other hand, the magnesium spark emits most of its photographically active radiation between 2791 and 2803 A., and a spark system assembled from readily available components has proved simple and convenient in operation. The transformer was of a type used commercially for neon lighting, with a secondary rating of 15,000 V., 30 m.amp., the 0·0025 μF. condenser was assembled by soldering forty 0·1 μF., 500 V. radio condensers in series and the 0·01 μH. coil consisted of seven turns of 14-gauge copper wire on a 3-in. diam. 'Tufnol' tube. The electrodes were made by winding two helices of magnesium ribbon about 1 cm. in diameter held approximately 6 mm. apart.

Photographs taken through No. 1 Whatman filter paper in contact with Ilford reflex document paper using 10 sec. exposure at 70 cm. enabled spots down to 1 μgm. œstrone/sq. cm. to be detected. Using a 4-cm. filter of nickel sulphide and cobalt sulphate to reduce undesirable radiation failed to give any apparent increase in sensitivity.

Although the spark system is run in air, the electrodes can be operated continuously for periods up to one minute without igniting.

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A New Detector for Vapour Phase Chromatography

Vapour phase chromatography has been used with great success in these laboratories for the analysis of the products of reactions in the gas phase. By using a thermal conductivity detector it has been possible to estimate amounts of product of the order of 10^{-8} mole; but this was the lowest limit which could be reached. In certain cases, however, it became necessary to detect 10^{-12} mole of a substance. The detector described below has been developed to meet this requirement. It is of wide applicability and is easil constructed.

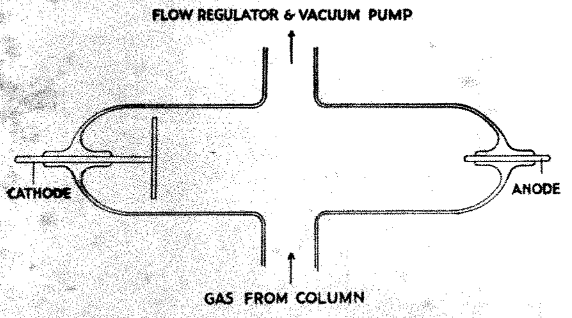

Fig. 1. Glow-discharge detector

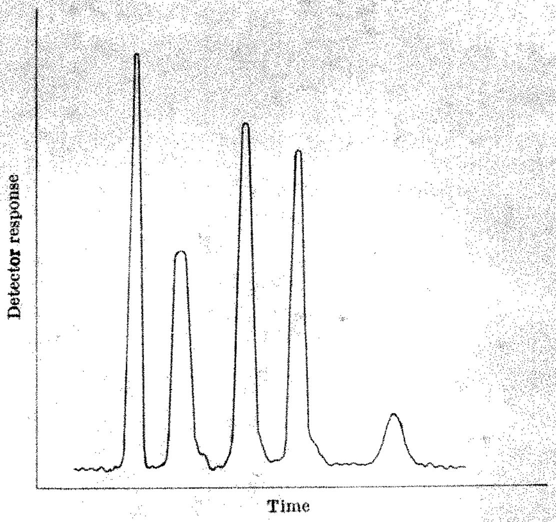

Fig. 2. Detection of components of paraffin mixture

Use is made of the fact that the voltage existin across a normal gaseous discharge is a function of th type of gas used. This voltage changes by severa volts with the introduction of a minute amount c impurity into the gas. The detector consists of a sma platinum disk cathode and a tungsten wire anod (Fig. 1) forming one arm of a Wheatstone bridge whic is supplied with 900 volts from a stabilized d.c. source The bridge is balanced with carrier gas flowin through the detector at a pressure sufficiently low t produce a normal glow discharge between the electrodes. Compounds eluted from the column cause voltage change across the detector which is measure by a recording potentiometer. Fig. 2 shows a recorc ing of the constituents separated from 10^{-10} mole c petroleum ether (40–60°) on a 4-ft. column of 'Celit and amyl phthalate. Details of the technique will t published later.

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Definition of Chromatography

The essence of the classical chromatograph method of Tswett[1] is presented by Ratchinsky[2] the form of the following definition: "Any liqu or gaseous mixture of the substances is divided in its components during the process of its movemer through a layer of sorbent, if there are differenc in sorbtion interaction between the components the mixture and the sorbent". I believe the relati movement of the phases to be the important feature in the case of the movement of the dispersed sorbe through a layer of a liquid or gaseous mixture t chromatographic process of Tswett will be inverte In relation to the aggregate state of the disperse sorbent the inverted method of Tswett thus embrac three varieties of chromatography: (1) suspensic chromatography—when the solid dispersed particl of the sorbent settle or rise through the liquid gaseous mixture[3,4]; (2) emulsion chromatography when the dispersed drops of liquid move through t liquid or gaseous mixture[5]; (3) foam chromatography when the dispersed bubbles move through the liquid mixture[6,7].

It follows that all the varieties of chromatography can be divided into two groups: the group when the liquid or gaseous mixture flows through the layer of the sorbent (classical method of Tswett) and the group when the dispersed sorbent settles or rises through a liquid or gaseous mixture (inverted method of Tswett).

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Cathodic Protection of Iron

It has been frequently suggested that the cathodic protection of iron in chloride solutions is due to the depression of its potential to or below the open-circuit potential of the local anodes[1,2]. However, in neutral solutions containing dissolved oxygen the open-circuit potential of the local anodes cannot be measured directly without assuming the previous statement to be true. Nor can it be calculated from the Nernst equation, since the ferrous ion activity in equilibrium with hydrated ferric oxide is unknown. Since the formation of hydrated ferric oxide may be represented by an equation such as

$$4\,\mathrm{Fe}^{++} + 8\,\mathrm{OH}' + \mathrm{O}_2 = 4\,\mathrm{FeO.OH} + 2\mathrm{H}_2\mathrm{O}$$

it is implicit that the open-circuit potential of the local anodes should become more electronegative with increasing pH.

Valuable information on the mechanism of cathodic protection may be obtained by impressing constant currents using an inert anode and measuring the change in potential of iron cathodes with time. Specimens of iron measuring $2 \cdot 5 \times 0 \cdot 5 \times 0 \cdot 088$ cm. the composition of which has been given previously[3] were decreased in benzene, immersed in 0·1 N hydrochloric acid for 1 min., rinsed rapidly in water, dried and stored in dry air for 24 hr. Individual specimens were subjected to cathodic polarization in 100 ml. of sodium chloride solution at current densities of 20 and 40 microamp./sq. cm. using an inert platinum anode. Impressed currents completely protected the iron specimens against corrosion.

Fig. 1 shows potential–time curves on the standard hydrogen scale for the iron cathodes at the two current densities in 1 N sodium chloride (pH = 6·2) and at 20 microamp./sq. cm. in 1 N sodium chloride with the pH adjusted to 8·9 (potentials are expressed on the standard hydrogen scale). Fig. 1 also shows the potential–time curve for uncoupled iron in 1 N sodium chloride.

Although the open-circuit potential of the local anodes on the iron is unknown, it must certainly be more electronegative than the corrosion potential of iron in the same solution. At 20 microamp./sq. cm. at initial pH values of 6·2 and 8·9, potential–time curves for cathodically polarized iron are clearly very erratic, even though the potential of the platinum anode remains completely steady. The form of the curves strongly suggests a process of alternate oxide film breakdown and repair. Separate experiments under similar conditions on iron cathodes oxidized to the first-order violet interference colour show no overall disappearance of colour in 24 hr. and demonstrate that any oxide film on the cathode is not cathodically reduced to soluble ferrous ions at an appreciable rate[3]. After several hours at both pH values, the potentials of the iron cathodes become more noble than that of unpolarized iron, and yet they still remain completely passive. Clearly, under these conditions the potentials of the iron cathodes are more noble than any value that may be attributed to open-circuit potential of the local anodes. Furthermore, the curve at pH = 8·9 is displaced to more noble potentials than that at pH = 6·2, even though increasing pH should move the open-circuit potential of the local anodes in the more electronegative direction.

At 40 microamp./sq. cm. and an initial pH value of 6·2 the potential–time curve is first fairly steady. Separate experiments on iron cathodes oxidized to the first-order violet interference colour show that under these experimental conditions the oxide film suffers cathodic reduction to soluble ferrous ions with an accompanying disappearance of colour within 5 min. Probably the higher impressed current results in partial oxygen depletion at the cathode. Since recent work (Oswin, H. G., private communication) has demonstrated that α-ferric oxide films may be

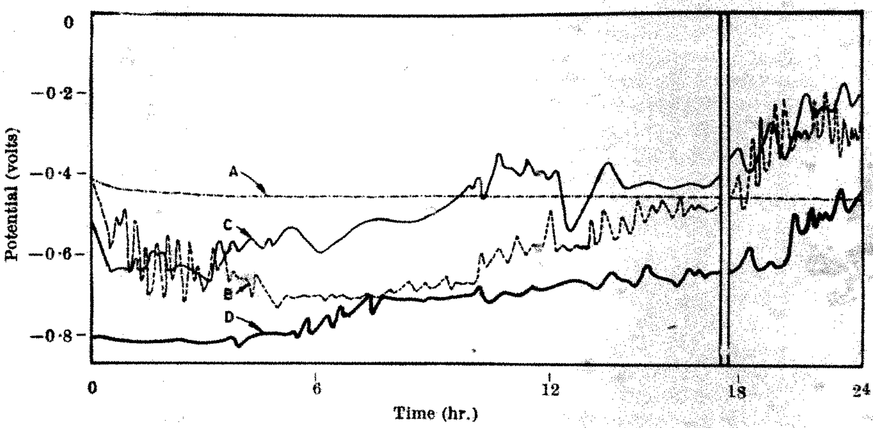

Fig. 1. Potential–time curves for cathodically polarized and unpolarized iron in 1 N sodium chloride at 25° C. A, Corroding iron—no external polarization; B, iron polarized cathodically at 20 microamp./sq. cm., pH = 6·2; C, iron polarized cathodically at 20 microamp./sq. cm. pH = 8·9; D, iron polarized cathodically at 40 microamp./sq. cm., pH = 6·2

cathodically reduced in deaerated solutions at pH values up to 11·0, it is not unreasonable to expect that reduced oxygen content due to the higher impressed current would favour reduction of any initial oxide film on the iron. However, as the pH of the solution around the cathode increases with prolonged cathodic polarization, the efficiency of cathodic reduction of the oxide probably decreases and alternate film repair and breakdown is observed after 4 hr. As film repair gradually achieves ascendancy the potential of the cathodically polarized iron again becomes more noble than that of unpolarized iron.

It is believed that these results indicate that the present theory of cathodic protection is applicable only to a limited number of cases. Clearly, the potential of iron may be depressed enough to make rapid corrosion unlikely from the thermodynamic point of view. Under such conditions the initial oxide film on the iron must be cathodically reduced. If the potential is maintained at the depressed value, perhaps by coupling an active zinc or magnesium anode, the oxide film will not re-form.

However, many cases of cathodic protection must exist where prevention of corrosion can be attributed to an entirely different mechanism. These would include the protection of iron by coupling to high-purity aluminium, by the use of impressed current densities less than 40 microamp./sq. cm., and by coupling to zinc the potential of which had been somewhat ennobled by the formation of corrosion products. In these cases the oxide film is not cathodically reduced. Instead, the function of the cathodic current is probably to reduce the rate at which iron ions leave the metallic lattice. The kinetics of the competing reactions of corrosion and protective oxide film formation are thus disturbed, and the evidence from Fig. 1 indicates that oxide will progressively cover the surface and help to prevent further egress of iron ions from the metallic lattice. During the gradual build-up of a protective oxide film, localized film breakdown, either due to localized reduction of the film or else to undermining by chloride ions, occurs as evidenced by the rapid potential fluctuations. However, these active areas are evidently later repaired by oxygen in solution as the potential continues to move in the noble direction and passivity is maintained.

This kinetic mechanism of cathodic protection is essentially similar to a recent mechanism proposed for anodic inhibition of the corrosion of iron[4] when the inhibitor reduces the rate at which iron leaves the metallic lattice, thereby permitting the formation of a highly protective film of $\gamma\text{-Fe}_2O_3$. It is implicit that higher initial pH values of the electrolyte should also favour the development of the passive state, and it is of interest to note in Fig. 1 that at 20 microamp./sq. cm. the potential fluctuations at $p\text{H} = 8{\cdot}9$ are much slower and the rate of ennoblement of potential higher than at $p\text{H} = 6{\cdot}2$.

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A Quantity Analogous to Trouton's Constant

IT is well known that van der Waals, in conformity with the theory of the corresponding states, stated the relation:

$$\ln \frac{p_c}{p} = A\ \frac{T_c - T}{T} \qquad (1)$$

where A is a universal constant.

Such relation is also the result of the application, to the vaporization phenomenon, of Clausius and Clapeyron's equation, integrated at constant heat of vaporization (λ) between the critical temperature (T_c) and another temperature (T) below the critical one:

$$\ln \frac{p_c}{p} = \frac{\lambda}{R}\left(\frac{1}{T} - \frac{1}{T_c}\right) = \frac{\lambda}{RT_c}\left(\frac{T_c - T}{T}\right) \qquad (2)$$

Comparing the two relations (1) and (2) we obtain:

$$A = \frac{\lambda}{RT_c} \qquad (3)$$

Van der Waals gives $A = 6{\cdot}9$. This value applied to equation (1) gives, generally, good results; 6·9 is, however, a median value, and the figure after the decimal point varies with different substances and also at different temperatures.

On the other hand, I have shown[1] that, for normal liquids, the following equation of state is valid (per mole):

$$3\,N_A{}^{1/3}\,V_M{}^{2/3}\gamma = K(T_c - T) \qquad (4)$$

where N_A is Avogadro's number; V_M is molecular volume; γ is superficial tension; and T_c is critical temperature.

The constant K, as well as Eötvös's constant, which is given by the relation $\frac{V_M{}^{2/3}\gamma}{(T_c - T)}$, proves to be a universal constant, independent of temperature.

As Eötvös's constant corresponds, for normal liquids, to a median value of 2·12 ergs, the value of K is found from the following relation:

$$K = 3\,N_A{}^{1/3} \times 2{\cdot}12 \times 2{\cdot}389 \times 10^{-8} = 12{\cdot}86 \text{ cal.} \qquad (5)$$

where $2{\cdot}389 \times 10^{-8}$ is the factor for converting ergs into calories.

I have also shown[2] that:

$$RT \ln \frac{p_c}{p} = 3\,N_A{}^{1/3}\,V_M{}^{2/3}\gamma \qquad (6)$$

Comparing (6) with (4), we obtain:

$$RT \ln \frac{p_c}{p} = K(T_c - T)$$

and, upon dividing by RT:

$$\ln \frac{p_c}{p} = \frac{K}{R}\,\frac{T_c - T}{T} = \frac{12{\cdot}86}{1{\cdot}98}\cdot\frac{T_c - T}{T} = 6{\cdot}5\,\frac{T_c - T}{T} \quad (7$$

The relation (7) shows that the van der Waals's constant, the value of which is 6·5, is a dimensionless quantity, equal to the relation between the normal liquid constant (K) and the ideal-gas constant (R).

The constancy of A that, as previously said, is found by experiment, requires either (a) the mol heat of vaporization (λ) and R (constant for the idea gas) to remain unchanged with temperature (idea case), or (b) such quantities to change in a way tha should keep their relation to one another constant.

In the latter case the behaviour of the vapour wil not be that of the ideal gas, and we shall have t substitute for R the value $\frac{p(v_g - v_l)}{T}$, where p is the equilibrium pressure at temperature T, and v_g and v_l respectively the gas volume and the liquid volume per mole at such temperature.

Therefore relation (3) may be written:

$$A = \frac{T\lambda_s}{p(v_g - v^l)T_c} = \frac{\lambda}{RT_c}$$

where λ_s represents the experimental heat of vaporization.

Taking $(v_g - v_l) = \Delta v$, we obtain:

$$A\ \frac{T_c}{T} = \frac{\lambda_s}{p\,\Delta v} \qquad (8)$$

The above equation shows that the value of the relation $\frac{\lambda_s}{p(v_g - v_l)}$ is the same for all substances when they are in a corresponding state.

In particular, for the normal boiling point (T_e) $p = 1$ atm.) putting $T_c/T_e = 3/2$, we obtain, measuring λ in calories, Δv in litres and p in atm.:

$$A\ .\ \frac{3}{2} = \frac{1}{24{\cdot}12}\ .\ \left(\frac{\lambda_s}{\Delta v}\right)_{Te} = 6{\cdot}5\ .\ \frac{3}{2} \simeq 10 \qquad (9)$$

where 24·12 is the equivalent in calories of the litre atmosphere.

The universal constant, derived in this way, corresponds to half Trouton's constant (λ_s/T_e), nearly.

Equation (9) shows, therefore, that at the normal boiling point, the heat of vaporization is for all normal liquids about ten times as much as the absorbed heat, during the evaporation, required to do the external work (given by $p\,\Delta v$, where $p = 1$ atm.).

Further, since

$$\left(\frac{\lambda_s}{T}\right)_{Te} \simeq 20 \quad\text{and}\quad \frac{1}{24{\cdot}12}\ .\ \left(\frac{\lambda_s}{\Delta v}\right)_{Te} \simeq 10$$

we have also:

$$24{\cdot}12 \left(\frac{\Delta v}{T}\right)_{Te} \simeq \frac{20}{10} \simeq 2 \qquad (10)$$

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Ric. Sci., **19**, 553 (1949).

Gazz. Chim. Ital., **77**, 448 (1947).

A Function Multiplier

WE are at present developing, for use in a repetitive ectronic differential analyser of 1 per cent nominal ccuracy, a function multiplier which shows great romise in simplicity and electrical characteristics.

The principle of multiplication based on a geometrical system, amely, a rectangular area which deflected relative to a sys-em of rectangular axes. The xes divide the rectangular area to four rectangles, A, B, C d D, which are equal in area its undeflected position. The eas in the four quadrants are mmed according to the algebraic xpression:

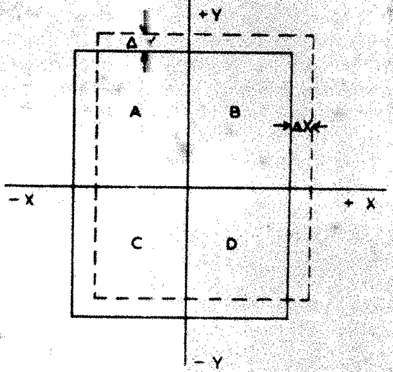

Fig. 1

$$\begin{aligned} R &= A - B - C + D \qquad (1)\\ \text{so that for } A &= B = C = D\\ R &= 0 \end{aligned}$$

If the total rectangular area is displaced a distance Δx in the x direction and Δy in the y direction as shown in Fig. 1, the resultant area as given by the expression (1) above is:

$$R = 4\ \Delta x\ \Delta y$$

Inspection will show that this results in a four-quadrant multiplier yielding the correct algebraic sign of the product and being zero when either Δx or Δy is zero.

A suitable rectangular area was produced on the screen of a cathode-ray oscillograph tube, by defocusing the beam sufficiently to allow the deflecting plates to act as a rectangular aperture shielding the rest of the electron beam. The pattern is deflected by applying deflecting voltages in the normal way, the deflecting plates thus having the dual role of mask and deflecting system.

The area in each quadrant is evaluated by measuring the total light emitted from that quadrant, uniform illumination being produced by saturating the phosphor over the total rectangle.

The light measurement is done by 'piping' the light along four rectangular polished 'Perspex' light-guides on to the photo-cathodes of four 931-*A* photomultipliers. The schematic diagrams of Fig. 2 (left and right) illustrate the method used. This method yields high optical efficiency, and the guide ends nearest the cathode-ray oscillograph face are machined to fit the curvature of the tube. The light at the photomultiplier end is diffused and is proportional to the illuminated area exposed to the input end of the guide. The output currents of the four photomultipliers are summed in a simple feedback adder, the required negative signs for B and C being obtained by suitably connecting the photomultiplier dynodes.

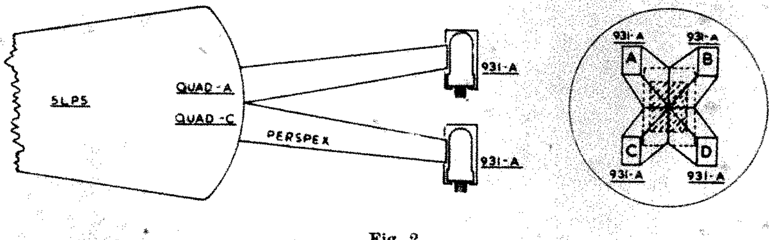

Fig. 2

In an experiment a Du Mont type 5*LP*5 cathode-ray oscillograph tube was used because the deflecting plates gave a good rectangular pattern and the *P*5 phosphor has a high frequency response. Excellent zero adjustment characteristics were experienced and from interpretation of multiplied wave-shapes the linearity and accuracy were deduced to be good. The frequency response is potentially good since all the individual elements used have wide band-widths.

A unit is now being engineered with the view of detailed tests and incorporation in a differential analyser.

I wish to express my appreciation to the President of the Council for Scientific and Industrial Research for permission to publish this communication.

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Liquid Crystals of Montmorillonite

If a section of a dry sodium montmorillonite film is placed in a solution of sodium chloride it will swell parallel to the *c*-axis, the swelling increasing as the salt concentration is reduced, until at a sufficiently low concentration (about $N/100$) complete dispersion occurs. This swelling has now been observed under a microscope. Fractions less than 2μ from samples of Wyoming and Dakota bentonites were washed with N sodium chloride and then freed from chloride by dialysis through a cellulose casing, keeping the *p*H of the dialysate about 7·0 by adding dilute sodium hydroxide. An aliquot of the suspended clay was then slowly dried to form an orientated flake about 0·01 cm. thick.

Sections about 0·3 mm. thick were cut with a scalpel from the prepared flakes, placed on a glass slide and a few drops of $N/30$ sodium chloride added. The swelling was observed with the flake on its side, that is, with the *c*-axis of the crystallites perpendicular to the axis of the microscope. The swollen gel showed no structure with ordinary light, but under crossed nicols, on rotating the gel, instead of the extinction being sharp at 90° intervals as each of the nicols in turn became parallel to the *c*-axis, irregular dark bands were observed parallel to the *c*-axis (Fig. 1). The angle between the appearance of the first bands through maximum extinction to the disappearance of the bands was about 20°. The bands appeared independent of the direction in which the section was cut from the flake. The bands were sharpest with very thin gels (birefringence colour, first-order white) and were visible only with the microscope focused on the gel (in particular, with thick gels only on the upper surface of the gels). Between parallel nicols the bands reappeared at an angle of 45° to their original direction. A similar type of band formation has been observed with liquid crystals of tobacco mosaic virus[1]. If the concentration of sodium chloride surrounding the gel was reduced below the flocculating concentration, the bands increased in length and finally disappeared when the specimen became too thin to show birefringence colours. There was no evidence of structure if the flake was viewed parallel to the *c*-axis. The expanded gel from a flake made with the clay fraction less than 0·5μ gave slightly more regular bands there being fewer of the occasional very wide bands present in the gels of less than 2μ particles. Sections from a flake dried only to the 'cheesy' condition gave rise to bands on immersion in sodium chloride but the angle over which the bands appeared was increased to 70°.

A flake was also prepared from a montmorillonite suspension to which a small quantity of a cationi stabilizing agent (*CTAB*) had been added. In the swollen gel the non-expanded crystallites are visible perpendicular to the bands because of their highe birefringence (Fig. 2).

Ross and Hendricks[2] deduced that in dry flakes of sodium montmorillonite the individual platelet or crystallites are arranged approximately paralle to the surface of the flake and randomly orientated perpendicular to this plane. The average width o the bands, about 2μ, is much greater than the diameter of the individual crystallites, 9·6 A. thick many of which are known to be about 1500 A. in diameter. The length of each band is not well defined but is usually greater than 150μ in the expanded gel, corresponding to an unexpanded thickness o clay of 5μ. It is inferred that in the dry flake th crystallites are stacked parallel to the *c*-axis to form crystals of height at least 5μ and diameter 2μ. Th bands are due to the crystals not being exactl parallel to the surface of the flake, so that the opti axes of the crystals are inclined at a few degrees The inclination of the crystals must be random, sinc the bands are observed irrespective of the directio in which the flake is cut. The bands would be expected to be sharpest in the very thin gels, first-orde white corresponding to a thickness of dry clay of 5μ that is, one or two layers of crystals only. From th experiment with the incompletely dried flake, appears that during drying the crystals are forme first and that afterwards the orientation of the crysta is improved. Previous evidence of the existence o montmorillonite crystals is that (00*l*) reflexions ca be obtained from powder photographs.

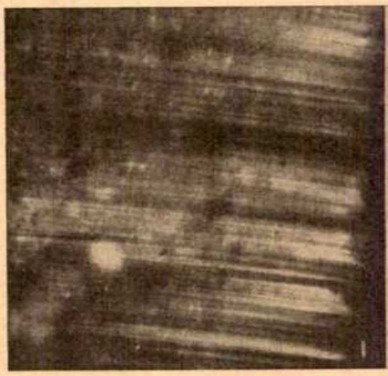

Fig. 1. Sodium Wyoming bentonite in $N/30$ sodium chloride, particles less than 2μ. × 10

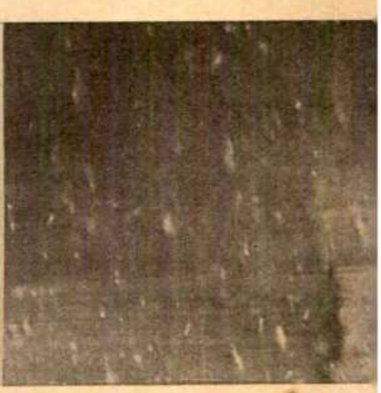

Fig. 2. Sodium Wyoming bentonite + 0·5 per cent *CTAB* in $N/30$ sodium chloride particles less than 2μ. × 100

I wish to thank Dr. H. L. Penman and A. H. Weir for helpful discussions.

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Aug. 28.

Wilkins, M. F. H., *et al.*, *Nature*, 166, 127 (1956).

[2] Ross, C. S., and Hendricks, S. B., *U.S.D.I. Prof. Paper* 205-*B* (1945).

Noise Radiation from Tropical Thunderstorms in the Standard Broadcast Band

AN objective method of measuring atmospheric noise interference to broadcasting based on subjective observations and statistical considerations has been reported[1]. Results of systematic measurements by the method in the 3 and 5 Mc./s. bands have been published[2,3]. It has been shown that these results can be satisfactorily explained on the basis of the available data on lightning discharges[4], the distribution of thunderstorm days[5], the growth and decay of thunderstorms[6], and the laws of propagation. For this purpose, the available data on lightning discharges have been utilized to deduce an idealized statistically valid representation of a typical flash as it occurs in a tropical thunderstorm[4]. It is found that

$$P = 45/f^2 \tag{1}$$

where P is the power in watts and f is the frequency in Mc./s.

The calculations are with specific reference to the band-width and time-constant characteristics of the noise meter. It has been assumed that there are three strokes to a flash and that all thunderstorms recorded by weather offices as 'thunderstorm days' radiate noise. It has, however, been clearly stated that the equation must break down for frequencies below 1 Mc./s. This statement was based partly on theoretical considerations and partly on the preliminary investigations[1]. It was therefore felt that measurements of atmospheric noise interference to broadcasting at frequencies below 1 Mc./s. would be valuable not only from the point of view of getting noise data but also for theoretical evaluations. Hence, noise measurements were carried out at 20 and 930 kc./s. at Poona for 18–23 hr. I.S.T., during 1954–56, by C. G. Khot under my direction. Occasionally, observations have also been taken for 2–24 hr. The results have been analysed and the noise data deduced as usual.

Estimates of noise were made as usual by using the power given by equation (1). These estimates were invariably found to be higher than the measured alues. Further, our study of individual thundertorms simultaneously at a number of frequencies ad indicated something abnormal at frequencies elow 1 Mc./s. In order, therefore, to attempt a possible explanation of the results, the lightning discharge data and the original theoretical calculations were re-examined. It appears that the discharges within the cloud or into the air do not radiate any significant power at frequencies below Mc./s., that is, noise radiation at frequencies below Mc./s. appears to arise entirely from thunderstorms n which the discharge strikes the ground. Further, ven in these cases, it is only the stepped leader that s responsible for the radiation of noise. There appears to be no radiation from the dart leaders. Calculations carried out on the basis outlined above resulted in the following expression for the noise power radiated:

$$P = \frac{16 \cdot 2}{f^2} \cdot \frac{1}{\text{[illegible]} + \dfrac{\delta^2}{4\pi^2 f^2 \cdot 10^{12}}} \text{ watts} \tag{2}$$

δ is the constant in the expression for the exponential rise of current in the discharge.

Using equation (2) and the laws of propagation, noise values were estimated, and these appear to agree well with measured values. It appears that equation (2) holds up to 500 kc./s. or even lower. This lower limit has to be evaluated by further experiments. The higher frequency up to which the equation holds lies between 1 and 3 Mc./s. and detailed investigations in this region should prove interesting.

This communication is being published in view of its possible interest to those studying the wave-forms of atmospherics and other problems of thunderstorm electricity during the forthcoming Geophysical Year. The complete theoretical and experimental work will be published in due course elsewhere.

S. V. CHANDRASHEKHAR AIYA

L.D. College of Engineering,
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Aug. 22.

[1] Aiya, S. V. C., *J. Atmos. Terr. Phys.*, 5, 230 (1954).

[2] Aiya, S. V. C., and Phadke, K. R., *J. Atmos. Terr. Phys.*, 7, 254 (1955).

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Temperatures in the Earth's Interior

THE melting-point gradient for the Earth's mantle has been determined by Uffen[1] from Lindemann's law; the results yield an upper limit on the actual temperature. Simon[2] and Bullard[3] have made estimates, from Simon's semi-empirical fusion equation, of melting temperatures in the Earth's core, which provide a lower limit to the corresponding temperature in the liquid outer core.

In a recent paper[4], I have derived the Lindemann law from the theory of Debye and Waller for the thermal dependence of the intensity of reflexion of X-rays by a crystal. The development yields[5] a direct derivation of the Simon melting equation, which can be written

$$P_m = A[(T_m/T_{m,o})^B - 1] \tag{1}$$

where T_m and $T_{m,o}$ are the absolute melting temperatures at pressure P_m and zero, respectively, and A is a constant. If the Earth's core is presumed to consist of iron, my results show that

$$B = (6\gamma_{m,r} + 1)/[2(3\gamma_{m,o} - 1)] \tag{2}$$

where $\gamma_{m,o}$ is the Grüneisen constant of the solid at fusion under zero pressure. The applicability of equation (2) follows[5,6] from the fact that iron is sufficiently incompressible for osculating approximations at the origin of the fusion curve to be valid. An

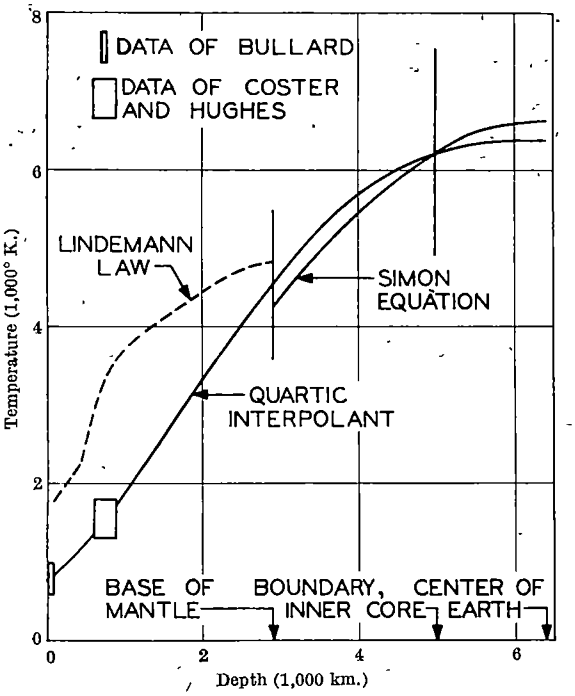

Fig. 1. The fusion temperature in the Earth's core as estimated from the Simon equation, with fusion temperatures (dashed) for the mantle from the Lindemann law (Uffen). The quartic interpolation polynomial yields an estimate of the actual temperature (rectangles and lines indicate possible limits of error)

experimentally verified theoretical relation[4], in terms of fusion parameters, for the Grüneisen constant of a solid at melting yields $\gamma_{m,0} = 0{\cdot}92$, as a mean value for iron; one obtains $B = 1{\cdot}9$ from equation (2). With this value of B and Simon's value[2] of A for iron, equation (1) yields the curve shown in Fig. 1 for the melting temperature in the Earth's core, when the pressure is related to the depth by values from seismic data[3]; Uffen's curve for the melting temperature (corresponding to use of the Debye frequency) in the mantle is shown also (dashed). One notes that the fusion temperature for the inner core is higher than that for the mantle at its base, so that no conflict appears with Jacobs's hypothesis[7] on the origin of a solid inner core. In evaluating B for iron, Simon and Bullard used values for the highly compressible alkali metals as a guide; correspondingly, their fusion temperatures for the core are considerably below those of Fig. 1, and are in conflict[8] with Jacobs's hypothesis.

Bullard[3] has estimated the temperature in the Earth at a depth of 35 km. as 800±200° K. The only experimental evidence on the temperature at depth is the determination by Coster[9] and Hughes (unpublished) of 1,300–1,800° K. as the temperature at which silicates show the low resistivity for a depth of 600–900 km. required by geomagnetic results. Average points from these data are shown in Fig. 1 by rectangles indicating limits of error. At the base of the mantle, computed fusion temperatures yield immediate limits to the actual temperature, which must lie between the fusion temperatures of the liquid core and solid mantle at this point. The temperature at this point will be taken as an average corresponding to the two fusion temperatures in question; possible limits of error are shown by a vertical line in Fig. 1. Further, if the inner core is solid, the fusion temperature at its boundary is the actual temperature (for inner an outer core of the same composition). The fou temperatures in question can be used for constructin a quartic polynomial for the temperature as a functio of depth, when one imposes the constraint that th temperature gradient vanishes at the centre of th Earth (as follows from Gauss's law). The interpolatin polynomial for the temperature T in 10^3 ° K. is

$$T = 0{\cdot}773 + 0{\cdot}750d + 0{\cdot}463d^2 - 0{\cdot}1148d^3 + 0{\cdot}00708$$

in terms of the depth d in 10^3 km. The coefficien are given to the figures shown, merely for prop round-off; the limits of error are given as abo ±25 per cent by the limits indicated in Fig. 1. Th temperatures implied are quite close to those give by Daly[10] for the greater depths in the mantl Inasmuch as the mean temperature gradient pr dicted for the mantle exceeds substantially th adiabatic gradient of 0·17 deg. C./km. estimated b Verhoogen[11] for the (solid) mantle, this temperatu distribution is consistent with solidification of th mantle from the base up. The mean temperatu gradient (0·78 deg. C./km.) for the outer core is clo to the values 0·5–0·7 deg. C./km. for the adiabat gradient which follow from results of Birch[12].

A full account of this work (performed while I w associated with the Rand Corporation, Santa Monic California) will appear elsewhere.

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Research Laboratories,
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Sept. 12.

[1] Uffen, R. J., *Trans. Amer. Geophys. Union*, **33**, 893 (1952).
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Guarded-Field Ionization Chambers: a New Principle applied to both Free-Air and Thimble Versions

Taylor and Singer[1] placed a system of parall guard wires around the inter-electrode space of 'free-air' ionization chamber, the wires being mai tained at potentials evenly graded between those the collecting electrode and the high-voltage electro respectively. Electrostatic field distortion (large arising from the proximity of the earthed casing) w thereby diminished, enabling the chamber dimensio to be reduced—an important factor in a chamb designed for portability. However, the guard wire taken together, comprise a relatively inefficie screening and field-shaping system[2], and we ha investigated a guard strip system, a cross-secti through the mid-plane of a typical free-air chamb incorporating this system being as shown in Fig. AA', BB', CC', etc., are the sections of rectangul metal (or graphited plastic) frames, which pass alo

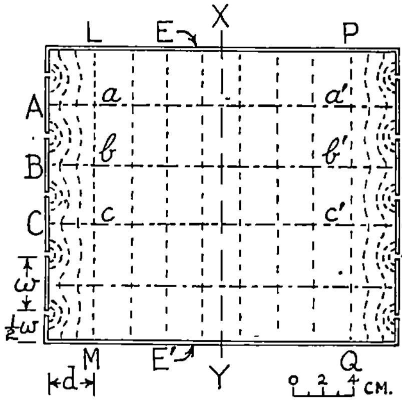

Fig. 1. Mid-plane section of free-air chamber employing guard strips

both sides of the chamber and across the ends, except for small apertures in the ends of the central one (or the central pair, as the case may be), permitting the passage of the X-ray beam. The width w of each of the frames is large compared with the gap g between consecutive frames. Thus w might be, say, 4 cm., and g 4 mm. only. The upper and lower electrode systems E and E' have an edging of width $\frac{1}{2}w$, as shown. Equal potential differences are maintained across all the gaps g. It is easily seen that in these circumstances the horizontal planes (represented by aa', bb', cc', etc.) bisecting each frame, together with the upper and lower electrodes E and E', constitute equi-spaced, equipotential planes. The associated lines of force are somewhat as indicated. It has been found by electrolytic tank studies that these lines (namely, LM and PQ) have become quite straight at a distance d from the guard strips, where d is approximately $\frac{3}{4}w$. The guard system is thus seen to be a very efficient one, enabling particularly compact chambers to be constructed.

An important further step appears to be the extension of this principle to thimble chambers. Thus, imagine Fig. 1 to be rotated about the axis XY. We then obtain a cylindrical chamber, the wall of which can consist of several annular sections separated from one another by very thin washers of insulating material, and possessing a flat circular disk as a collecting electrode. If, in addition, the latter is surrounded by a guard space of appropriate width d, all the lines of force terminating on the collecting electrode will be straight, and the collecting region thereby accurately determined. It has been found that with d equal to one-fifth of the internal diameter of the chamber (the only ratio as yet investigated), the width w of the rings making up the cylindrical wall can be approximately equal to d in value. Fig. 2 shows a section through a practical form of such a chamber, constructed in this case of graphite, and housed in a very thin 'Perspex' shell. 'Terylene' washers, 0·001 in. thick, serve as insulation between the components of the chamber wall. We are also experimenting with chambers of insulating material, the inner surfaces of which are graphited, the cylindrical surface being subdivided according to the above scheme, or screw-cut to provide a steady fall of potential from one end to the other. A very thin and even conducting coating on the cylindrical wall to provide a constant potential gradient may also be possible.

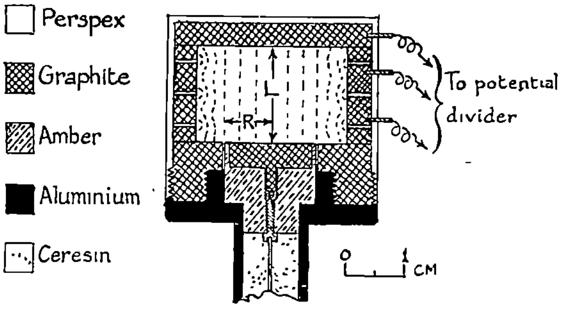

Fig. 2. Section of guarded-field thimble chamber. Note that the top edge of the amber 'cup' holding the collecting electrode is graphite-coated, to minimize the effective gap width. The cup is necessary to avoid charge collection in the gap

Chambers of this type appear to have a number of applications in the study of cavity ionization chambers, and in their use for dosimetric purposes. Among other advantages, the design appears to offer the following:

(i) Geometrical simplicity of the collecting region, enabling its volume to be calculated more easily and more accurately. In particular, the volume depends on knowing two dimensions only: (a) the length L of the cylindrical air space; and (b) the radius R of the collecting region (inclusive of one-half of the width of the gap surrounding the collecting electrode, which can be made very small indeed, namely, approximately 0·1 mm. or less). Furthermore, the elimination of the usual collecting peg, and the fact that the only solid surfaces bounding the collecting volume are plane ones (on which a very high finish can be attained), remove the uncertainties associated with the exact contours obtaining at the junction of plane and curved surfaces which have been machined.

(ii) Completely uniform electrostatic field throughout the collecting volume, thus eliminating regions of abnormally high field-strength, which might prove troublesome in low-pressure studies.

(iii) Complete symmetry of the electrode system, with a resultant simplification of the problems associated with electron emission and exchange.

(iv) Ease of adjustment of chamber volume; annular wall sections can be added or subtracted at will, without disturbing the configuration of the electrostatic field. The collecting volume is thus strictly proportional to its length.

A fuller account of these new chambers and their design data will be published elsewhere in due course.

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[1] Taylor, L. S., and Singer G., *Radiology*, **15**, 637 (1930).

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Opaque Spherules in Dust collected at Isolated Sites

A YEAR-LONG programme involving daily collections of atmospheric dust at several widely separated, isolated sites has been undertaken with the object of identifying particles that may be of extra-terrestrial origin. The particles in question are opaque, shiny spherules with diameters less than 10 microns. They appear to be of a nature entirely different from that of the larger spheres abounding in densely populated areas. Their meteoritic nature is suggested by the fact that the rate of fall and the frequency distribution with size of these particles have been found to be the same at the various stations.

The principal collecting sites were the Smithsonian Astrophysical Observatory's Table Mountain Station above the Mojave Desert of California, a field site of the Geophysical Institute in central Alaska, and the Meteorological Observing Station of the Canadian Meteorological Service at Resolute, North-West Territory, on Cornwallis Island in the Arctic. The collections, begun on July 1, 1955, and completed on June 30, 1956, involved exposing adhesive-covered glass slides to the atmosphere for periods of 24 hr., weather permitting. These slides were scanned under a magnification of 500, making possible identification of particles greater than 3 microns in diameter. Those suspected to be meteoritic were counted and measured after identification by means of tests designed to distinguish them from other types of dust present, involving the use of back lighting, side lighting and polarized light.

The average rate of fall for each station was 1·1 spherules greater than 3 microns in diameter per sq. cm. per day. Assuming that the density of the counted particles is that of iron, this rate corresponds to an annual accretion for the entire Earth of about 10^9 kgm. of these particles.

These results are of interest in relation to the work of Thomsen[1] and of Buddhue[2], who have studied spheres of greater abundance and larger size. No particles of the type they describe were found in the collections from the three principal stations of this programme. Other investigators, notably Crozier[3] and Kizilirmak[4], have studied the magnetic components of dust in the air at their respective institutions.

A promising beginning has been made with an analysis of individual particles by X-ray diffraction techniques. The results of this work will be included in a comprehensive report to be submitted to *Geochimica et Cosmochimica Acta*. A subvention of this project by the Office of Naval Research and the co-operation of the Directors of the collecting stations are gratefully acknowledged.

Paul W. Hodge

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New Haven,
Connecticut.
Aug. 31.

[1] Thomsen, W. J., *Sky and Telescope*, 12, 147 (1953).

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Dried Breadfruit

In many of the Pacific territories breadfruit (*Artocarpus altilis* Forst.) constitutes a staple part of the diet. Excepting fermentation procedures, no means of preserving this food in the Pacific islands have previously been described. It has recently been reported[1] that the people of the Reef Islands in the British Solomon Islands Protectorate dry breadfruit for use when it is out of season. It is used also as an item of trade with some of the nearby islands.

The method used for drying is to cook the fresh ripe fruit in the ashes of a fire for an hour. The cooked product is left for a day and then it is peeled, the seeds removed, and it is cut into small pieces which are arranged on a net to a depth of four or five inches. This net is suspended over a smokeless fire and the pieces are turned continuously for about six hours.

The dried breadfruit may be kept for twelve months or more if it is stored in coconut baskets on racks above the kitchen fireplace.

A sample of the dried breadfruit was sent to this laboratory. The composition of the product is given in Table 1 together with results obtained for fresh breadfruit from Western Samoa. It is noted that the calcium content of the dried breadfruit is much higher than would be expected from the fresh breadfruit figure. This may be due to contamination of the product by coral dust during preparation.

Table 1

	Dried (per cent)	Fresh (per cent)
Water	8·0	80·0
Ether extract	2·1	0·5
Crude fibre	4·7	1·2
Total nitrogen	0·68	0·12
Ash	4·2	0·8
Starch (acid hydrolysis)	72·0	12·0
Calcium	0·44	0·03
Phosphorus	0·13	0·03

We wish to thank Mr. J. L. O. Tedder, District Commissioner, Eastern District, British Solomon Islands Protectorate, for supplying us with a sample of dried breadfruit for analysis.

F. E. Peters
Pamela A. Wills

South Pacific Commission,
Noumea,
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Sept. 20.

[1] Tedder, J. L. O., *South Pacific Comm. Quart. Bull*, 6, No. 3, 21 (1956).

"Fluorimetry"

In a recent communication to *Nature*[1] there appears an article entitled "Determination of Intermediary Metabolites by Enzymic Fluorimetry". May I suggest that the term *fluorimetry* is quite inappropriate in the sense in which it is employed in the article, namely, that of the measurement of *fluorescent light*.

As the words 'fluor-spar' and 'hydrofluoric' show, *fluor* is well established as an abbreviation of *fluorine*. Surely, then, fluorimetry, in a chemical context, can scarcely be interpreted otherwise than as meaning *assay of fluorine*, not the *measurement of fluorescence*.

It would seem unfortunate if the usage here called in question were followed by others; it would certainly be most confusing to foreign workers.

In the absence of a suitable *single* word for the measurement of the intensity of fluorescent light, the determinations referred to in the article would seem properly to be described as 'by fluorescence measurement' or 'by fluorescence estimation'—longer though these are. Brevity may be bought too dearly.

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London, S.W.19.
Sept. 25.

[1] Greengard, P., *Nature*, 178, 632 (1956)

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, December 3

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO and MEASUREMENT SECTIONS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Informal Evening on "Electronics and Automation—The Use of Nucleonic Devices". Talk by Dr. Denis Taylor.

ROYAL METEOROLOGICAL SOCIETY (in the Conference Hall, County Hall, London, S.E.1), at 5.30 p.m.—Mr. N. Bradbury: "Aviation Meteorology".* (Lecture for Sixth-form Scholars.)

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Sir Charles S. Lillicrap: "The Submarine. Past, Present and Future".

UNIVERSITY OF LONDON (at Queen Mary College, Mile End Road, London, E.1), at 5 30 p.m —Prof. J. D. Roberts (California Institute of Technology): "Nuclear Magnetic Resonance Spectroscopy and Applications to Organic Chemistry".* (Further lecture on December 5.)

ROYAL INSTITUTE OF CHEMISTRY (joint meeting with the LONDON SECTION of the SOCIETY OF CHEMICAL INDUSTRY, at 14–16 Belgrave Square, London, S.W.1), at 6.30 p.m.—Prof. P. M. S. Blackett, F.R.S.: "Elementary Particles of Nature".

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.30 p m.—General Sir James Marshall-Cornwall: "Military Geography of Wales".

Tuesday, December 4

BRITISH ASSOCIATION FOR COMMERCIAL AND INDUSTRIAL EDUCATION (at the Royal Festival Hall, London, S E.1), at 10.30 a.m.—Conference on "Automation, Education and Training".

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY (in the Main Chemistry Lecture Theatre, Imperial Institute Road, London, S.W.7), at 5.30 p.m.—Prof. B. G. Peters. "Parasitology at Imperial College" (Inaugural Lecture)

INSTITUTION OF CHEMICAL ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. R. P. Fraser: "High Intensity Combustion in Chemical Engineering".

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. C. L. Champion, Mr. R. J. R. Hancock and Mr. W. Woolfson: "The Design and Construction of a Laboratory for Research in Underwater Ballistics".

Wednesday, December 5

IRON AND STEEL INSTITUTE, IRON AND STEEL ENGINEERS GROUP (at 4 Grosvenor Gardens, London, S.W.1), at 10.30 a.m.—Mr. F. J. Potter and Mr. L. Duffy: "Blowers for Use in Iron and Steel Works"; at 2 p.m.—Mr. V. Barnett: "Gas and Air Compressors".

CIBA FOUNDATION (in the Large Hall, Friends House, Euston Road, London, N.W.1), at 5 p.m.—Prof. R. B. Woodward (Harvard): "Recent Advances in the Chemistry of Natural Products".

INSTITUTE OF PETROLEUM (at 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. P. W. Cooke: "The Hydraulics of Drilling Mud Flow".

INSTITUTION OF ELECTRICAL ENGINEERS, LONDON GRADUATE AND STUDENT SECTION (at Savoy Place, London, W.C.2), at 6.30 p.m.—Mr. P. L. M. Rockwell. "Air Navigation".

SOCIETY FOR ANALYTICAL CHEMISTRY (in the Meeting Room of he Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Meeting on "Trade Effluents".

Thursday, December 6

PHYSICAL SOCIETY, LOW TEMPERATURE GROUP (at the Royal School of Mines, South Kensington, London, S.W.7), at 4 p.m.—Annual General Meeting, followed by Mr. H. J. Goldsmid. "Thermo-electric Cooling".

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), t 4.30 p.m.—Sir Wilfrid Le Gros Clark, F.R S.. "Enquiries into the Anatomical Basis of Olfactory Discrimination" (Ferrier Lecture).

INSTITUTION OF NAVAL ARCHITECTS (in the Weir Lecture Hall, 10 Upper Belgrave Street, London, S.W.1), at 4.45 p.m.—Mr. A. Augustin Normand and Mr. Bartholon: "Some Problems in Design nd Use of Free Piston Gas Generators on board Ships".

CHADWICK TRUST (in the Lecture Theatre, Wright-Fleming Institute, t. Mary's Hospital, Paddington, London, W.2), at 5 p.m.—Dr. J. N. Morris: "Clinical and Community Medicine".* (Malcolm Morris Memorial Lecture.)

ROYAL SOCIETY OF ARTS, COMMONWEALTH SECTION (at John Adam treet, Adelphi, London, W.C.2), at 5.15 p.m.—Dr. J. E. Richardson: Technical Education in Nigeria".

INSTITUTE OF REFRIGERATION (at the Junior Institution of Engineers, Pepys House, 14 Rochester Row, London, S.W.1), at 5.30 p.m.—Miss B. Shilling: "Cooling Problems in High Speed Military Aircraft".

SIR THOMAS MIDDLETON MEMORIAL TRUST (in the Auditorium, he Wellcome Building, 183 Euston Road, London, N.W.1), at 30 p.m.—Prof. V. B. Wigglesworth, F.R S: "Insects and the Farmer" (Fourth Middleton Memorial Lecture).

SOCIETY OF CHEMICAL INDUSTRY, ROAD AND BUILDING MATERIALS ROUP (at 14 Belgrave Square, London, S.W.1), at 6 p.m.—Meeting on New and Revised Test Methods".

INSTITUTE OF METALS, LONDON LOCAL SECTION (joint meeting with the London Branch of the Institute of British Foundrymen at 17 Belgrave Square, London, S.W.1), at 6.30 p.m.—Dr. E. F. Emley: "The Founding of Magnesium".

INSTITUTION OF MECHANICAL ENGINEERS, EDUCATION GROUP (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p.m.—Discussion on "The Sphere and Duties of the Industrial Education Officer".

ROYAL INSTITUTE OF CHEMISTRY (joint meeting with the BATTERSEA POLYTECHNIC CHEMICAL SOCIETY, at the Battersea Polytechnic, Battersea Park Road, London, S.W.11), at 7 p.m —Dr. C. H. Bamford: "Properties and Configuration of Large Molecules".

BRITISH GLACIOLOGICAL SOCIETY (at Bedford College, Regent's Park, London, N.W.1), at 7.30 p.m.—Annual General Meeting, followed by Mr. G. A. Kellaway: "Frost Heaving and Thermokarst Phenomena in Perennially Frozen Regions".

Thursday, December 6—Friday, December 7

BRITISH INSTITUTE OF RADIOLOGY, incorporated with the RÖNTGEN SOCIETY (at Caxton Hall, Westminster, London, S.W.1)—Annual Congress and Exhibition.

Friday, December 7

BRITISH SOCIETY OF RHEOLOGY (at the Institute of Physics, 47 Belgrave Square, London, S.W.1), at 10 a.m.—Meeting on "Rheological Control of Industrial Processes".

ROYAL SOCIETY OF MEDICINE, OTOLOGY SECTION (at 1 Wimpole Street, London, W.1), at 10.30 a.m.—Discussion on "Noise and Its Effects". Opening speakers. Dr. J. D. Hood, Prof W. Burns, Mr. D. E. Broadbent and Dr. H. F. Schuknecht (Detroit).

ASSOCIATION OF APPLIED BIOLOGISTS (in the Lecture Hall of the Royal Entomological Society, 41 Queen's Gate, London, S.W.7), at 10.50 a.m.—Scientific Papers.

PHYSICAL SOCIETY, ACOUSTICS GROUP (at Imperial College, Imperial Institute Road, London, S.W.7), at 5.30 p.m.—Mr. H. J. Pain: "Shock Waves in Gases".

INSTITUTION OF MECHANICAL ENGINEERS (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6 p.m.—Mr A. D. S. Carter and Mr. D. A. Kilpatrick: "The Self Excited Vibration of Axial Flow Compressor Blades".

UNIVERSITY OF LONDON at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6.30 p.m.—Mr. R. V. Moore: "The Development of Nuclear Power".* (Ninth of ten University Extension Lectures on "Technology and Industry". Further lecture on December 14.)

BRITISH PSYCHOLOGICAL SOCIETY, EDUCATION SECTION (at the University of London Institute of Education, Malet Street, London, W.C.1), at 6.45 p.m.—Dr. Alice W. Heim: "Some Preliminary Experiments on a Test of Concept-Formation".

SOCIETY OF CHEMICAL INDUSTRY, FINE CHEMICALS GROUP (in the Chemistry Lecture Theatre, King's College, Strand, London, W.C.2), at 7 p.m.—Mr. A. E. T Neale: "Newer Applications of Fine Chemicals in the Rubber Industry".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir George Thomson, F.R.S.: "J. J. Thomson".

Saturday, December 8

BRITISH MYCOLOGICAL SOCIETY (at the Linnean Society of London, Burlington House, Piccadilly, London, W.1), at 12 noon—Annual General Meeting.

BRITISH PSYCHOLOGICAL SOCIETY (in the Psychology Department, Birkbeck College, Malet Street, London, W C 1), at 2.30 p m.—Prof. Frank A. Geldard (University of Virginia). "Tactile Literacy".

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Mr. John Usborne: "Watching North American Birds".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

BIOCHEMIST (with at least three years' experience in the procedures of biochemistry or chemical pathology, and a higher degree in biochemistry or physiological chemistry such as the M.Sc., Ph.D., or equivalent) at St. Kevin's Hospital, Dublin—The Secretary, Local Appointments Commission 45 Upper O'Connell Street, Dublin (December 7).

ENTOMOLOGIST (with a first- or second-class honours degree or equivalent and interested in applied entomological research, and preferably with both field and laboratory experience) IN THE TECHNOLOGICAL IRRADIATION GROUP of the Isotope Division—The Establishment Officer, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting Ref. 667/34 (December 10).

PRINCIPAL (with high academic qualifications and wide experience, preferably including industrial, research, and teaching experience) OF THE ROYAL TECHNICAL COLLEGE, Salford—The Director of Education, Education Office, Chapel Street, Salford (December 12).

LECTURER IN ELECTRICAL ENGINEERING—The Registrar, University College, Singleton Park, Swansea (December 15).

LECTURER, Grade I (with high academic qualifications, and preferably industrial experience), to take charge of the Sub-Department of Malting and Brewing in the Department of Biochemistry—The Registrar, The University, Birmingham (December 17).

Chair of Therapeutics and Pharmacology—The Secretary, The Queen's University, Belfast (December 20).

Assistant Lecturer in Chemistry at Makerere College (University College of East Africa)—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (December 31).

Lecturer or Assistant Lecturer in Applied Mathematics at the University of Malaya—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (December 31).

Research Assistant in the Department of Chemistry, for work on the fundamental chemistry of grass conservation—The Secretary, The University, Edinburgh (December 31).

Senior Lecturer/Lecturer in Mathematics; Lecturer in Physics; and a Lecturer in Zoology at Kumasi College of Technology, Gold Coast—The Secretary, Advisory Committee on Colonial Colleges, 1 Woburn Square, London, W.C.1 (December 31).

Lecturer or Assistant Lecturer in Mathematical Statistics—The Registrar, The University, Manchester (January 1).

Lecturer in Experimental Physics—The Registrar, The University, Liverpool (January 2).

Lecturer in Biochemistry at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (January 31).

Assistant Biochemist (with a B.Sc. in chemistry or biochemistry, or the A.R.I C.) in the Group Laboratory, Crumpsall Hospital—The Hospital Administrator, Crumpsall Hospital, Manchester 8.

Assistant Chemist (with a degree in chemistry, agricultural chemistry or A.R.I.C.), for analytical work on crops and soils—The Secretary, Rothamsted Experimental Station, Harpenden, Herts, quoting Ref. 1052/9.

Assistant Lecturer (graduate, with experience in teaching or in industry) in the School of Physics—The Registrar, College of Technology and Commerce, Leicester.

Assistant Lecturer (with a university degree in electrical engineering and practical experience in the electrical industry) in the Department of Electrical Engineering—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

Biochemist (with a science degree of a recognized university and special experience in medical biochemistry) with the Ministry of Health, Gold Coast Local Civil Service, to take charge of the Biochemistry Division of the Medical Research Institute—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.117/13/042.

Demonstrator (preferably with a university degree or professional qualification) in the Department of Aircraft Electrical Engineering, to take charge of the everyday running and maintenance of a teaching and research laboratory devoted to work in the telecommunications, radio navigational, radar and microwave fields—The Recorder, College of Aeronautics, Cranfield, Bletchley, Bucks, quoting Ref. ER/D.

Laboratory Technician (with considerable experience in virology and preferably also in tissue culture work)—The Secretary, Research Institute (Animal Virus Diseases), Pirbright, Surrey.

Laboratory Technician (with some training in bacteriological technique and preferably with Inter. I.M.L.T.)—The Secretary, Royal Veterinary College, Royal College Street, London, N.W.1.

Lecturer (Grade II) in the Department of Chemical Engineering—The Registrar, The University, Birmingham 15 (January 1).

Lecturer (with an honours degree or equivalent, and preferably some industrial or teaching experience) in Mathematics at Coventry Technical College—The Director of Education, New Council Offices, Coventry.

Research Assistant (with an honours degree in biochemistry or physiology, or a B Sc. (Pharmacy), with some research experience) in the Experimental Radiation Therapeutics Department—The Administrative Officer, Christie Hospital and Holt Radium Institute, Manchester 20

Senior Scientific Officers/Scientific Officers (with a first- or second-class honours degree in physics or electrical engineering, together with experience of conducting independent research in suitable aspects of electronics), to carry out original research into problems arising in the application of electronics to nuclear physics, and to develop new electronic techniques and methods of use in nuclear physics research—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting Ref. 1325/34.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Metallurgical Reviews. Vol. 1, Part 1, 1956. To be published quarterly. Pp. 156. Annual Subscription rates: Members of the Institute of Metals, 32*s.* 6*d.* (5 dollars); Non-members, 42*s.* (6.50 dollars). (London: Institute of Metals, 1956.) [189

British Museum (Natural History). Ruwenzori Expedition 1934–35. Vol. 1, No. 7: Tipulidae. By Charles P. Alexander. Pp. 129–380 + plates 27 and 28. (London: British Museum (Natural History), 1956.) 60*s.* [189

Aero Research Technical Notes. Bulletin No. 164: Honeycomb Sandwich Flooring for Aircraft. Pp. 6. (Duxford: Aero Research Limited, 1956.) [189

Institute of Navigation. Report of the Council, 1955–56. Pp. 16. (London: Institute of Navigation, 1956.) [189

British Broadcasting Corporation: Engineering Division. Monograph No. 8: An Automatic Integrator for Determining the Mean Spherical Response of Loudspeakers and Microphones. By A. Gee and D. E. L Shorter. Pp. 16. (London: British Broadcasting Corporation, 1956.) 5*s* [189

Memoirs of the Royal Astronomical Society. Vol. 67, Part 4: A Survey of Southern HII Regions. By Colin S. Gum. Pp. 155–178 + 12 plates. (London: Royal Astronomical Society, 1956.) 32*s.* [189

A Short Course in Radiological Protection. By the Health Physics Division and the Isotope School, A.E.R.E. Edited by R. J. Sherwood and H. J. Dunster. Pp. 118. (London: H.M. Stationery Office, 1956.) 13*s.* 3*d.* net. [189

Other Countries

Union of South Africa: Department of Agriculture. Science Bulletin No. 359: Fertilizer and Irrigation Experiments at the Upington Agricultural Research Station, 1942–1952. By C. P. Naude, T. P. Pretorius and I. J. Nothling. Pp. ii+42. (Pretoria: Government Printer, 1956.) 6*d.* [249

National Museum, Bloemfontein. Research, Vol. 1, Part 9: The Macrolithic Culture of Florisbad. By A. J. D. Meiring. Pp. ii+205–238 (5 plates). (Bloemfontein: National Museum, 1956) [249

Journal of Technology. Vol 1, No. 1 (June, 1956). Pp. 104. (A half-yearly publication of original contributions in Science and Technology.) Subscription rates: India, Rs. 10; Elsewhere, 16*s.*; 2.50 dollars. (Howrah: Bengal Engineering College, 1956.) [249

Institut pour L'Encouragement de la Recherche Scientifique dans l'Industrie et l'Agriculture. Rapport Annuel Exercice 1955. Pp. 236. (Bruxelles: Institut pour l'Encouragement de la Recherche Scientifique dans l'Industrie et l'Agriculture, 1956.) [249

Indo-Pacific Fisheries Council. Special Publications. No. 3: Economic Marine Algae of Tropical South and East Asia and their Utilization. By J. S. Zaneveld. Pp. ii+55. (Bangkok: FAO Regional Office for Asia and the Far East, 1955.) [249

United States Department of Agriculture. Circular No. 979: Dryland Crop-Rotation and Tillage Experiments at the Colby (Kans.) Branch Experiment Station. By J. B. Kuska and O. R. Matthews. Pp. ii+87. (Washington, D.C.: Government Printing Office, 1956) 35 cents. [249

National Academy of Sciences—National Research Council. Nuclear Science Series—Report No. 18: Basic Mechanisms in Radiobiology 4—Cellular Aspects. Edited by Harvey M. Patt and E. L. Powers. (Proceedings of an Informal Conference, Bear Mountain, New York, May 12–14, 1955.) Pp. vii+190. (Publication 450.) (Washington, D.C.: National Academy of Sciences—National Research Council, 1956.) [249

Indian Journal of the History of Medicine. Vol. 1, No. 1 (June 1956). Pp. iv+69. Published twice a year in June and December. Subscription rates: India, Rs. 8; Outside India, the foreign currency equivalent to Rs. 12. (Madras: Indian Association of the History of Medicine, 1956.) [249

United States Department of the Interior: Geological Survey. Water-Supply Paper 1280: Surface Water Supply of the United States, 1953. Part 6-B: Missouri River Basin below Sioux City, Iowa. Prepared under the direction of J. V. B. Wells. Pp. x+460. 1.50 dollars. Water-Supply Paper 1288: Surface Water Supply of the United States, 1953. Part 14: Pacific Slope Basins in Oregon and Lower Columbia River Basin. Prepared under the direction of J. V. B. Wells. Pp. viii+302. 1 dollar. Water-Supply Paper 1358: Geology and Ground-Water Resources of Buffalo County and Adjacent Areas, Nebraska. By R. L. Schreurs. With a section on the Chemical Quality of the Ground Water by Frank H. Rainwater. Pp. v+175+5 plates. n.p. Water-Supply Paper 1360-A: Reservoirs in the United States. By Nathan O. Thomas and G. Earl Haebeck, Jr. Pp. v+99+1 plate. 75 cents. Water-Supply Paper 1359: Geology and Ground-Water Resources of the Orestonsburg Quadrangle, Kentucky. By William E. Price, Jr. Pp. v+140+4 plates. 1 dollar. Bulletin 965-D: Birth and Development of Paricutin Volcano, Mexico. By William F. Foshag and Jenaro Gonzalez R. Pp. vi+355–490+plates 12–51. n.p. Bulletin 1009-K: Uranium-Bearing Nickel-Cobalt-Native Silver Deposits, Black Hawk District, Grant County, New Mexico. By Elliot Gillerman and Donald H. Whitebread. Pp. iv+283–312+plates 14–16. 65 cents. (Washington, D.C: Government Printing Office, 1956.) [249

The Time Concept in Special Relativity. By Prof. José Alvarez López. Pp. iv+32. (Cordoba: Edicion Scientia, 1956.) [249

Schweizerische Medizinische Wochenschrift, Beiheft zu Nr. 37: Herrn Prof. Dr. Fritz Verzar, zum 70. Geburtstag, 18 September 1956. Pp. ii+1041–1086. (Basel: Benno Schwabe and Co., 1956.) [249

Inter-American Tropical Tuna Commission. Bulletin. Vol. 1, No. 5: Observations on the Taxonomy, Biology, and Ecology of the Engraulid and Clupeid Fishes in the Gulf of Nicoya, Costa Rica By Clifford L. Peterson. Pp. ii+139–280. Vol. 1, No. 6: Studies of the Sexual Development and Spawning of Yellowfin Tuna (*Neothunnus Macropteris*) and Skip-Jack (*Katsuwonus Pelamis*) in Three Areas of the Eastern Pacific Ocean, by Examination of Gonads. Pp. 281–350. (La Jolla, Calif.: Inter-American Tropical Tuna Commission 1956.) [249

Publications de l'Institut National pour l'Étude Agronomique du Congo Belge. Carte des Sols et de la Végétation du Congo Belge et du Ruanda-Urundi 7, Bugesera-Mayaga (Ruanda), A, B et C. Notice explicative de la Carte des Sols et de la Végétation. Par R. Frankar et L. Liben Pp. 58+3 cartes. (Bruxelles: Institut National pou l'Étude Agronomique du Congo Belge, 1956.) 150 francs. [249

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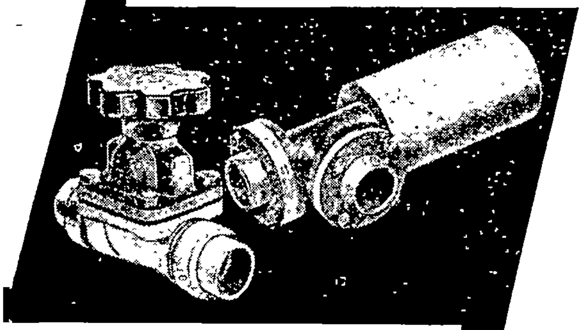

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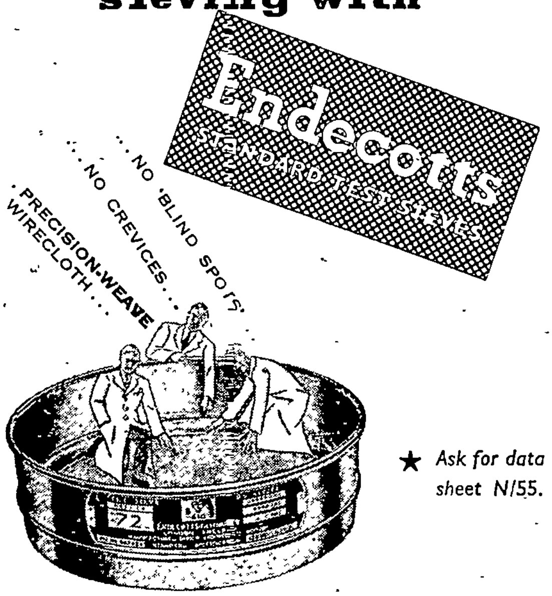

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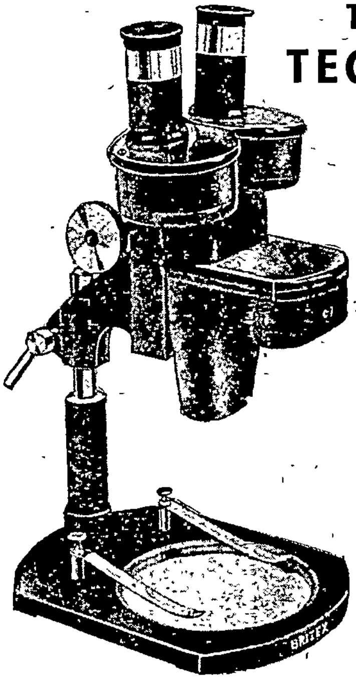

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OFFICIAL APPOINTMENTS

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FACULTY OF RURAL SCIENCE

Applications are invited for the position of Research Fellow or Senior Research Fellow in Dairy Science. The successful applicant will be expected to carry out fundamental research on the problem of depressed butter fat percentage in cattle on certain diets Salary will be fixed according to qualifications within the limits £A.1,100 to £A 1,500 for Research Fellows and £A.1,600 to £A 2,000 for Senior Research Fellows, plus cost of living allowance of, at present, £A.81 per annum (males) and £A.61 per annum (females). The appointment will be for three years in the first instance, and may be extended to five years

Further information and the conditions of appointment may be obtained from the Registrar, University of New England, Armidale, N S W. Australia, with whom applications will close on January 7, 1957

W. M. ROBB.
Registrar

COLLEGE OF AERONAUTICS

Applications are invited for the appointment of Lecturer in the Department of Aircraft Electrical Engineering. Salary dependent on qualifications and experience within a range rising to £1,200 per annum with F S.S.U. and family allowance. A university degree or equivalent in engineering or physics is desirable and candidates should preferably (though not essentially) have experience of one of the following: (a) electrical machine design, (b) aircraft electrical installations, or (c) electrical power systems. Successful candidate will be required to lecture at postgraduate level on aircraft and G.W. power systems and to assist in the equipping and supervision of laboratories Opportunities exist for private research work

Applications (quoting reference EP/L), giving full particulars and the names of three referees, should be forwarded to the Recorder, The College of Aeronautics, Cranfield, Bletchley, Bucks, from whom further particulars may be obtained.

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SYDNEY, AUSTRALIA

LECTURER IN APPLIED PHYSICS

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Five copies of applications (including the names of two referees), should be lodged with the Agent General for New South Wales, 56 Strand, London, W C 2, and one copy air mailed in an envelope "University Appointment," to the Bursar, Box 1, Post Office, Kensington, Sydney, Australia, before December 27, 1956.

UNIVERSITY OF MANCHESTER

Applications are invited for the post of Lecturer or Assistant Lecturer in Mathematical Statistics. The successful candidate will be expected to assist in advisory and research work in addition to his teaching duties. Salary scales per annum: Lecturer, £650 to £1,350· Assistant Lecturer, £550 to £650; initial salary and status according to qualifications and experience. Membership of F S S U and children's allowance scheme.

Applications should be sent not later than January 1, 1957, to the Registrar, the University, Manchester, 13, from whom further particulars and forms of application may be obtained.

DRUMMOND FELLOWSHIPS FOR RESEARCH in Nutrition. The Managing Trustees will consider in March, 1957, applications for Drummond Fellowships, normally tenable for two years. One Senior Fellowship: value £900 per annum, superannuation and expenses grant. Not more than two Junior Fellowships value £500 per annum, plus expenses grant —Full particulars from Honorary Secretary, Drummond Trust, University College London, Gower Street. W C 1. Completed application forms must be received by January 31, 1957.

COMMONWEALTH of AUSTRALIA

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION

DIVISION OF FOOD PRESERVATION AND TRANSPORT

APPOINTMENT NO. 305/46 OF BACTERIOLOGIST

Applications are invited for appointment to a position of Bacteriologist on the staff of the Division of Food Preservation and Transport's Meat Research Laboratory situated in the grounds of the Brisbane Abattoir, Queensland. The Division is concerned with problems of wastage, quality, and efficiency in Australia's food processing industries The question of storage and transport has particular interest because of Australia's comparative isolation from the major food importing nations and the appointee will be required to supervise, under the direction of the Senior Bacteriologist of the Division, the work of a small group of investigators studying the metabolism of phychropilic micro-organisms and the application of the results to the microbiology of chilled and frozen meat. Applicants should possess a university honours degree with bacteriology or biochemistry as a major subject and postgraduate research experience in bacteriology. Prior experience with meat is not essential Dependent upon qualifications and experience appointment will be made within the salary ranges of Research Officer (£A.1,287 to £A 1,912 per annum) or Senior Research Officer (£A.2,022 to £A 2,297 per annum). First-class sea fares will be paid to Australia for the appointee, his wife, and family The appointment will be conditional on a satisfactory medical examination and the successful applicant will be required to contribute to, and eligible to receive benefits from either the Commonwealth Superannuation Fund or the Commonweath Provident Account.

Applications, referring to Appointment No 305/46, and stating full name, place, date and year of birth, marital state, nationality, present employment, particulars of qualifications and experience, and of war service, if any, accompanied by copies of not more than four testimonials, and the names and addresses of at least two persons willing to act as referees, should reach the undersigned, from whom further particulars may be obtained, not later than December 28, 1956

A SHAVITSKY.
Chief Scientific Liaison Officer
Australian Scientific Liaison Office,
Africa House, Kingsway, London, W C.2.

UNIVERSITY OF MALAYA

SINGAPORE

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Detailed applications (six copies), naming three referees, by January 31, 1957, to Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W C 1, from whom further particulars may be obtained.

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benefits are provided, to which the succes
candidates will be required to contribute 5
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dates must have taken a degree in a faculty
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Ireland, or a medical diploma registrable in
United Kingdom. Elections to Junior Fellows
are rarely made above the age of 35 years.
plications from candidates must be received
later than April 1 Candidates must sub
evidence that they can be given accommoda
in the departments where they propose to w
which must be either in Great Britain or Irel.

Forms of application and all information
be obtained by letter only, addressed to the Se
tary, Beit Memorial Fellowships for Medical
search, the Lister Institute, Chelsea Bridge R
London, S W 1. For overseas candidates fo
of application may be obtained from the Se
tary, South African Medical Council, P O
205, Pretoria, South Africa; The Director, C
monwealth Office of Education, Box 3879,
ney, Australia, the Department of Health,
lington, New Zealand, and the Canadian Med
Association, 244 St. George Street, Toro
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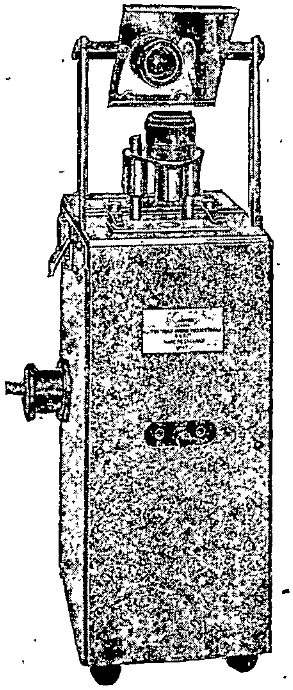

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PITMAN

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DEPLOYMENT OF SCIENTIFIC MAN-POWER IN BRITAIN

THE central theme with which the Advisory Council on Scientific Policy has been concerned during the past year or more is that of scientific man-power in Britain. The results of two inquiries by the Council's Committee on Scientific Man-power have already been published as separate reports. The ninth annual report of the Council, recently issued*, which covers the fifteen months from April 1955 to June 1956, inclusive, is devoted mainly to other matters with which the Council has been concerned; apart from a brief note in which the Council welcomes the Government's announcement of its plans for the expansion of technical education and also the prospect of substantial new developments in the universities during the next quinquennium. Nevertheless, the problem of scientific man-power may be said to provide indirectly the keynote of even the present report.

It is true that, as the Council remarks in this report, everything possible also needs to be done to ensure, by adequate provision for the secondary schools, that there are enough potential students of the right quality to take full and proper advantage of the increased provision for higher education in the pure and engineering sciences. It is no less true, however, that the nation's demand for scientific man-power, in both the pure and the applied sciences, depends on the efficiency with which that man-power is used. It is right that the recent White Paper on the Factory Inspectorate should stress the importance of making sure that at the present time, neither in Government departments nor in industry, nor, it might be added, in the universities or in teaching, should a highly trained scientist or technologist be employed on duties which do not make reasonably full use of his or her special qualifications and knowledge. It is well that the Service Ministries should be pressed hard in Parliament as to the duties on which they employ science and engineering graduates, and that there should be other evidence that it is at least being recognized in industry and elsewhere that such scarce knowledge and skills are to be used with due forethought and economy.

The wise and economic use of scientific man-power depends also on the provision both of ancillary technical assistance and of the requisite aids and equipment. The ninth annual report of the Advisory Council on Scientific Policy does not refer to the former, though, in view of the lacuna in this respect in both the White Paper on Technical Education and the more recent report on Scientific and Engineering Man-power in Great Britain, it might well have been expected to do so if only to clarify the distinction between technical and technological education, and to emphasize that there is need of a really large expansion in the number of technicians. More technicians are undoubtedly needed to ensure that existing resources in scientific and technological man-power are used efficiently, let alone the increased numbers which the expanded facilities for technological and scientific training should provide. There is still very real danger that the expansion of the technical colleges in Britain may be so conducted as to hinder their primary function of providing the necessary technicians, and that the effect of an increase in the number of technologists and scientists may be more than offset by the absence of a sufficient force of supporting technicians.

This ninth annual report is, however, concerned with various aspects of the provision of the ancillary aids, and its common theme might be said to be the provision of means to make more effective use of scientific and technological man-power in Britain. This may not be directly true of the detailed study of the various systems of training engineers in different countries which, with the help of other interested bodies, the Advisory Council is seeking to arrange; but by providing, as the Council believes it would, useful guidance in the development of technological education, this study could well contribute to an increase in the efficiency of technological education, even if it pointed to no economy in man-power there. Even in the United Kingdom, there is a wide range of technical qualifications and methods of training technologists, and there is abundant evidence of muddled thinking, not least in Government circles, about technological education, which such a study could at least help to remove.

Much more serious, however, is the matter of the National Scientific Reference and Lending Library projects. In its eighth annual report, the Advisory Council emphasized once again the importance which it attached to an adequate national service of scientific reference and lending libraries as an essential tool in disseminating the results of scientific research to industrial and other users; and since then there has been strong support for the Advisory Council's view—particularly at the recent conference of the Library Association—some of it referring to the bearing of these projects on the efficient use of scientific and technological man-power.

The Advisory Council's hope that the Government would give firm decisions in favour of an early start on both projects has again been disappointed. Once more the Council has to report that no progress has been made; provision of £2,500 in the current estimates for the purchase of literature for the future National Scientific Lending Library, to be housed for the present in the Science Museum Library in South Kensington, points to a complete failure on the part of the Government to appreciate the vital bearing of ancillary aids on the economic use of scientific man-power. For lack of the material service recommended by the Advisory Council, it is probable that scientific effort representing many times that £2,500 is wasted every year, and there is no sign as yet that the Government is prepared to take any step to arrest this wastage of one of our most precious assets.

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* Ninth Annual Report of the Advisory Council on Scientific Policy. London: H.M. Stationery Office, 1956.) 1s. 6d. net.

The Advisory Council has been informed that a decision has been taken to place ultimate responsibility for the National Science Lending Library on the Department of Scientific and Industrial Research, and the Department has been authorized to start planning such a library. The Council accordingly hopes that another year will not pass without some concrete evidence that its recommendations are being put into effect. There is no indication, however, that any action is contemplated about the Reference Library project. Moreover, the full advantage of neither project can be gained if it is planned and executed in isolation or without regard to the building up of an appropriate supporting regional system. No confidence can be entertained in the Government's intentions until it takes up these schemes as part of the Science Centre project, and allocates the sum required to make this essential contribution to the efficient use of our resources in scientific and technical man-power.

The Advisory Council, which should certainly be thinking about its next step, does not leave it at that. It cites the difficulty of handling the ever-increasing output of Russian scientific and technical literature as an example of the inadequacy of the national scientific library service in Britain. No simple recipe for dealing with this problem is offered. The Advisory Council is content to outline the main components of the problem as a basis for discussion, but is careful not to divorce its solution from the long-overdue general modernization of library and information service for all scientific and technical literature. The importance of various factors—the extent to which Russian is read and the encouragement of the teaching of Russian as an important modern language in schools and universities, the securing of Russian scientific literature and making it available, its dissemination and translation—varies, but the problems are not unique and apply in varying degrees to literature in Chinese, Japanese and other languages. Since the Department of Scientific and Industrial Research already runs a limited translating service for Russian scientific periodicals and is to be responsible for planning the proposed National Scientific Lending Library, the Advisory Council has invited the Department to survey existing facilities and to consider what additional arrangements are required. This investigation, in consultation with the Advisory Council's Scientific Library and Technical Information Committee, is already under way.

Of a different order are the proposals to establish a national research centre at which a number of high-energy particle accelerators might be installed to provide research facilities for teams from universities and other institutions concerned with nuclear physics, and to set up in Britain a central mineral-processing laboratory to undertake research into the methods of treating low-grade and complex ores and into chemical and other processes of extractive metallurgy which have been successfully developed. The former proposal, which came to the Council from the Atomic Energy Authority, is under discussion with the university authorities. Various bodies during the past few years have urged the establishment of central facilities for long-range research in the latter field, and the Department of Industrial and Scientific Research is at present discussing with scientific and industrial interests the possibility of establishing such a centre. Although the proposals involve a risk that the centre might monopolize the research facilities available, both schemes offer the possibility of increasing the effectiveness of existing workers in this field by providing them with more adequate equipment and technical assistance.

Of a like nature in its bearing on the effective deployment of scientific man-power is the proposal examined by a working party of the Advisory Council's Biology and Allied Sciences Committee to establish in Britain a centre for tropical agriculture. As territories have become self-governing, British experts in the various agricultural and forestry services have been gradually withdrawn and many have left such territories as Burma and the Sudan, either at their own wish or under pressure from the governments of those territories. If Britain is to help the future development of these newly independent territories, she must be able to provide the training and advice in agricultural matters which they still urgently need; and the working party was convinced that an institution in the United Kingdom is needed both to ensure a future supply of British experts in tropical agriculture, forestry and fisheries, and also as a place which citizens of tropical and sub-tropical countries can use as a base and to which they can turn for advice when studying in Britain.

The need is not for a new college or school for tropical agriculture, the place for which is in the tropics; but for an institute which can help in tackling these problems, and others, such as identifying the most urgent and important problems of research, serving as a channel of communication between agricultural interests in tropical territories and British firms at home and as a meeting place and clearing house for inquiries and advice. The working party was not asked to draw up a plan for such an institute, but the Advisory Council is in broad sympathy with the lines on which the working party suggests the problem should be tackled. In particular, it agrees that the proposed institute, while enjoying support from government sources in Britain as well as from industry and philanthropic institutions, should not be itself a government organization. The working party's report has been submitted to the various Ministers concerned, but it would seem that in view of the potentialities of the proposal for economy in scientific man-power, it could well have been backed by something more tangible than the hope that early consideration will be given to the best means of achieving them.

The remaining two matters discussed in the report —the population problems of tropical countries and esearch in independent Commonwealth territories—also bear on the utilization of scientific man-power. The latter problem directly affects the demand for cientific man-power, and the Advisory Council believes it is desirable that the Agricultural and Medical Research Councils and the Department of Scientific and Industrial Research should co-operate n the provision of scientists for work in the independent Commonwealth territories as well as in the Colonial territories, even if it means adjustments in their present powers to operate overseas. These bodies have already been asked to give further thought to the measures necessary, and the Advisory Council is convinced that it is in the best interests of the territories themselves, and of science and scientists n Britain, for British scientists to continue and ncrease their activities and research in the Commonwealth overseas.

Developments here could increase the demand for cientific man-power in Britain, as well as increase the efficiency with which it is used in some fields. The former matter calls for an increase of expenditure and man-power in a field that will require much work before practical results are obtained. The two main lines of approach to this difficult problem of population growth in tropical countries are social research into problems of family life and social attitudes towards them, and physiological research into the ontrol of fertility and infertility. It is essential to build up a store of knowledge in the latter field, as no artificial means of birth control has any prospect of uccess unless it is desired by the people who are to use it. The need for financial support from the United Kingdom for research into problems of family life in these territories became urgent during the past year, for American authorities which have been responsible for a large-scale investigation in Puerto Rico wish to extend their studies to other territories, ncluding British Colonies. Money has been made available for such a project in Jamaica, but similar tudies are needed elsewhere, and there is no guarantee that any funds will be available after the present Colonial Development and Welfare Act terminates in 1960.

The Advisory Council looks to the Medical Research Council in Britain to proceed as fast as possible with its researches into fertility and infertility and the factors affecting them; but it has hitherto been difficult to persuade sufficient scientists to take up this line of work. Nor does this report suggest any assured prospect of adequate financial support from Government or other sources. Here again is an important field demanding a greater research effort, ut one which could ultimately result in the saving f scientific man-power and in the more effective pplication of scientific and technical knowledge. The Advisory Council on Scientific Policy's ninth nnual report displays admirably the bearing of iverse ancillary matters such as equipment and upporting technicians on the demand for scientific man-power and the efficiency with which it is used; ut presumably its very terms of reference prevent t from calling for action with the vigour and firmness which the situation demands.

SIR JOHN RUSSELL, F.R.S.

The Land Called Me

An Autobiography. By Sir E. John Russell. Pp. vi+286+5 plates. (London: George Allen and Unwin, Ltd., 1956.) 25*s*. net.

I ESTEEM it an honour to be asked in my ninetieth year to review the autobiography of so distinguished and unique a personality as Sir John Russell, acclaimed throughout the English-speaking world—and in many countries outside it—as Britain's outstanding agricultural scientist, and I do so with the greater pride as he was born in a village (Frampton-on-Severn in my own county (Gloucestershire), where his father was a nonconformist minister.

Russell has been unique in his combination of profound scientific knowledge (based upon research and experiment) with an unrivalled capacity for imparting it to others in simple, easily intelligible language, untiring energy, a passion for land development in every part of the world and, above all, deep human sympathy and a yearning for the alleviation of human ills. Well might he say, as Abou Ben Adhem said to the Recording Angel, "Write me as one who loves his fellow men". In view of what became his life's career: it is interesting to note that his youthful zeal as a social reformer while running a mission in the slums of Manchester when a student at Owens Cottage developed in him a craving—albeit without worldly means—to establish an agricultural settlement in the countryside into which its degraded and poverty-stricken slum population could be moved, and with that object he sought, and obtained, a post as a lecturer in chemistry in Wye Agricultural College, Kent.

Russell's social settlement scheme proved impracticable. But this it was which brought him for the first time (at the age of twenty-nine) in touch with agriculture and the land. Thereafter the "Land called" him and eventually placed him in the forefront of its most eminent scientific pioneers. He relates how he never saw a hill without longing to climb to the top of it, and this was true in a moral and intellectual, as well as a physical, sense, the dominating motive being the betterment of humanity and of its chief sources of food. Considering his strenuous professional life, his constant journeys to countries in almost every part of the world and the innumerable lectures which he delivered in them, not to mention his recorded observations of their social, political and economic conditions, are among the surprises of this highly instructive and thrilling narrative, besprinkled with humorous anecdotes and quaint sayings. In almost every country that he visited, honorary degrees and other distinctions were conferred upon him.

Among outstanding landmarks in Russell's amazing career were his appointment in 1907, at the age of thirty-five, as director of Rothamsted Experimental Station, our oldest and greatest agricultural research station, the award of the Albert Gold Medal of the Royal Society of Arts, his presidency of the British Association for the Advancement of Science at its Newcastle meeting in 1949, the celebration of his golden wedding in 1951 in the hall of St. John's College, Oxford, and that of his eightieth birthday in 1952 in the Apothecaries Hall in the City of London, and in 1954 the presentation to him by the Queen of the Gold Medal of the Royal Agricultural Society at the Royal Show at Windsor.

Not the least valuable of his life's assets, as he affectionately testifies, have been a devoted and selfless mother and wife. The eminent autobiographer has proved himself in every sense a great Englishman and a fine exemplar to our rising generation.

BLEDISLOE

EDUCATION OF THE LAYMAN IN ATOMIC ENERGY

Facing the Atomic Future

By Prof. E. W. Titterton. Pp. xi+379+6 plates. (London: Macmillan and Co., Ltd.; New York: St. Martin's Press, Inc., 1956.) 21*s.* net.

WE have heard a great deal since the advent of the atomic bomb about the social responsibility of scientists and the need for them to teach the public more about the implications of scientific advances. If the scientist is to succeed in this task it is essential that his pupils should be prepared to co-operate with him and to work seriously. At the same time, in the field of education we hear more and more about the importance of preserving breadth in the training of the scientists and technologists through the provision of courses in the humanities. It is not by any means equally obvious to some of our educators that those trained in the humanities should be furnished with a reasonable grounding in science and technology. Indeed, it is alarming to find in some quarters what appears to be a kind of pride in confessing to an almost complete ignorance of science. This situation makes it an extremely difficult, and indeed almost impossible, task to write in an instructive way for a very large cross-section of the educated public. There is a large fraction of those forming the rather nebulous group known as 'intelligent laymen' who have no real grasp of science. To those content to remain in this category there is nothing to be said in favour of the admirable effort of Prof. E. W. Titterton in this volume.

He has written a book which is in no sense superficial in its treatment of a very vast subject, and his book is one which demands concentration on the part of the readers for whom it is primarily intended. In spite of clarity of style, a thorough grasp of the many major topics with which he chooses to deal and the liberal use of analogy, it is, as might be expected, impossible for the author to avoid or gloss over the hard scientific core of the subject. Indeed, the book would fail in its purpose if the author had tried to do so. He chooses then to meet the difficulty fairly and squarely, and he succeeds very well in all the important aspects of his task. Nevertheless, for the reasons already advanced, it is difficult to say with any confidence how far he will achieve the particular aim which is in his mind. The specialist, reasonably conversant with much of the material, will find the exposition a little laboured, whereas the 'intelligent layman' will need to make a determined effort to understand.

It might be questioned whether the author is wise to include so much detail about the existing situation. It is true, as he himself rightly points out, that the great majority of books are out of date; but it is difficult to ensure any really lasting value to a book if it deals very largely with the detailed features of the field, since these may change very rapidly. It could be argued that Prof. Titterton in this book deals somewhat excessively with the present situation and that he includes the particular to an extent which is rather excessive for a book intended for the further education of the 'intelligent layman'.

With these remarks, I have expressed the only doubts that rise to mind. There are many points on which I am perfectly happy. Thinking of the type of reader who is educated in science or engineering, though not necessarily engaged in pursuits specifically involving such education, I can confidently assert that these readers will be rewarded by a careful reading of this volume. It should give them a thoroughly up-to-date and comprehensive knowledge of the many advances that have been made and an idea of those likely to come in the future. They will find a thoughtful attempt to assess these advances in relation to the functioning of society. The same features should make the volume very valuable to those genuinely seeking an understanding—for example, students in extra-mural classes dealing with modern science. Certainly, with a minimum of help from a teacher, the book could become an exceedingly valuable text.

Prof. Titterton divides his volume into three main parts: atoms for peace; atoms for war; and social and political problems of atomic energy. Each part is dealt with in considerable detail, and the first, not unnaturally, accounts for roughly three-fifths of the whole. The second and third parts are roughly equal in length. The author has collected together much of the openly published material on weapons, and he analyses and discusses it in a careful and factual manner. The same approach is made to the social and political problems—he is admirably unemotional in dealing with the many grave issues that are raised. In this part he guides us skilfully through the maze of efforts that have been made to reach international co-operation in the field.

There is another feature of the book that calls for favourable comment. It is difficult to imagine much improvement on Prof. Titterton's selection of facts and figures. Without giving the impression of a pocket encyclopædia in any way, the book contains a very notable store of useful general information in the form of tables. Thus in Chapter 4, on the need for an atomic power source, are found tables giving water-power, coal and oil in terms of geographical location and under a variety of sub-divisions such as annual production and reserves. The tables reveal many interesting and thought-provoking facts such as the power per head of population in various parts of the world. In this respect the book will form a useful addition to the literature, since it has rapidly become increasingly difficult in the great volume of detailed literature on atomic energy to find the more general facts and figures. Prof. Titterton, as befitting the holder of the chair of nuclear physics in the Australian National University, Canberra, gives in some detail the Australian side of the picture.

To the serious reader this book will provide a really comprehensive survey of the subject so far as it has been made available, and it will provide the basis of a well-balanced view of the advances already made and the probable scope in the near future o the field of atomic energy. It will provide him with the background necessary to a continuing appreciation of a very rapidly expanding subject. The serious work of the author deserves serious application on the part of the 'intelligent layman'. Books such as this from practising scientists are the best answer to the call for more education of the public in the specialized fields. They constitute in turn a challenge to the 'intelligent layman' to fulfil his part of the task. The author's efforts should not be in vain, as the book will provide those with a reasonable grounding in the physical sciences with a straightforward but uniquely comprehensive picture of perhaps the most important field of scientific activity and engineering of the present day. It is refreshing to find a book which shows no tendency to the somewhat hysterical approach to the subject evident in the works of others who aim at catching the attention of the layman. The phase in which there was any justification for such treatment is long past, and a sober factual exposition is now required. The book provides this admirably.

S. C. CURRAN

BIOLOGY AND MEDICINE OF ATOMIC WARFARE

Medical Effects of the Atomic Bomb in Japan

Edited by Prof. Ashley W. Oughterson and Prof. Shields Warren. (National Nuclear Energy Series: Manhattan Project Technical Section. Division 8, Vol. 8.) Pp. xvi+477. (London: McGraw-Hill Publishing Company, Ltd., 1956.) 60*s*.

MILITARY science is advancing apace, and not least in the development of atomic weapons. Military medicine must necessarily keep abreast of he times. It is now more than ten years since the first atomic bombs were detonated over Hiroshima and Nagasaki to conclude the Second World War. These nominal atomic bombs were then about a thousand times more powerful than the current igh-explosive bombs. To-day, 'hydrogen' bombs are rated at about one thousand times the power of ominal atomic weapons. This volume, therefore, ite though it may appear to be, is a necessary work f reference for everyone in the medical branches of rmed forces and civil defence.

The contents have been hitherto available only in multitude of specialized reports, such as those of he Joint Commission for the Investigation of the Effects of the Atomic Bomb in Japan and its successor, he Atomic Bomb Casualty Commission. This book ummarizes the early reports and supplies much of he evidence in a convenient form. Prof. Ashley Oughterson, clinical professor of surgery in the Yale University School of Medicine, was editor-in-chief of he report (in six volumes) of the Joint Commission. rof. Shields Warren, professor of pathology in the Harvard Medical School, and lately head of the Division of Biology and Medicine of the Atomic Energy Commission, has personally assessed the athological material.

There are two main features to be stressed. First, Although the atomic bomb is a finite weapon whose ffects can be calculated and partly offset, it has made possible the infliction of stunning casualties at far lower cost in men, money and materials than ever before". The medical problems raised are herefore not so much technical as administrative— amely, how to cope with tens of thousands of casualties, as at Hiroshima, with virtually all local facilities estroyed. The element of surprise found the apanese medical administration wanting; but seventy per cent of the total deaths, in Hiroshima ccurred on the first day. At least another 5 to 10 per cent of those who died were so seriously injured that death was unavoidable. . . . It is apparent that if the mortality from atomic bomb explosions is to be effectively reduced, chief reliance must be placed on preventative measures". The second point is that casualties from the secondary effects of blast and from burns presented few novel pathological features. The influence of ionizing radiation on the response to injury was a strikingly new feature, and radiation injury alone was a common cause of death and severe illness. The clinical and pathological features of this syndrome are carefully analysed.

The book is notable for the very large amount of material presented graphically, tabulated or pictorially. There are so many photographs of clinical and histological material that special plates are a rarity, and most of the production is on the very good paper of the ordinary pages. For most of the clinical photographs this is adequate, but many of the photomicrographs are more than usually obscure.

J. F. LOUTIT

BUILDING: MYTHS AND MAGIC

Architecture, Nature and Magic

By W. R. Lethaby. With a Biographical Note by Alfred Powell. Pp. 155+15 plates. (London: Gerald Duckworth and Co., Ltd., 1956.) 16*s*. net.

IT was more than fifty years ago when Mr. W. R. Lethaby, who died in 1931, published a little book with the title of "Architecture, Mysticism and Myth". It was true, as the author rather humorously admitted, that there was very little about mysticism in the book; but the title had some substance in it, since it was the first-fruits of a study of what the author considered to be the less understood causes which were so closely connected with the art of building.

Mr. Lethaby believed that ideas of building and architecture generally were intimately allied with other ideas relating to the general structure of the world, and also that man's concept of Nature and his belief in magical properties had a profound influence on the development of ancient architecture. To Mr. Lethaby, man was primarily a builder, and in his architecture he formed a kind of framework for his explanation of the universe. Thus in viewing man's building processes a mere æsthetic appreciation was not enough: it was only by understanding the religious and magical ideas of any particular epoch that the architecture of the period could be fully understood. After "Architecture, Mysticism and Myth" was published, Mr. Lethaby set to work to re-write his thesis in a more comprehensive form. He found, however, that the mass of material on the early history of man, his myths, his magic and his cults, was so voluminous that he finally gave up the attempt; and it was not until 1928 that he re-wrote, with additions, much of his former material and published it in a series of articles in *The Builder* under the title "Architecture, Nature and Magic". These are the articles which are now reprinted in the present more convenient form and they illustrate not only the wide range of Mr. Lethaby's reading but also the power of his imagination and the depth of his understanding.

In the course of his discussion, the author deals with man's idea of the fabric of the world, with special reference to the world tree and the temple of heaven. He then proceeds to examine these ideas as seen in the architecture of both East and West. Following from these more general considerations, he goes on to consider the more detailed aspects of building, linking up both ornament and style with magical beliefs and the deeper mental processes deriving from the unconscious mind of the master builders. It is here that Mr. Lethaby is at pains to show that modern architecture, when it attempts to copy the past, has lost its soul. To him these sham styles are, as he so graphically puts it, the mere "grimaces of grown-ups". The age of magic has passed: what remains is, to the author of this illuminating book, the mystery of reality, and although mysticism and an outmoded view of the universe have passed away, both mystery and beauty are still left in service and science. If the modern builder is able to achieve a high functional beauty, then he will be able to show in his own architectural creations the same kind of inspired and creative work that Mr. Lethaby has shown to exist in the great buildings and decorative architecture of the ancient world.

E. J. DINGWALL

BOTANY OF BRITISH HILLS

Mountain Flowers

By John Raven and Dr. Max Walters. (The New Naturalist: a Survey of British Natural History.) Pp. xv+240+40 plates. (London: William Collins, Sons and Co., Ltd., 1956.) 25*s*. net.

THE New Naturalist series has proved a potent force in stimulating popular interest in British field natural history during the post-war years, and this latest addition is well in the best tradition of its predecessors—at once informative, authoritative and eminently readable. Already in the series there has appeared a classic concerned with the vegetation of the higher parts of the British Isles in Prof. W. H. Pearsall's "Mountains and Moorlands"; the present volume, as its authors affirm, is scarcely comparable with that of Pearsall as a scientific study, but it is nevertheless in many respects complementary, concerned as it is with the floristic rather than the ecological aspects of the mountain flora.

The book is written in two principal sections: a general one in which the history of the botanical exploration of the British mountains is reviewed and some account given of the nature and history of their flora, and a regional one in which characteristic species of the more important mountain systems of the British Isles are described and discussed. In the appendixes, the authors provide lists of the mountain flora with distribution maps for several species, and keys for the identification of three critical genera with several representatives on the British hills, *Hieracium*, *Alchemilla* and *Salix*.

The chapters concerned with the environment, nature and origins of the British mountain flora in the general section are the work of Dr. Max Walters. He presents the ecological features of montane habitats starkly and in rather general terms; for an appreciation of the subtlety of the interaction of organism and environment in the communities of the hills, the reader would do well to follow his advice and consult other books of the New Naturalist series, notably those of Gordon Manley and of Pearsall. Dealing with the general biology, distributions and origins of mountain plants he is much more at home. Chapte 4 should be particularly informative to naturalist without access to professional journals, containing as it does, an excellent general account of the tren of contemporary thinking about the history of th mountain species of Britain. Included therein is a survey of the evidence obtained from the investigation o Quaternary peat deposits—evidence which has s convincingly confirmed the view of Edward Forbe of more than a century ago, that the arctic and alpin elements of the British flora, now mostly restrict to the mountain summits, are essentially the residu of a tundra type of vegetation once widespread, eve in the lowlands, during the later stages of the glaciation.

Mr. John Raven contributes the historical intr duction, and a number of pleasantly written chapte in the regional section. He is evidently a great love of rare plants, and one who gains much pleasu from the hunt-the-slipper element so conspicuous i mountain botany. He has a lively sense of t principle of relative rarity—that what matters i extracting the maximum entertainment from pla hunting is not so much how common a plant is i area *A*, but how difficult it is to find at all in area Perhaps, however, he does not carry the princip far enough, for his disparaging comments on t general poverty of the Irish mountain flora awake a defensive reaction in at least one of his readers.

Both authors are repeatedly at pains to stress t need for preserving what remain of our mounta plants, and are commendably reticent about localiti for rarities. Nevertheless, one is uncomfortab aware of the grim possibility that a book like thi by its very success in popularizing the British mou tain flora, may increase the threat to its continue existence if it results in even more profligate collec ing. It must be agreed, of course, that a good de of the damage has been done and is being done agents other than collectors; even the weights dried montane herbage in herbaria must be insig ficant compared with the tons converted over t years into mutton. But in the present situati where the 'best' mountain plants often survi happily enough in minor oases, inaccessible to shee and fire although surrounded by burnt and graz deserts, it is the collector who is their most seve enemy. Furthermore, it is not the indiscriminati tyro who forms the greatest menace to the ma mountain species which are distinguished only their rarity, but rather the type of expert who, his vanity, imagines that the needs of his particul herbarium or his special research privilege him ignore the moderation in collecting which he wou so severely enjoin upon others.

As one now expects from the New Naturali volumes, the photographic plates, colour and mon chrome, are mostly of a high standard. Some perha lack the sparkle that a touch of sunshine would ha given, but who would deny that this is appropria enough in portraits of inhabitants of the British hil Most of the illustrations are in fact of native in viduals. Of the exceptions, it is unfortunat understandable enough why it was necessary to vi the Austrian Alps for a photograph of *Pinguic alpina*, but it seems a little superfluous to ha journeyed so far as North Greenland for a picture so accessible a British mountain plant as *Sil acaulis*. In the interests of newcomers to mount botany, some indication of scale might well have be given for the plates.

J. HESLOP-HARRISON

THE ROYAL SOCIETY

ANNIVERSARY ADDRESS* BY SIR CYRIL HINSHELWOOD, F.R.S.

ANOTHER year of intensive preparation reached its climax on November 13 when H.M. the Queen visited the *Magga Dan*, which was to convey the Royal Society expedition to the Antarctic, and when the members of the expedition were presented to her. The ship sailed two days later bearing the good wishes of all, on this combination of physical and scientific adventure which will make an important contribution to the International Geophysical Year. A great debt is owing to all who took part in the arrangements and especially to Sir David Brunt and to Dr. D. C. Martin, who have borne so much of the burden and heat of the day.

When he has completed a year of office, the President cannot but be very conscious of all that he himself owes to the other officers and to the staff at Burlington House. As the activities of the Society increase this becomes more and more one of the major things which need to be emphasized in this address. I must speak specially of the retiring Treasurer, Sir Thomas Merton, who is handing on his great responsibilities after seventeen years of unique service in that office. Sir Thomas took control of the Society's finances at a moment when they were beset by difficulties of all kinds. By a whole series of wise reorganizations, by a brilliant policy of reinvestment and by unremitting vigilance, he not only weathered the storm but has left the financial position of the Society stronger than it has ever been. Sir Thomas not only carries with him our grateful appreciation for what he has done, but also the assurance of an honoured place in the history of the Royal Society.

AWARD OF MEDALS, 1956

Copley Medal : Prof. P. M. S. Blackett, F.R.S.

Prof. Blackett has made important contributions to three main fields of physical discovery : the interaction with matter of fast particles from radioactive sources, the nature of the particles in the cosmic rays, and the magnetism of the Earth. In each of these he has combined outstanding insight and skill with novel developments in instrumentation.

During 1921–31 he was chiefly occupied with the development and operation of automatic Wilson cloud chambers and their application to the precise measurement of the parameters involved in collisions between α-particles and atomic nuclei. He showed that very infrequent inelastic collisions with nitrogen produced the then unknown isotope ^{17}O by the capture of the α-particle and the ejection of a proton.

In this period also he verified, with Champion, the Mott theory of the wave-mechanical diffraction scattering of slow α-particles.

From 1931 onwards he applied and extended the cloud-chamber technique to the study of the collisions involved in the cosmic rays, establishing (with Occhialini) the existence of nearly equal numbers of positive and negative electrons. This confirmed Anderson's discovery of the positive electron a few months before and extended it by giving strong evidence for actual pair production. The 0·5 MeV. scattered γ-rays were recognized by him to arise from the annihilation of positive and negative electron pairs.

Blackett proceeded to study in more detail the nature and the energy spectrum of cosmic-ray particles. Much valuable work on cosmic-ray showers was carried out under his direction, and he himself explained the negative temperature coefficient of the cosmic rays in terms of the decay of the μ-meson.

These detailed studies led to a discovery which opened up a new field when Rochester and Butler in Blackett's Manchester laboratory in 1946 found the first neutral V-particles and in 1947 the first charged V-particles. The identification by the Manchester team of V^0 decay into a proton and a pion and of the probable division of a V^1 particle into two pions, together with the best determination to date of the life-times of V^0 and V^1 neutral particles, are outstanding further discoveries. These were made possible by Blackett's energetic action in moving the equipment to the observatory of the Pic du Midi.

From 1947 onwards he interested himself in the possibility, originally discussed by Schuster, of a 'fundamental' connexion between the angular momentum of a large rotating body, such as the Earth, and its magnetic field. Although experiments conducted and directed by him gave no support to this idea, the sensitive magnetometer designed by Blackett for this work has been used by him and by Runcorn at Cambridge with success in remarkable studies of palæomagnetism and the light it can throw on polar wandering and continental drift.

Throughout his career Blackett has shown great ability and drive in organizing team effort in difficult fields of research. The building up of the Jodrell Bank radioastronomical station by Lovell owes much to him. He was awarded a Royal Medal in 1940 and the Nobel Prize for Physics in 1948.

Rumford Medal : Dr. F. P. Bowden, C.B.E., F.R.S.

Dr. Bowden is recognized as a leading research worker on the properties of solid surfaces. His early work was on the mechanism of the electrodeposition of ions at metal surfaces. He then turned his attention to the nature of the contact between solid surfaces and the mechanism of friction. He showed that however carefully surfaces are prepared they are generally covered with asperities large compared with atomic dimensions. When such surfaces are placed together, they touch at the tips of these asperities, which are crushed down until they are large enough to support the applied load. The area of real contact is thus independent of the size of the bodies and is proportional to the applied load ; it is usually only a minute fraction of the geometric size of the bodies. At the regions of real contact strong adhesion occurs. The resulting friction arises from the shearing of the welded junctions formed at these points and to a lesser extent from the ploughing of one metal through the other.

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* Delivered at the Royal Society on November 30.

Bowden has shown that because the area of true contact is so small, the work done in overcoming friction can raise the temperature of the local contact points to extremely high values. Ingenious methods for measuring this temperature were developed, and it was shown that in many cases surface melting may be produced which plays a fundamental part in processes such as polishing and the surface flow of solids. With modern physical methods he has studied the effect of surface films and in particular of boundary lubricants on the interaction between solid surfaces. This work forms the background to the modern theory of friction and boundary lubrication. The practical implications of the work are widely appreciated, and it has led to the development of new low-friction surfaces, improved bearing materials and to the development of special lubricants.

Another phase of Bowden's work is the study of fast reactions in solids and the initiation and growth of explosion in crystals. This has led to a clearer understanding of the cause of accidental explosions and improved methods of manufacturing and handling explosive substances.

Royal Medal (A) : Dr. Dorothy M. C. Hodgkin, F.R.S.

Dr. Dorothy Hodgkin has made many outstanding contributions to our knowledge of the structure of complex organic molecules by the method of X-ray crystal analysis. Her best-known work is perhaps that on the structure of penicillin, and more recently her complete elucidation of the structure of vitamin B_{12}. In this work she has shown that it is possible to apply the methods of X-ray analysis to elucidate structures of molecules which are too complex to yield to the ordinary methods of chemistry.

With Bernal she obtained the first X-ray pattern from a protein single crystal (pepsin) in 1934, and from insulin in 1935. Later, with Schmidt, she made the first X-ray study of a virus single crystal (tobacco necrosis virus). With Bernal and Fankuchen she has completed a most comprehensive study of the crystallography of more than eighty sterol derivatives, belonging mainly to the cholesterol and ergosterol series.

It is perhaps in the field of complete structure determinations that her most important work has been done. She was among the first to realize the importance of the heavy-atom phase-determining methods, and these she used to effect the first complete determination of the geometry of a sterol derivative in her analysis of cholesteryl iodide. This was followed later by a similar analysis of a calciferol derivative and of a lumisterol derivative.

The same powerful phase-determining methods of analysis, and in particular her gift of being able to interpret correctly the complex and partially resolved electron-density patterns obtained, have been mainly responsible for her success in finally elucidating the structure of penicillin and of vitamin B_{12}. This last work is the most beautiful and complex analysis which has yet been achieved in this field.

Royal Medal (B) : Dr. O. T. Jones, F.R.S.

Dr. Jones is widely recognized as the most versatile of living British geologists, being equally at home when dealing with stratigraphical, structural, palæontological or petrological problems.

It was he who first worked out in detail the succession of graptolitic sediments in central Wales, thereby bringing order into a vast area which had formerly been quite wrongly interpreted. More recently, with Pugh, he has, by detailed large-scale mapping, in the Builth area, revealed an example of an ancient Ordovician shore-line, with cliffs and beach deposits, thereby proving that large-scale elevation, erosion and deposition of many hundreds of feet of sediments can fall into the time represented by a single fossil zone, which elsewhere is indicated by only a few feet of sediments.

His work has thrown an entirely new light on the origin of certain complex structures in the sediments of the Lower Palæozoic rocks of north Wales. This study of 'slump structures' enabled him not only to point to the origin of the structures themselves, but also led him to use the detailed patterns in the sediments to interpret the general arrangement of land and sea during the time of their formation. The results of this study have revolutionized the views concerning the growth of the Welsh Palæozoic geosyncline.

In recent years he has published the results of a life-long study of the plateau surfaces of the Welsh mountain areas and traced their origin far back into geological time, thereby giving a firm foundation to the theories advanced by others concerning the river systems of Wales and the West Country.

His best-known work centres on his native Wales, but much of it also deals with more general topics, and of recent years he has taken much interest in the geological interpretation of geophysical results, where his wide knowledge of structural geology has enabled him to assess the value of the interpretation made by the geophysicists.

Wherever his researches have taken him, he has broken new ground and led the way to new lines of research.

Davy Medal : Prof. R. D. Haworth, F.R.S.

Prof. Haworth, over a period of some thirty-five years, has made outstanding contributions to the chemistry of natural products, particularly the alkaloids.

His first important work was on the isoquinoline synthesis of alkaloids in the aporphine, berberine and related groups. Later he extended his synthetic work on the aporphine group of alkaloids and in particular synthesized morphothebaine methyl ether, which was a connecting link between the thebaine and morphine groups of alkaloids.

In association with G. R. Clemo, he successfully synthesized a number of degradation products of santonin, and then with various pupils, particularly at Sheffield, he studied many natural pigmented compounds of high molecular complexity, notably retene and the phenolic resins which constitute the lignan group of natural products. Purpurogallin yielded up the secrets of its structure to him and he was able to synthesize this interesting compound in 1949. His discovery that it contained a tropolone ring led him to engage in tropolone chemistry, in which field he has made significant contributions, particularly to the study of novel substitution reactions. He has conducted valuable researches in the complex steroidal group of alkaloids, especially on conessine, he has investigated the fundamentals of the reaction of formaldehyde with proteins, and he has carried out numerous synthetic studies on a variety of complex nitrogen-containing natural compounds.

Darwin Medal : Dr. J. S. Huxley, F.R.S.

Dr. Julian Huxley has left his mark in a number of varied fields of biological science. His concept of the cline proved of such value in the description and understanding of geographical variation, in both its genetical and ecological aspects, that it passed almost immediately into very wide use. He was one of the pioneer students of courtship behaviour in birds; indeed, in his classical paper on the great crested grebe he gave the first descriptive analysis of mutual display and introduced the notion of mutual selection. He has contributed to the evolutionary study of behaviour and to the theory of sexual selection. He has given us the idea of allæsthetic selection and has defined allometry or heterogonic growth as it is variously called. His investigations of heterogonic growth in a variety of animals brought to light the existence of allometric gradient fields, the evolutionary implications of which he pointed out. His early genetical investigations of *Gammarus* led him to appreciate the evolutionary significance of rate genes, and he has recently discussed the significance of polymorphism, or morphism as he prefers to call it.

Yet to many his greatest work will have been the part he has played in the development of the neo-Darwinian theory of evolution, of which he was indeed one of the earliest exponents. He is one of a number of biologists who have contributed in their various ways to this development, by experiment, mathematical analysis and theoretical discussion. Huxley has a place all to himself in that his wide nterests, encyclopædic knowledge, and ability to see the connexion between widely separate fields, have enabled him to bring together and bind into a single evolutionary thesis the findings of the most diverse branches of biology. He has been one of the leaders n the rise of modern evolutionary biology, and a never-failing stimulus to those who have come into contact with him in this field.

Hughes Medal : Viscount Cherwell, P.C., C.H., F.R.S.

Lord Cherwell's earliest papers are mainly connected with specific heats at low temperatures, but nclude many contributions on such varied items as radiation pressure applied to cosmic problems, the transmission of X-rays and the structure of atoms and nuclei, including an approximate quantitative theory of the Geiger–Nuttall relation. His work on he solid state led to the well-known melting-point formula. In this connexion he began to take an interest in the photoelectric effect, connecting the frequency of the selective effect in the alkali metals with the characteristic frequencies, the latter being calculated either from the melting-point formula or by 'Rest-Strahlen' determinations.

During the First World War he worked at the Royal Aircraft Establishment. There he learnt to ly, and his main interests were concerned with the nstruments of flight and with the problems of flight tself. He produced many technical papers in a wide range of subjects, including those on the theory of ompasses, on the collision of aircraft with balloon-barrage cables, and on the conditions which caused ertical spin in aircraft in flight and the methods of extraction of the machine from spin when involved either accidentally or deliberately in such a manœuvre.

After the War he devoted himself in Oxford to the reorganization of an obsolescent department into the important laboratory it is to-day. Perhaps his most important direct contribution to physics was his pioneer work with Prof. G. M. B. Dobson on meteors, which led by means of calculations of the height, frequency and the temperatures of the trails to a considerable increase in our knowledge of temperature distribution in the upper atmosphere, particularly the increase in temperature above the stratosphere. The latter was satisfactorily explained by the absorption of radiation by a layer of ozone. Further work was done on photoelectricity, mainly in connexion with its application to the determination of temperature, both in stars and in terrestrial sources, work which included the design of the well-known Lindemann electrometer. He has always been interested in astrophysics and cosmic phenomena, and has written many notes on these subjects. In particular, he has suggested the origin of magnetic storms as due to the recombination of electrons and ions in the upper atmosphere which arise from ionized clouds of gas ejected from the Sun, the velocity of the particles in the cloud being ascribed to light pressure.

In the Second World War he acted as scientific adviser to Sir Winston Churchill and produced a large number of reports and appreciations, many of which are mentioned in Churchill's book "The Second World War".

SOME INTERACTIONS OF THE PHYSICAL AND THE BIOLOGICAL SCIENCES

The citations which have just been read leave no anxiety about the importance of the contribution which Fellows of the Royal Society make to the improvement of natural knowledge. In hearing them we may perhaps feel that passing regret which we experience on a journey when some fascinating vista opens at a new turn of the route, and we are moved by the desire to explore it while realizing that we never shall. We are swept onward about our own business.

People often think nostalgically of the early days of this Society when all the Fellows could understand everything that went on. Range and diversity were, however, available at the price of superficiality and incoherence when even Newton seems to have felt that his view of Nature consisted after all of a series of very imperfectly related parts. To-day the whole has more structural unity, yet often seems so vast and labyrinthine that we get lost if we venture beyond our own small locality, which itself reveals subtleties and complexities multiplying almost without limit the more closely we look.

The process of elaboration, though deplored in one quarter or another almost daily, is not quite irreversible. As in all the great movements of Nature or of humanity, there are opposing tendencies and compensating reactions. On one aspect of this matter I shall dwell a little now.

At one time the segregation of the physical and the biological sciences could scarcely have been more complete. It is reflected indeed in the dichotomy of the Royal Society itself. The lines of demarcation are gradually vanishing, and our duplex structure is becoming something of an anachronism.

The fusion is occurring in many places: the interpretations of nerve action in terms of ionic flow, and of cortical events in terms of spatio-temporal patterns of neuronal activity; the analogies between the working of the brain and the operations of electronic calculators; all these and many more have for a long time compelled the simultaneous study of widely different fields of science.

It is difficult to think oneself back to the time when the preparation of urea from ammonium cyanate caused something of a sensation in the world. In his "Essays on Historical Chemistry" Thorpe wrote: "That particular day in 1828 when Wöhler first observed the transformation of ammonium cyanate into urea should be accounted a red letter day in the history of science".

Things have moved since then; structures have been determined and syntheses achieved for every kind of vital product from the anthocyanins of flowers to the adenosine triphosphate which so subtly regulates the energy exchanges in the cell. A year or two back the pituitary hormone oxytocin was synthesized by du Vigneaud and his collaborators, and the synthesis of another peptide pituitary hormone has been announced this year. Steroids are the object of unremitting and successful work in several laboratories, and nucleotide coenzymes continue to yield to the investigators of Todd's school, the total synthesis of cozymase having recently been carried out.

The relation of molecular structure to properties is a major chapter of science and now forms a body of doctrine built up over a century. Through the stimulus, partly industrial, of the intensive work on polymers—those huge molecules now made almost to a predetermined specification of properties—this study to-day embraces some of the chief constituents of the living cell.

Natural compounds of very high molecular weight, formed at low temperature and under the directing influence of existing cell structures, have normally a much more regular configuration than the chains randomly formed in polymerizations initiated by free radicals at high temperatures. The gap between the natural and the artificial has been significantly narrowed by the recent discoveries of Ziegler and of Natta. By the use of new catalysts based upon aluminium alkyls and titanium or vanadium chlorides, beautifully oriented polymers of regularly repeating structures are formed. The initiation mechanisms may well be ionic, and the regularity is almost certainly due to the guiding influence of a heterogeneous catalyst.

The closer approach of this mechanism to that used in the cell is very suggestive. Substances closely resembling natural rubber and guttapercha (which stand in a *cis-trans* relation to one another) have indeed been made by such means. The properties of these regularly ordered polymers are profoundly different from those of the less ordered forms, and during this year Natta, Corradini and Dall'Asta, in a study of crystalline polypropylene oxide, comment on the notable analogies between their product and the fibroin of silk.

In this general connexion the recent work of Ballard and Bamford is highly suggestive. These authors find that in the polymerization of DL-phenylalanine-N-carboxy α-amino-acid anhydride initiated by polysarcosine dimethylamide, the polysarcosine chain is able to catalyse the reaction between the base and the anhydride in a marked degree. They justly point out the analogy between this phenomenon and an enzyme reaction.

Work continues in many laboratories on the fibrous and globular proteins and on nucleic acids (and models have recently been shown to the Royal Society of the beautiful structures which the X-ray crystallographers are beginning to propose for these vitally important substances).

The problem is enormously complicated, but its attraction depends, of course, largely upon the belief, widely held on good grounds, that these structures are fundamentally concerned in the processes of heredity. Nevertheless, the view that nucleoproteins are the basis of genes which could ever be self-replicating in isolation and merely in virtue of their structure is probably a dangerous over-simplification.

In the chemistry of inanimate Nature the study of structure alone is quite insufficient, and must be undertaken in conjunction with that of function; in other words, reaction mechanisms are as important as molecular structures.

That the properties of living things are an emergent result of contributions from finite, if large, numbers of structural units or genes, that the genes are rather stable though not immutable, that in proper circumstances they change their associations in accordance with the laws of probability, are among the major basic principles of science. Recent work has, however, widened the view of the ways in which hereditary characters are transmitted. Besides sexual unions there are transmission by infective agents, by transduction and by Pontecorvo's parasexual mechanisms. Moreover, the combinatory phenomena that are so important in the Mendelian system cannot play much part in micro-organisms which multiply by binary fission. Fruitful as the reference of cell properties to the structure of genes has been, the body of doctrine which rests on this assumption is in some important respects incomplete, as indeed every chapter of science must be incomplete by itself. The picture presented is essentially static. The phenomena of growth, adaptation and reproduction need a dynamic one.

No one structure is likely to be autosynthetic in isolation; even the viruses require as hosts more or less intact cells, the machinery of which they can exploit. The building blocks of the cell, wonderful though they may be as structures, are useless by themselves. Cell function depends upon the rhythm and harmony of their reciprocal actions: the mutual dependence of protein and nucleic acid; the spatial and temporal relations of a host of elementary processes which with their sequences and bifurcations make up the reaction pattern of the cell. A system of mutually dependent parts, each of which performs something like enzymatic functions in relation to another, will, as can easily be shown, in the steady state appear as a whole to be autosynthetic. No individual part need be credited with a new and mysterious virtue by which to duplicate itself. Thus the picture widens beyond the structural units to their quantitative proportions, to their reciprocal dependence and to their rates of growth. This fusion of physical chemistry and biology leads to conclusions about the nature of adaptive processes, the automatic attainment of maximum growth-rates, and mechanisms for the choice of the most favourable metabolic patterns (as in the Pasteur effect).

The reality of the dynamic picture is sometimes called in question because there may be alternative explanations of particular phenomena. For example the important phenomenon whereby drug resistance develops is often referred exclusively to selection of random mutants, although it is easy to show on the basis of very general physico-chemical assumptions that the effect should demonstrably occur as an automatic response, the adapted cells having reorganized their reaction patterns. This conclusion in its turn in no way denies the possibility of spontaneous resistance due to structural mutations. Nor, on the other hand, does the occasional demonstration of mutations leading to resistance rule out automatic cytoplasmic adjustments.

One possible prescription for steering between the opposite hazards of narrowness and of superficiality is to try to set the particular objects of one's own interest into a general framework, working with a large map but filling in small areas with as much detail and accuracy as possible. Partly on this principle, but also, I confess, a little to vindicate my feeling that a president of this Society, whatever his other preoccupations, has the right and duty to remain a working man of science, I am proposing to devote a few paragraphs to some matters, relevant to the general theme, but closely connected with one of the fields of my own activity.

Resistance to the idea that some biochemical adaptations of cells are due to automatic internal reorganization has been largely founded on the relative stability of such changes, and upon the doctrine that heredity only changes by spontaneous gene mutation. Evidence, however, accumulates that adaptive processes are indeed reversible. *Aerobacter aerogenes*, once it has acquired the power of utilizing D-arabinose (A^+ character), holds it for a long time, but some strains of *Escherichia coli* revert rather quickly. Cross found that with *Aerobacter* loss of the A^+ character occurred more rapidly in certain media which themselves imposed a new adaptive necessity on the cells. The effect might have been attributed to a re-selection in these media of a small residual contamination of A^- (or of reverse mutants); but this explanation was ruled out by comparative experiments with artificial mixtures of the A^+ and A^- types. The real reversion of the population in conditions not favouring the selection of the A^- cells showed that arguments based upon the assumed permanence of the change are inadmissible.

The impression that drug resistance is a necessarily stable character is weakened still further by the study of micro-organisms other than bacteria. Wild found that with strains of *Saccharomyces cerevisiae* the degree of persistence of adaptation to various inhibitors is very variable.

Other evidence bearing on the nature of the adaptive changes responsible for drug resistance comes from the detailed study of time–number relations in colony formation on agar plates containing an inhibitory substance. If, say, 10^8 cells are plated on a solid medium containing a drug at a suitable concentration, there may appear 10–100 well-developed colonies which have been widely regarded as spontaneous mutants. But if the statistical distribution of the times at which they appear is compared with that for a correspondingly small number of cells previously adapted to resist the drug, then the comparison shows that the few survivors from the unadapted strain have formed colonies much more slowly than the members of the adapted strain. Individuals of this latter could therefore not have been present in the original even in the minute numbers supposed. Results of this kind have been found by Wild with yeast and by Dean with some bacterial strains. In some of these examples, moreover, the non-existence of minute numbers of the adapted forms in the original population is demonstrable even when the standard of resistance studied is quite a low one. Thus alternative explanations based upon complex series of multiple mutations would be forced to include highly unlikely assumptions.

One method by which pre-existent mutants are often tested for may be illustrated in the example of the well-known *Bacterium coli mutabile*. This organism normally refuses to grow on a lactose-agar plate except after a long delay. If, however, a very large inoculum of cells of the order 10^8 or 10^9 is plated, some colonies develop much more rapidly, and their number has been used to give a measure of the mutation-rate to the so-called lactose-positive condition.

Dean undertook a study of the statistics of colony formation by this organism on lactose-agar plates, measuring the distribution of colony sizes at various times, and the distribution of the times required for the formation of colonies of various standard sizes. The results conformed rather closely to Gaussian distributions, and the relatively few early-forming large colonies which might have been labelled lactose-positive mutants did not seem to be more frequent than the Gaussian law could permit in so enormous a population.

All these observations support the view that the cell makes adaptive changes by dynamical adjustments as well as by any mutations which it may suffer.

Normally, mutations, apart from those caused by radiation or special chemical agents, have been supposed to occur only when cells divide. This view itself seems to be changing.

Some years ago, Baskett made a number of observations individually and collectively indicating that during the long delay which attends the first growth of *Bact. lactis aerogenes* on D-arabinose there is in fact a physiological adaptation of the cytoplasm, and not the selection of mutants. Generally similar results have been found by Dean for cells initially reluctant to use lactose.

Somewhat analogous observations in a more spectacular form were reported by Akiba, and more fully by Szybalski. Bacterial strains exposed to streptomycin for a number of days in a buffer not supporting growth were found eventually, if they had survived at all, to have become resistant to the antibiotic. Szybalski, however, quotes what he calls "tentative evidence" that the changes occur in a nucleus. This evidence is derived from observations on the crossing or transduction phenomena which occur with certain strains of *Escherichia coli* and *Salmonella*.

The conclusion, however, seems to be far from certain, since the relations found in crossing drug-resistant with sensitive organisms are usually very complex. In genetic analysis with micro-organisms the number of parameters which can be adjusted is considerable, and illusory effects of sharp segregation phenomena are sometimes produced by the process of dividing continuous variables such as rate or time of growth into arbitrary domains such as 'slow' and 'fast' or 'plus' and 'minus'. That a high percentage of non-dividing cells should suffer nuclear mutations making them resistant precisely to that drug to which they are being exposed seems much harder to explain than the alternative of a dynamical change by which the cell as a whole reacts to the presence of the drug in an almost predictable way. The same general comments might be made about the 'spontaneous mutations' in the absence of division, to histidine-independence of a bacterial strain recently studied by Ryan.

In spite of some alarm, physico-chemical mechanisms of cell adjustment need not be in any conflict at all with valid principles of genetics. But it is a misapplication of the latter when they are used to exclude all mechanisms except selection of random mutants or of favourable gene combinations. Random mutations to drug resistance may indeed be shown by the relatively rare examples where the Lederberg technique of replica plating has given positive results. Nature, however, presents us with a vast hierarchy of systems: sub-atomic units (in a vast and confusing array), atoms and molecules, micelles, chromosomes, nuclei, cells, colonies, tissues, individuals and communities of individuals. Nobody can suppose that all phenomena have their origin at any one particular level.

In the organisms studied by classical genetics, individuals develop from fertilized germ cells, and, not surprisingly, show characteristics largely inherent in those cells. In micro-organisms which multiply by binary fission, the new individual does not develop from a much smaller germ cell but is formed by the approximate halving of an existing one, and, no more surprisingly, shows the characteristics of this. The manifestation of the effects of genes has long been recognized to be profoundly affected by their environment, so that the subsequent growth of the divided daughter cells is largely governed by the total organization. This explains—and more specific physico-chemical illustrations can be given—why such characters as drug resistance due to enzymatic reorganization can persist through many divisions. But to call the phenomenon or its interpretation Lamarckian is a plain misuse of language.

The disentangling of the complicated and fascinating relationships met with in this field will demand close co-operation of the physical and biological sciences, which brings me back to the keynote of this address. To the highly ingenious models of structure must be added equally illuminating models of function. Whatever the answer may be to the controversial problems of to-day, that is what the future in one way or another will surely bring forth.

OBITUARIES

Prof. Winifred Cullis, C.B.E.

By the death on November 13 of Prof. Winifred Cullis the world has lost not only a fine scientist but also an outstanding personality.

Winifred Clara Cullis was born in Gloucester on June 2, 1875. King Edward VI's High School for Girls, Birmingham, and Newnham College, Cambridge, laid the foundation of her abiding interest in science and began many life-long friendships. In 1901 she was appointed demonstrator in physiology at the London (Royal Free Hospital) School of Medicine for Women; later she became lecturer, reader and head of the Department, and finally professor of physiology in the University of London. She retired during the Second World War.

From the beginning, research was Prof. Cullis's great interest, and her name will always be associated with two outstanding pieces of work, one on the mechanism of the secretion of urine and the other on the perfused isolated heart of rabbit. Her experimental technique was precise and careful, and it was a joy to see the delicacy and sureness with which she would snip sufficient of the auriculo-ventricular bundle in the beating heart in order to demonstrate the effects of partial heart block. In later years lectures at home and abroad made continued research work more difficult; but periodically she would give herself a 'holiday' and with one or more colleagues settle down for several weeks investigating some interesting problem. She gave unstintingly of her knowledge and wide experience to her departmental colleagues but always insisted that publications should be in their own names, and any appreciation of their work gave her great pleasure.

No one who knew her could be other than filled with admiration for the absolute integrity and shining honesty which characterized her scientific outlook and the public work which later claimed so much of her time. For self-seeking, pomposity or hidden motives she had no use, and nothing was more direct than her own approach to a problem.

This directness, together with her gaiety and wit, made her lectures and speeches unforgettable. She had a store of appropriate stories—often against herself—and it was seldom that a speech of hers was not punctuated by laughter.

She herself realized how valuable were her special gifts as a speaker, and she gladly spoke for any cause she had at heart, particularly where she felt she could assist in securing for professional women equal opportunity and status with men. Her great charm was to a large extent due to her intense interest in and understanding of her fellow men and women. This and her generous appreciation of the other person's point of view, even when she disagreed, was particularly valuable in international contacts. In her work for the British Federation of University Women and for the International Federation of University Women, in each of which organizations she held the presidency for a number of years, she combined her interest in the advancement of women and her belief in the great value of international understanding and good will

Of the many honours and marks of appreciation that came her way, few gave Prof. Cullis greater pleasure than the decision of the British–American Associates to name one of their lecture fellowships after her.

She felt strongly that physiology should be taught in the schools and gave a series of most successful talks in the B.B.C. Schools Programme. She wrote two excellent books on the subject for use in schools. "Your Body and the Way it Works", published in 1949, is a very clever blending of her text with pictures by Ian T. Morison. Included is a section on growth, reproduction and heredity which is an aspect of human biology normally omitted from elementary books.

Few women could have had so many friends. She collected them from a world-wide circle. Her memory for them was amazing, and she would call to mind details about people she had not met for years and with whom she could have had the briefest conversation.

The loss of Winifred Cullis leaves a void in the lives of those who knew her, not only because she was a unique personality but also because of the deep affection she inspired.

M. BOND

Dr. A. L. Clark

IT was with a sense of genuine sorrow that the many friends of Dr. Arthur Lewis Clark learned of his death on September 20 at Kingston, Ontario, at the age of eighty-three.

Dean of the Faculty of Applied Science at Queen's University, Ontario, for twenty-four years from 1919, an outstanding physicist in research, Dr. Clark had retired in 1943, but continued to lead a full and active life until a short illness before his death. Dr. Clark was born on February 19, 1873, at Worcester, Mass., where he was educated, going to the Polytechnic Institute, where he obtained his B.Sc. degree. After doing his graduate work and some teaching, he went to Queen's University in 1906 as head of the Physics Department.

Dr. Clark's scientific interest was in thermodynamics and he carried out considerable research in this field. In 1916 he was appointed chairman of the University Scientific Research Committee. His recommendations with regard to the support of research at that time were far-reaching and established standards worthy of acceptance by any university to-day. In 1919 Dr. Clark was appointed dean of the Faculty of Applied Science, a post which he held until his retirement in 1943.

Retirement did not mean idleness to Dr. Clark, for one of the first tasks he set his hand to was writing his own now famous Queen's document, his book "The First Fifty Years", a history of the Science Faculty of Queen's from 1893 until 1943. The book filled a blank in the University records and has been enthusiastically received by graduates of all faculties.

During these twenty-four years there was war and depression, bringing great stress and strain to the University. Nevertheless, under Dean Clark's wise and efficient guidance, the standards of work in the various branches of engineering were more than maintained and the School of Applied Science grew to maturity. Dean Clark's firmness, tempered with patience and sympathy, won the esteem of staff, graduates and students alike.

In compiling the above note, I am indebted to Mr. David G. Dewar for information from his book, "Queen's Profiles", published by the office of Endowment and Public Relations, Queen's University.

H. G. CONN

NEWS and VIEWS

International Meteorological Organization Prize : Dr. H. T. Hesselberg

DR. HANS THEODOR HESSELBERG, formerly director of the Norwegian Meteorological Institute and president of the International Meteorological Organization, has been awarded the International Meteorological Organization Prize. This Prize was created by the World Meteorological Organization to perpetuate the memory of the non-governmental international organization which that specialized agency of the United Nations has succeeded. It is to be presented once a year in recognition of scientific contributions to meteorology and work for international meteorological organizations. Dr. Hesselberg, who has received the first award, was born at Lierne in Norway in 1885, and has devoted himself from 1912 onwards to meteorological and hydrological research. As scientific assistant to Dr. Bjerknes, he participated in research in the fields of dynamic meteorology and hydrology. He was director of the Norwegian Meteorological Institute during 1915–55. During these forty years he was mainly concerned with the organization of the Meteorological Service of Norway and international co-operation. From 1919, he took an active part in the work of the International Meteorological Organization, of which he was president during 1935–46. Dr. Hesselberg was a member of the executive committee of the World Meteorological Organization during 1951–55.

Mathematics in the University College of North Staffordshire : Prof. D. S. Jones, M.B.E.

MR. DOUGLAS JONES, who has been appointed to the chair of mathematics in the University College of North Staffordshire in succession to Prof. I. N. Sneddon (see *Nature*, 177, 1109 ; 1956), was educated at Wolverhampton Grammar School, and went up to Corpus Christi College, Oxford, with an open scholarship in 1940. Soon afterwards, however, he joined the R.A.F., becoming attached to night fighters as a signals radar officer. In 1942 he was put in charge of a special research unit, and for his work in this capacity was mentioned in dispatches and later made M.B.E. In 1945 he returned to Oxford, where he took first-class honours in mathematics two years later. Then he went with a Commonwealth Fund fellowship to the Massachusetts Institute of Technology, where he started his researches on wave diffraction theory. This has continued to be his major research interest ; but the power and complexity of the mathematical methods he has brought to bear on it have never been allowed to obscure in Jones's mind, nurtured alongside the pressing needs of war-time radar, the many practical applications of the results of his calculations. In 1948 he returned to England as an assistant lecturer in the Mathematics Department in the University of Manchester, where he was promoted to lecturer in 1951 and to senior lecturer in 1955. He has held the responsible position of tutor to the Faculty of Science since 1954, and while on leave of absence for six months in 1955 was a visiting research professor at the Institute of Mathematical Sciences, New York University. His most recent interest is a fundamental study of methods for calculating short-wave scattering.

British Cotton Industry Research Association : Dr. G. F. Davidson

DR. G. F. DAVIDSON, of the British Cotton Industry Research Association, head of the Chemistry Department at the Shirley Institute, Manchester, is resigning his post at the end of this year, though he will remain in the service of the Association. Dr. Davidson has already served for thirty-four years on the scientific staff of the Association. Much of this time was occupied by studies of the chemistry of cotton cellulose, and his contributions to this subject are widely recognized. At the beginning of his investigations, the modern concepts and theory of cellulose structure were only just emerging. He used the new concepts to correlate a large body of otherwise confusing experimental observations. In doing so, he helped to establish the theory; and, in seeking a theoretical explanation of certain practically important observations, he uncovered fresh facts stimulating theoretical investigations in a more general field.

Dr. J. Honeyman

DR. J. HONEYMAN, lecturer in organic chemistry at King's College, University of London, has been appointed to succeed Dr. Davidson at the Shirley Institute. Dr. Honeyman's work has also been mainly in the field of carbohydrate chemistry. He graduated from the University of St. Andrews in 1939 and obtained his Ph.D. from that University in 1944. After spending a number of years in industry, Dr. Honeyman was appointed assistant lecturer at King's College, London, in 1945, and lecturer in 1947. He has contributed many papers, chiefly concerned with carbohydrates, and in 1948 published an "Introduction to the Chemistry of the Carbohydrates", of which a revised edition was published in 1951. During 1954–55 Dr. Honeyman held the post of Hibbert Fellow at McGill University, and was visiting scientist at the Pulp and Paper Research Institute of Canada.

Royal Society: Officers and Council

AT the anniversary meeting of the Royal Society held on November 30, Sir Cyril Hinshelwood was re-elected president. Sir William Penney, director of the Atomic Weapons Research Establishment, Aldermaston, was elected treasurer in succession to Sir Thomas Merton. The other officers re-elected for the ensuing year were: Physical Secretary, Sir David Brunt, chairman of the Electricity Supply Research Council of the Central Electricity Authority; Biological Secretary, Prof. G. L. Brown, Jodrell professor of physiology at University College, London; and Foreign Secretary, Dr. H. G. Thornton, head of the Department of Soil Microbiology at Rothamsted Experimental Station. Other members of the Council elected were: Prof. C. E. H. Bawn, professor of inorganic and physical chemistry, University of Liverpool; Prof. T. A. Bennet-Clark, professor of botany, University of London (King's College); Brigadier J. S. K. Boyd, lately director of the Wellcome Laboratories of Tropical Medicine; Dr. Mary L. Cartwright, mistress of Girton College and university lecturer in mathematics, Cambridge; Prof. N. Feather, professor of natural philosophy, University of Edinburgh; Sir Claude Gibb, chairman and managing director of Messrs. C. A. Parsons and Co., Ltd.; Sir Bryan Matthews, professor of physiology, University of Cambridge; Prof. J. S. Mitchell, professor of radiotherapeutics, University of Cambridge, and director, Radiotherapeutic Centre, Addenbrooke's Hospital, Cambridge; Prof. W. T. J. Morgan, deputy director of the Lister Institute and professor of biochemistry, University of London; Prof. N. F. Mott, Cavendish professor of experimental physics, University of Cambridge; Prof. L. Rosenhead, professor of applied mathematics, University of Liverpool; Dr. B. F. J. Schonland, deputy director, Atomic Energy Research Establishment; Dr. K. M. Smith, director of the Virus Research Unit (Agricultural Research Council), Molteno Institute, University of Cambridge; Prof. M. Stacey, professor of chemistry, University of Birmingham; Dr. W. H. Thorpe, university lecturer in entomology, Cambridge; Prof. L. R. Wager, professor of geology, University of Oxford.

International Journal of Applied Radiation and Isotopes

THE new periodical, the *International Journal of Applied Radiation and Isotopes*, published by Pergamon Press (London and New York), is to provide a medium for the publication and discussion of radioactive and radiation techniques and the applications of radioactive isotopes and large fluxes of radiation in the pure and applied sciences, medicine, agriculture and industry. The subscription is £6 (17 dollars) or, for individual subscribers certifying that the journal is for their private use, £3 10*s*. (9.80 dollars). The list of nine editors, headed by P. C. Aebersold (Oak Ridge, U.S.A.), which includes eminent scientists from France, Holland, Great Britain, the Netherlands and the U.S.S.R., and the editorial advisory board which consists of representatives from thirteen different countries, emphasize the international character and high standard of the new periodical. Sir John Cockcroft, one of the United Kingdom representatives of the board, contributes a brief editorial to the first number of the *Journal* (pp. 144; July 1956), and W. B. Mann (U.S. National Bureau of Standards) is the author of the leading article, entitled "The Preparation and Maintenance of Standards of Radioactivity", in which he gives a historical survey of the preparation and measurement of international radium standards and explains the need for standards of other radioisotopes. A report is given of the present state of international comparison of several radioisotopes, and a policy for wider international comparison is discussed. There are nine other original articles dealing, respectively, with radioactive tracer techniques for sand and silt movements under water, particularly the use of powdered glass containing scandium-46; a radiochemical technique for determining the surface area of aluminium metal surfaces; liquid scintillators; labelled metabolic pools for studying the biochemistry of toxic action; the behaviour in the rat of plasma proteins labelled with carbon-14 and iodine-131; the production and clinical application of iodine-132; autoradiography; gamma-ray vulcanization of rubber; and an impulsion discriminator for activation analysis. The number concludes with the titles and abstracts of the papers presented to the third annual meeting of the Society of Nuclear Medicine, held during June 21–23 at Salt Lake City, Utah.

Automation Progress: New Journal

'AUTOMATION' is an ill-defined word which no one likes and everyone uses. For the past three years, however, it has been a very live topic, and, as a result, existing journals have tried to persuade their readers that they cover at least a part of automation, and new journals with automation in the title have been appearing at frequent intervals in Europe as well as North America. The latest such periodical is *Automation Progress: The Journal of Automatic*

Production and Control, a monthly publication, the first number of which appeared last October (London: Leonard Hill Technical Group; 50*s*. a year). It is designed to fill the gap between highly specialized publications and the general technical press, in order to meet a long-felt need for a means of exchanging information between engineers and executives who have no time to follow the literature on any subject but their own. The first two numbers contain a number of interestingly written articles on problems of the automatic factory, and a vast range of equipment is described. There are also short digests of relevant articles in other journals, and of relevant patent specifications accepted, notices of forthcoming events, an editorial, "news briefs" and a cartoon. The new journal, therefore, not only provides interesting material for higher management interested in automation, but also brings together a great deal of information useful to development engineers working in the field. The format and arrangement of material are both good, and it is noteworthy that the American practice of mixing up advertisements and text has been avoided. It must, however, be emphasized that the number of journals dealing with automation in one form or another is now so great that it is quite impossible for any one man to read them all, although the amount of new and useful information available is probably not more than could be covered by a single journal, allowing for cross-references to and abstracts of specialized articles in periodicals covering other fields. Eventually, therefore, there may be a marked reduction in the number of journals purporting to cover the field of automation, and, from the engineer's point of view, the sooner this happens the better.

Fisheries and Animal Husbandry in Japan

A LINKING of fisheries and animal husbandry may indicate a new and broadly based view of the development of natural resources or a 'marriage of convenience' possible only when traditional barriers have been removed by catastrophe. The University of Hiroshima established its Faculty of Fisheries and Animal Husbandry in 1949 at Fukuyama, on the shores of the Inland Sea and with a cattle-raising hinterland, and the Faculty began to issue a journal in 1955. From the first number it is difficult to visualize the proposed scope of work of the Faculty; its contents no doubt reflect the interests of staff rather than suggest an outline of its programme. T. Irie reports a study by X-rays and histochemical techniques of the crystal structure and texture of otoliths of the marine teleost *Pseudosciaena*; T. Fujiyama describes the life-history of and cytological studies on the monœcious plant *Prasiola japonica* Yatabe. Both these papers are in English. Y. Anagama contributes an extensive review, in German, of research on vitamin C in milk and milk products, in conjunction with the results of his own work. Two papers in Japanese, with brief English summaries, complete the number; of these the first, by S. Ono, describes the system and methods of selling calves by auction practised in Japan, while the second is a long account by M. Ikeda of "Studies on Properties and Agricultural Development of Alkali Soil in Manchuria", with numerous tables and text figures of which the legends are also in English, and 141 references of which only those of Oriental origin bear dates later than 1938. The journal is well printed and the illustrations, line drawings and plates, are clearly reproduced. In its present form and content it would seem more acceptable to central reference libraries than for circulation to specific interests; as an addition to the mass of literature in these fields it can be welcomed in so far as it gives a medium of publication for this group of workers.

Bulletin of Polish Medical History and Science

POLISH medical literature comprises at present no less than thirty-nine periodicals, but only a few of these reach medical men and scientists outside Poland. It is for that reason that the Polish Medical Alliance, an organization with editorial offices in Chicago, decided to "present to the English-speaking physician the outstanding research works, both past and present, along with a résumé of the accomplishment of Polish medicine". The first issue of the *Bulletin of Polish Medical History and Science* (Vol. 1, No. 1; July 1956. Pp. 48. Polish Medical Alliance, 2424 N. Kedzie Avenue, Chicago 47, Ill. 1.50 dollars) contains, apart from abstracts from numerous papers which appeared in Polish journals, three original articles, of which the first, on "Nicolaus Copernicus, Physician and Humanitarian", has been written by the chief editor, Dr. Alexander Rytel.

Alchemy and Early Chemistry

THE October issue of *Ambix, the Journal of the Society for the Study of Alchemy and Early Chemistry*, contains an appreciative obituary of the late Dr. F. Sherwood Taylor (who was editor from the inception of the journal in 1937) by the chairman, Dr. E. J. Holmyard. The new editor is Mr. D. Geoghegan. The number includes several interesting articles. The first, by Dr. Sherwood Taylor, is on the alchemical work of Isaac Newton and gives a transcription of a manuscript written by Newton which is apparently an attempt to form an intelligible body of doctrine from a number of quotations from alchemical authors, of which it mainly consists. Prof. Lynn Thorndike contributes a study of some alchemical manuscripts at Bologna and Florence. There are short articles on John Hariot's secret script by E. Seaton, and on J. B. Hunyades by Sherwood Taylor and C. H. Josten. An article on "Chymeutike, the real Hellenic Chemistry", by Procopios D. Zacharias, is a concise but detailed summary of publications by Prof. M. K. Stephanides, of Athens, which are otherwise available only in Greek. It attempts to put further back the beginning of chemistry, but is in error in saying that the famous Leyden Papyrus was found by Maspero (it was sold by collectors to Anastasy) and in dating it in the third century B.C. (it is dated by experts as A.D. 346). Stephanides suggested that the name 'chemistry' comes from the Greek *chymeia*, meaning 'preparing a *chyma*', and that the practice arose from the washing of auriferous sands in Egypt. The theory was based on old Greek philosophical ideas, Heraclitus and Democritus being connected with the development; the "Hellenic chymeutike has no connection whatever with Alchemy". Esoteric alchemy is represented in this number of *Ambix* by some reviews of books, including two on Lull, from the writings attributed (probably wrongly) to whom, it is said, much of English alchemical tradition seems to be derived.

Two Palæolithic Sites in Lower Austria

VOL. 7 of the "Mitteilungen der Prähistorischen Kommission der Österreichischen Akademie der Wissenschaften" (Vienna, 1954–55) contains an account of two palæolithic sites in Lower Austria, one near Kamegg in the Krems region and the other near Getzersdorf im Traisental. The former belongs to a very late palæolithic and can be grouped with the Hamburg series; the latter is rather older and can be classed as a late gravettian, so far as the upper levels are concerned, the lower level being somewhat older. Both sites are described by Dr. F. Brandtner, the actual description of the industries from Getzersdorf being by Dr. F. Felgenhauer. The illustrations of the tools found at Kamegg are excellent, those from Getzersdorf are indifferent. The whole forms a useful number with full descriptions of what are obviously important local sites.

Observations on the Size of the Sun

While numerous workers have claimed to have detected variations in the diameter of the Sun, other investigators have failed to find any variations, or to detect any significant differences between the equatorial and polar diameters. A paper entitled "Greenwich Observations of the Horizontal and Vertical Diameters of the Sun", by P. J. D. Gething, of the Royal Greenwich Observatory (*Mon. Not. Roy. Astro. Soc.*, 115, 5; 1955), gives the results of the yearly mean horizontal and vertical radii of the Sun observed at Greenwich from 1851 to 1939, but corrections for personality have not been applied. These are compared with observations for the horizontal semi-diameters of the Sun, made at Campidoglio since 1876, and later at Monte Mario; but there is no obvious agreement between the variations found at the two observatories. It has been claimed by Miss M. A. Giannuzzi, however, that the Greenwich observations of horizontal diameter contained an oscillation with a period of 22–24 years, agreeing in period and phase with an oscillation found from the Italian results, and a more detailed analysis of the Greenwich measurements of both horizontal and vertical diameters during 1915–36 was undertaken, in which allowance was made for the effect of personality and irradiation. The resulting diameters show that there were comparatively large variations from year to year; but it is emphasized that these variations do not necessarily represent real changes in the size of the Sun and may be due to variations in the mean personality correction. It is pointed out that Miss Giannuzzi's use of observations obtained by a large number of observers without applying personality corrections, on the assumption that changes in the mean personality corrections would be sufficiently small to be ignored, may not have been justified. A table in Gething's paper, which gives the horizontal semi-diameters corrected for personality, in the observations during 1917–36 by five members of the Greenwich staff, shows that the scatter around the combined mean of the individual means, when corrected for personality, is so large that the reality of the variations from year to year is untrustworthy. From the relative sunspot areas during 1917–36, it is seen that there is no obvious connexion between sunspot activity and the apparent variations in diameter. The conclusion is that Greenwich observations do not provide any clear evidence of real variation in the size of the Sun.

Growth of Isolated Oat Embryos

In an investigation of amino-acids as sources of nitrogen for the growth of isolated oat embryos, G. P. Harris (*New Phytol.*, 55, 2, 253; 1956) has found that ammonia, nitrate and casein hydrolysate were each effective as nitrogen sources. Casein hydrolysate was not inferior to the inorganic forms of nitrogen. A mixture of eighteen of the amino-acids present in casein hydrolysate was able to substitute for the latter as a nitrogen source for the growth of the embryos. The value of the mixture of amino-acids as a nitrogen source was dependent on interactions occurring between its constituent amino-acids. Out of twelve of the latter, all except arginine were markedly inhibitory to growth in length of the roots, when supplied alone. Marked antagonisms occurred between L-phenylalanine and L-tyrosine, DL-isoleucine and DL-valine, L-leucine and DL-valine, and L-arginine and L-lysine in their effects on root growth. Amino-acids which alone produced no, or relatively little, inhibition of root growth generally antagonized the effects of amino-acids which were more inhibitory.

Geographical Association: Annual Meeting

The annual meeting of the Geographical Association will be held in the London School of Economics during January 1–4 under the presidency of Lord Nathan, who will speak on "Aviation and Geography: Reaction and Interaction". Among the topics to be discussed are: water supply in Britain (Prof. W. G. V. Balchin); techniques in field-studies (Dr. E. W. H. Briault); antarctic exploration (Mr. E. W. K. Walton); the International Geophysical Year (Dr. D. C. Martin); agricultural changes in the Chilterns (Mr. J. T. Coppock); economic development of Brazil (Prof. R. O. Buchanan); and geography and the social revolution (Prof. D. L. Linton). There will also be a discussion on "Geography and a Liberal Education". There will be the usual publishers' exhibition of books, maps and appliances, and exhibits of field-work, film strips, etc., by members of the Geographical Association. Further particulars of the meeting can be obtained from Mr. R. C. Honeybone, University of London Institute of Education, Malet Street, London, W.C.1.

Conference of the Universities of Great Britain and Northern Ireland

The annual conference of the Universities of Great Britain and Northern Ireland will be held in the Senate House of the University of London during December 14 and 15. The topics for the three sessions are: "Overloading Curricula and the Length of Undergraduate Courses" (Sir Philip Morris, chairman of the Committee of Vice-Chancellors and Principals (*chairman*); Mr. R. B. McCallum, master of Pembroke College, Oxford; Prof. C. B. Perry, professor of medicine, University of Bristol; Prof. D. G. Christopherson, professor of applied science, Imperial College of Science and Technology, London); "Organization of Postgraduate Studies" (Dr. Constance M. Rigby, president of the Association of University Teachers (*chairman*); Sir James Mountford, vice-chancellor, University of Liverpool; Dr. D. A. Bell, Department of Electrical Engineering, University of Birmingham; Prof. F. S. Dainton, professor of physical chemistry, University of Leeds; Prof. E. R. H. Jones, Waynflete professor of chemistry, University of Oxford); "Impact on the Universities of the Government's Policy for the Expansion of Technological Education" (Dr. J. F. Lockwood, vice-chancellor, University of London (*chairman*); Sir Eric Ashby, president and vice-chancellor, The Queen's University, Belfast; Sir Harry Pilkington (*chairman*), National Advisory

Council for Industry and Commerce; Dr. Willis Jackson, chairman of the Joint Committee on the Supply and Training of Teachers for Technical Colleges). The conference is open only to delegates and to specially invited guests.

Christmas Lectures

The Christmas Lectures at the Royal Institution, Albemarle Street, London, W.1, will be given this year by Dr. H. Baines; the subject will be "Photography", and Dr. Baines is giving six lectures on Thursdays, Saturdays and Tuesdays, beginning December 27. At the Institution of Electrical Engineers, the Christmas Lecture for older schoolchildren will be given by Mr. J. F. Coales, of the Engineering Laboratory, University of Cambridge; he will speak on "Automation" and the lecture will be given on January 1 and repeated on January 2, at 3 p.m. Applications for tickets for Mr. Coales's lecture, which are free, should be sent to the Secretary, Institution of Electrical Engineers, Savoy Place, London, W.C.2.

Oversea Service Division, Colonial Office

The following appointments have recently been made in the Oversea Service Division, Colonial Office: N. Lawrence (scientific officer, Royal Observatory, Hong Kong), deputy director, Royal Observatory, Hong Kong; F. J. Parnell (assistant director, Game and Tsetse Control, Northern Rhodesia), director of Game and Tsetse Control, Northern Rhodesia; P. R. Adam, agricultural officer, Gold Coast; J. L. Anderson, agricultural officer, Western Region, Nigeria; M. G. Clough, agricultural engineer, Northern Region, Nigeria; R. Comber, agricultural specialist (plant physiologist), Gambia; P. G. Dennison, agricultural officer, Kenya; D. P. Drew, agricultural officer, Northern Region, Nigeria; W. M. Graham, entomologist, Maize and Produce Control, Kenya; F. N. Goodwin, agricultural officer, Northern Region, Nigeria; R. T. Harberd, agricultural officer, Northern Region, Nigeria; H. E. Hill, soil surveyor (Soil and Land Use Survey), British Guiana; S. P. Legg, livestock research officer, Ebini, British Guiana; K. R. Middleton, agricultural chemist, Northern Region, Nigeria; E. J. Mundy, agricultural officer, Northern Region, Nigeria; O. S. Swainson, principal, Farm Institute, Uganda; J. F. Ward, horticulturist, Department of Agriculture, Jamaica; R. B. Iles, scientific officer (zoologist), East Africa Fisheries Research Organization, East Africa High Commission; D. G. Almond, geologist, Uganda; H. P. J. Barr, assistant conservator of forests, Northern Region, Nigeria; P. B. Cruickshank, assistant conservator of forests, Gold Coast; R. M. Lee, assistant conservator of forests, Gold Coast; J. S. Scott, conservator of forests, Northern Region, Nigeria; O. Barnes, tsetse officer, Tanganyika; E. A. S. La Croix, entomologist, Tsetse Control Department, Gold Coast; P. L. Shinnie, director of antiquities, Ministry of Social Services, Uganda; B. Heyworth, veterinary officer, British Guiana; D. McManus, veterinary officer, Kenya; D. D. O. Pawson, veterinary officer, Tanganyika; J. H. Robb, veterinary officer, Western Region, Nigeria; L. F. Slater, veterinary officer, Uganda; R. C. H. Sweeney, section scientific officer, Nyasaland; W. Martin, senior technical assistant, Tuberculosis Research Unit, Gold Coast; P. Thomas, cocoa soil survey officer, Western Region, Nigeria.

Announcements

Sir Christopher Hinton, managing director of the Industrial Group, United Kingdom Atomic Energy Authority, has been awarded the Churchill Gold Medal for 1956 of the Society of Engineers, for his work on atomic energy.

Dr. William J. Robbins, director of the New York Botanical Garden and professor of botany in Columbia University since 1937, has been elected a trustee of the Rockefeller Institute.

Mr. W. A. Sanderson, an assistant director of the Nuffield Foundation, has been appointed secretary of the United Kingdom and British Commonwealth Branch of the Calouste Gulbenkian Foundation, which will be temporarily accommodated in Nuffield Lodge, Regent's Park, London, N.W.1.

The following appointments in the University of Sheffield have been announced: Dr. A. Critchlow, to be lecturer in chemistry; Dr. A. R. Entwisle, to be lecturer in metallurgy. Dr. P. H. Price, lecturer in fuel technology, has resigned.

The annual exhibition of laboratory apparatus and techniques arranged by the Manchester and District Section of the Royal Institute of Chemistry will be held in the College of Science and Technology, Sackville Street, Manchester, during 2 p.m.–8 p.m. on January 3 and 10 a.m.–8 p.m. on January 4.

The Education Panel of the Corrosion Group of the Society of Chemical Industry is offering a prize of 25 guineas for an essay or paper on any aspect (not necessarily research) of corrosion of metals and its prevention. Competitors must not be more than twenty-seven years old, and their contributions, which may contain diagrams and photographs, should be approximately four thousand words in length. Entries must be submitted before March 31 to the Corrosion Group Essay Competition, c/o Society of Chemical Industry, 14 Belgrave Square, London, S.W.1, from which further information can be obtained.

The Managing Trustees of the Drummond Fellowships for Research in Nutrition will consider in March 1957 applications for not more than one Drummond Senior Fellowship (£900 per annum) and not more than two Drummond Junior Fellowships (£500 per annum) for research in nutrition. The fellowships will normally be tenable for two years. Particulars can be obtained from the Honorary Secretary, Drummond Trust, University College, Gower Street, London, W.C.1. Completed application forms must be received not later than January 31, 1957.

Research papers on the chemistry and technology of oils and fats by a scientific worker in India are invited for consideration for the award of the Prof. T. P. Hilditch Medal. Such papers must relate to work carried out in the past two years, and should reach the convener of the award committee, Dr. D. R. Dhingra, H.B. Technological Institute, Kanpur, India, by December 31.

The British Steel Castings Research Association has moved to new laboratories at East Bank Road, Sheffield 2.

A review of "The Chemistry of Living Cells" by Prof. Helen R. Downes was published in *Nature* of November 24, p. 1140. We are informed that the English publishers are Longmans, Green and Co., Ltd., and the price is 45*s*. net.

NEW MAUNA LOA OBSERVATORY UNIT

By ROY L. FOX

Meteorologist in Charge, Pacific Area, U.S. Weather Bureau

A NEW high-altitude unit of the Mauna Loa Observatory to be used for observations and research projects was recently completed and dedicated. This unit, termed the 'slope' unit of the Observatory, is situated on the north slope of Mauna Loa at an elevation of 11,134 ft. above sea-level and is accessible over a gradual grade highway constructed of crushed lava and volcanic cinders. It is a companion unit to the much smaller and decidedly less accessible unit of the Observatory erected in 1951 at an elevation of 13,453 ft. near the summit of the mountain.

Its setting is the large volcanic mountain, Mauna Loa, often referred to as one of the largest single land masses in the world. The mountain comprises approximately half the island of Hawaii, the largest and south-easternmost of the Hawaiian Islands, and is noted not only for its massiveness but also for its very gradual slopes with almost constant grade. The 'straight line' average grade over a distance of approximately forty miles along the north-east slope from the summit, at 13,680 ft. above sea-level, to the sea in the vicinity of Hilo, the principal city on the Island, is less than 7 per cent. This is the slope traversed by the highway to the Observatory and also the one almost directly facing the prevailing quarter from which the trade winds in the vicinity of the Hawaiian Islands blow.

A trip up this highway to the 'slope' unit from Hilo carries one from a point near sea-level, where the average annual rainfall is 140 in., past the region of maximum rainfall near 3,000 ft. above sea-level, where it is more than 240 in., thence through a section of rapidly decreasing rainfall with height and then to the area from around 9,000 ft. to the Observatory unit, where the average annual rainfall is just under 20 in. The vegetation zones along the roadway serve as excellent climatic indicators and strikingly attest to these rainfall regimes. For the first 1,500 ft. or so of elevation the vegetation is predominantly shrub and closed forest. A dense tropical rain forest extends from around 1,500 ft. to near 5,500 ft. above sea-level, where vegetation begins to thin. Open forest then prevails for some distance, giving way to upland open shrub-type vegetation which, in turn, is replaced by a sparse growth of the primitive plant forms such as fungi, lichens and some mosses existing in the lava wastelands.

The 'slope' unit is housed in a pleasant one-story concrete block building, 20 ft. × 40 ft., partitioned into a 16 ft. × 20 ft. combination laboratory and workshop, three bedrooms and a combined kitchenette and dining room. There is also a ground-level concrete pad 15 ft. × 45 ft. for basing instruments, a raised wooden instrument platform and two instrument and antenna towers. It develops it own electrical power from its diesel-operated generating system. It also has its own radio communications link with the Weather Bureau Office in Hilo, an electrical lighting system and a water catchment and water storage and distribution units as well as a space heater, water heater, cooking range and refrigerator, all using butane.

The Mauna Loa Observatory is operated by the U.S. Weather Bureau, but at present it is not staffed on a fully continuous basis. Plans are, however, to have personnel regularly man the station and attend the instruments on four days of each week beginning in the very near future. For the remaining portion of each week, meteorological data will then usually be obtained, as they are now, by recording devices alone. However, for those periods when special research projects are being carried on at the Observatory by other groups through arrangements with the Weather Bureau, the meteorological instruments, along with other types of equipment, will be attended daily, and data on recorder records will be supplemented with visual data. Ultimately, if plans materialize, the Observatory will be staffed continuously, year in and year out.

The usual meteorological instruments, most with recording features, are now in use or soon will be in use at the Observatory. Data to be obtained on a continuous basis are wind speed and direction, pressure, temperature, humidity and rainfall. Additional data being anticipated for interrupted periods of several days per week are duration of sunshine, sky cover, cloud types and amounts, current weather and related features and pilot-balloon information. It is also expected that, when the Observatory is operated on a continuous basis, all these elements will be observed and/or recorded continuously, day in and day out, and that there will also be such additional measurements as those of solar radiation and ozone content of the air and that possibly some high-volume dust sampling and other dust measurements will be made.

Its accessibility, fine living accommodation and excellent provisions for basing instruments make this 'slope' unit particularly useful for special short-period projects. Other attractive features are its tropical location, its altitude—which is well above the usual height of the trade wind inversion in this tropical mid-Pacific area and which places it above much of the atmosphere's moisture and trade wind cumulus cloudiness most of the time—and its great distance from any large continental land masses and industrial areas.

The Observatory's high-altitude setting at a tropical location near the centre of the largest ocean on the globe makes it a unique facility. It is also less than a seven-hour trip from Honolulu, the travel hub of the Pacific, from which the first portion of the trip is by air to Hilo, thence up the mountain highway by motor-car.

One special project, namely, a series of spectrographic observations of the atmosphere of the planet Mars by a group of National Geographic Society scientists, has recently been completed at the Observatory. During the coming winter, it is hoped to study the structure of naturally formed snow crystals in an atmosphere with limited quantities of aerosols. Also arranged for next spring is a special study of solar radiation.

Preliminary negotiations for use of the 'slope' unit for a special project should be with the Chief of the Weather Bureau, by writing to the Chief of the Observations and Stations Facilities Division, U.S. Weather Bureau, Washington 25, D.C.

AFRICAN VEGETATION

MEETING AT YANGAMBI

THE study of natural vegetation, which has no regard for international boundaries, is of primary importance in the scientific development of Africa. It is therefore good to note that the Conseil Scientifique pour l'Afrique au Sud du Sahara, in conjunction with the Commission de Co-operation Technique en Afrique au Sud du Sahara, is now taking steps to promote international co-operation in this basic branch of science.

During July 29–August 8 this year a meeting of specialists in phytogeography was held in the Belgian Congo, under the presidency of Prof. J. Lebrun, secretary-general of the Institut National pour l'Étude Agronomique du Congo belge. The sessions were held at Yangambi, the African headquarters of the Institute, which is on the north bank of the Congo, about 90 kilometres downstream from Stanleyville, in dense evergreen rain forest. In 1885, H. M. Stanley wrote, "Yangambi is beautifully situated on a level terrace. The summits of the ridge appear to offer a charming field for European agriculturists". To-day the Institute's impressive organization at Yangambi employs some two hundred Europeans.

The member-governments of the two sponsoring bodies were represented by Prof. J. Lebrun (Belgium), Prof. J. Trochain (France), Dr. R. A. Dyer (Union of South Africa), Prof. P. W. Richards (United Kingdom), Dr. F. A. Mendonça (Portugal) and Prof. A. S. Boughey (Federation of Rhodesia and Nyasaland). The other participants were Prof. J. Millot, Prof. Th. Monod, A. Aubréville, Prof. R. Pichi-Sermolli, Dr. R. O. Whyte (Food and Agriculture Organization), R. W. J. Keay (sponsored by Unesco), and E. A. Bernard, Dr. R. Germain, E. Maudoux, R. Devred, L. Liben, C. Evrard and R. Gutzwiller, of the Institut National pour l'Étude Agronomique du Congo Belge.

In the field of plant taxonomy, international co-operation in Africa south of the Sahara is already well organized. The International Association of Plant Taxonomists and the Association pour l'Étude Taxonomique de la Flore d'Afrique Tropicale make important contributions towards this co-operation, the great national herbaria are in close contact with each other, and taxonomists—by and large—use much the same methods and concepts and accept comparable standards.

The position as regards plant ecology or phytogeography is, however, very different. There are, at the outset, considerable differences in the methods and concepts of the 'ecology' taught in British universities, largely influenced by Clements and Tansley, and the 'phytosociology' of the Braun-Blanquet school taught in most French and Belgian universities. The divergence has been aggravated by the fact that vegetation-mapping had been unfashionable in Britain during the past thirty years or so. British-trained botanists have, consequently, been going to Africa without much guidance on one of the first problems presented by African plant-life, so that ecological work has developed very individually in each territory. There is also a considerable difference, particularly outside the rain-forest regions, between the approach of the agriculturist who thinks of the vegetation as potential grassland, and that of the forester who thinks of the same vegetation as potential forest.

Much literature and many vegetation maps have been produced in recent years, but it is extremely difficult to correlate the work done by different authors, even in neighbouring African countries. The initiative taken by the Counseil Scientifique pour l'Afrique au Sud du Sahara in promoting international understanding in these matters is therefore most welcome.

The meeting at Yangambi was preceded by an interesting and well-organized excursion to the Haut-Uele Province in the north-east Belgian Congo. After examining forests near Stanleyville, the party travelled by air 350 km. north-east to Paulis. This important centre for *Coffea robusta* and cotton plantations lies in the rain-forest zone, and it was only after the party had travelled about 75 km. toward Dungu, that the first savannah vegetation was seen. All agreed that this vegetation and much of that seen on the journey (210 km.) next day to Aba had been derived from closed forest by man's farming and grass-burning activities; there was, however, a good deal of argument about the precise nature of the climax. Near Aba, the party saw a most interesting outlier of semi-evergreen rain-forest at Kurukwata, and later an example of the *Isoberlinia doka* woodlands, which are characteristic of a distinct belt stretching from French Guinea to Uganda and correspond to the well-known 'myombo' woodlands of east, central and southern Africa.

This excursion, and two trips near Yangambi, provided a unique opportunity for some of Africa's leading ecologists to see together a good range of vegetation types and to discuss them in the field, while travelling, and at the end of each day. This field-work provided an excellent basis for the more formal meetings at Yangambi. There was a considerable measure of agreement concerning the recognition in the field of the plant communities and how they are influenced by biotic, edaphic and climatic factors. It was encouraging to find that on many points workers had independently come to similar conclusions. The greatest divergence of opinion was in matters concerning nomenclature and the concept of the climatic climax. The informal discussions about the latter more academic point were particularly lively and valuable.

Matters of nomenclature were dealt with in the formal sessions at Yangambi. MM. Aubréville, Trochain and Monod each presented classifications of the main types of tropical African vegetation. These and other participants worked hard during the meeting to produce a classification of physiognomic types with parallel names and diagnoses in French and English. This agreed synthesis is to form a basis for a synopsis of tropical African vegetation, illustrated by profile diagrams and photographs, which, it is hoped, M. Aubréville will shortly prepare for publication.

Prof. Monod presented a remarkable account, intended for publication, of the chorological divisions, that is, the broad patterns of distribution not only of the vegetation and plant species but also of the animals.

The meeting reviewed the present state of vegetation-mapping in Africa south of the Sahara and proposed the creation of a permanent centre in Africa to which all new maps of interest to phytogeographers would be sent, and from which research workers could borrow maps. It also considered proposals for the preparation of a botanical atlas of Africa, including vegetation maps on a scale of 1 : 5,000,000, as well as maps showing the distribution of economic species and other subjects.

The Conseil Scientifique pour l'Afrique au Sud du Sahara, and in particular Prof. Lebrun, are to be congratulated on organizing such a useful meeting, and it is to be hoped that means will be found to implement many of its recommendations.

R. W. J. Keay

NINTH INTERNATIONAL CONGRESS OF APPLIED MECHANICS

THE ninth International Congress of Applied Mechanics was held at the Université Libre of Brussels during September 5–13. More than seven hundred members attended the Congress, and no less than five hundred communications were presented. The Congress was administered by the International Committee for Congresses of Mechanics, which is one of the organizations adhering to the International Union of Theoretical and Applied Mechanics. The president was Prof. F. van den Dungen and the secretary-general M. Jean Vandenkerckhove. A feature of the organization was the special provision which was made for young scientists, who were able to obtain cheap accommodation and meals in the Cité Universitaire, while a grant of 2,000 dollars was also available to help with their expenses of travelling to Brussels.

The main interest of the Congress naturally centred around the one-hour addresses. Mr. K. S. Davidson, of the Stevens Institute of Technology, Hoboken, N.J., gave a lecture on "Ships", in which hydrodynamics, boundary-layer theory and practical yachtsmanship were pleasantly combined. Much of the substance of this lecture is available in the Sir Geoffrey Taylor Memorial Volume entitled "Surveys in Mechanics" (Cambridge University Press, 1956).

Prof. R. Hill, of the University of Nottingham, gave a lecture on "New Horizons in the Mechanics of Solids". In this lecture he set up a theoretical framework sufficiently general to include problems of visco-elastic solids, including the theory of creep and work hardening.

Prof. P. Germain, of the University of Lille, lectured on "Some Recent Advances in Theoretical High Speed Aerodynamics". This was a general survey of problems of linearized supersonic theory treated by the method of the Laplace transform. Some extensions to second-order effects were also included in the lecture, which was remarkable for the speed with which it covered almost all recent developments in this subject.

Prof. H. Mettler, of the Technische Hochschule, Karlsruhe, spoke on "Forced Non-linear Vibrations of Elastic Bodies".

But perhaps the address which was most appreciated was that by Sir Geoffrey Taylor, which bore the title of "Steady Flow of Fluid entering a Region through Porous Boundaries", and which in fact dealt with the hydrodynamics of paper-making, and of painting with rollers and ordinary artists' brushes. In this extremely interesting address, Sir Geoffrey gave an account of the recent work which he has carried out to investigate the flow of the paper pulp over the rollers in paper-making machines. His investigations of roller painting and of brush painting consisted not only of simple theories embodying the main physical factors, but also of experiments which satisfactorily bore out the predictions of the theory and which were remarkable for the economy of material with which they were executed.

Apart from these general addresses, the work of the Congress was divided into two sections, the first dealing with fluid mechanics and containing some 258 papers, and the second with the mechanics of solids, containing 243 papers. In view of this great mass of material, it was necessary to limit the time available for the presentation of most papers to 15 minutes, although a certain number were given 30 minutes. The papers were grouped in such a way that only two papers were ever being read at the same time, namely, a 30-minute paper in Section I and a 15-minute paper in Section II, or vice versa.

The section on fluid mechanics included papers on aerodynamics in subsonic, transonic, supersonic and hypersonic conditions, on atmospheric pollution, boundary-layer theory, hydrodynamics of water-entry problems and surface waves, lubrication, cavitation, and seepage problems in the Nile valley. A particularly interesting demonstration was given by Prof. M. Reiner, of the Israel Institute of Technology, of his centripetal pump. This machine consists of two parallel plates ground accurately flat, of which one forms the stator and the other the rotor. A pressure hole is located at the centre of the stator and the rotor is rotated at a few thousand revolutions per minute. Initially, the pressure at the centre of the stator is reduced; but as the distance between the plates is progressively reduced to a few thousandths of an inch, a pressure of several feet of water is built up.

The section on the mechanics of solids included some papers on classical problems of vibrations, on the elastic theory of plates and shells, on buckling and post-buckling problems, and on a yielding sub-soil; but the emphasis seemed to be on plasticity, limit analysis, creep and visco-elasticity.

Mention must also be made of the social activities and of the financial support which the Congress received from Belgian banks and industries. Members of the Congress enjoyed the traditional Belgian hospitality at two receptions and a banquet. A reception was given at the University by the President, Vice-President and Rector of the Free University of Brussels and a reception at the Town Hall by M. L. Cooremans, mayor of Brussels. The banquet was held at the Hotel Metropole.

It is planned to hold the next International Congress of Applied Mechanics in 1960 in Italy.

THE NUCLEI OF ATMOSPHERIC CONDENSATION

ATMOSPHERIC aerosols cover a wide range of particle-size from about 10^{-7} cm. for the small ions to more than 10μ radius for the largest salt and dust particles, and a range of concentrations from less than $100/\text{cm.}^3$ over the oceans and in the upper air to, perhaps, $10^6/\text{cm.}^3$ in the polluted air of large cities. Being the products of natural and man-made combustion, of dust and spray raised from the Earth's surface, of chemical reactions taking place in the atmosphere, and perhaps even of matter entering the atmosphere from outer space, the particles will vary greatly in chemical composition and, because of coagulation, will often be of mixed constitution. The abundance, size, physical properties and nature of these particles are matters of particular interest to those working in the fields of cloud physics, atmospheric electricity, atmospheric pollution and atmospheric chemistry.

Since the pioneer work of Aitken seventy-five years ago, a great deal of effort has been devoted to measurement of the concentration, size, mobility and electric charge of the smaller particles with radius between 10^{-7} and 2×10^{-5} cm. But in recent years more attention has been given to the particles larger than 0·1μ in diameter—the so-called 'large' and 'giant' nuclei—since it is these which are mainly responsible for the formation of cloud droplets. The selective sampling of these larger particles has necessitated the development of new techniques for collection and measurement; but at these sizes it now becomes possible to use electron microscopy, electron diffraction and microchemical methods for identification.

These trends were reflected in the proceedings of the Second International Symposium on Condensation Nuclei, held in Basle and Locarno during October 1–4 and attended by scientists from ten countries.

After the delegates had been welcomed by Prof. F. Verzár on behalf of the organizing committee, the conference opened with a review by Dr. B. J. Mason (Imperial College, London) in which he summarized and assessed the present state of knowledge concerning the abundance, size distribution, physical properties, nature and origin of condensation nuclei, particularly of those which are likely to be involved in cloud formation.

An interesting paper by A. C. Chamberlain, W. J. Megaw and R. D. Wiffen (Harwell) described the consequences of the attachment of radioactive particles (particularly the decay products of radon and thoron) to condensation nuclei, the use of radioactive markers to study the behaviour of condensation nuclei, and the production of condensation nuclei by ionizing radiations. The diffusion constant of radium A and thorium B ions was found to be 0·054 cm.²/sec. when uncombined, and of order 10^{-5} cm.²/sec. when attached to condensation nuclei, this difference having an important effect on the site of deposition in the human respiratory system of inhaled radioactive matter. Unattached radioactive particles are largely deposited in the nose, trachea and bronchi, but the attached particles penetrate to the alveoli. The new radioactive method of determining the diffusion constant of nuclei gave results which differ from those obtained by the normal methods by a factor of about two—a discrepancy which has still to be resolved.

Reviewing the methods of measuring the concentration of Aitken nuclei, Prof. L. W. Pollak (Dublin) stressed the limitations of the Aitken pocket counter and of the Schulz counter and described the development, calibration and accuracy of the Nolan–Pollak photoelectric counter, which has proved a much more satisfactory instrument. There followed papers by various members of the Dublin school describing a nucleus counter with stereophotographic recording of the deposited droplets, the formation and decay of the fog in the photoelectric counter, and the results of some experiments carried out with Verzár's automatic photoelectric counter.

There were two other papers of particular interest from the instrumental point of view. Prof. A. Goetz (Pasadena) described an ingenious device for the separation and size classification of airborne particles greater than 0·2μ diameter. The particle-laden air is introduced into the space between a helical screw and an outer cylinder rotated at high speed. The particles are deposited on the surface of the helix under a centrifugal acceleration, the linear displacement being proportional to the ratio particle diameter/mass. Under these conditions, the particles move only slowly relative to the air and so are not subjected to large shearing forces.

Dr. J. Podzimek (Prague) described some preliminary experiments on the formation and growth of clouds produced in Findeisen's large expansion chamber (capacity 2 m.³) and, in particular, the effects of varying the initial temperature, expansion ratio and rate of expansion (that is, the rate of cooling of the air).

The role of condensation nuclei in atmospheric electricity, and in particular the effect of their concentration, charge and mobility on the conductivity of the air, was the subject of papers by H. Israël (Aachen), J. A. Chalmers (Durham) and Herpertz, Israel and Verzár.

Dr. C. Junge (Air Force Research Center, Cambridge, Mass.) described the results which have emerged from the chemical analysis of samples of rain-water collected once a month at some sixty stations spaced across the whole of the United States. Maps showing the geographical distribution of chlorides are very similar from month to month, with high concentrations near the coast, but dropping to a fairly constant value inland. This, together with the fact that the total number of giant salt particles occurring in unit vertical column of the atmosphere is much the same over both land and sea, suggests that the air undergoes strong vertical mixing when it passes over the continent, and also that the giant salt particles are not effectively removed from the atmosphere by rain. Junge estimates the mean half-life of the giant salt particles to be three to four days in the eastern part of the United States, where the average rainfall is 0·1 in./day, and six to seven days in the western part of the continent, where the average daily rainfall is only 0·05 in. The half-life of the smaller natural aerosols, measured by radioactive techniques, was estimated to be about twelve days. This all suggests that natural aerosols may be transported for great distances over the Earth before falling out or being washed out by precipitation.

During the second part of the conference, held in Locarno, Prof. Giuseppina Aliverti (Naples) reviewed recent researches on the condensation and ice-forming nuclei which are of particular interest in cloud physics.

Dr. B. J. Mason (London) reopened the old controversy as to whether salt particles produced by sea spray are the main source of condensation nuclei involved in cloud formation. His experiments show that air bubbles of diameter between ½ mm. and 2 mm., bursting in sea water, each produce about three hundred nuclei which, under the electron microscope, are mainly between 0·1μ and 0·5μ in diameter, the smallest containing only 10^{-15} gm. of sodium chloride. These results, together with measurements of the size distribution of salt nuclei collected over the oceans in areas of spray formation, indicate that the total concentrations of salt nuclei over the oceans in winds of up to 15 m./sec. probably do not exceed 100/cm.^{3}. The corresponding rate of production of salt nuclei at the sea surface is estimated to be 1,000/cm.^{2} sec. It was therefore inferred that sea-spray contributes perhaps only one-fifth of the nuclei involved in cloud formation, the majority being the products of combustion.

A paper by K. Isono (Tokyo) described how the residues of cloud droplets collected on the summit of a mountain 150 km. from the sea have been examined under the electron microscope and their nature determined by electron diffraction. Most of the nuclei are less than 1μ in diameter; about 30 per cent consisted of sodium chloride, 20 per cent of unidentified soluble particles, and 50 per cent of insoluble particles—probably combustion products.

H. Dessens (France) has established that giant hygroscopic nuclei ($r > 10\mu$) exist in concentrations of at least 100/m.^{3} in the equatorial forests of the Belgian Congo, while nuclei of radius less than $0 \cdot 4\mu$ are present in much higher concentrations. No sodium chloride crystals have been identified among the giant particles, the most important source probably being the savannah fires. M. Dessens also described some very interesting experiments in which he has been able to produce quite large cumulus clouds in an otherwise clear sky by the burning of vegetation.

Other aspects of the subject were represented by contributions from H. W. Georgii (Frankfurt) on the measurement of the turbulent diffusion of aerosols near the ground, and by F. Volz (Mainz) on the production of dusts and their spatial distribution in the atmosphere.

Although a good deal of the material presented was not entirely new, the conference produced much vigorous and good-humoured discussion and some clarification and agreement as to what are the important problems. These include the collection and identification of the large and giant nuclei over both land and sea at different levels in the atmosphere, and investigation of the processes by which they are produced and transported.

The organizing committee is to be congratulated on the excellence of the arrangements in ideal surroundings. The proceedings of the conference will be published in a special issue of *Geofisica Pura e Applicata*. It is expected that the next symposium will be held in Britain in 1958. B. J. MASON

WORLD TELECOMMUNICATION

THE major part of the inaugural address as president of the Institution of Electrical Engineers, delivered by Sir Gordon Radley, director general of the Post Office, on October 4, was devoted to a consideration of world telecommunication, a subject particularly topical in view of the recent opening to traffic of the first trans-Atlantic telephone cable. The practical realization of inter-continental multi-channel telephone communication by submarine cable is, in Sir Gordon's view, revolutionary in its possibilities, because the traffic capacities of such cables are likely to exceed the existing demand for telegraph and telephone facilities on their routes. It is important to appreciate that it is the advent of the submerged repeater or amplifier which has rendered long-distance submarine telephony practicable. The attenuation of the Newfoundland–Scotland section of the trans-Atlantic telephone cable at 164 kc./s. is approximately 1·6 db. per nautical mile, and an input power at the enormous level of 100 MW. would not be detectable by the most sensitive galvanometer at a distance greater than 150 miles. In the cable, repeaters are inserted every 38 miles, and the gain of each of these is 65 db., representing a power amplification greater than 10^6. On this basis multi-channel telephony is practicable on the longest submarine circuits.

The trans-Atlantic cable circuit utilizes, for the longest ocean link, separate cables for the two directions of transmission. The 'one-way' repeaters in these cables are accommodated in flexible housings only a little larger in diameter than the cable itself. These repeaters can be passed over the laying gear of the cable ship, and laying can be carried on continuously as with a conventional cable. The alternative arrangement of two-way transmission on a single cable requires a considerably greater space in the repeater housing to accommodate the additional filters and more complex circuits. The rigid housings for these repeaters require special handling in laying and considerably complicate that operation. The devising of means whereby the laying of such rigid repeaters could be carried out as part of a continuous cable-laying operation is, in fact, an immediate task of great importance.

Sir Gordon devoted considerable attention to the relative costs of single- and double-cable schemes, illustrating the matter by curves showing the estimated capital cost and annual cost per telephone circuit for cables 2,000 miles long, plotted to a base of total band-width transmitted in each direction. The cost per circuit is shown to decrease rapidly as the band-width or total capacity of the system is increased. It is thus economically advantageous to include in one cable, or pair of cables, all required facilities, telegraphy, telephony and—ultimately—television.

In regard to the economics of telephone-cable schemes on the main cable routes of the world, there appears to be a marked distinction between the North Atlantic route and all others. Sir Gordon remarked that the impetus to the growth of traffic between Western Europe and North America given by the 1956 telephone cable might well produce an early demand for a second cable of the greatest capacity technically possible. Eighty circuits in a single-cable system or two hundred in a twin-cable system was an objective only just beyond the limits at present imposed by repeater spacing and cable diameter, and either system, if reasonably loaded with traffic at the present call-rates, would be profitable.

On other world routes the economic prospects are less promising. Circuits to Australia and New Zealand, 12,000 miles long, might have a volume of traffic between 5 per cent and 10 per cent of the traffic with North America. It is clear that, for so great a distance with a small group of circuits, cable could not be competitive on cost with radio. On the other hand, experience of the propagation of high-frequency waves has shown that satisfactory radio communication cannot be maintained continuously over such difficult routes as the North Atlantic, or to the Antipodes.

It thus appears that the challenge to the communication engineer is that of providing submarine cable facilities on the main trunk routes of the world on a similar scale to that which has become established practice on land. This challenge is of very direct concern to British manufacturers, for Britain has a unique tradition of submarine cable manufacture and has an exceptionally large manufacturing capacity for this class of equipment.

In relation to inland telecommunication, Sir Gordon stated that "electronic techniques are likely to revolutionize the art of telephone switching within the foreseeable future". Fully electronic switching systems are being developed along two distinct lines, one in which gas diodes or other corresponding devices are used in a 'space multiplex' to connect speech paths, and the other in which time-division multiplex operation enables individual subscribers to communicate. The production cost of an electronic exchange is likely to be less than that of the corresponding mechanical equipment, and it is thought that maintenance costs should also be reduced.

A new facility is planned for the trunk telephone network of Great Britain in the form of subscriber-dialling of long-distance calls. To render this practicable, it is necessary to have a nation-wide number scheme, and the system is being planned on the basis of 20 million subscribers connected to 8,000 telephone exchanges.

In the trunk network, co-axial cables carrying 600 speech channels are in operation between the main centres of population, and similar plant modified to transmit a slightly wider band of frequencies is used for television. It is proposed, on these co-axial cable routes, to reduce the spacing between repeater stations to three miles, if sufficient traffic offers, as this would enable each tube of the cable to carry 1,000 telephone channels plus a 405-line television channel. The micro-wave radio relay system planned for Britain is capable of carrying 600 channels of telephony, or one television channel.

In his concluding remarks, Sir Gordon mentioned that he had not followed the example of his predecessors in office during the past few years as he had made no reference to the great need in Britain for more technologists, or to the means of training them. He had, however, described a few of the problems and projects which at present are challenging the ingenuity and energy of the telecommunication engineer, and he hoped that in so doing he might have kindled here and there a spark of interest and enthusiasm for work in a field of endeavour where much can be done to serve the nation, the Commonwealth, and the world at large.

J. GREIG

CITY AND GUILDS OF LONDON INSTITUTE

THE year 1955 was a memorable one for the City and Guilds of London Institute in that the entries for the Institute's examinations exceeded a hundred thousand for the first time. From 1878 until 1955 more than 1½ million people have entered for the Institute's examinations, and the fact that half a million of these have done so within the past six years emphasizes how great has been the expansion of technical education. During the year many new subjects have been introduced to meet new needs, and a large number of existing subjects have been carefully reviewed and where necessary the syllabuses have been modified.

The Institute regularly surveys its schemes not merely as separate subjects but also in their relationship to each other and in relation to their place in the national economy. As an example, some account is given in the annual report of those subjects which have a particular bearing on the proper use of the nation's fuel resources and the contribution which appropriate courses of study can make to industrial fuel efficiency.

The Associated Examining Board for the General Certificate of Education, for which the Institute has undertaken the administrative and financial responsibility in the initial years, has now been successfully launched. In the first examination, held in the summer of 1955, nearly five thousand papers were taken in more than seventy subjects at ordinary and advanced levels, and the entry figure has been more than doubled in the summer examination of 1956. Omissions in the list of subjects offered by the Board are continually being made good, and the new subjects recently approved include commercial subjects (including shorthand and typewriting) at ordinary level, music at ordinary level, and dress at ordinary and advanced levels.

The report also contains an account of the way the Institute has been re-organized to meet the challenge of changing times.

NITROGEN METABOLISM AS AFFECTED BY POTASSIUM DEFICIENCY

SOME new and interesting aspects of nitrogen metabolism in barley, especially as it is affected by potassium deficiency, have been investigated by R. G. Coleman and F. J. Richards (*Ann. Bot.*, N.S., 20, 79, 393; 1956). Barley was grown in water and sand culture, using a variety of nutrient solutions, the most important variable being potassium supply. It was observed that the diamine putrescine, which is not normally found in this plant in appreciable amounts, was present in potassium-deficient seedlings and that it accumulated during their growth. Its maximum accumulation coincided with the development of the severe symptoms associated with advanced deficiency. Putrescine occurs at an earlier stage in potassium-deficient plants, the nitrate and phosphate of which are supplied as ammonium salts, than in those to which the corresponding calcium salts are given. It is found less abundantly in the roots than in the tops. It is absent from protein hydrolysates.

These investigators have also shown that a leaf necrosis characteristic of potassium deficiency can be induced by feeding putrescine to barley having a high potassium status after prolonged feeding the appearance of such plants suggested severe potassium starvation. The putrescine is slowly utilized, and at the same time an unidentified substance is produced. It is stated that what seems to be the same substance appears in quantity in high-potassium red clover during the course of rapid utilization of administered putrescine. It also occurs naturally in potassium-deficient red clover. When potassium is supplied to potassium-deficient barley in which putrescine has accumulated, the amine soon disappears. Application of either rubidium or sodium also leads to a reduction in putrescine, though to a lesser extent, rubidium being the more effective element. Under conditions of extreme potassium-deficiency, wheat and red clover also accumulate putrescine. The free amino-acid composition of the wheat then bears a striking resemblance to that of deficient barley.

PHYSIOLOGY OF MUSCLE

THE Medical Department of the British Council has once more been able to persuade a group of active and distinguished scientists to leave their benches and spend time on summarizing and interpreting recent progress in a field of active research—this time, the physiology of voluntary muscle (*British Medical Bulletin*, 12, No. 3, 161 (1956). London: British Council. 15*s*. net). There are sixteen reviews in this symposium, and they succeed in giving a clear, connected and up-to-date summary of research in the physiology, biochemistry and biophysics of this type of muscle. The scientific editor is W. D. M. Paton, and the chairman of the planning committee is Sir Rudolph Peters, who contributes an introduction.

A. V. Hill contributes essays on thermodynamics and on the design of muscles. He mentions that an animal's muscles could be quickened about 20 per cent by raising its body temperature 2 deg. C., and he wonders whether, if this were achieved rapidly by diathermy, it would enable a good runner to do 100 yards in 8 seconds. He points out, though, that the margin of safety in mechanical strength of muscle systems is a small one and thinks that the experiment would be risky. There is an essay by A. F. Huxley, illustrated by photomicrographs, on the interpretation of muscle striations, based on work with modern techniques of light microscopy. This is followed by one on the 'ultra-structure' of muscle as revealed by the electron microscope and the X-ray camera (H. E. Huxley). It is possible by means of suitable salt solutions to extract the main proteins of muscle selectively, so that the residual structure can be viewed after successive removal of myosin and actin. The results suggest a delightfully simple picture of muscle as being made up of discontinuous, parallel filaments of myosin and of actin which seem to slide or 'crawl' past one another during contraction, perhaps because of the pull exerted by oblique cross-linkages between the molecules of the two proteins. Adenosine triphosphate can affect this interaction and may itself be broken down by myosin. The word 'crawl' would scarcely seem apt to R. G. Bannister, who contributes a section on muscle effort in running. In spite of the limits set by speed of muscle contraction or of oxygen supply, he believes that in a race, psychological factors—mental excitement and ability to ignore pain—"set the razor's edge between defeat and victory".

Mrs. D. M. Needham describes the biochemical reactions which provide energy for muscle contraction. In the past, glycogen and creatine phosphate have successively been displaced from the role of primary energy source in muscle. Whether adenosine triphosphate will suffer the same fate remains to be seen, though there are hints of this in the work of H. A. Krebs and his colleagues and of W. F. H. M. Mommaerts (see *Nature*, 174, 1081; 1954). At present, adenosine triphosphate seems to occupy the key position even after death, and E. C. Bate-Smith and J. R. Bendall show that the onset of rigor depends on the fall in the concentration, or in the turn-over rate, of this substance to a critical level. Other biochemical features of muscle are considered by K. Bailey and by S. V. Perry in their essays on the protein and enzyme systems of muscle.

The comparative physiology of muscle is discussed by C. F. A. Pantin and the methods of locomotion in fishes and four-footed animals by Sir James Gray. The role of the cell membrane is described by B. Katz, particularly the phenomenon of liberation of acetylcholine in quanta or 'pre-formed parcels' at the nerve–muscle junction. The only article of immediate clinical application is the one on familial periodic paralysis by B. McArdle, though Sir Rudolph Peters points out in his introduction that most of the academic research reviewed in the other essays is needed to provide a basis for complete understanding of this one disease.

Most of the reviews contain an up-to-date and fairly extensive bibliography, which greatly adds to their usefulness.

D. C. Harrison

SENSITIVITY OF IMMATURE MOUSE SPERM TO THE MUTAGENIC EFFECTS OF X-RAYS

By Dr. A. J. BATEMAN*

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IN an earlier communication[1], I questioned the accepted view that the first three weeks mating of a male mouse irradiated with a dose in the neighbourhood of 500 r. represented *all* the post-meiotic stages of sperm at the time of irradiation[2,3]. My objection was based upon data being accumulated at the time and which can now be presented.

The mutagenic response was studied in terms of dominant lethals. Twelve days after their insemination, females were dissected and the numbers of corpora lutea, implantation sites and dead implants recorded. From this last category were excluded fœtuses which had made appreciable growth before death. In so far as they are genetic in origin, these would arise from gene mutation rather than chromosome breakage and loss, which is the source of the main type of dominant lethal mutation.

It is usual (for example, Russell *et al.*[3]) to estimate the proportion of dominant lethals from the corpora lutea not represented by live fœtuses. This will include all dominant lethals; but unfortunately it will also include all unfertilized eggs. There is likely to be a substantial and erratic proportion of unfertilized eggs even in the control series (matings of unirradiated males), which is therefore an important source of random error. But if the treatment affects the amount of sperm, its fertilizing capacity, or even its ability having effected fertilization to promote cleavage, there is the possibility of a systematic error.

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* British Empire Cancer Campaign Fellow.

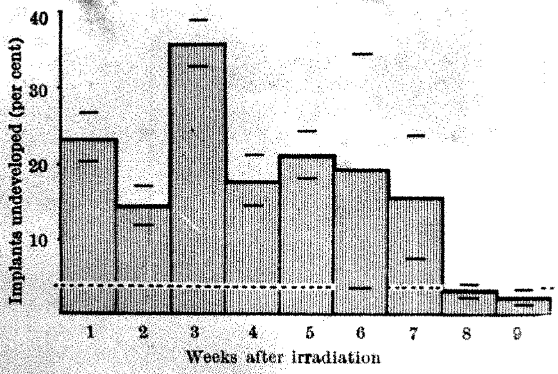

Fig. 1. Dominant lethal rates in successive weekly samples of sperm following the irradiation of male mice with 200 r. The broken line shows the control value: 3·78 per cent. The standard errors of the weekly means are indicated by the thin horizontal lines above and below

In the data here presented, only the proportion of implantations without signs of a fœtus is considered. While excluding in this way about half the true dominant lethals (those failing to be implanted) the above-listed sources of error are also excluded, and the control value is conveniently low and constant. There is one important unproved assumption: that the frequency of failed implantations is proportional to the *total* incidence of dominant lethals. There is some evidence that this is approximately true. Meanwhile, the convenience of the method is a good recommendation. The only improvement would be a method which was able to distinguish between unimplanted eggs due to dominant lethals and those due to other causes, which would probably necessitate the cytological examination of all the eggs at a critical stage after fertilization.

Both irradiated males and the females to which they were mated were F_1 hybrids between two large-bodied strains supplied by Dr. D. S. Falconer of Edinburgh. They are vigorous, mate readily and have high ovulation-rates. The modal number of corpora lutea is 14–15.

The males were given a testis dose of 200 r. They were then placed with four females each, which were renewed at weekly intervals for nine weeks.

Nine males were analysed in this way. There was no indication of heterogeneity between them. The mean weekly values for dominant lethals for all males are presented in Fig. 1, with the standard error based on variation between males.

The most important feature is the continuous incidence of dominant lethals over seven weeks, followed by a return to the control value by the eighth week. It is accepted that dominant lethals induced in pre-meiotic stages are not transmitted by the sperm. The detection of dominant lethals is therefore proof that these sperm were in a post-meiotic stage or, possibly, meiosis at the time of irradiation. It is concluded, therefore, that, contrary to many shorter estimates, spermiogenesis from spermatocyte to insemination in the mouse takes six weeks.

It may be objected that no allowance has been made for the possible storage of sperm after it has matured, thus producing an extension of the apparent length of the post-meiotic period. This assumption of sperm storage is common in the literature and is implied in all data in which matings are analysed according to mating sequence rather than the interval from irradiation[3,5]. There may well be stock differences in this matter; but my own material shows no evidence of the storage of sperm. On the contrary, it shows clear evidence that there is *no* storage.

Males given 500 r. become completely sterile after three weeks, whether or not they have been mated previously. Moreover, the raised mutation-rate detectable in the third week is also found to be independent of the previous mating history. This absence of storage is consistent with the anatomy of the genital system, which has no storage organ, the so-called 'vesiculæ seminales' being secretory organs containing material for the vaginal plug.

If spermiogenesis takes six weeks, it follows that the failure to obtain progeny from males over three weeks from irradiation with doses of the order of 500 r. must be due to the lethal effect of such doses on immature sperm, in much the same way that 30,000 r. kills immature *Drosophila* sperm[4].

Fig. 1 shows a marked peak in mutation for the third week. This confirms the observations of Auerbach and Slizynski[2] for translocations, and that of earlier workers[3,5] for dominant lethals, following higher doses. In the present data the mutation-rate in the third week is more than twice that in the second.

After this peak, however, the mutation-rate falls in the fourth and fifth weeks to a level indistinguishable from that of the two weeks before the peak. Evidently the mutagenic sensitivity of the earliest stages of spermiogenesis is no greater than that of mature sperm. It is only at a certain critical stage, 2–3 weeks from maturity (week 3 samples sperm utilized 14–21 days after irradiation), that hypersensitivity is encountered. This is in direct contrast to *Drosophila*, where the peak sensitivity is found in the most immature spermatids.

Pronounced oligospermy is encountered during weeks 6 and 7. This explains the high standard error for these weeks. Owing to this high error we can say nothing more definite regarding the mutation-rate at this stage than that it is not significantly different from that of the two preceding weeks. Owing to the oligospermy there is a high degree of pseudopregnancy (more than 50 per cent), and the fertile matings have implantation-rates of only 40 per cent. Indeed the paucity of sperm was so great that none was found in the uteri of females shortly after insemination, though similar samples during all the other weeks showed abundant sperm. This is independent evidence that weeks 6 and 7 are close to meiosis, irradiation of which has been shown by Auerbach[6] to lead to oligospermy in *Drosophila*.

A minor point is the barely significant reduction in mutation from the first week to the second. The difference is 8·9 ± 4·2 per cent. Such an effect has been frequently encountered in *Drosophila* in comparing the first and second days mating[4,7].

To return to the main features of Fig. 1, it would appear that the variation in mutagenic sensitivity during spermiogenesis is *not* the same in mouse and *Drosophila*. A possible objection is that our assumption of a constant ratio of pre-implantation to post-implantation losses due to dominant lethals is not a valid one. But one would have to invoke extreme variation in the ratio to transform a *fall* in the ratio of post-implantation lethals to total implants into a *rise* in the total frequency of dominant lethals.

Another possibility which must be considered is that the recovered mutation-rate is not the primary one. Thus in sperm more than three weeks to maturity there might be selective elimination of those carrying dominant lethals. This possibility needs to be investigated further.

It may be concluded that spermiogenesis in the mouse takes 6–7 weeks. This is the period during which dominant lethals can be detected following a testis dose of 200 r. Unlike *Drosophila*, the highest mutagenic sensitivity is not found in the most immature spermatids, but in the relatively late stage sampled in the third week from irradiation. Before and after this peak the sensitivity is almost constant, being about half that of the peak. The incidence of dominant lethals among implantations alone is 35 per cent at the peak sensitivity and averages 20 per cent over the rest of spermiogenesis. The control value is 4 per cent. Assuming all these failed implants to be genetic in origin, we obtain as an estimate of the 'doubling dose', 50 r. (for the less-sensitive stages), which is the same as that calculated by Russell[8] for mutation in spermatogonia, and given extra weight by being cited in the recent White Paper on radiation hazards to man[9].

The data will be presented more fully and discussed more intensively elsewhere.

[1] Bateman, A. J., *Nature*, **177**, 934 (1956).

[2] Auerbach, C., and Slizynski, B. M., *Nature*, **177**, 376 (1956).

[3] Russell, W. L., Russell, Liane B., and Kimball, A. W., *Amer. Naturalist*, **88**, 269 (1954).

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[5] Hertwig, P., *Biol. Zentr.*, **58**, 273 (1938).

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[8] Russell, W. L., *Cold Spring Harbor Symp. Quant. Biol.*, **16**, 327 (1952).

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A DISTURBING FACTOR IN VERY HIGH FREQUENCY COMMUNICATIONS VIA IONOSPHERIC FORWARD SCATTER

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AND

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IT is now well known that it is possible to communicate over long distances at very high frequencies by forward scatter from ionospheric turbulence[1-3]. Since the latter part of 1955, an elusive but persistent trouble has been experienced on an experimental scatter communications link from Gibraltar to the United Kingdom, operating on 37·30 Mc./s. Difficulty was experienced when attempts were made to receive teleprinter signals at 50 bauds with frequency-shift keying. Initially, the difficulty was evidently largely due to keying equipment faults, and the whole effect seemed to be greatly enhanced when the frequency deviation was increased from 2000 c./s. to 4800 c./s. in January. The effect manifested itself as a lack of purity in the note of the heterodyned signal, combined with a beat tone of the same order as the frequency deviation, and resulted in complete inability to print teletype correctly. The fact that the effect often appeared and disappeared within a very few minutes, and frequently coincided with some alteration made to the transmitter, at first suggested equipment troubles. However, when these had been carefully eliminated, the effect remained.

At this stage, some long-delay multipath effects were suspected, and it was clearly desirable to pulse-

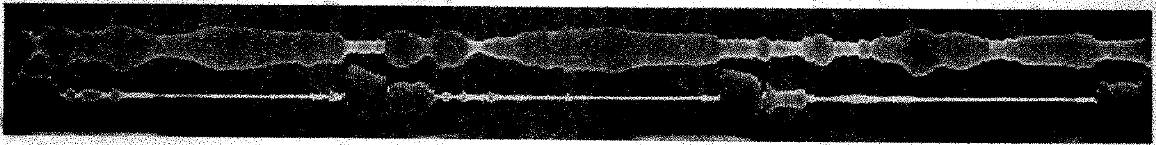

Fig. 1. 50-baud letter shift, 12.04 hr., G.M.T., March 14, 1956. Directive array

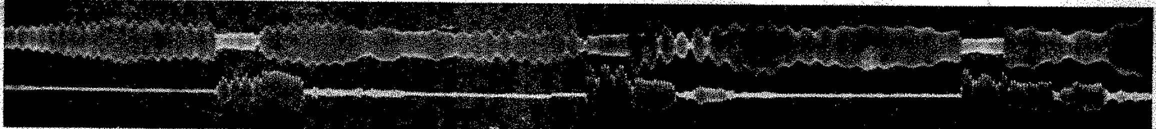

Fig. 2. 50-baud letter shift, 12.04 hr., G.M.T., March 14, 1956. Directive array

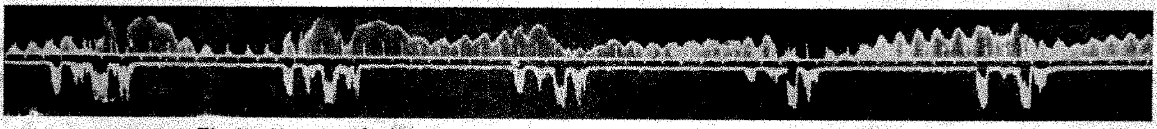

Fig. 3. 10-msec. pulse at *PRF* of 4 per sec., 11.10 hr., G.M.T., April 3, 1956. Directive array

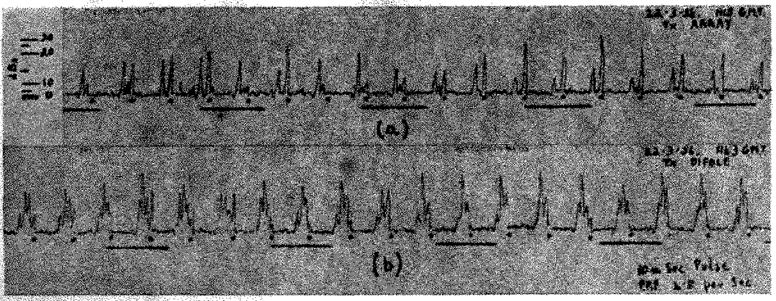

Fig. 4. High-speed amplitude recordings of the 'space' channel signal. (*a*) Directive array; (*b*) dipole

modulate the transmitter to determine their origin. Since this was not possible directly, an approach to pulse modulation was achieved by sending a sequence of teleprinter letter-shift signals, which consist of the start digit (20 ms space), followed by all mark including the stop digit (a total of 130 ms). By observing with a narrow-band receiver tuned to the space frequency, the effect of a pulse transmission was obtained with 20 ms pulses at 6⅔ pulses per sec. At once it was observed that discrete delayed signal components were present, at approximately 20 and 40 msec. delay relative to the direct forward scatter signal. Occasionally 60 and 80 msec. delay components were detected, and also possible traces of later components up to 130 msec. Figs. 1 and 2 show these effects as originally observed on a visual display of the receiver outputs. The outputs from both mark and space channels are shown, the upper trace being the mark signal. Fig. 2 illustrates a most interesting distinction between the direct forward-scatter component of the signal, which carries a Doppler amplitude modulation of variable pitch, and the delayed signal components accompanying it, which have no such modulation. This suggested that the two signal components were being supported by different propagation mechanisms.

In order to obtain greater time discrimination between the delay components, and to disprove a suggestion that round-the-world echoes were involved, arrangements were made to reduce the pulse of space-frequency signal to 10 ms, while increasing that of the mark-frequency signal to about 200 ms. The result is shown in Fig. 3, where the separation of the components at discrete intervals of approximately 20 msec. is clearly seen. Timing marks at 20 ms intervals are shown on the mark signal trace. The film speed is slower than on the previous photographs, and this record is of the rectified audio output of the receiver. Fig. 4 shows a series of high-speed amplitude recordings made of the 'space' channel signal. That received from the transmitting array is shown in (*a*) and that from the transmitting dipole in (*b*). Both records were made within a space of half an hour and they are typical of propagation conditions existing in the morning during March. In each of the records the position of the direct signal component has been marked with a distinctive dot. Time advances from right to left, second intervals being indicated by the commencement of each black bar under the record. A calibration of relative amplitudes is included in Fig. 4(*a*).

The discrete nature of delayed signal components is well illustrated in each record, but it should be noted that in the dipole transmissions the direct signal component often disappears into noise. Further typical results obtained when transmissions were made on a horizontal dipole, instead of the normal directive array, are shown in Fig. 5. The direct component of the received signal is again of relatively small amplitude, whereas that of the delayed component is somewhat greater than that normally experienced using the array. This indicates quite clearly that the dipole radiation to the *rear* of the direct path is responsible for the enhancement in the amplitude of the delayed signal components. The appearance of the gap on the mark trace at the instant of the delayed signal component, rather than at the instant of the direct component, is to be expected under these conditions.

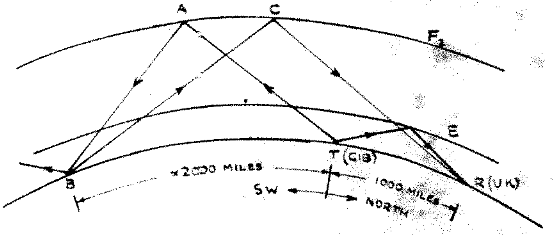

Fig. 6. Elevation of scatter signal paths

An earlier investigation⁴ had predicted that long-distance propagation of frequencies up to 50–55 Mc./s. due to normal *F*-region reflexion could be expected around mid-day in the months of seasonally high *F*-region ionization densities between the autumnal and vernal equinoxes, in years near the solar cycle maximum, thereby causing mutual interference between remotely situated, short-distance VHF services. Moreover, it has long been known that, under these conditions, scattered signals can be reflected back by the *F*2-region towards the transmitter⁵. At the time of the present observations, it was known from predicted data that the sunspot activity was rising very rapidly towards a high maximum, expected in 1957, and the other parameters were favourable to this mode of propagation coming into play for 37 Mc./s. at low latitudes, at least for certain daylight hours.

Consideration of available data on the *F*-region characteristics of the ionosphere led to the suggestion that, for several daylight hours, back radiation from the Gibraltar transmitting aerial was being propagated via this region to an area south of Gibraltar and

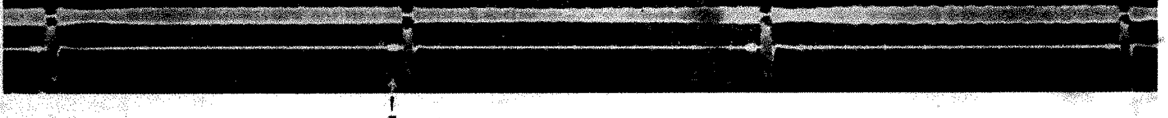

Fig. 5. 10-msec. pulse at *PRF* of 4 per sec., 15.35 hr., G.M.T., March 20, 1956. Reference dipole

Fig. 7. 50-baud letter shift, 20.25 hr., G.M.T., March 14, 1956. Directive array

scattered back by the ground or sea, the components of the scattered signal being re-transmitted via the *F*-region direct to the United Kingdom.

Such a process is illustrated in Fig. 6. The back radiation makes one hop via the *F*2 layer to an area approximately 2,000 statute miles to the rear of the Gibraltar aerial at *B*, where it is scattered back from the Earth's surface towards the United Kingdom by a single hop of 2,500 miles. The total difference of path-length between this path and the direct Gibraltar/United Kingdom path, allowing for the curvature of the Earth, the influence of the troposphere and the heights of the lower *E* and the *F*2 layers, is sufficient to give the observed delay of about 20 msec. on the earliest delayed component to arrive. An important point in this explanation is that the *F*2 reflexion point *A* for the backward hop was in a lower latitude than that of the corresponding point *C* for the forward hop. Thus, the higher ionization density at point *A* was able to support the higher-angle radiation required over the shorter path in the *F*2 region involved.

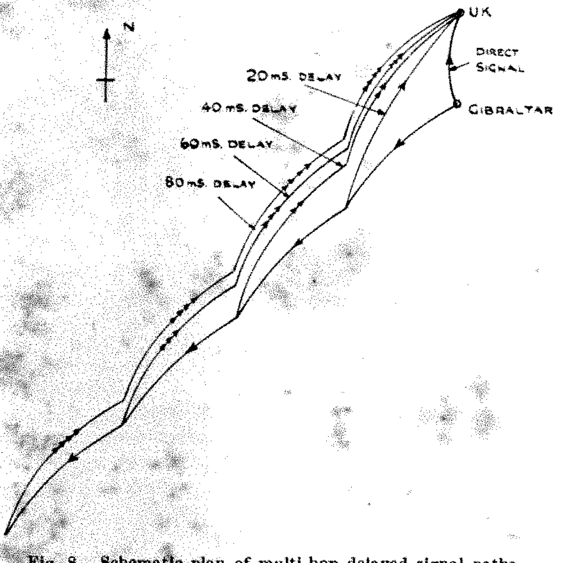

Fig. 8. Schematic plan of multi-hop delayed signal paths

It was at once confirmed that the effect was confined to daylight hours, showing a steady increase from its first occurrence at about 1000 G.M.T. to a maximum around 1600, and disappearing again quite sharply at about 1900. Fig. 7 shows the clear reception obtained later in the evening, which confirmed that the effect was not due to faulty transmitter keying. Afterwards, during the *S.I.D.* observed at 1620 G.M.T. on March 15, the delayed components disappeared completely for the duration of the disturbance, confirming that they are returned by *F*-region reflexion.

While the above explanation might serve for the first delay component, the later components could be accounted for by assuming that the back radiation from the transmitting aerial made two or more hops before being back-scattered and then returned to the receiver in the United Kingdom by similar hops (see Fig. 8). Each additional hop in this case would probably be of the order of 1,750 miles, to give a total additional delay of multiples of about 20 msec. Direction-finding measurements have shown that the delay components arrive from the south-west. This is in accord with measurements of the azimuthal radiation pattern of the Gibraltar transmitting aerial (Fig. 9), which shows that the back lobe of radiation is distorted to the westward by the upper flanking surface of the Rock. Radiation to the south-east is prevented by the upper mass of the Rock itself. The radiation in a south-westerly direction is sufficiently strong to support an 80 msec. delayed signal, as shown schematically in Fig. 8. It appears that such a delayed signal component could only be supported in this direction from Gibraltar, because of the distribution of *F*-region ionization density. In the absence of the Rock, the whole sector between the south-east and south-west directions from the transmitting site would be a potential source of delayed signal components. However, the discrete nature of the various delay components normally observed requires further investigation.

Support for this explanation of the delayed signal components experienced on 37 Mc./s. is available in that 45 Mc./s. television signals from the United Kingdom were being received concurrently in South Africa.

While it is clearly necessary to pursue this investigation further to confirm the identity of the mechanism by which these long-delayed multipath signals arise in VHF propagation in the lower latitudes, sufficient evidence is available to show that the

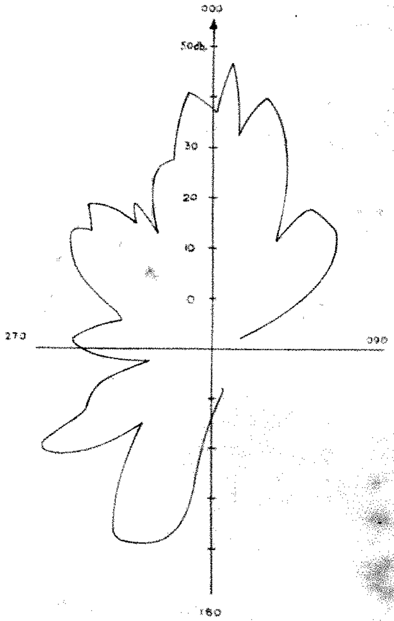

Fig. 9. Azimuthal radiation pattern of the Gibraltar transmitting aerial

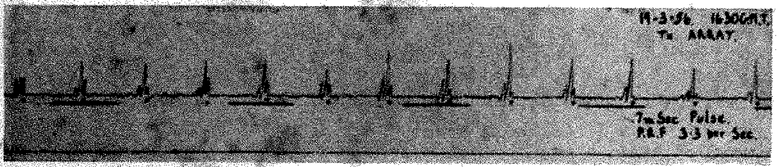

Fig. 10. High-speed amplitude recording during the late afternoon. Directive array

effect which these will have on operational automatic telegraphy circuits using VHF forward-scatter propagation in these areas may be disastrous. This is emphasized by Fig. 10, a typical record made of the array transmission in the late afternoon when the level of the direct signal component is low and that of the back-scattered component is normally high. Thus, from this record it can be seen that, in spite of the back-to-front protection of the array, the back-scattered component can be as much as 20 db. greater in amplitude than the direct forward-scatter component. This implies that, in order to achieve a safe 10db. signal/interference ratio, the present back-to-front ratio of the array must be improved by 30 db. While substantial improvement can doubtless be achieved by use of transmitting aerials of higher back-to-front ratio, allowance will have to be made for these effects and operational frequencies may have to be increased to values greater than 50 Mc./s. for periods near sunspot maximum[4]. The present effects are likely to continue for a few years, and may even be experienced under summer conditions on the present operating frequency.

The results described were obtained as part of a joint programme of research sponsored by the Admiralty and the Marconi Research Laboratories. Thanks are due to both these authorities for facilities granted in the conduct of the work, and for permission to publish this article.

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DISTRIBUTION OF ANTHOCYANIN PIGMENTS IN POPPIES

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IN the course of a comparative study of the biology of the cornfield poppies, *Papaver rhoeas*, *P. dubium*, *P. lecoqii*, *P. argemone* and *P. hybridum*, it was considered of interest to determine whether the slight differences in petal colour found in this group were due to qualitative differences in anthocyanin and, if so, whether the differences might be of taxonomic value.

On morphological grounds, *P. argemone* and *P. hybridum* constitute a distinct group possessing spines on the capsules and more dissected leaves than the smooth-capsuled species, *P. rhoeas*, *P. dubium* and *P. lecoqii*. The stamens of the former group possess laterally expanded, club-shaped filaments in contrast to the fine thread-like filaments of the latter species. Specimens labelled *P. hybridum* from several botanic gardens were markedly different from field collections of this species. Flowers were larger, were orange pink instead of the characteristic crimson of *P. hybridum*, and the degree of spine development on the capsule and the general growth habit were quite different. In the subsequent discussion this material is described as *Papaver* β pending further taxonomic investigation. Flower samples were collected from plants grown both in a greenhouse and in the field: the original seed samples were collected in the field or obtained from botanic gardens. Most of the species show a range of petal colour, and so, where possible, the extreme colour forms were examined for each species.

Anthocyanins were extracted by moistening the plant material with 0·1 per cent hydrochloric acid. Several species possess a characteristic black spot at the base of the petals and the pigments from the top and the base of the petals were therefore extracted separately.

Cyanidin and pelargonidin derivatives have previously been detected in the flowers of a number of *Papaver* species by colour and distribution reactions[1], and in the case of *P. rhoeas* two pigments were isolated[2]. Detailed studies have been made of the genetics of flower colour in *P. rhoeas*, especially in the cultivated Shirley poppy[3]. Chromatographic methods recently developed[4] permit an easier and more accurate characterization of the anthocyanins than the distribution reactions and have been applied to the flowers of the five *Papaver* species already listed above. Ascending chromatograms on Whatman No. 1 paper with *n*-butanol / acetic acid / water (40 : 10 : 50 by volume) at 22·5° C. gave better separation than when a descending solvent was used. The R_F values obtained were occasionally somewhat variable and so a minimum of four determinations was made on each flower extract. Synthetic fragasin (pelargonidin-3-galactoside, R_F 0·51), callistephin (pelargonidin-3-glucoside, R_F 0·55) or chrysanthemin (cyanidin-3-glucoside, R_F 0·35) were used as standards on every chromatogram, and the R_F values agreed with values already published[4] for the last two compounds (0·59 and 0·33).

Hydrolysis of the anthocyanins to the anthocyanidins and identification of the latter by colour reactions was undertaken and chromatographic comparisons were made with synthetic pelargonidin (R_F 0·70) and cyanidin (R_F 0·50) in the Forestal solvent[5]; Bate-Smith[5] gives R_F 0·68 and 0·50, respectively. Our results confirm and extend earlier less-detailed conclusions regarding both the anthocyanin content and distribution in *P. rhoeas* and *P argemone*, the only poppies of the *rhoeas* group which have been investigated from this aspect before.

Six distinct anthocyanins have been found in the poppies which we have examined, three cyanidin derivatives (*A*, *B* and *C*) and three pelargonidin derivatives (*A*, *B* and *C*). The species differ strikingly both in kind and distribution of these pigments (Fig. 1).

The petals of the morphologically similar species, *P. rhoeas*, *P. dubium* and *P. lecoqii*, contain only two anthocyanins, cyanidin *B* and pelargonidin *C*. The pelargonidin derivative is absent from the anthers where cyanidin *B* is present, and cyanidin *B* is abundant in the bases of the petals and absent from the tips (except in *P. rhoeas*, where it is present in lower concentration). No qualitative differences were detected between any of the colour variants of these species collected from the wild, but a specimen of the Shirley poppy lacked pelargonidin derivatives. A Shirley poppy examined by Robinson[1] lacked cyanidin derivatives. Scott-Moncrieff[3] has shown that the development of cyanidin and pelargonidin pigmentation in the Shirley poppy is genetically controlled and provides a biochemical interpretation of the results obtained by Newton and by Philp[3] in breeding experiments. Our results confirm those of Scott-Moncrieff in finding only one cyanidin derivative in *P. rhoeas*, whereas Schmidt and Huber[2] stated that a second cyanidin derivative was present.

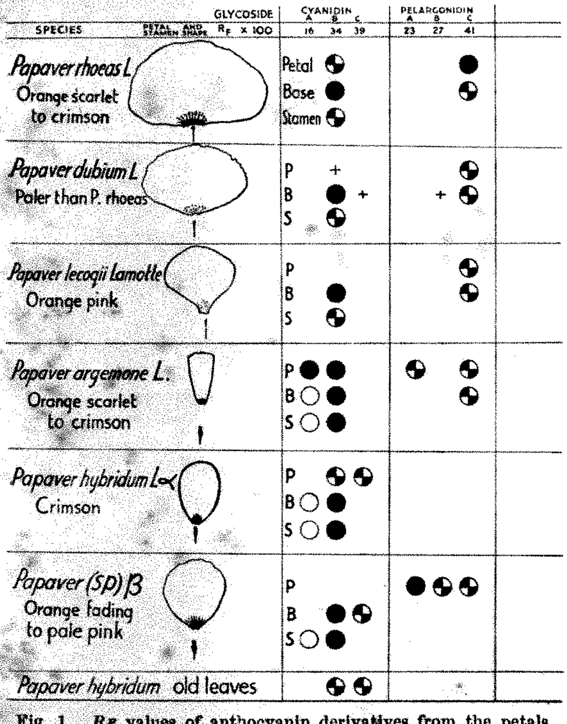

Fig. 1. R_F values of anthocyanin derivatives from the petals, stamens and leaves of *Papaver* spp. (*rhoeas* group). Typical petal and stamen shapes are illustrated, but the size of these organs and extent of the basal spot are very variable

●, Well-defined, relatively very intense spot; ◕, well-defined spot; ○, diffuse spot; +, found in only one specimen (see text)

Papaver argemone generally resembles *P. rhoeas* in the distribution of cyanidin *B* and pelargonidin *C*, although concentrations of cyanidin appear higher in the tips of the petals and the stamens. However, two additional anthocyanins are present in this species, a slow-moving cyanidin derivative (*A*) and a slow-moving pelargonidin derivative (*B*), both of which are in greatest concentration in the tips of the petals. No qualitative differences could be found between the pigments of orange and deep red forms of this species, but the amount of pelargonidin was less in the red form.

Papaver hybridum lacked all pelargonidin derivatives: cyanidin *A* was present in low concentrations in petal bases, where it was associated with the highest concentration of cyanidin *B*. In the tips of the petals a fast-moving anthocyanin (cyanidin *C*) was present. The botanic garden specimens β also contained all three cyanidin derivatives, but in addition three pelargonidin derivatives were present, the slow-moving pelargonidin *A* characteristic of *P. argemone*, the common pigment *C*, and in addition a further unknown anthocyanin, intermediate in R_F value between *A* and *C*, but giving a quite distinct spot. (A spot in this position was obtained from one sample of *P. dubium*, but was not found in any other samples.) Cyanidin *B* and *C* were also found in the old leaves of *Papaver* β. No other species developed pigments in the leaves.

No attempt has been made to identify the anthocyanins accurately, but it is worth noting that cyanidin *A* and cyanin (cyanidin-3 : 5-di-glucoside, R_F 0·16 [4]) and cyanidin *B* and chrysanthemin may be identical. Chromatographic identity of the pigments obtained from different species was shown by chromatography of mixed samples and the constituents on the same paper.

It is evident that the characteristic grouping of the anthocyanin pigments in different species supports groupings of the five species which might be made on morphological grounds. It can be seen that studies of the characteristics of petal pigments, even of species with rather similar coloration, may prove of taxonomic value; in this case the analysis of anthocyanins adds strong support to the original supposition that *P. hybridum* and the form β are distinct. In this connexion it may be noted that biochemical investigation has proved valuable in establishing relationships in the genus *Senecio*, where characteristic alkaloids of the necic acids are of taxonomic value[6].

Attempts are being made to synthesize hybrids of all the cited species, and, where possible, examination will be made of the anthocyanins present in F_1 and F_2 material.

The study of the biology of the poppies is being supported by a grant from the Nature Conservancy to the Department of Agriculture.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

The Cones of the Grass Snake's Eye

In the course of an investigation of the photosensitive pigments of the grass snake retina, photomicrographs were taken of fresh flat retinal preparations. The retina was carefully removed from a newly killed animal and mounted in a drop of saline confined within a shallow wax ring on a coverglass with the outer retinal surface in contact with the glass. The whole was then inverted on to a slide[1] and examined under the microscope. In such a preparation the light passes across the retina in the same direction as it does in the living eye, that is, from the internal to the external limiting membrane, and then along the visual cells parallel to their long axes. What one looks at down the microscope is a cross-section of the visual cells.

All the visual cells of the retina of the grass snake (*Tropidonotus natrix natrix*) are cones (Fig. 1). These cones are a little unusual in the relative sizes of their inner and outer limbs. The outer limb of a cone is always more slender than the inner limb (unlike the rods, where the thicknesses of the two parts tend to be much more nearly equal) but the disproportion in the grass snake is markedly greater than is common.

When the fresh cones were viewed end on, as in the preparation described above, it was noticed that they appeared very bright when the microscope was focused on the outer limbs; but when the focus was moved down on to the inner limbs these appeared dark (Fig. 2). At the same time the cross-section of the cones increased very much. Photomicrographs were taken in monochromatic light, and the density of different parts of the preparation measured by means of a microdensitometer.

We found that at 578 and 640 mμ the intrinsic brightness of the light emerging from the tips of the outer limbs of the cones was greater than that transmitted through the plain glass of the slide and coverslip with the saline layer but no retinal tissue between. At shorter wave-lengths (436 and 546 mμ) there was some loss on passage through the retina and cone, but the tip of the outer limb still appeared intrinsically brighter than the surround.

This result can only mean that in some way light is condensed on passing through a cone on a path parallel to its axis or nearly so. The simplest way in which this could be accomplished would be if there were total internal reflexion within the cone, so that all the light which enters by the broad base of its inner limb on the internal limiting membrane is directed into the narrow tip of its outer limb. The idea of total internal reflexion of rays parallel to their axes within human cones has been put forward by Wright and Nelson[2] and elaborated by O'Brien[3] as a result of experiments with models. Such reflexion would prevent spreading of light after it is brought to a focus in the inner limb and might also explain the Stiles–Crawford effect. In addition, it would increase the absorption by pigment in the outer limbs of the cones. There are, of course, other possible explanations of the phenomenon described here, but in the absence from the grass-snake cone of any structure (except the inner limb as a whole) such as a paraboloid or oil droplet which might act as a condensing

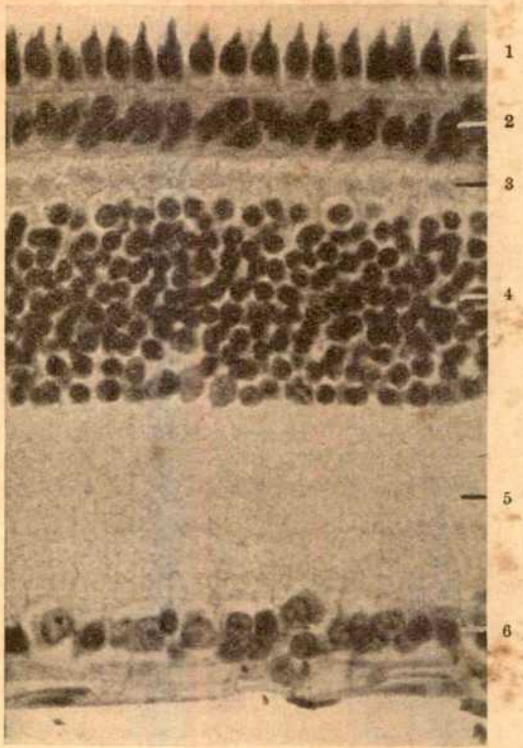

Fig. 1. Section through the pure-cone retina of the grass snake. (1) Cones; (2) outer nuclear layer; (3) outer fibre layer; (4) inner nuclear layer; (5) inner fibre layer; (6) ganglion cells. Kolmer's fixative; Mallory's phosphotungstic acid hæmatoxylin. × 440

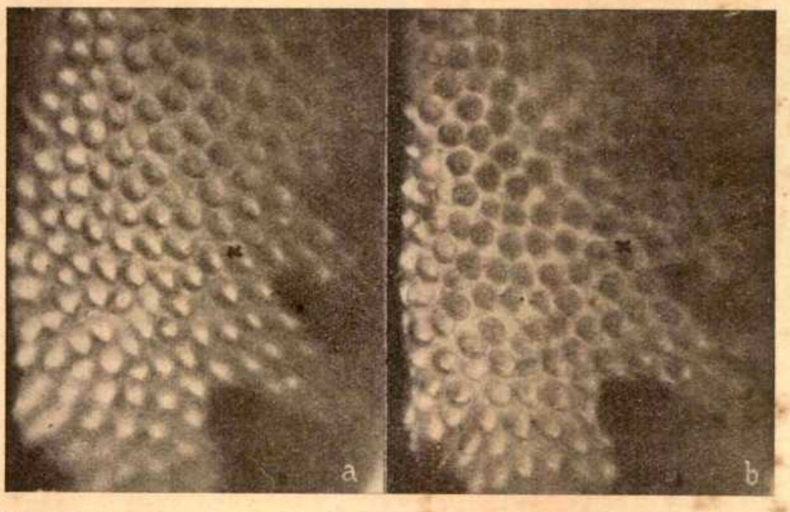

Fig. 2. Fresh snake cones. Two photomicrographs of the same field: (*a*) focused as far as possible on to the outer limbs; (*b*) at a lower focus. The cone marked × shows the bright outer limb in *a* and the larger, darker, inner limb in *b*. × 300. Photographed in 436 mμ light

lens, that of total internal reflexion seems to provide a reasonable preliminary hypothesis.

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Survival of the Heart following Deep Hypothermia

DEEP hypothermia of warm-blooded animals favours the survival of their organs. For example, in the rat at normal body-temperature the heart ceases to beat several minutes after opening the chest, whereas in the rat cooled to 15° C. by the closed-vessel technique cardiac contractions can be seen approximately 1 hr. after respiratory arrest[1]. The intestine removed from a hypothermic dog contracts spontaneously when re-warmed and retains this property longer than an intestine isolated from a normothermic dog[2]. We have shown that the heart continues to beat for a much longer period after opening the thorax in rats which have been severely chilled and then re-warmed to normal body-temperature than in rats at the same temperature which had not been previously chilled[3].

The effect of profound hypothermia is shown equally well by survival of the heart after functional arrest. This is illustrated by the experiments to be described here.

When rats at normal body-temperature are killed by destroying the medulla and opening the chest, their hearts cease to beat after several minutes. If the bodies are then placed in the refrigerator at 6–9° C., cardiac contractions can be induced 6–12 hr. later in about half the animals by pouring Ringer's solution at 38–40° C. directly on to their hearts. Even after 48 hr. this technique sometimes elicits weak signs of activity around the orifices of the great veins.

Much more striking results are obtained if the rats are in a state of deep hypothermia when killed. Rats cooled by the closed-vessel technique[4] to body-temperatures between 13° and 16° C. were killed as described above and put with open thoraces in the refrigerator at 6–9° C. At this temperature the heart soon stops beating. Next day and on subsequent days the hearts are re-warmed by pouring over them Ringer's solution at 38–40° C. As a result, ventricular contractions are frequently seen several days after death, while rhythmic movements near the openings of the great veins have actually been seen when the corpses had been kept at 6–9° C. for as long as eighteen days.

Re-warming the heart for several moments daily by our method seems to prolong the functional survival which we have just described. We also noticed that this phenomenon is more regularly seen in exsanguinated hearts.

It is known that, in rats cooled to the point of freezing or even below, cardiac activity can be completely re-established approximately one hour after cessation of breathing and circulation[5]. Certain manifestations of myocardial activity can, as we have just seen, be observed many days after death provided that the rat was killed in deep hypothermia and the corpse stored at a low temperature.

The point is not, of course, that there is a genuine re-establishment of the functions of the heart, but only that there are a few signs of activity of the myocardium. Our results nevertheless indicate that deep hypothermia before death is favourable for survival of the myocardium. It might also be an advantage when transplanting or culturing organs and tissues from homœotherms to remove them from animals in deep hypothermia.

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Effect of Surface-active Agents on the Living Cell

IT was observed some time ago[1] that treatment with surface-active agents influences the freshness and the keeping qualities of picked fruit and the development of cut flowers. When freshly picked fruit were sprayed with a dilute (0·01–0·1 per cent) solution of a surface-active substance the fruit kept about twice as long as the controls. It has also been demonstrated that similarly treated buds of freshly picked flowers can be forced to open prematurely.

Experiments have been carried out on the action of such compounds on living plants. Undiluted non-ionic surface-active agents were used, as earlier investigations seem to indicate that little effect can be obtained with dilute solutions.

Twelve bare twigs on a shrub of mock orange (*Philadelphus coronarius*) were painted with 'Tween 40' (polyoxyethylene sorbitan-mono-palmitate) at the beginning of August; on six of the twigs the treatment was repeated twice at intervals of one week. On the twigs which had been treated only once, the first green buds appeared six weeks later, 12–14 days before they did on any of the untreated branches. The twigs which had been treated three times remained bare throughout the summer.

On a red flowering rosebush three small rosebuds were painted with 'Triton *X* 100' (alkylated aryl poly-ether alcohol). Three days later the buds started to open, although they were only half the size of the buds which open under normal conditions. The flowers were distorted; their petals nearly colourless. This distortion was also observed when the experiment was repeated using other surface-active substances.

Four *Hibiscus* buds were painted with *G* 8916-*P* (polyoxyethylene-sorbitan esters of mixed fatty and resin acids). The buds started to open two days after the treatment, five days before the control buds which were at the same stage of development. In another experiment a branch of a *Hibiscus* shrub carrying several flower-buds was painted with 'Span 80' (sorbitan-mono-oleate). The effect of this substance could be observed for three weeks; all the flowers were slightly distorted.

Six *Hydrangea* twigs were painted with 'Triton *X* 100' at the end of winter and the treatment was repeated, after an interval of four weeks. On all the treated twigs axillary buds appeared first, 6–7 weeks before their appearance on the untreated branches.

Kurssanow[2] assumed that the enzymes in the plant cell synthesize or hydrolyse according to whether they are adsorbed or free. In recent years Veldstra[3] and Wain[4] have tried to correlate the structure and the surface-activity of different hormones with their physiological activity. We are attempting to show the action of surface-active compounds on animal cells. Such compounds of dissimilar constitution are very similar in action to plant-hormones; in further experiments on plants we hope to determine whether these compounds have themselves growth-regulating properties or whether they only stimulate the cells to produce growth-regulating substances.

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Serum Protein Differences between Africans and Caucasians

THE use of starch gels as a supporting matrix for electrophoresis was found by Smithies[1] to result in much greater resolution of the serum globulins than can be achieved by the other media thus far employed. On the basis of differences in the behaviour of the α_2 globulins he was able to divide the Caucasians whom he studied into three qualitatively different groups and obtained evidence that these groups were the result of a Mendelian two-allele system showing no dominance, Types I and II*B* representing the two homozygotes and Type II*A* the heterozygote[2].

We recently have had an opportunity to examine a series of blood samples obtained from natives of Liberia and the Ivory Coast and find that the frequencies of the three types differ rather markedly in these samples from the frequencies thus far observed in Caucasians. The results are shown in Table 1. The values given for Caucasians were obtained by combining our unpublished data with those of Smithies[2], the two series being very similar. The difference between the two racial groups is highly significant. The frequency of the gene which when homozygous results in Type I can be calculated to be 0·42 in the Caucasians and 0·70 in the Africans. It thus appears that this trait may be of value in anthropological studies.

Table 1

Type	No. of individuals of each serum type			
	I	II*A*	II*B*	Total
Caucasians	16	54	33	103
Africans	69	60	13	142

$\chi^2 = 36{\cdot}77$. d.f. = 2

Although it has been possible to classify all the specimens thus far encountered with respect to the three Smithies types, there exist quantitative variations within the nominal types which raise the possibility that the genetic basis of these proteins may be more complex than originally postulated. However, the frequencies of the three types in the African sample agree unusually well with the assumption of equilibrium based on the genetic hypothesis of Smithies and Walker[2].

A second difference which has been discovered in the blood samples from Africa is the existence of qualitative variations in the protein fraction designated by Smithies[3] as $S\alpha_2$. In all these samples, this fraction migrates faster than the corresponding fraction of Caucasians, very nearly coinciding in hæmoglobin-complexed specimens with the slowest moving of the three bands which characterize II*A* individuals. This may lead to some difficulty in identifying the Smithies fractions. The significance of this additional variation, which may also be under genetic control, is being studied.

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Reversible Degradation of Adenosine Triphosphate to Inosinic Acid during a Single Muscle Twitch

IN a muscle which performs mechanical work, adenosine triphosphate is degraded to inosinic acid. During aerobic rest, adenosine triphosphate is resynthesized from inosinic acid and creatine phosphate[1]. We have succeeded in demonstrating qualitatively that the same holds true in a single muscle twitch.

Isolated fibres from the frog's semi-tendinosus muscle were stretched perpendicular to a monochromatic ultra-violet beam. The light intensity was measured with a photomultiplier and the changes in photoelectric current recorded on a cathode-ray oscilloscope (Fig. 1: lower curves; a positive deflexion means an increase in light intensity). The tension of the fibre, as measured by a transducer, was recorded on the same oscilloscope screen (Fig. 1: upper curves), both beams being triggered by the stimulating pulse.

In the experiment illustrated in Fig. 1, there is a drop in light transmittance during the twitch at all wave-lengths from 546 to 240 mμ. In this experiment, scattered light has been excluded by the schlieren method. Any sudden rise in the scattering power of the muscle fibre would exert, in our condi-

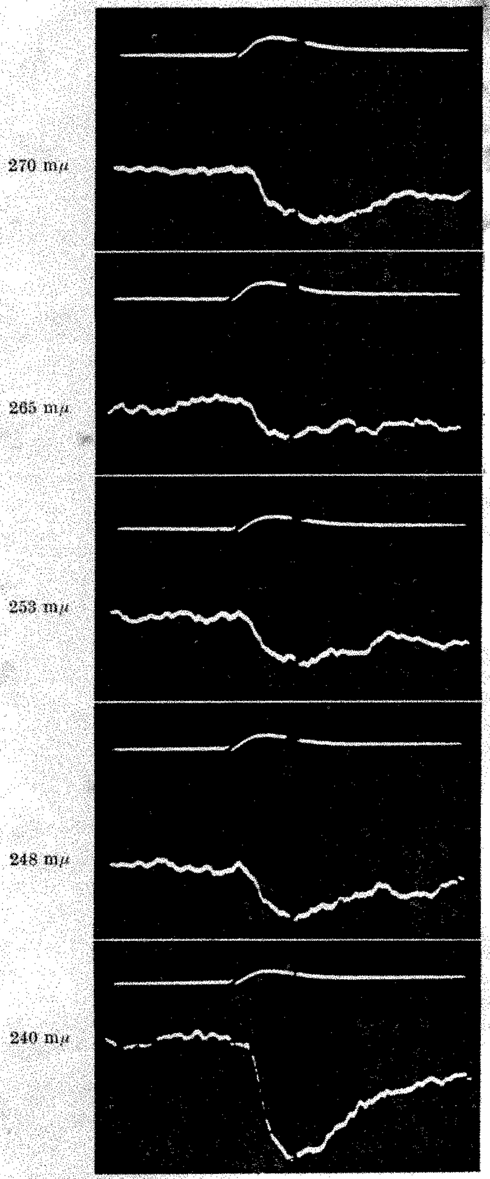

Fig. 1

tions, precisely the same unspecific effect on the total transmitted light: such a rise in scattering has been described for visible light[2].

At 265 mμ the drop in transmittance is markedly smaller than at 270 mμ or at 253 mμ, which means that an antagonistic effect, which cannot be other than a decrease in absorption, is superimposed on the scattering effect.

At 240 mμ the drop in transmittance is markedly larger, which shows that here an increase in absorption occurs.

The decrease in absorption at 265 mμ, the increase in absorption at 240 mμ, and no change at 248 mμ have been generally accepted since Kalckar's work[3] as a sign that adenine compounds are being deaminated to hypoxanthine compounds. The work reviewed above and the present material leave little doubt that what we have observed is in fact a reversible dephosphorylation–deamination of adenosine triphosphate during a single twitch.

We gratefully acknowledge the encouragement of Prof. A. von Muralt and Dr. S. Weidmann.

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A Complement-fixation Reaction with *Haemobartonella muris* and *Eperythrozoon coccoides*

Hitherto no serological reactions were known in *Haemobartonella* and *Eperythrozoon* animal infections. In the present study, antigens of *H. muris* and *E. coccoides* have been prepared from heavily infected blood cells of splenectomized rats and mice respectively. The blood was hæmolysed by 0·01 *M* citrate buffer (*p*H 6), washed three times by centrifugation (10 min. at 4,500 r.p.m.) and resuspended in veronal-buffered saline[1]. In the case of *E. coccoides* a further antigen containing the free organisms could be prepared by spinning the plasma fraction at 6,000 *g* and using the sediment. The frozen antigens could be stored for a long period without appreciable loss of activity. Immune sera were obtained either from splenectomized rats and mice after recovery from infection or from normal animals 3–5 weeks after intraperitoneal inoculation of parasitized blood. Normal sera were obtained from animals of parasite-free breeds.

The micro-method of complement-fixation[2] was used throughout the experiments. This technique proved to be very advantageous, as often only small quantities of sera or antigens were available. A series of complement solutions, diluted by the factor 1·6, was always used. By this means the anticomplementary activities of antigens and sera could be taken into account. The titres were expressed in logarithms of fixed complement units, the 50 per cent hæmolysis being used as the end-point. Antigens prepared from parasite-free blood did not react. Normal sera showed a weak reaction with some antigen preparations only. The specificity of the reaction could thus be established. Two- and three-dimensional tests revealed a similar relationship between antigen, antibody, and complement as can be found in other complement-fixing systems.

The time-course of antibody formation against *H. muris* was followed by testing sera taken repeatedly from individual rats. In non-splenectomized *bartonella*-free rats antibodies arise about five days after infection. The climax is reached after 3–5 weeks

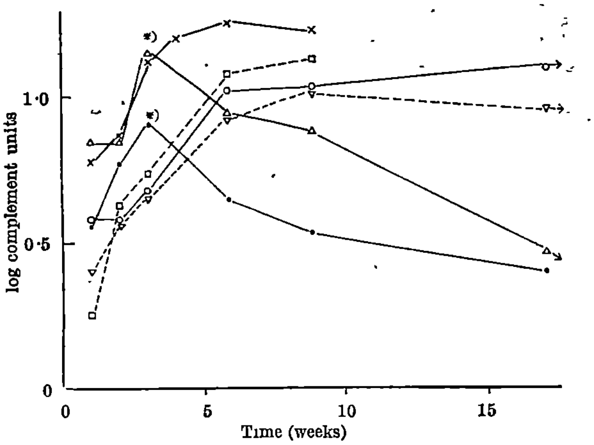

Fig. 1. Formation of antibodies after intraperitoneal infection with *H. muris* in non-splenectomized rats. 6 mgm. of neoarsphenamine at points marked *

(Fig. 1). Later on, the antibody-level remains constant for a long time. The latent infection of rats naturally infected with *H. muris* could thus be recognized by demonstrating complement-fixing antibodies in the sera. After treatment of the infection with neoarsphenamine the antibodies may gradually decrease (Fig. 1). The antibody-level of animals with latent infection diminishes after removal of the spleen, and the decrease is associated with an increase in the intensity of blood infection. The same occurs during relapses, when the parasite number increases (an example is shown in Fig. 2). The nature of this relationship between the undulations of the parasite number and the complement-fixing antibodies is uncertain. Neutralizing antibodies, which could conceivably account for the course of relapses, could not be demonstrated in any phase of the infection[3].

Different strains of *H. muris* showed no qualitative or quantitative antigenic differences in cross-fixation experiments. Furthermore, a unilateral cross-reaction between *H. muris* and *E. coccoides* could be demonstrated: *E. coccoides* immune sera reacted specifically with *H. muris* antigen; in the inverse case, however, no reaction occurred.

The complement-fixation reaction may be of practical use in the diagnosis of the carrier state in animal bartonelloses, as it has already proved to be in bovine anaplasmosis[4]. Moreover, it appears to offer a new method for the classification of animal bartonellas.

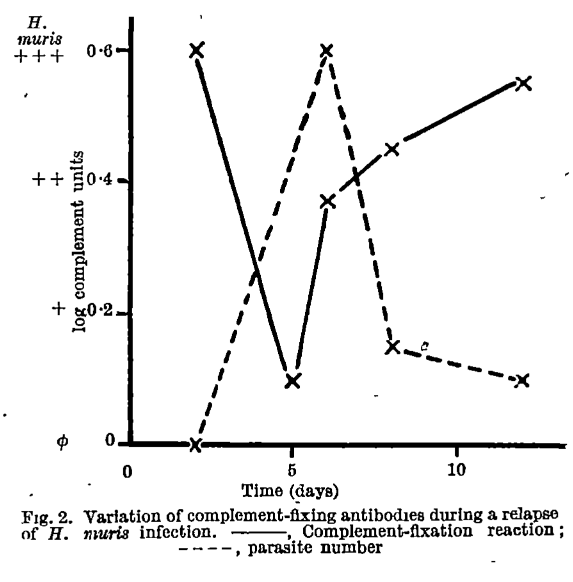

Fig. 2. Variation of complement-fixing antibodies during a relapse of *H. muris* infection. ———, Complement-fixation reaction; – – – –, parasite number

It should be mentioned that Marmorstone-Gottesman and Perla[5] as well as Lawkowicz[6] claimed to have demonstrated a complement-fixation reaction using cultured organisms from rat blood as antigens. The significance of these findings, however, is questionable, as the identity of the organisms with *H. muris* has not been proved.

Further results will be published in the *Zeitschrift für Tropenmedizin und Parasitologie*, and details of methods concerning the use and limitations of the micro-technique in the *Zeitschrift für Hygiene*.

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Role of a D-glucosamine as Inhibitor of the Precipitation of Blood Group Substances by Anti-Type XIV Pneumococcus Serum

Beeson and Goebel[1] followed up earlier observations that human erythrocytes are agglutinated by Type XIV anti-pneumococcus horse serum[2] with the demonstration that blood group *A* substance obtained from commercial pepsin precipitated with the Type XIV antiserum. Subsequent studies have shown that blood group substances isolated from hog gastric mucin, human saliva and human stomachs by peptic digestion cross-react with anti-Type XIV serum[3]. Human blood group A, B or H substances isolated from ovarian cyst fluids by the phenol extraction method[4] do not precipitate to any appreciable extent in this system; but a strong cross-reactivity is developed after mild hydrolysis with acid[5] or by treatment with specific enzymes[6].

The detailed structure of the Type XIV pneumococcus polysaccharide has not yet been fully elucidated; but it is generally believed that the chemical basis for the cross-reactivity of the blood group substances with anti-Type XIV serum lies in the presence of galactose and *N*-acetyl-D-glucosamine in both the Type XIV polysaccharide and the blood group specific mucopolysaccharides[7]. Examination of the infra-red absorption spectrum of the Type XIV polysaccharide has indicated the presence of predominantly β-linkages[8]. Recently, Heidelberger[9] studied the precipitation of Type XIV antibody by a number of gums containing galactose, and concluded that multiple recurrences of non-reducing galactose end-groups suffice to produce cross-reactivity, but that gums with very few such end-groups which contain a number of 1,3- and/or 1,6- and/or 1,3,6-

Table 1. INHIBITION OF PRECIPITATION OF TYPE XIV PNEUMOCOCCUS ANTISERUM BY DEGRADED BLOOD GROUP SUBSTANCES

Inhibiting substance	Dilution of inhibiting substance			
	1:100	1 200	1 400	1 . 800
D-Galactose	1	2	3	3
L-Galactose	3	3	3	3
α-Methyl-D-galactopyranoside	1	2	3	3
β-Methyl-D-galactopyranoside	1	2	3	3
β-Methyl-D-galactofuranoside	3	3	3	3
Melibiose	1	2	3	3
Lactose	0	1	2	3
O-β-D-Galactosyl-(1→3)-*N*-acetyl glucosamine	1	2	2	3
O-β-D-Galactosyl-(1→4)-*N*-acetyl glucosamine	0	0	0	1
O-β-D-Galactosyl-(1→6)-*N*-acetyl glucosamine	1	2	2	3
Control (Type XIV antiserum + blood group substance)	3			

The inhibition tests were carried out using 0·1 ml. 1 1,000 conc. blood group substance, 0·1 ml. of inhibitor and 0 1 ml. horse anti-type XIV pneumococcus serum. Degree of inhibition read after standing at 1–2° for 1 hr. Increasing amount of precipitation recorded as 1, 2 or 3.

linked galactose residues precipitate the antiserum as readily.

The presence of units containing galactose linked to *N*-acetyl-D-glucosamine in human blood group substances is known from the isolation of O-β-D-galactopyranosyl-(1→4)-*N*-acetyl-D-glucosamine from meconium[10] and more recently from the isolation of (1→3)-, and (1→4)-O-(β-galactopyranosyl)-*N*-acetylglucosamine from *A*-substance of ovarian cyst origin[11]. Cross-reactivity of the blood group substances with antibody to Type XIV pneumococcal polysaccharide could be due to either of these disaccharide units or to some other disaccharide of galactose and *N*-acetylglucosamine which has not yet been identified in the group specific materials. The (1→3) and (1→4) compounds, together with O-β-D-galactopyranosyl-(1→6)-*N*-acetyl-D-glucosamine and a number of other sugars, have therefore been examined for their capacity to inhibit the precipitation of horse Type XIV pneumococcus antibody by preparations of human blood group substances which have been degraded by mild acid or enzyme treatment.

As shown in Table 1, D-galactose and all the methyl glycosides and disaccharides tested which contained D-galactopyranosyl units exhibited some capacity to inhibit precipitation. By far the most effective inhibitor, however, was O-β-D-galactopyranosyl-(1→4)-*N*-acetylglucosamine. The following sugars at a concentration of 1 per cent showed no detectable inhibition in this system: L-fucose, *N*-acetyl-D-glucosamine, α- and β-methyl-*N*-acetyl glucosaminides, *N*-acetyl-D-galactosamine, α-methyl *N*-acetylgalactosaminide, cellobiose and laminaribose. The increased efficiency of O-β-D-galactopyranosyl-(1→4)-*N*-acetyl-D-glucosamine over lactose (O-β-D-galactopyranosyl-(1→4)-glucose) as an inhibitor suggests that, although *N*-acetylglucosamine does not, by itself, prevent precipitation taking place, it plays an important part in the determinant specificity of the Type XIV antibody.

Inhibition reactions with simple substance have been widely used to study the relationship between chemical structure and serological specificity and, in general, the preferential inhibition of a precipitation reaction by a certain substance can be taken as an indication that a similar structure is present in the antigen under investigation[12]. The inference to be drawn from the results presented here, therefore, is that cross-reactivity of the blood group mucopolysaccharides with Type XIV pneumococcus antiserum is attributable, at least in part, to the presence in these substances of β-linked 1 : 4 galactopyranosyl-*N*-acetylglucosamine units.

We wish to thank Prof. R. Kuhn for specimens of (1→3)- and (1→6)-O-β-galactosyl-*N*-acetylglucosamine and Prof. P. Gyorgy for the corresponding O-β-galactosyl-(1→4)-*N*-acetylglucosamine. The investigation was supported by a grant from the Nuffield Trust.

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Effect of Butyrate Administration on Blood Glucose in Sheep

THE concentration of glucose in the blood of ruminants has been found by earlier workers to change after the administration of butyrate. Blood glucose was depressed in goats after a transient rise[1], raised in adult sheep possibly by a sympatho-adrenal mechanism[2], and elevated in lambs with insulin-induced hypoglycæmia in a way that suggested glycogenesis[3]. Pharmacological reactions and great individual variation between sheep "made any statistical analysis difficult to interpret"[2].

During a study on gluconeogenesis in sheep[4], 500 ml. of a 10 per cent solution of sodium butyrate at *p*H 7·4 was infused during 50 min. into the jugular vein of Merino ewes. The pulse-rate rose to about 150 per min.; but distress or coma was avoided by the slow infusion. The initial blood glucose was in the normal range, was raised by glucose infusion, or was depressed by a fast of three days. Carotid and jugular blood samples were taken simultaneously before and after infusion and glucose determined[5]. The change in mean blood concentration (arterial plus venous divided by two) was plotted against the initial mean blood concentration (see Fig. 1).

When the blood glucose was initially around the normal average value[6] of 40 mgm./100 ml. it increased during butyrate infusion by 5–50 mgm./100 ml. in all but one case which decreased by 12 mgm./100 ml. When the ewes were fasted for three days, their blood glucose fell to 25–35 mgm./100 ml. and upon butyrate infusion it increased by 50–80 mgm./100 ml. When the blood glucose was high initially, it fell during butyrate infusion. The change in mean

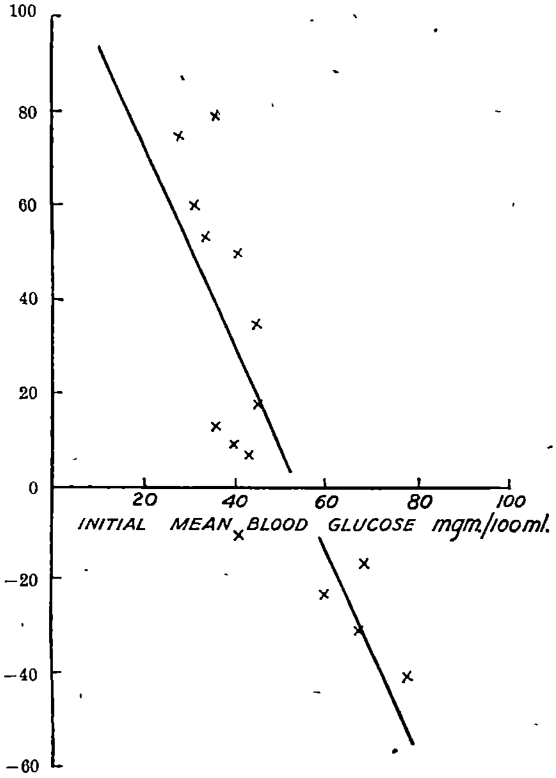

Fig. 1 Change in mean blood glucose in sheep 50 min. after infusion of 10 per cent sodium butyrate

blood glucose correlated with initial mean blood glucose ($r = 0{\cdot}848$) at a highly significant level ($p < 0{\cdot}001$) for fifteen observations.

These results indicate that sheep have a glucostatic mechanism which is facilitated by the administration of butyrate. Apparently gluconeogenesis from butyrate may occur in sheep; the conversion is inhibited by a plethora of glucose and is stimulated by a shortage.

My thanks are offered to Prof. W. V. Macfarlane for advice and encouragement and the Rural Credits Fund of the Commonwealth Bank of Australia for financial assistance.

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Acquired Resistance to Chloroquine Diphosphate in *P. gallinaceum* in Chicks

Past experiments have shown that acquired resistance in *Plasmodia* to antimalarials can be developed easily and in a short time in certain groups of compounds. *Per contra,* such resistance to some other groups of anti-malarials can be built up either with difficulty or not at all. Proguanil and pyrimethamine belong to the former group, and it is noted that a *Plasmodium* made resistant to one becomes resistant also to the other[1-3].

Quinine, mepacrine, 4-aminoquinolines and 8-aminoquinolines belong to the latter group of compounds to which parasites do not seem to become resistant easily. For example, while Williamson *et al.*[4] failed to demonstrate any such resistance to quinine, Knoppers[5] had ultimately succeeded in developing only a two-fold resistance in *P. gallinaceum.* Again, only a slight degree of resistance could be built up in respect of pamaquine[6,7] and none at all to mepacrine[8,9] or the 4-aminoquinolines[10,11].

The present report records the findings of the development of at least a two-fold resistance to chloroquine diphosphate in *P. gallinaceum* in chicks. Although the exact mechanism of development of such acquired resistance is not fully known, it is noted from previous experience that whenever there had been a failure in the development of such resistance, either the initial dose was high and/or increase in doses was made very rapidly or abruptly. In view of this, during the present investigations, the initial dose administered was fairly low, the dosage schedules were increased cautiously, often the same dose was repeated over and over again, sometimes up to twelve times, during each passage, and lastly the strain was kept continuously exposed to the drug.

The procedure adopted for inoculation, drug administration, etc., was similar to that described earlier by Jaswant Singh, Basu and Ray[12]. Sub-passages were carried out on day 4 in respect of every batch after blood smears were taken for parasite count. Along with each experimental group, there was always an untreated group for comparison. The degree of parasitæmia in the experimental group was expressed as a percentage of that observed in the untreated group.

Before commencement of the studies, the minimum effective dose (the lowest dose which would reduce parasitæmia to approximately 25 per cent of the comparison group) of chloroquine diphosphate ('Avloclor', received through the courtesy of Imperial Chemical Industries, Ltd.) was first determined and it was observed to be 0·0615 mgm. per 50 gm. chick (equivalent to 1/26 of the M.E.D. of quinine). For development of acquired resistance, the initial dose selected was 0·05 mgm. per 50 gm., which allowed parasitic development to a reasonable degree (60–70 per cent as compared to the untreated group). The same dose was repeated three times in the succeeding passages before further increase in the schedule to 0·057 mgm. was made. Subsequent schedules were 0·0615, 0·066, 0·08, 0·088, 0·1, 0·114, and 0·123 mgm. per 50 gm. chick. The doses are equivalent to 1/26, 1/24, 1/20, 1/18, 1/16, 1/14 and 1/13 of the M.E.D. of quinine.

After nine months, during which period fifty-seven passages were made, a check test was initiated and repeated several times for confirmation. For this, both the parent strain and the sub-strain were exposed to the same dose of drugs in different batches of chicks. Side by side, untreated batches were kept for comparison. It was observed that under the dosage schedule of 0·0571 mgm., the degree of parasitæmia was somewhat similar (66 and 75 per cent) in respect of the two strains, but in groups treated with 0·0615 (M.E.D.) the parasitic densities were 28·2 and 62·5 per cent in respect of the parent strain and the sub-strain, respectively. In higher dosage schedules like 0·114 and 0·123 (1/14 and 1/13 the M.E.D. of quinine), the parasitic densities in respect of the parent strain were 0·018 and 0·009 per cent, respectively, against 33·3 and 27 per cent in respect of the sub-strain. In other words, the degree of parasitæmia (27 per cent) in the sub-strain under schedule 0·123 mgm. was about the same (28·2 per cent) as in the case of the parent strain under schedule 0·0615 mgm. At still higher dosage (0·133 mgm.), the infection rate was 6 per cent in respect of the sub-strain.

Therefore, while the M.E.D. for the parent strain was determined to be 0·0615 mgm., that for the sub-strain was 0·123 mgm. Thus the sub-strain could be considered to have developed a two-fold resistance. (Since submission of this communication, the sub-strain has now developed more than three-fold resistance to chloroquine-diphosphate.) Further observations are being continued, and details will be published elsewhere.

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Enhancement of Activity in a Pacinian Corpuscle by Sympathomimetic Agents

It has been shown that the sensory input into the central nervous system can be modulated at the very origin of the nervous message—at the receptor[1]. For example, the response of a cutaneous touch receptor to a constant mechanical stimulus may be increased by excitation of the sympathetic nerve supply to the frog's skin. Only a few sympathetic impulses—in some cases only one—are required to modulate the activity of the receptor. The effect appears to be due to the release of an adrenaline-like substance by sympathetic fibres ending near the tactile receptor[1]. The present communication deals with the facilitatory action of sympathetic amines on an isolated mechano-receptive sense organ.

Pacinian corpuscles of the cat's mesentery were isolated, together with a length of sensory axon. For mechanical stimulation, the deflexions of a piezo-electric crystal produced by square voltage pulses of 0·1 msec. duration were transmitted to the corpuscle by a glass stylus[2]. The deflexions could be varied between 1 and 40μ, their magnitude being a known function of the voltage applied across the crystal. Threshold of the receptor could thus be expressed in terms of the voltage as well as in terms of the displacement of the crystal. The electric activity of the sense organ was led off at its afferent axon while physiological solutions containing test substances could be conveniently applied to the corpuscle. The application of adrenaline or noradrenaline caused a reversible lowering of the corpuscle's threshold for mechanical stimulation, which falls slowly to 90–70 per cent its original value in the course of 2–7 min. (Fig. 1). The effect was observed in 16 out of 19 cases tested and has a latent period of 1½–3 min. A latency of this order was to be expected in view of the very slow diffusion speeds of even relatively small ions across the layers of the corpuscle found by Gray and Sato[3]. Reversibility of the effect was obtained after repeated washing with physiological solution. Pairs or trains of sub-threshold mechanical stimuli which previously failed to excite the corpuscle to firing-level by temporal summation could be shown to add up to threshold during the period of increased excitability produced by the sympathetic agents. In about 20 per cent of the cases tested the addition of adrenaline or noradrenaline caused a reversible lowering of the adaptation-rate. Thus the corpuscle which ordinarily gave only a single impulse in response to a threshold stimulus discharged repetitively after the application of the sympathetic hormones. The appearance of iterated firing of impulses usually ran parallel with the period of highest excitability of the receptor (Fig. 1, *b* and *c*). Care was taken to maintain the stimuli continuously at threshold when the latter was decreasing under the influence of the amines. The repetitive firing appears to indicate, therefore, a genuine change in adaptation of the sense organ.

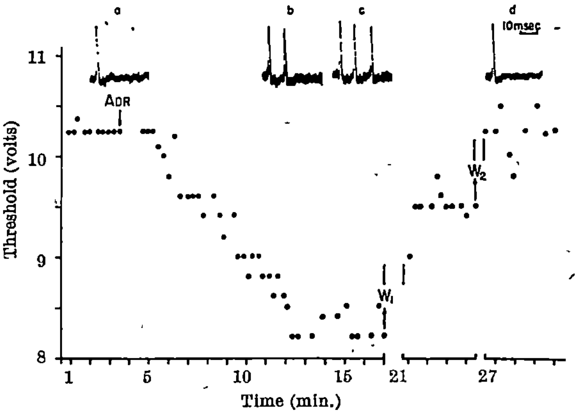

Fig. 1. Changes in excitability and adaptation of the corpuscle by adrenaline. 10 gm. in 10^6 ml. of adrenaline (*Adr*) are applied at arrow mark, causing lowering of threshold (expressed in volts applied across the piezo-electric crystal) and adaptation-rate (*b*, *c*). Reversibility is obtained after two periods of washing (*W*) with Ringer's solution. *a*, *b*, *c* and *d* are patterns of action potentials in response to threshold stimulation. The beginning of each pattern is placed in approximate accordance with the time along the abscissa

In a series of experiments a few corpuscles showed 'spontaneous' discharges at a steady rhythm in the absence of external stimulation. The application of adrenaline then caused an increase of 12–25 per cent of the impulse-rate.

Concentrations of 1–10 gm. in 10^6 ml. of adrenaline or noradrenaline were generally employed for the experiments. But clear effects could already be obtained with doses of 1 gm. in 10^7 ml.

The mechanism of action of the sympathetic hormones seems to be situated at the impulse generator of the corpuscle. 'Generator potentials' of the corpuscle's nerve ending were recorded with external leads at the emergence of the axon, while propagated action potentials were abolished by procaine[3] or by other blocking procedures. The latter will be described in another publication. The 'generator potentials' showed an increase in peak amplitude, an increase in rate of rise and, in some cases, a prolongation of its decay time, as a consequence of the addition of adrenaline. As the 'generator potentials' would normally present spontaneous fluctuations in shape in the course of the experiments, statistical analysis of the changes caused by the amines was necessary. The modifications in 'generator potential' mentioned above proved to be highly significant. The possibility of an antagonistic effect between adrenaline and procaine being responsible for these modifications may be discarded, since the same changes in 'generator potential' were found when other entirely different procedures for blocking of the action potential were used. A similarity between the facilitatory effects of adrenaline at diverse structures at which impulses are generated becomes apparent by comparing the increment of the 'end plate potential' of skeletal muscle[4], the alteration in the 'generator potential' of the heart's pacemaker[5,6] and the changes in 'generator potential' of a sensory nerve ending reported here.

This work was aided by a grant from the Rockefeller Foundation.

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Binding of Histamine in Mammalian Tissues

MUCH of the histamine in mammalian tissues is contained in tissue mast cells[1]; but it is by no means certain how it is held at high concentration inside these cells. Evidence suggests that the mast cells do not produce the histamine but have a specific faculty of storing this compound. However, storage does not occur until metachromatically staining granules of heparin become visible in the cytoplasm of the cells. Experiments have been carried out, therefore, to study the affinity of histamine and heparin for one another.

When heparin (20 mgm.) and histamine acid phosphate (1 mgm.) are mixed in solution, and alcohol (70 per cent) or acetone is added, the precipitated heparin removes about 70 per cent of the histamine from the solution when the *p*H is around 5. The combination, however, is dependent upon *p*H, since at neutral or alkaline reaction much less histamine is removed by the heparin. Fig. 1 illustrates this point and compares the combination of heparin and histamine base (*B*, *p*H 9) with that of heparin and histamine acid phosphate or dihydrochloride. The precipitated heparin–histamine complex can be washed with alcohol or acetone without loss of histamine, but the complex is easily rendered soluble by water, saline or weak acid. If adenosine triphosphate (1 mgm.) is also present in the solution before precipitation, the uptake of histamine by heparin is increased to more than 90 per cent.

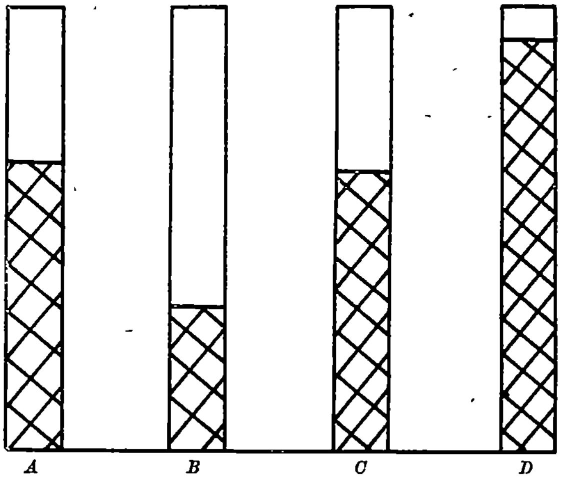

Fig. 1. Diagram to illustrate the distribution of histamine between the supernatant liquid (clear areas) and the precipitate of heparin (shaded areas). *A*, Histamine acid phosphate; *B*, histamine base; *C*, histamine dihydrochloride; *D*, histamine acid phosphate with adenosine triphosphate. All columns represent the means of ten experiments

The staining properties (for example, with toluidine blue) and chromatographic behaviour of the complex resemble those of the natural mast cell granules isolated from mouse connective tissue[2]. Further, the morphological characters of the precipitated complex approximate to those of the living granules.

The formation of the complex is fairly specific for histamine, since adrenaline, noradrenaline and 5-hydroxytryptamine are not removed under similar conditions. Certain basic amino-acids such as arginine, lysine or ornithine combine with heparin when alcohol is added[3]; and it is of interest to find that these amino-acids are bases of sufficient strength to displace histamine from its attachment to the acidic residue of heparin in the tissues by some kind of cation exchange[4].

Thus the base histamine and the acid heparin can form a complex *in vitro*. The proportions of the two substances present in the complex, namely, one part of histamine to twenty parts of heparin, are similar to those found in extracts of tissues which are rich in mast cells[5]. So far it has not been possible to release the histamine from the synthetic histamine heparinate without solution of the heparin.

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Enzyme-Substrate Complex Formation : a First Stage in Ribonuclease Activity

THE exact intermediate steps in the breakdown caused by ribonuclease enzymic activity awaits clarification in spite of the many methods currently used in the measurement of ribonuclease activity.

The method presented here was found very useful for demonstrating the stepwise ribonuclease enzymic specificity. The technique depends on the fact that basic dyes which normally polymerize in aqueous

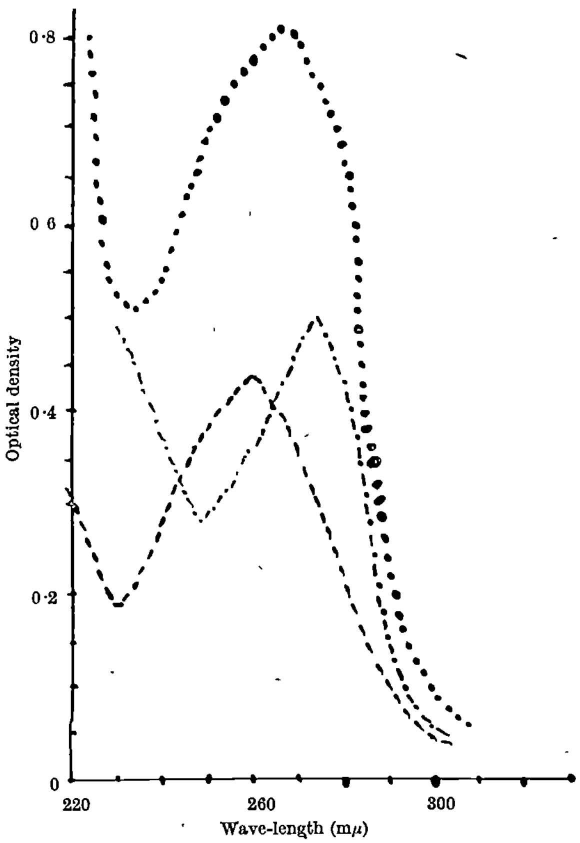

Fig. 1. Absorption curves of the elute: —.—, enzyme (ribonuclease); — — — —, substrate (ribonucleic acid); ...., enzyme-substrate complex (ribonuclease–ribonucleic acid) from the electrogram after ionophoretic separation

solution are depolymerized by nucleic acid, resulting in complex formation. Ionophoretic mobility of the dye–nucleic acid complex resulting is altered as enzymic activity progresses, thus giving a quantitative estimation for the action of ribonuclease on ribonucleic acid.

Using this procedure, an enzyme-substrate complex has been demonstrated using ribonuclease–ribonucleic acid (enzyme-substrate), desoxyribonuclease–desoxyribonucleic acid (enzyme-substrate), desoxyribonuclease–ribonucleic acid (enzyme-competing substrate) and ribonuclease–desoxyribonucleic acid (enzyme-competing substrate).

The materials employed include: (1) yeast ribonucleic acid, prepared and reported by Hakim[1,2]; (2) crystalline ribonuclease (Armour), triply recrystallized by the Kunitz procedure[3]; (3) desoxyribonuclease (Schwartz), recrystallized three times by the Kunitz procedure[4]; (4) sodium desoxyribonucleate, prepared by the method of Kay, Simmons and Dounce[5]; (5) methyl green solution, 0·4 per cent, after exhaustive extraction with chloroform to remove contaminating crystal violet, found by ionophoresis to be present in the commercial sample; (6) methylene blue.

Paper ionophoresis was carried out in type *LKB* 3276 paper ionophoresis equipment, using 40 × 10 mm. Schleicher and Schuell No. 2043 *B* filter paper, and a barbiturate buffer, *p*H 8·5, ionic strength 0·05.

Ribonucleic acid in 15 μl. volumes (1 per cent solution, w/v) was applied about 150 mm. from each end of the ionically equilibrated strips of filter paper, ribonuclease (or desoxyribonuclease) was applied on top of the nucleic acid spot in equal volumes (0·02 per cent solution, w/v). Finally, methyl green (or methylene blue) solution was applied in 5 μml. volumes (0·4 per cent solution, w/v). Four hours after the final application, a potential of 300 volts and 0·5 m.amp. was applied for 24 hr., after which the papers were dried. The location of the dye was noted, marked with a pencil, and the papers were stained with bromphenol blue to locate the position of the proteins. Experiments were run in triplicate on three parallel strips of filter paper. After ionophoresis and drying of the three ionograms, one strip was stained with bromphenol blue. In all cases, the enzyme-substrate complex was located at the line of application, while the different enzymes showed their own characteristic ionophoretic mobilities. Elution was accomplished in phosphate buffer *p*H 5·64, ionic strength 0·05, and activities of the eluates determined. Ribonuclease activity was measured by following the optical density of methylene blue (0·20 mgm./ml.) and ribonucleic acid (5 mgm./ml.), at 5500 A., as a function of time, following the addition of the eluate[6]. Desoxyribonuclease activity was measured by the Kunitz method[4].

Figs. 1 and 2 show the ultra-violet spectrophotometric spectra of the eluted enzyme (ribonuclease, or desoxyribonuclease), enzyme-substrate complex (ribo-

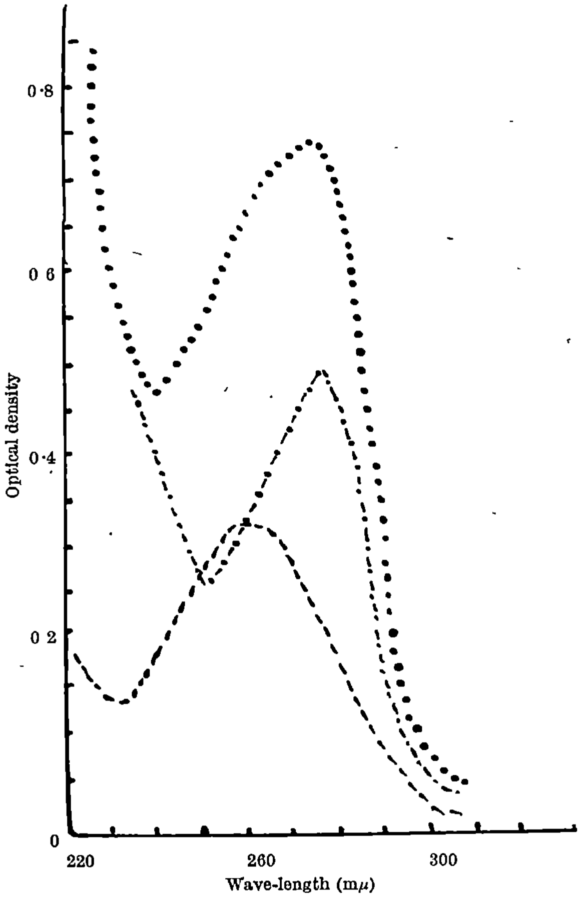

Fig. 2. Absorption curves of the elute: — —, enzyme (desoxyribonuclease); — — — —, substrate (desoxyribonucleic acid); ...., enzyme–competitive substrate (desoxyribonuclease–ribonucleic acid) from the electrogram after ionophoretic separation

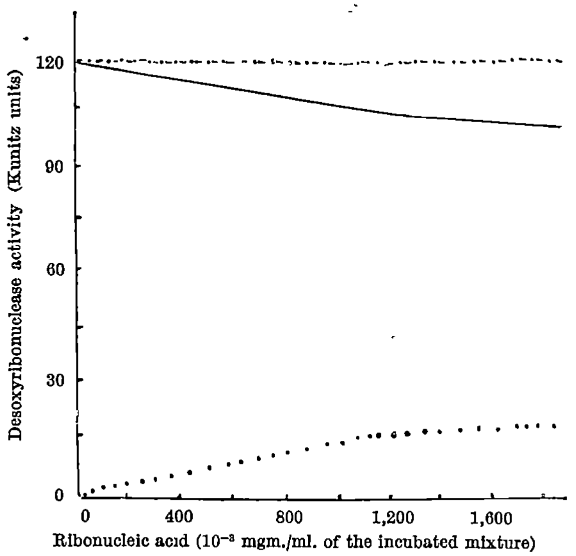

Fig. 3. Desoxyribonuclease inhibition by ribonucleic acid: — —, enzyme (desoxyribonuclease) added; ———, enzyme (desoxyribonuclease) found; ......, per cent inhibition

nuclease–ribonucleic acid, or desoxyribonuclease-desoxyribonucleic acid), enzyme-competitive substrate (desoxyribonuclease–ribonucleic acid), and substrate (ribonucleic, or desoxyribonucleic acid).

Figs. 3 and 4 show the results of experiments on paper ionophoresis, where fixed amounts of ribonuclease were incubated with increasing amounts of desoxyribonucleic acid on ionically equilibrated filter paper at room temperature. Ribonuclease activity then was titrated against yeast ribonucleic acid. In all cases the enzymic activity was found in the mobile fraction and not in the enzyme-competitive substrate complex, which remained at the point of application after ionophoresis. Similarly, fixed amounts of desoxyribonuclease were incubated with increasing amounts of ribonucleic acid and desoxyribonuclease activity was titrated against desoxyribonucleic acid (Fig. 3).

The competitive action between desoxyribonucleic acid and ribonucleic acid for ribonuclease has been demonstrated. The competition is due to the formation of complexes composed of the enzyme with either of the two acids.

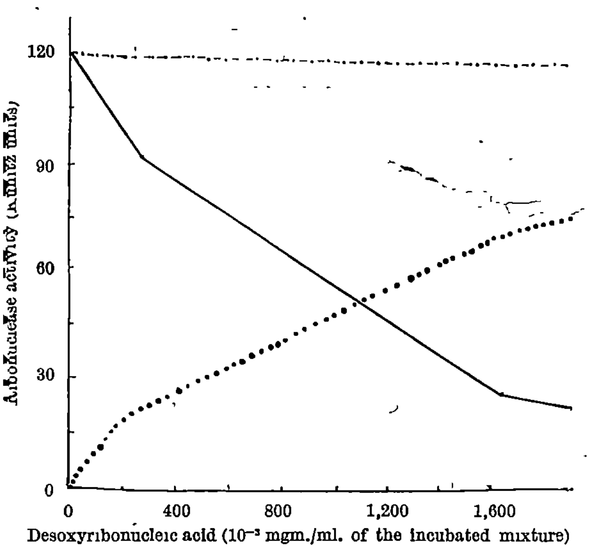

Fig. 4. Ribonuclease inhibition by desoxyribonucleic acid: —.—., enzyme (ribonuclease) added; ———, enzyme (ribonuclease) found; ......, per cent inhibition

This work was started during a visit to the Department of Experimental Pathology and Cancer Research, Leeds. The work was repeated and similar results were obtained in the Department of Medical Research, National Children's Cardiac Hospital, Miami, Florida.

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Distribution in the Soft Tissue of the Rat of Radioactive Fluoride administered as Sodium Fluoride

Because the analysis of soft tissue for fluoride is difficult, little has been published on the distribution of fluoride in tissues other than bone, dentine and enamel. Data of this nature are of interest in view of the widespread use of fluorides in drinking water as a caries-preventive measure. Such data also may be useful in assessing the fluoride exposures of livestock pastured near certain industrial plants.

Preliminary experiments in which rats were given radiofluorine, reported here, afford additional insight into a number of aspects of fluoride metabolism. Radioactive fluoride was prepared by proton bombardment, in the small cyclotron of the University of Rochester Physics Department, of frozen samples of water enriched in oxygen-18. Following a 4–6 hr. bombardment, the ice now containing radioactive fluoride was melted, transferred to a 5-ml. volumetric flask containing aqueous sodium fluoride, and the solution brought to volume with distilled water; the final fluoride concentration was 1 p.p.m. Three different solutions were prepared; a different solution was used in each of the three distribution experiments (Table 1). Since samples from three different bombardments were employed, the data have been adjusted to the same activity, namely, 1,416, 200 counts per minute per microgram of fluoride, to facilitate comparison. The decay curve was determined for each sample. The half-life closely approximated 115 min.; in no instance was contaminant radioactivity detected.

At various intervals after administering the radioactive fluoride, the rats were killed by ether anæsthesia. The organs were removed in their entirety, with considerable care taken to minimize contamination by extraneous blood. The tissues were weighed, placed in beakers containing 20 per cent sodium hydroxide and digested on a hot plate as rapidly as possible. The digests were transferred to suitable volumetric flasks, diluted to volume, and 1-ml. aliquots counted by a surface-counting technique.

The experimental design was as follows.

Rat I: Four ml. of sodium fluoride solution containing 1 p.p.m. fluoride were administered by

Table 1. Distribution of Fluoride in the Rat following Administration of 1 p.p.m. Fluorine as Sodium Fluoride in Water

Animal No.	I		II		III	
Route of administration	per os		intravenous		intravenous	
Dose	4 μgm. fluorine		1 μgm. fluorine		1 μgm. fluorine	
Time to sacrifice	30 min.		10 min.		90 min.	
Body-weight	170 gm.		147 gm.		171 gm.	
Tissue	% dose/ organ	% dose/ gm.	% dose-organ	% dose/ gm.	% dose/ organ	% dose/ gm.
Brain	0·04	0·03	0·06	0·05	0·04	0·03
Parotid glands	0·07	0·21	0·04	0·16	0·03	0·14
Submaxillary and sublingual glands	0·06	0·15	0·24	0·64	0·03	0·06
Thyroid	0·01	1·17	0·009	2·17	0·02	0·09
Heart	0·08	0·13	0·18	0·37	0·03	0·03
Lungs	0·14	0·18	0·43	0·48	0·12	0·07
Stomach	41·30	9·16	0·53	0·27	0·09	0·02
Small intestine	14·95	1·61	2·54	0·28	1·09	0·16
Large intestine	0·49	0·08	0·71	0·02	0·41	0·06
Liver	1·84	0·19	4·69	0·67	0·67	0·06
Spleen	0·24	0·14	0·38	0·48	0·14	0·10
Kidneys	0·70	0·45	3·03	2·29	2·41	1·20
Adrenals	0·01	0·23	0·03	0·69	0·01	0·14
Uterus	0·09	0·22	0·05	0·15	0·02	0·07
Muscle	0·07	0·16	0·06	0·25	0·02	0·04
Bone	—	—	0·53	1·26	0·37	1·92
Carcass	11·27	0·09	37·60	0·32	20·81	0·16
Blood	—	0·93	—	2·98	—	0·11
Urine	—	—	—	—	—	15·38/ ml.
Total	71·4		51·1		26·9	

stomach tube to an adult, female, albino rat; the animal was killed after 30 min. This procedure should give preliminary data on the soft-tissue distribution of fluoride as normally consumed per os.

Rat II: One ml. of the fluoride solution was injected into the femoral vein of an adult, female, albino rat; the animal was killed after 10 min.

Rat III: One ml. was given intravenously to an adult, female, albino rat which was killed 90 min. afterwards.

Results are given in Table 1. In the time available, total digestion of the carcass and skeleton was not accomplished; this accounts in great part for the low total recoveries obtained. The best recovery was obtained following oral administration; in this experiment more than half the administered dose was found in the stomach and small intestine, both easily digested organs. However, the relative distribution of fluoride can be compared in a number of the soft tissues.

The thyroid, kidneys, and adrenal glands contain the highest concentrations of fluoride following oral administration or 10 min. after intravenous administration. 90 min. after receiving fluoride by vein the kidneys and adrenals still contain the highest concentrations with somewhat less fluoride in the thyroid gland. By this time the parotid glands and spleen show increased fluoride concentration. The uptake of fluoride by the thyroid is in agreement with earlier work from this laboratory in which tissues were analysed chemically[1], but differs from the data of Wallace-Durbin, who found no accumulation of fluorine-18 by the rat thyroid[2]. The increased concentration in the parotid glands after 90 min. is in agreement with the results of Wallace-Durbin[2], Wills[3], and Volker, Sognnaes and Bibby[4], and is consistent with the view that these glands are sites of excretion of fluoride. The principal route of excretion of fluoride is via the kidney into the urine. Given intravenously, the fluoride concentrations were greatest in this organ; in the oral experiment it was the second highest. The intestinal secretion of fluoride[1,5] is revealed by the significant concentrations of fluoride in the small intestine following intravenous administration.

The sharp decrease in tissue fluoride concentrations from the tenth to the ninetieth minute after intravenous administration reflects the rapid removal of fluoride from the tissues and circulating blood. These results confirm the findings of Wallace-Durbin[2] and Parkinson *et al.*[5]. Normal human adults have excreted approximately one-third of an oral dose of fluoride in about 3 hr.[6].

We are indebted to Drs. J. A. Bruner and D. A. Bromley, and to Messrs. M. Awshalom and R. A. Campbell for these proton bombardments.

This communication is based in part on work performed under contract with the United States Atomic Energy Commission at the University of Rochester Atomic Energy Project, Rochester, New York, and in part supported by Grant *G*-3696(*c*) from the National Institutes of Health, to Eastman Dental Dispensary.

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Occurrence of 'Lumps' of Coagulated Material in the Bladders of Adrenalectomized Guinea Pigs

During the past five years, seventy-six male guinea pigs from four different colonies have successfully undergone bilateral adrenalectomy. Of these, twenty-two have afterwards developed 'lumps' in their bladders. These animals appeared healthy until a few hours before death. The 'lumps', composed of a firm yellow cheese-like material and weighing 9–800 mgm., were circular with a diameter varying from approximately 0·25 to 1·0 cm. and they had frequently a small projection which might block the urethra. The bladder did not always contain urine, and the ureters were never dilated.

This phenomenon has never been seen in female guinea pigs nor in more than two thousand male guinea pigs killed or dying from other causes. It has only been observed in male animals which have been completely adrenalectomized for periods of four days to one year and either maintained on cortisone or deoxycorticosterone acetate or untreated apart from glucose–saline to drink. The lumps did not develop until both adrenal glands had been removed. There was no seasonal incidence.

Histological examination of sections (stained with hæmatoxylin and eosin) of the kidneys of four such animals was carried out. The kidneys of one appeared to be normal; but in the other three there was hyperæmia of the medulla, and also of the cortex in one animal. Two animals showed some cloudy swelling of the tubules, and in one there were zones of polymorph infiltration in the medulla. All the glomeruli appeared normal. The ureters, bladder and seminal vesicles were also sectioned, but no abnormality was seen. Urine samples were tested for albumen with salicylsulphonic acid. A positive result was sometimes obtained with urine from both normal and adrenalectomized animals; but there was no evidence of increased albuminuria or polyuria in adrenalectomized guinea pigs.

It seemed most probable that the coagulated secretion of seminal vesicles was the main constituent of the 'lumps'. Smears made of seminal vesicle secretion and those taken from the 'lumps' had a similar microscopic appearance and showed varying-sized rosettes of amorphous material. The similarity was even more striking when the smears were made from secretion which was first coagulated by immersing the whole vesicle in hot water. No spermatozoa have ever been seen in smears from either the secretions or the 'lumps'.

In the guinea pig, a greater amount of fluid is contributed to the semen by the seminal vesicles than by the rest of the accessory glands together[1]. Mann[1] has shown that the seminal vesicle secretion contains appreciable amounts of citric acid of the order of 200 mgm./100 ml.

In the present study, citric acid was determined by the method of McArdle[2] in the seminal vesicle secretion and in 24-hr. samples of urine collected from normal and adrenalectomized animals with and without 'lumps', in the 'lumps' themselves and in the urine recovered from the bladders of adrenalectomized animals at autopsy.

The results of citric acid analyses are summarized in Table 1.

As can be seen, the concentration of citric acid in the 'lumps' and in the seminal vesicle secretion was nearly the same, suggesting that the lumps were made up of coagulated vesicular secretion. It is of interest that the citric acid content of 24-hr. urine samples was higher in cortisone-treated or untreated adrenalectomized guinea pigs than in normal unoperated animals. The urine in the bladder of one adrenalectomized guinea pig not included in the series of figures given contained 737 mgm. citric acid/100 ml. urine. The urine was cloudy while in the bladder, and as soon as it was aspirated into the glass syringe it formed a solid mass.

Table 1. CITRIC ACID IN THE SEMINAL VESICLE SECRETION, URINE AND 'LUMPS' REMOVED FROM THE BLADDERS OF MALE GUINEA PIGS

Guinea pig	No. of animals used in the determinations	Material	Citric acid (± standard error) (mgm./100 ml.)
Normal	4	Vesicular secretion	174·0 ± 29·4
Adrenalectomized	12	Vesicular secretion	195·5 ± 16·3
Adrenalectomized	8	'Lumps'	192·0 ± 34·8
Adrenalectomized, with 'lumps'	7	Urine in the bladder at autopsy	66·8 ± 10·5
Adrenalectomized, without 'lumps'	4	Urine in the bladder at autopsy	94·1 ± 33·0
Normal	5	24-hr. urine sample	5·3 ± 0·6
Adrenalectomized, maintained on cortisone	4	24-hr. urine sample	28·8 ± 9·3
Adrenalectomized, no treatment for 6–24 days	9	24-hr. urine sample	41·5 ± 14·5

The actual cause of death was not evident. It seems unlikely that renal failure was the cause, since the onset of the terminal condition was very rapid; albuminuria was not gross, anuria did not develop, and the bladder was not always obstructed or distended.

It is well known that in some species, notably rodents, semen coagulates after ejaculation; in the guinea pig, coagulation normally occurs after mating so that a vaginal plug is formed. The tentative suggestion is made that in the adrenalectomized guinea pig, whether treated or untreated, the normal process of ejaculation and coagulation is disturbed and that coagulation takes place in the bladder; the 'lump' thus formed can no longer be ejaculated.

We are grateful to Dr. T. Mann for helpful discussion. The cortisone used in the maintenance of the adrenalectomized animals was a gift from the Medical Research Council.

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Communal Oviposition in *Simulium damnosum* Theobald (Diptera, Simuliidae)

Simulium damnosum is the main vector of human onchocerciasis over a large part of tropical Africa. Although a considerable amount of work has been done on the habits of this insect—as summarized by Freeman and de Meillon[1]—there are many points in its biology which are still obscure, one of the most important of these being the normal method and site of oviposition. The only published description of the egg-laying habits of this species is that of Wanson and Henrard[2], who recorded thirty-five egg batches on specially attractive breeding sites mainly in the form of floating and vertical artificial frameworks of *Pennisetum* stems. Eighteen of these batches were deposited on the floating stems, thirteen on the vertical stems and four on artificial accumulations of stones. Ovipositing females did not penetrate the water but were observed to lay their eggs at or just above water-level; the egg batches consisted of 200–250 eggs. There is no record of the time of day on which oviposition was observed.

Since these observations were made, very little additional information on *Simulium damnosum* has appeared; but several illuminating observations have been made on species of *Simulium* in other countries which reveal a wide range of ovipositing behaviour both with regard to method and time. For example, Dalmat's observations on the blackflies of Guatemala[3], particularly those incriminated as vectors of onchocerciasis, showed that *S. ochraceum* oviposits by hovering above the less-turbulent parts of the stream and dropping relatively few eggs in any one place on the floating emergent vegetation. In the case of *S. metallicum* two methods of oviposition were observed; in a rapid current the female approaches the appropriate leaf at the surface of the water and deposits an egg without apparently landing. It then hovers above the leaf and returns to the same spot to deposit the second egg. In slow-moving streams the fly will actually land on the leaf, and several females —up to thirty—have been seen ovipositing on a single leaf. *S. callidum* was seen to oviposit only on sharply inclined surfaces of rock where the current was not very strong. The female hovers and then lands only long enough to deposit one egg, flying away to repeat the performance on another suitable surface. The time of oviposition of these three species was observed to be mainly between noon and 2 p.m. for *S. ochraceum*; between 5 and 6 p.m. (or occasionally as early as 3 p.m.) with *S. metallicum* and usually between 3.30 and 5.30 p.m. in *S. callidum*.

A further variation in ovipositing behaviour is shown by some North American species. *Simulium venustum*, for example, exhibits communal oviposition[4] while with *S. arcticum* it is considered that oviposition generally takes place on the surface of the river water, eggs being laid singly and sinking to the bottom[5].

In view of the wide potential range of behaviour likely to be encountered and of the paucity of observations on such an important species as *S. damnosum*, it was felt that a strenuous effort should be made to investigate this aspect of behaviour. The Liberian Institute provided unusual opportunities for this kind of work, as breeding of *S. damnosum* was found to occur regularly in parts of a comparatively small stream only 12 miles from the Institute. Repeated observations over several months, however, failed to reveal any sign of ovipositing females or of egg batches, even during periods of dense breeding. Finally, in March of this year *Simulium* eggs were found on several broad leaves of bushes dipping into the stream, bushes which had recently been cut down along the stream edge. The eggs were laid in large irregular masses, sometimes distinct, sometimes contiguous. As the eggs were piled in several layers it was difficult to assess their density or number; but a rough estimate showed that two to three thousand eggs per square centimetre was not unusual. On one particular leaf with a continuous egg mass about 30 sq. cm. it was estimated that there must have been at least 50,000 eggs. Provided the leaf surface was kept moist with spray it was found that the egg masses would extend two or three inches above the actual water surface. As larvæ hatching from these eggs could not be kept alive longer than a few days it was not possible to attribute them definitely to *S. damnosum*, as other species, particularly *S. cervicornutum* and *S. unicornutum*, were also present in this stream and on the trailing leaves.

In the following weeks many similar sites were examined, and further batches of eggs were seen twice on trailing leaves and twice on rattan strands dipping into the water. On the assumption that these egg masses were very likely those of *S. damnosum* it was already fairly clearly indicated that such masses could only have been produced by a large number of females, very likely ovipositing at one time. As observations carried out throughout the greater part of the day had failed to reveal any sign of ovipositing females, it also seemed increasingly likely that egg-laying would be restricted to the late afternoon or evening. The opportunity for confirming this point had to await a suitable combination of circumstances, the right time and the right place.

In the month of August, during a period of dense breeding of *S. damnosum*, one particular series of artificial sites in the form of leafy twigs dipping into the stream proved to be an unusually attractive ovipositing site in that fresh batches of eggs were recorded, not spasmodically but on several consecutive days. A careful watch was therefore kept on this spot during the hour before dusk. No fly activity was evident until dusk, when at about 1850 G.M.T. (sunset 1852 G.M.T.) a dense swarm of black flies was seen just above the surface of the water at the point where the tips of the leaves dipped into the stream. The swarm quickly settled on the trailing leaves and mass oviposition started immediately. On one leaf the swarm of flies, now obviously *S. damnosum*, settled at the tip trailing downstream and moved steadily from apex to base. As the mass of flies moved from the narrow tip to the broader part of the leaf they formed a solid line extending from one side to the other. As the line advanced steadily towards the base of the leaf the surface of the leaf behind them was left covered with a carpet of glistening white eggs (which turned brown during the course of the following few hours). As the flies moved upwards the entire leaf surface was covered with the white egg mass. Similar activity was also taking place on the two or three adjacent leaves of this twig, but not on any of the other eight similar twigs trailing in the stream at this point. By the time maximum ovipositing activity had been reached the waning light was making visibility difficult, and it is doubtful if the ovipositing swarm would ever have been spotted if attention had not been concentrated on this one suspected site.

When the peak of activity was already past, specimen tubes slipped quickly over two of the leaf tips secured 48 and 50 *damnosum* females respectively. As many flies escaped and as many others had already left the leaf it is fairly certain that two or three hundred females must have taken part in the pre-oviposition swarm and in the communal ovipositing itself. As a single female may lay several hundred eggs (200–250 according to Wanson and Henrard[2], or even up to 500[6]) it is now possible to understand how the previous estimate of anything up to 50,000 eggs on one leaf is not unreasonable.

This communal oviposition of *S. damnosum* appears to resemble in many respects that described for *S. venustum* (Hocking and Pickering, *loc. cit.*), in which the authors say that "egg-laying females were so numerous that they were lined up closely side by side while others crawled over them seeking a place". As far as *S. damnosum* itself is concerned this communal oviposition is evidently the regular method of ovipositing on this type of site, a leaf or branch trailing in the stream. On the other occasions when eggs have been found on such sites, whether natural or artificial, they have been in the form of large masses, undoubtedly the product of many females and in all those cases the appearance and dimensions of the eggs agreed with those of eggs actually laid by observed *S. damnosum* females. The dimension of the *damnosum* eggs—as judged by a random sampl of 20—were as follows:

	Length	Greatest breadth
Range	203–245 microns	126–140 microns
Mean	222μ	134μ

The observations of Dalmat quoted above to the effect that one species of *Simulium* may vary its ovipositing habits according to site and conditions, combined with the rather different behaviour of *damnosum* originally recorded by Wanson and Henrard[2], make it inadvisable to conclude that this communal ovipositing of *S. damnosum* is an unvarying feature of the species. As such ideal sites in the form of leafy twigs trailing in the turbulent part of the stream are rather unusual, other sites must be used as well in order to account for the almost continuous production of *S. damnosum* larvæ in this stream over long periods. Further observations are being made to investigate this point.

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Sept. 17.

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Effect of Changes in Humidity on the Toxicity and Distribution of Insecticides sorbed by some Dried Soils

Recently it has been noticed during field trials in mosquito control that there is an apparent correlation between relative humidity and the insecticidal effectiveness of deposits in houses made of mud walls and thatched roofs. Bordas and Navarro[1] in Mexico found a steady increase in toxicity of dieldrin deposits as the relative humidity increased throughout the season. Burnett[2] in Taveta, Kenya, found that seasonal variations in rainfall, presumably accompanied by variations in humidity, were associated with corresponding changes in the mortalities of mosquitoes exposed to dieldrin deposits.

Relative humidity could presumably exert its influence either upon the insect itself after the nsecticide has been picked up or it could modify he availability of the insecticide in the deposit, and these two aspects have now been examined in laboratory experiments.

We have not been able to find any effect of changes n relative humidity upon the kills of mosquitoes which were kept at humidities ranging from 20 to 5 per cent after topical application of DDT, gamma-BHC, dieldrin or 'Diazinon', or after exposure to eposits of wettable powders of DDT, gamma-BHC r dieldrin. Therefore it seems most likely that any nfluence of relative humidity is upon the availability f the insecticide to the insect.

It has been shown previously[3,4] that the air-dried oils which are frequently used for house construction n the tropics can rapidly adsorb insecticides applied s surface deposits of wettable powders. This process esults in a marked decrease in contact action of DDT and dieldrin because there are no longer any particles of insecticide lying on the surface of the house walls. We noticed in this work[3] that relative humidity had an influence upon the rates at which DDT and gamma-BHC thus disappeared; increasing the humidity reduced the rate of loss. It is therefore possible that the behaviour of deposits observed in field trials could be due to variations in the availability of insecticides on and in mud walls and this has been more fully investigated.

Table 1. The Effect of Changes in Relative Humidity upon the Toxicity of Dieldrin-treated Mud Blocks to *Aedes aegypti* Females

Relative humidity conditions	Percentage kill 24 hr. after exposure of . . . min.			
	4	8	16	32
90 per cent for 24 hr.	55	100	100	
40 per cent for 24 hr.		0	30	68
90 per cent blocks transferred to 40 per cent for 24 hr.		0	5	48
40 per cent blocks transferred to 90 per cent for 24 hr.	38	65	100	

It was confirmed that deposits of DDT, gamma-BHC and dieldrin on blocks of Uganda soil are sorbed at rates which decrease as the humidity increases. This was also observed on nine other soils of varying composition and origin. However, dieldrin, which was the insecticide of major interest with field experiments, even at a dosage of 100 mgm. per sq. ft. and at 90 per cent relative humidity, still disappeared from the surface of Uganda mud blocks in about five days, and so for interpretation of the field results it is of more importance to know what happens after sorption is completed. Table 1 shows the results of biological tests with mud blocks sprayed twenty-one days previously with a suspension of dieldrin crystals in the size range 0–10 microns at a dosage of 100 mgm. per sq. ft. and kept for 24 hr. at two different humidities before the exposure of mosquitoes. The positions of the blocks were reversed for a further 24 hr. and re-tested.

It can be seen that the insecticidal activity increases with humidity from 40 to 90 per cent and this difference in activity is almost completely reversible in 24 hr. Similar results were obtained for contact action of DDT and both contact and fumigant action of gamma-BHC. The kills therefore follow closely any changes in humidity and the biological effectiveness of the treated blocks can be rapidly raised or lowered. Because of this close correspondence it seemed unlikely that there could be any marked changes in distribution of insecticide as postulated by Bordas and Navarro[1], who suggested that the insecticide migrated back to the surface under conditions of high humidity. This was borne out by chemical determination of the distributions of the insecticides in the blocks kept at different humidities. These showed that the rate of diffusion of the insecticides into the blocks after sorption was complete actually increased with humidity and this naturally resulted in a decreased concentration of insecticide near the surface of the blocks on which the insects rested. Table 2 gives some results obtained with dieldrin-treated blocks kept at different humidities after spraying.

In the field, therefore, long periods of high humidity would be expected to give a progressive decrease in the concentration of insecticides near the surface of the walls whereas lower humidities would tend to keep the concentration static. At any given time and

Table 2. AVERAGE PERCENTAGE RECOVERIES OF DIELDRIN FROM SUCCESSIVE LAYERS OF UGANDA MUD BLOCKS

Relative humidity (per cent)	Layer No	Weight of layer (gm.)	Time after spraying		
			1 hr.	4 days	13 days
10	1	0·25	92	69	52
	2	4·0	8	31	48
	3	4·0	0	0	0
	4	4·0	—	—	0
	5	4·0	—	—	0
50	1	0·25	92	17	10
	2	4·0	8	79	67
	3	4·0	0	4	20
	4	4·0	—	0	3
	5	4·0	—	—	0
90	1	0·25	92	16	6
	2	4·0	8	37	23
	3	4·0	0	27	20
	4	4·0	—	20	15
	5	4·0	—	—	12
	6	4·0	—	—	10
	7	8·0	—	—	14

concentration, however, an increase in humidity would give higher kills, and a decrease lower kills. The enhanced kill at high humidities can more than compensate for decreases in concentration so that kills would remain high even during extended periods of high humidity.

We explain these results on the basis of competition between the water and the insecticides. Water appears to be adsorbed preferentially to the insecticide and the increased amounts which are present in soils at high humidities have two effects. The initial disappearance of the insecticide from solid particles lying on the surface is retarded because water molecules already occupy a large proportion of the 'active' surface of the soil and cannot be displaced. Once the insecticide is adsorbed, however, the same preferential adsorption of water results in an increased mobility of the insecticide molecules and therefore an enhanced rate of diffusion farther into the soil or, alternatively, an enhanced rate of diffusion on to and into an insect resting on the soil.

The laboratory findings therefore provide an explanation for the results obtained in the field by Burnett and by Bordas and Navarro where mosquitoes enter huts and can be killed by contact or fumigant action on treated walls.

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Sept. 17.

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Reactions to Shading in the Sea Urchin, *Psammechinus miliaris* (Gmelin)

IN this urchin, podia withdraw in response to sudden shading. When the aboral hemisphere was subjected to an illumination of 250 metre-candles from a tungsten filament lamp, according to the individual, a 3–20 per cent decrease in intensity proved a minimal stimulus. Most of the podia responded simultaneously when the light was relatively bright; but when dim, or when the shadow was faint, many fewer responded and then at different times.

By using calibrated neutral filters it was found that the interval between instantaneous shading and the appearance of a clearly visible response varied inversely with the intensity of illumination and the degree of intensity change.

In successive experiments with an illumination of more than 100 metre-candles, in response to a 20 per cent decrease, this interval was approximately constant for each individual, but at 5–20 metre-candles it varied considerably. Despite such variations, there was sometimes an indication of adjustment, in that this period decreased in successive experiments under the same conditions.

Urchins must be exposed to light for a certain length of time before they react to shading, the duration varying inversely with the light intensity. Different individuals required 0·5–2·0 min. at 60 metre-candles, and 3–22 min. at 6 metre-candles. The response thus depends, in part at least, on photochemical reactions.

The relative effectiveness of exposure to light in regions of the spectrum between 400 and 560 mμ and between 620 and 700 mμ was determined by means of four coloured filters with known transmission, and a light source of known colour temperature. For this response, using the relative amount of light energy transmitted by the filters as a basis for comparison, the animal appeared most sensitive between 440 and 560 mμ.

The work was done at the Plymouth Laboratory of the Marine Biological Association, and a full account will be published later.

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Plastochron Determination in *Ranunculus* using Carbon-14 Dioxide

DETERMINATION of the plastochron, or tim interval between the formation of successive lea primordia, suffers from the difficulty of establishin the age of a primordium at any particular stage c development. An autoradiographic technique ha been successfully used for obtaining an estimate of th plastochron of *Ranunculus* by indirect means.

The technique utilizes differences in amount c active material taken up by young leaves in differer stages of development following administration c carbon-14 dioxide to one of the fully mature leaves Two doses, at an interval of several weeks, are fol lowed by a period in which the adjacent young leave are allowed to grow to maturity. The leaves are the dried and exposed for two weeks to X-ray film allowing the relative activity of successive leaves to b determined. Differences in uptake become evider as peaks of activity separated by a gap of leave with lower activity. From the number of leave between the peaks, the average rate of formatio of successive leaf primordia can be calculated.

Ten plants of *Ranunculus hirtus* B. and S. we grown for four months under fluorescent lighting 500 foot-candles intensity and at a temperature

Table 1. RESULTS OF PLASTOCHRON DETERMINATION IN *Ranunculus hirtus* B. AND S. AFTER LABELLING THE YOUNG PRIMORDIA WITH CARBON-14 DIOXIDE

Time interval	Number of leaves between peaks	Plastochron in days
67 days	5 (1 plant)	13·4
	6 (2 plants)	11·1
	7 (3 ,,)	9·6
	8 (2 ,,)	8·4
	9 (2 ,,)	7·4
	Mean plastochron	9·6 s.e. 0·59

15° C. The second administration of $^{14}CO_2$ was made after 67 days, a further 43 days being allowed to elapse before contact autoradiographs were prepared (Table 1). Under these conditions the mean plastochron was found to be a little less than 10 days.

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Chasmogamous Flowering in *Viola palustris* L.

AFTER a short burst of chasmogamous flowering in early spring, plants of *V. palustris*, like those of many other violet species, produce a succession of cleistogamous flowers throughout the summer. Such a change in flowering habit could be associated with changes in day-length, as in *V. fimbriatula* and *V. papilionacea* with which Allard and Garner[1] obtained chasmogamous flowers only in short days and cleistogamous flowers in long days. With several other violet species Chouard[2] has obtained chasmogamous flowering only in short day-lengths (for example, *V. odorata*), or after exposure to winter temperatures (for example, *V. silvestris*), or after both winter temperatures and subsequent short-day treatment (for example, *V. hirta*).

Experiments carried out in the Earhart Laboratory at Pasadena on members of five clones of *V. palustris* gave results that may be summarized as follows. Flower initiation may occur in plants under both short (8 hr.) and long (16 hr.) photoperiods, and also in continuous light. Plants kept in long days at a phototemperature of 20° C. and nyctotemperature of 14° C. (20°/14° C.) produced an abundance of large long-petioled leaves and of even taller peduncles bearing cleistogamous flowers, but never any chasmogamous ones. Plants transferred from long to short days continued to produce cleistogamous flowers for about two weeks: most of them then ceased flowering altogether, although a few plants later bore an occasional chasmogamous flower.

In short days the leaves were much smaller, round rather than cordate, and with short petioles; at 20°/14° C. most of the initiated flower buds did not develop, but nearly all plants produced occasional chasmogamous flowers, never any cleistogamous ones. In short days at higher temperatures no flowers of either kind were obtained, nor any at 17°/10° C. Several of the plants transferred from short days produced a few chasmogamous flowers when first moved to long days at 20°/14° C. before cleistogamous flowering began.

All the plants vernalized for eight weeks at 4° C. in short days of artificial illumination at 400 foot-candles intensity gave a short burst of chasmogamous flowering when transferred to 20°/14° C. in either short or long photoperiods. In long days this initial burst was followed by continuous cleistogamous flowering, in short days by no further flowering.

These results suggest a certain equivalence between short day-lengths and low temperatures in their encouragement of chasmogamous flowering in *V. palustris*, as also in the flowering of winter rye[3], and Chouard's results indicate that in some species the vernalization pathway, in others the short-day path, is the more effective, while in *V. hirta* the joint action of both is usually required. Allard and Garner considered that chasmogamy occurred only in conditions of reduced vegetative expression, which may account for the complete absence of chasmogamous flowers in short days at temperatures above 20°/14° C. where growth was more abundant. On the other hand, the fact that cleistogamous flowering was also absent in these conditions indicates clearly that the flowering habit is not simply an expression of the amount of growth made. Bergdolt[4] found that chasmogamous flowering of several violet species was favoured by a high nutrient supply; but in the present experiment all plants received a balanced nutrient solution every day, yet only cleistogamous flowers appeared in the continuous long-day treatments. Thus the effect of photoperiod on the type of flowering does seem to be specific, and not merely an indirect growth effect. However, the effect of vernalization and short-day treatments on the induction of chasmogamous flowering in *V. palustris* is strikingly ephemeral, few of the buds present during these treatments giving rise to chasmogamous flowers, which does suggest that the specific effects of short days and low temperatures on full flower development may be expressed only within a narrow range of growth conditions.

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Control of Watercress Crook Root Disease by Zinc-fritted Glass

CROOK root disease of watercress (*Nasturtium officinale*, R.Br. and *N. officinale* × *N. microphyllum*, Boenn. ex Rchb.) was first reported in 1948 by officers of the National Agricultural Advisory Service. During 1949 the disease was found in all the watercress-growing districts, and it has now reached such serious proportions that it is a major threat to the industry.

The disease was found by Spencer and Glasscock[1] to be caused by a water-borne fungus (probably a species of *Spongospora*) which infects the roots and causes them to become swollen, distorted and 'crooked'. Infected plants lose vigour, become stunted and may eventually die. Investigations, since made by me, indicate that a practical control of the disease may be obtained by the addition of traces of zinc to the water in the watercress bed.

Laboratory studies on the disease were made by growing healthy rooted watercress cuttings in distilled water in glass jars together with watercress cuttings bearing infected roots. The fungus in the infected roots liberated zoospores which infected the healthy roots, the cycle from infection to further zoospore liberation occurring in 8–10 days.

No infection could be obtained, however, when laboratory tap water at the Sub-centre of the National Agricultural Advisory Service, Wye, Kent, was used, although heavy infection was obtained using local spring water. The possible use of zinc in the control of the disease first became evident to me when analyses of the two waters, made by Dr. R. L. Mitchell of the Macaulay Institute, Aberdeen, showed that the tap water contained 1·8 p.p.m. zinc compared with 0·04 p.p.m. zinc in the spring water. The greater amount of zinc in the tap water was apparently caused by its flow through ga'vanized pipes.

Tests were made with zinc sulphate, and it was found that whereas 19·5 per cent of the primary roots and 12·5 per cent of the secondary roots became infected in distilled water, no primary roots and 0·03 per cent of the secondary roots became infected in zinc sulphate solutions containing 0·5 p.p.m. zinc. Infection was completely suppressed at a concentration of 2·0 p.p.m. zinc.

The use of soluble zinc compounds to control the disease in watercress beds presented practical problems caused by the large quantity of water passing through the beds (3–500,000 gallons per acre per day). These led to a search for relatively insoluble materials from which zinc would be liberated very slowly and which could be applied over the whole bed. One such material, a very insoluble zinc-containing glass-frit (zinc F.T.E.), has given promising results under field conditions.

Zinc frit consists of zinc oxide dissolved in glass which is then milled to a fine powder (< 250 mesh).

Composition of zinc F.T.E. (zinc frit) F.N.266

	SiO_2	Fe_2O_3	Na_2O	CaO	ZnO
Per cent	55	4	16	2	23

The material is similar in type, though not in composition, to the fritted glasses used by Wynd[2] for supplying certain trace elements to plants.

Using the laboratory method described above, it was found that an amount as small as 0·05 gm. of zinc frit per 350 ml. water prevented infection. Comparative tests using two other frits, neither of which contained zinc, showed that these gave no control of the disease at amounts up to 0·2 gm. per 350 ml. of distilled water. This indicated that the effect of the zinc frit was due to its zinc content and not to the other constituents of the glass. This was substantiated by the fact that control was also obtained with 0·01 gm. zinc oxide and with 0·18 gm. powdered metallic zinc per 350 ml. of distilled water.

Field tests were then made in which zinc frit and two other non-zinc-containing frits were applied to three separate experimental watercress beds[3] in September 1955. These were treated with frits at the rate of 1 lb. per square yard; similar, adjacent, untreated beds, with common water supplies, served as controls. Zinc frit was also applied to two full-sized commercial beds in March 1956. They were divided longitudinally into three equal areas; the outer strips were treated with 1 lb. and ½ lb. of zinc frit per square yard respectively, and the centre, untreated strip was used as a control.

In all the trials, the plants in the beds were initially heavily infected with crook root. 4–8 weeks after treatments the watercress in the beds treated with zinc frit began to grow more strongly than that in the beds treated with the other frits and in the untreated beds. Very little or no crook-root infection could be found on the roots of the plants treated with zinc frit, whereas the control plants and the plants treated with the other frits remained heavily diseased.

These differences in growth and infection were still apparent eight months after treatment of the beds. The zinc content of the plants in the beds treated with zinc frit was somewhat higher than that of the plants in untreated beds; but the plants were still quite safe for human consumption. The zinc content of the outflow water from treated beds was less than that found to be toxic to fish in hard waters[4], such as supply most watercress beds.

Thanks are due to Messrs. Ferro Agricultural Division, Wombourn, Wolverhampton, for making and supplying the frits used in this study.

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Sept. 26.

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Molybdenum Deficiency in Hops

DURING the 1953–54 season, samples of leaves of hops showing chlorosis and breakdown, or a fine white speckling, of the lamina were received from a hop garden on the Motupiko soil type (*p*H 5·4–5·7) at Neudorf, Nelson (Fig. 1). Chemical analysis showed no important differences in zinc, copper and manganese contents between these leaves and those obtained for the many samples examined in this laboratory over a number of seasons. On the other hand, the molybdenum content of the affected leaves was 0·025 p.p.m. in the dry matter, which may be

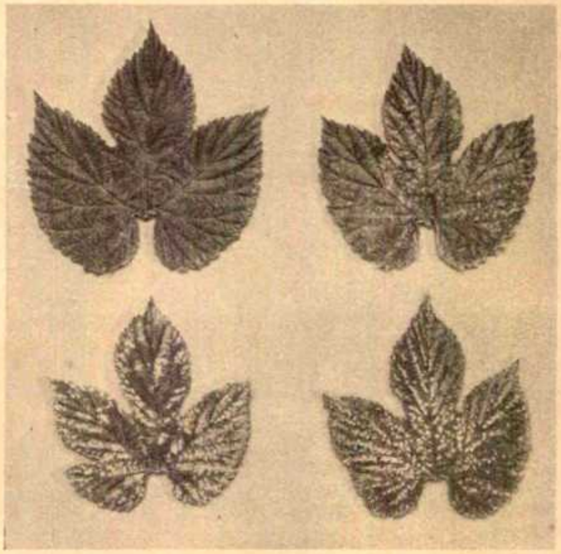

Fig. 1. Hop leaves; healthy leaf, top left; remaining leaves showing various grades of speckling

compared with 0·04 p.p.m. molybdenum for apparently healthy leaves in the same garden, and with the range of values, 0·08–2·1 p.p.m., for samples from other areas. In none of these latter samples was there any indication of abnormality in the leaves.

Because of the possibility that the unusual condition of the plants was due to a deficiency of molybdenum, a trial using sodium molybdate at 0·25 gm. per plant (250 gm. per acre), and ground imestone at 2 lb. per plant broadcast, singly and in combination, was set out on October 21, 1954. During the season, chlorosis and speckling of leaves were noted on a number of plants. By harvest time March 1955), there was a very good favourable response to the molybdenum treatment, plants on plots receiving molybdate being mostly healthy with fresh green leafage. Limestone was beneficial. When used in conjunction with ground limestone, sodium molybdate was not so effective as when used alone. Chemical analysis showed that the improved condition of the leafage was positively correlated with an increased level of molybdenum in the aminæ.

This experiment was continued and enlarged in the 1955–56 season. The original plots, and new plots, were treated on October 25 with sodium molybdate to provide a rate of 1 lb. per acre on all he plots. On December 9 plants on the untreated areas of the original plots were mostly seriously ffected by upward curling of the leaves with brown ecrotic areas about 2 mm. in diameter, which later urned white, with leaves smaller and of a lighter reen colour than normal. Where sodium molybdate was used, very satisfactory plants were produced. The effect of ground limestone was not completely atisfactory. For samples of laminæ taken on Janu- ry 21, 1956, at a height of approximately 5 ft., rom plants of the original series of plots, the follow- ng analytical data (p.p.m. molybdenum) were btained : untreated, 0·12 ; limestone, 0·23 ; sodium molybdate, 1·03 ; molybdate plus limestone, 0·66. lthough many of the plants on the untreated plots were showing severe symptoms, these did not gener- lly extend above 5 ft. from the ground, so that most of the leaves in the untreated samples were pparently healthy.

Molybdenum content of the cones was increased y the use of sodium molybdate. Cones have been ound to be richer in molybdenum than the corre- ponding leaf laminæ on both this deficient and other ealthy areas.

On December 20, 1955, the plants were classified percentages as follows, *H* referring to healthy and to those showing only a trace of leaf symptoms : dium molybdate, 90*H* and 10*T* ; molybdate plus nestone, 67*H* and 33*T* ; limestone, 42*H* and 42*T* ; ntreated, 6*H* and 22*T*. On the plots treated for nly one season, the counts were : molybdate, 89*H* nd 11*T* ; untreated, 25*H* and 33*T*. These results ow how completely the use of sodium molybdate as overcome the ailment, and confirm the diagnosis of olybdenum deficiency as the cause of the symptoms n the leaves.

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The Olivine–Spinel Transition in the Earth's Mantle

FROM seismic data, Jeffreys[1] has inferred the presence of a discontinuity in the Earth's mantle at a depth of 400–500 km. Bullen[2] has found that between 400 km. and 900 km., a rapid increase in density occurs. It was suggested by Bernal[3], in conjunction with Jeffreys, that these findings could be explained by the assumption of a pressure inversion in the olivine of the mantle. Bernal suggested that, at high pressures, magnesium silicate might be inverted from an olivine to a denser spinel structure.

The Jeffreys–Bernal hypothesis has been investigated by a thermodynamic study of sub-solidus phase equilibria in the pseudo-binary system Ni_2GeO_4—Mg_2SiO_4 (Fig. 1). At 1,500° C., nickel germanate, which possesses a spinel structure, dissolves 9 per cent of magnesium silicate. From this and other similar data, the molar free energy of transition (F) of magnesium silicate from the olivine to the spinel structure may be calculated.

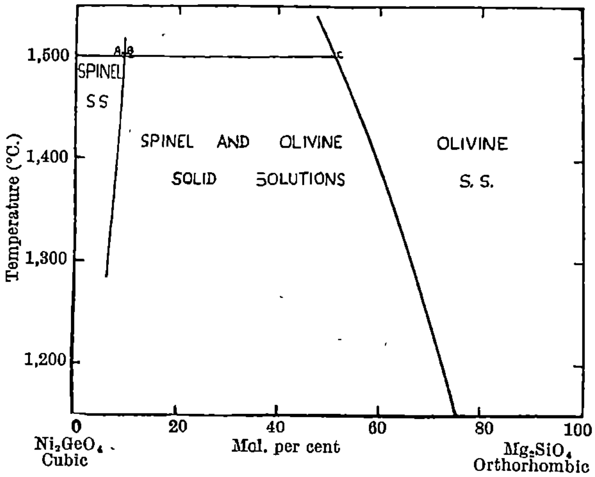

Fig. 1. Sub-solidus phase equilibria in the pseudo-binary system Mg_2SiO_4—Ni_2GeO_4

If a_1, a_2 are the activities of magnesium silicate in the spinel and olivine solid solutions in equilibrium, it is possible to show that:

$$F = RT \ln \frac{a_2}{a_1}$$

Assuming ideality and applying Raoult's law, a_1 and a_2 can be found from the compositions of co-existing phases in equilibrium. (The activity of Mg_2SiO_4 in a solid solution is given[4] by $[Mg]^2[Si]$ and not $[Mg_2SiO_4]$.) On this basis, a value for F of $68,000 \pm 10,000$ joules/mole is found. The accuracy of this result depends upon the assumption of ideality. Theoretical considerations and further experimental work support this assumption.

The density of Mg_2SiO_4 spinel is obtained by extrapolating the densities of Ni_2GeO_4—Mg_2SiO_4 solid solutions. The transition is found to involve an increase in density of 11 ± 3 per cent. This value is supported by analogous studies of the density difference between cubic and orthorhombic magnesium germanate. The function $\int_0^P \Delta v \, dP$, where Δv is the difference in molar volume, may be calculated for different pressures using reasonable assumptions as to the compressibility of Mg_2SiO_4 spinel. This gives the difference in free energy of the two forms due to compression. When this reaches 68,000 joules, spinel becomes the stable form.

Calculation indicates that this value will be reached at a pressure corresponding to a depth of 520 ± 180 km. within the Earth. This is in good agreement with the depth of the 20° discontinuity found by seismology and is considered to provide strong evidence supporting the Jeffreys–Bernal hypothesis.

An olivine–spinel transition in the mantle is capable of explaining the variation with depth of density, elasticity and electrical conductivity. It is consistent also with the inference by Bullen[5] and by Birch[6] that the transition takes place over a wide range of depths. A substantial pressure interval would accompany the transition, because of the presence of other components in solid solution, particularly Fe_2SiO_4, $MgSiO_3$, Ca^2, Al^3, Cr^3. (Spinels are widely tolerant towards ionic substitutions and are often able to dissolve compounds with ABO_3 type formulæ.) The presence of a finite temperature gradient and the possibility of hysteresis and non-attainment of equilibrium also contribute towards a range of transition.

Occurrence of the transition raises difficulties for the convection theory of orogenesis, because of the liberation of latent heat during the transition and difficulties in maintaining equilibrium. However, the contraction theory is considerably strengthened. As cooling causes inversion of olivine to spinel, the volume contraction for the same heat loss is about twenty times greater than the normal thermal contraction.

This communication is essentially an abstract of a more comprehensive investigation[7] the full results of which will be published in due course.

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WITH great interest I have read the preceding important communication by Dr. A. E. Ringwood, which seems to confirm a hypothesis about a phase-transition of the olivine between the depths of 200 km. and 900 km. in the Earth, which I proposed (*Proc. Roy. Netherlands Acad. Sci.*, B, **59**, 1; 1956), starting from a different basis, namely, the overwhelming evidence in favour of convection-currents in the mantle. This demands the same chemical constitution throughout the whole mantle, and so we have to assume a phase-difference between the upper layer, above 200 km. depth, and the lower layer, below 900 km. depth, with a transition-layer between, in order to explain the density results, derived by Jeffreys, Birch and others on seismological grounds.

In this paper I tried to show that all the facts agree to this supposition, if at least the transition energy K per gram is smaller than an upper limit given by

$$\left(\frac{K}{cA}\right)_m \leqq {}_l\theta_e - {}_u\theta_e$$

where the left-hand side is the mean value ove the whole transition layer of the ratio of K t the product of the specific heat c and the hea equivalent A, while ${}_u\theta_e$ and ${}_l\theta_e$, respectively, are th values of the equilibrium temperature θ_e of the tw phases, at the upper and lower boundaries, respectively, of the transition layer. For a value of c of 0·2 (see "Handbook of Physical Constants" by Birch Schairer and Spicer) the value of K derived fro Ringwood's result, namely, $F = 68{,}000 \pm 10{,}00$ joules/mole, would give:

$${}_l\theta_e - {}_u\theta_e \geqq 580° \pm 90°$$

As this value for the difference in temperature a 200 km. and 900 km. depth is acceptable, I canno agree with Ringwood's conclusion regarding th incompatibility of the convection theory of orogenesi with the phase-transition hypothesis here presente

In the paper mentioned above, I had occasion t make the following points. In the first place, th cooling of the Earth must bring about a broa transition-layer between the two phases, whic slowly travels upwards; it now has reached th position between 200 km. and 900 km. deptl Secondly, the presence of convection currents whic in this period of mountain formation we must su mise to rise below the continents, where the radi activity of the sial must cause a higher temperatu than below the oceans, and to subside below th oceans, must bring about a change of the dens phase into the lighter one below the continents, an the reverse below the oceans. This can explain th regressions of the continents during the first peri of an orogenic cycle and the subsidence afterwar in the way indicated by the geological evidenc In the third place, this state of affairs can expla why in general the temperature gradient found belo the ocean floors is about the same as that foun below the continents, notwithstanding the differen of radioactive heat production in the two areas whic might be expected to give a difference in gradien the phase changes indicated must have a contra effect on the gradient at the surface.

I may refer to the paper mentioned for so further evidence in favour of the hypothesis he presented. Dr. Ringwood's paper is a most importa contribution to it, by giving a solid base for t phase-transition hypothesis.

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Surface Adhesion and Elastic Properties of Mica

CONSIDERATION of the crystal structure of mic suggests that the strong adhesive forces observ between mica cleavage surfaces may be the same the forces which hold the alumino-silicate lay together in a block of the material. Cleavage occ between two such layers along a plane of potassi ions, and the surfaces so formed may be flat a molecularly smooth over appreciable areas[2]. App ently, both filled and empty potassium ion sites a present on the cleavage plane, but there is lit surface migration or diffusion of potassium ions. This is shown by the following experiment.

A sheet of muscovite mica was partially immersed in a solution containing radioactive cæsium chloride, rinsed and dried. The end of the sheet which had been immersed exhibited a counting-rate (Geiger–Müller counter) of the order calculated for the replacement of a half-filled layer of surface potassium ions by radioactive cæsium ions of the specific activity used, while the undipped end had a much lower activity. After the strip had been exposed to air at room temperature for three weeks, the counting-rates were found to be the same as they had been an hour after immersion. The presence of the surface ions, their ability to exchange with ions in solution, and the negligible diffusion of the ions either over the surface or into the bulk under these conditions is indicated.

If we assume that the adhesion is dominated by the presence of highly polarized potassium ions and the negative charges of their sites in the alumino-silicate framework, the energy required to cleave mica should be primarily that needed to overcome the coulombic attraction. Further, using the Born model for ionic crystals, the elastic properties in a direction perpendicular to the cleavage plane should be deducible from the same electrostatic forces.

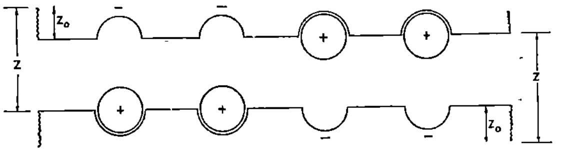

Fig. 1

Using a very simple model (Fig. 1) of potassium ions (+) and neighbouring sites of oxygen bearing a corresponding negative charge, we obtain for the force between a single ion and a single site the resultant of the electrostatic attraction and a repulsive term which decays more rapidly:

$$F = \frac{e^2}{z^2} - \frac{B}{z^n} \tag{1}$$

Since the lateral spacing of the potassium ions and negative sites (about 5 A.) is large compared with z (1·4 A.), only the immediate interaction of ion and site need be considered, that is, the Madelung constant may be taken as unity. Then the energy of separation is given by:

$$E = N \int_{z_0}^{\infty} \left(\frac{e^2}{z^2} - \frac{B}{z^n} \right) \mathrm{d}z \tag{2}$$

where N is the number of potassium ions per cm.^{2} and z_0 is the equilibrium spacing in the crystal (B is determined by the condition $F = 0$ at $z = z_0$). Using $N = 4{\cdot}2 \times 10^{14}$ as calculated from the crystal structure, $n = 7$, and $z_0 = 1{\cdot}4 \times 10^{-8}$ cm. (the radius of an oxygen ion—this is roughly equal to the distance between the potassium ion and the neighbouring plane of oxygen ions), we obtain $E = 5{,}750$ ergs/cm.^{2}. This crude value is within a factor of two of the value obtained by Orowan[3] from Obreimov's data for the cleavage of mica in vacuum. (It should be noted that Orowan computed a surface energy; we have calculated the energy required to effect separation of 1 cm.^{2}, producing 2 cm.^{2} of surface.)

The elastic modulus perpendicular to the cleavage plane is given by:

$$M = N \left(\frac{\Delta F}{\Delta z / z} \right)_{z=z_0} = z_0 N \left(\frac{\mathrm{d}F}{\mathrm{d}z} \right)_{z=z_0} \tag{3}$$

Using equation (1) for F and inserting the values above, we find $M = 2{\cdot}5 \times 10^{12}$ dynes/cm.^{2}. Bridgman[4] estimated the modulus of mica in this direction to be $1{\cdot}7 \times 10^{12}$ dynes/cm.^{2}.

An extension of the adhesion-energy calculation can be made by assuming that in air a monolayer of nitrogen is adsorbed on each side of the cleavage plane. Introducing the dielectric constant of liquid nitrogen and increasing z_0 by twice the thickness of a nitrogen molecule (estimated from the density of liquid nitrogen), we arrive at $E = 618$ ergs/cm.^{2}, or about 309 ergs/cm.^{2} of surface produced. This may be compared with Orowan's value for cleavage and re-adherence in air, 375 ergs/cm.^{2}.

The effect of liquid water in reducing the mica-to-mica adhesion is also readily understood, both the high dielectric constant and the occurrence of hydrogen ion–potassium ion exchange contributing to the reduction of attraction.

While the crudeness of this model and doubts about the accuracy of the experimental data cited make more detailed comparisons unwarranted, the qualitative agreement obtained emphasizes the important role of electrostatic forces in adhesion of mica. The results also indicate the need for more detailed studies of the properties of mica-like materials. It would seem that coulombic interactions can play an important part if the bonding is dominated by a highly polarized ion. In addition, there exists the interesting possibility of exchanging the surface ions after cleavage and so changing the surface properties of the material. Experimental work along these lines is in progress and will be reported elsewhere.

One of us (G. L. G.) acknowledges numerous interesting discussions with Dr. A. M. Bueche and Dr. B. H. Zimm.

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[2] Bailey, A., and Courtney-Pratt, J. S., *Proc. Roy. Soc.*, A, **227**, 500 (1955).

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Dependence of the Dielectric Breakdown of Transformer Oil on Electrode Conditions

Several workers have found that the breakdown strength of an insulating liquid may be determined not only by its own composition and purity but also by the material and condition of the electrodes used to test it. Recent work in this laboratory is believed to show that the impulse breakdown strength of transformer oil is also dependent upon the thickness of the natural oxide layer on the surface of the electrodes.

Filtered, dried, and degassed oil has been tested in a totally enclosed test cell with micro-second duration impulse voltages of up to 500 kV. Hemispherical electrodes of 2·5 cm. diameter were used at a gap setting of approximately 2·5 mm., and were freshly prepared before each breakdown measurement. After polishing with a soft buffing mop and suitable cutting composition the electrodes were lightly buffed with a clean swansdown mop. This was followed by an examination under a metallurgical microscope to ensure that there were no heavy scratches or pits, after which the electrodes were placed in a desiccator containing a drying agent until required. When the oil had been filtered and degassed the electrodes were placed in position in the test cell, which was then evacuated to a pressure of 10^{-2} mm. mercury before the oil was admitted and the pressure increased to atmospheric in readiness for the test. A series of impulses were applied, increasing in magnitude from a low value in steps of about 1 per cent of the expected breakdown voltage, until breakdown occurred.

The first few tests, for which stainless-steel electrodes were used, gave very erratic results. Further investigation showed, however, that the recorded breakdown strength was dependent upon the time for which the electrodes were stored in the desiccator between the final buffing and their being placed in the test cell. When this time was controlled consistent results were obtained which could be reproduced to within ±2 per cent, but which showed an increase in strength with increasing storage time. Thus tests using electrodes which had been placed directly into the test cell after buffing gave a strength of 1,100 kV./cm., whereas tests in which electrodes which had been kept in the desiccator for more than 5 hr. were used yielded breakdown strengths in excess of 2,000 kV./cm.

Further tests showed that this variation in strength was dependent only upon the treatment of the cathode, and also that the effect was not observed if the electrodes were washed in hexane or acetone after buffing. The same increase in strength was obtained when the drying agent was removed from the desiccator. Tests with aluminium electrodes showed a similar breakdown effect; but in this case the strength varied from 890 kV./cm. for tests with electrodes which had been placed directly into the test cell after buffing, to a constant value of 1,310 kV./cm., when the electrodes were stored in the desiccator for 15 min. or longer. Time lag measurements made during these tests showed that breakdown occurred on or just after the peak of the impulse voltage wave-form.

The only acceptable explanation of the results reviewed above is that oxidation of the freshly prepared surface occurred while the electrodes were stored in the desiccator. The increase in the breakdown strength over a period of several hours when stainless-steel electrodes were used is consistent with results for the oxidation of stainless steel at room temperature, and the steady results obtained with aluminium electrodes which had been left in the desiccator for more than 15 min. also reflect the stable conditions found on an aluminium surface after that time. In order to explain the growth of the natural oxide layer on a metal surface under these conditions Mott[1] has suggested that chemisorption of oxygen on the surface results in a strong field in the oxide, of the order of 10^7 volt/cm., and that this assists the reaction. This theory may be extended to show that under the conditions of the tests described above an electrical double layer exists on the surface of the cathode, the magnitude of which is proportional to the thickness of the oxide. This double layer would hinder the emission of electrons into the liquid and hence reduce the probability of breakdown.

I wish to acknowledge the receipt of a maintenance grant from the Department of Scientific and Industrial Research which enabled this work to be undertaken. It is intended to publish a more detailed account elsewhere.

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[1] Mott, N. F., *Trans. Farad. Soc.*, 43, 429 (1947).

Photochemical Conversion of Triethyl-tin to Diethyl-tin

DURING the development of a method for the determination of organo-tin compounds[1] it was found that exposure to light of the yellow triethyl-tin–dithizone complex in chloroform produced a rapid change to orange. Examination of the absorption spectra of these solutions has shown that the absorption maxima change from 440 mμ (triethyl-tin–dithizone complex) to 485 mμ (diethyl-tin–dithizone complex) if the complexes are formed in the presence of borate–versene buffer *p*H 8·75. Both the diethyl-tin–dithizone and the irradiated triethyl-tin–dithizone complex change to one with an absorption maximum at 510 mμ upon the addition of one drop 10 per cent alcoholic trichloroacetic acid. Also, triethyl-tin–dithizone, diethyl-tin–dithizone and the irradiated triethyl-tin–dithizone complexes all dissociate upon the addition of one drop of glacial acetic acid to give the spectrum of dithizone. It seems certain that the triethyl-tin–dithizone complex is converted by light to the diethyl-tin–dithizone complex. There is a slow formation of diethyl-tin upon storage on the laboratory bench of a triethyl-tin solution in chloroform, though under these conditions it would take months to effect the conversion obtained in 1 min. in sunlight in the presence of dithizone.

The method for organo-tin compounds[1] estimates only triethyl-tin and diethyl-tin and excludes tetraethyl-tin, monoethyl-tin and stannic ions. After formation of the complexes in the presence of borate–versene buffer *p*H 8·75, absorption at 510 mμ is a specific measure of diethyl-tin in the presence of triethyl-tin. After the formation and measurement of the complexes glacial acetic acid may be added, the complexes dissociated and the total concentration of dithizone measured by absorption at 610 mμ. Quantitative measurements using low concentrations of dithizone (0·00067 per cent) indicates that the irradiation of increasing amounts of triethyl-tin produces increasing amounts of diethyl-tin, and increasing amounts of dithizone are destroyed. Quantitative measurements of the diethyl-tin complex using higher concentrations of dithizone, such that the loss of dithizone does not influence the amount of complex formed for a given amount of diethyl-tin, show that 1 mol. diethyl-tin is produced from 1 mol. triethyl-tin (Table 1).

Table 1

Triethyl-tin irradiated (μm. moles)	Diethyl-tin formed (μm. moles)	$\frac{\text{Diethyl-tin}}{\text{Triethyl-tin}}$
15·8	18·6	1·18
31·6	33·3	1·05
47·3	48·6	1·03
63·0	65·5	1·04
78·8	78·5	1·00

0–20 μgm. triethyl-tin sulphate in borate–versene buffer, pH 8·75 (ref. 1), were mixed with 6 ml. 0·0033 per cent (w/v) dithizone in chloroform. After allowing the layers to separate, the tubes were exposed to sunlight for 10 min., remixed with the aqueous layer, which was then removed and the absorption of the chloroform layer at 510 mμ read against a dithizone control. After reading, the chloroform layers were mixed with 3 ml. of a dilute aqueous solution of 2.3 dimercaptopropanol (this complexes very firmly with diethyl-tin (ref. 2)) and the absorption read again at 510 mμ. This allows a small correction to be made for the loss of dithizone due to the reaction.

These results are consistent with a reaction of triethyl-tin with dithizone to give diethyl-tin and eliminate a possible disproportionation of 2 mol. triethyl-tin to produce 1 mol. tetraethyl-tin and 1 mol. diethyl-tin. All the trialkyl-tin–dithizone complexes so far examined (trimethyl up to trihexyl) are similarly photochemically decomposed. Although there is a very slow production of diethyl-tin from triethyl-tin in chloroform without dithizone, we have no evidence that a neutralized solution of triethyl-tin sulphate in water produces any diethyl-tin upon storage. The liquid tetraethyl-tin slowly liberates triethyl-tin upon storage under laboratory conditions either neat or as a solution in chloroform.

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Aldridge, W. N., and Cremer, J. E., *Analyst* (in the press).
Aldridge, W. N., and Cremer, J. E., *Biochem. J.*, **61**, 406 (1955).

A Method of promoting Water-forming Organic Reactions

THE great reactivity of the boric acid esters with water is well known; moreover, recently even the quilibrium constants of their hydrolysis have been measured[1]. So far as is known to us, hitherto the orates have not been used for promoting water-forming (condensation) reactions.

The basis of our investigations has been to add the esters of boric acid to reaction mixtures which form water during the reaction, in order to hift the equilibrium in the direction of the desired product.

Esterifications were studied first. In preparing the thyl and methyl esters of benzoic acid we observed a marked increase of the reaction velocity with high yields. Then we extended our method to the secondary esters, which are more difficult to prepare. In the presence of 0·11 mol. secondary butyl borate, 0·10 mol. benzoic acid and 0·11 mol. secondary butanol was refluxed for eight hours with 0·2 ml. sulphuric acid. Secondary butylbenzoate was isolated with an 2 per cent yield. In a similar manner, but in the absence of the borate, no ester was formed, the benzoic acid remaining unchanged.

It seemed interesting to prepare the benzyl esters of amino-acids by the same method. It is well known that these esters are important in peptide synthesis, and they are relatively difficult to prepare. In the presence of p-toluene-sulphonic acid[2], in carbon tetrachloride solvent at about 95° the corresponding amino-acid, benzyl alcohol and the benzyl borate were stirred for 4 hr. The p-toluenesulphonic acid salt of the amino-acid benzyl ester is crystallized by further addition of carbon tetrachloride, generally with an 80 per cent yield. Thus glycine, L-glutamic acid and threo-β-p-nitrophenylserine were esterified. Even in the case of glutamic acid the result was satisfactory.

The use of benzyl borates leads to almost quantitative yields in the case of peptides, for example, in the preparation of glycylglycine benzylester.

We have further used this method with another group of compounds in which we prepared acetals and ketals in the presence of borates. Benzaldehyde dimethyl acetal and diethyl acetal can be obtained with about 60 per cent yield. (Without adding the borates the yield is half this value.) The dimethyl ketal of cyclohexanone is prepared with a 65 per cent yield (without borate the yield is 30 per cent), and the diamyl ketal with a 40 per cent yield (without borate no ketal formed). The foregoing tests were carried out under reflux using 1 mol. of the carbonyl compound, 3 mol. alcohol and 1 mol. of borate with a small amount of hydrochloric acid.

This method may be considered useful for promoting other water-forming reactions. Details will be published elsewhere.

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[1] Bradley, J. A., and Cristopher, P. M., Abstracts of Papers 129th Meeting Amer. Chem. Soc., 39 *N* (1956).

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A Small Mercury Cut-off withstanding Large Pressure Differences

DURING the course of some work involving the handling of an easily adsorbed gas (ammonia) a number of taps and valves were tried and it was observed that all devices which incorporated greases, plastics or rubber were unsatisfactory owing to the large amount of gas adsorbed by these substances. It was a requirement that the valve for controlling the flow of gas should be vacuum-tight, withstanding a pressure difference between atmospheric pressure and 10^{-3} mm. mercury, have a minimal hold-up of gas and be small and suitable for attachment to a portable piece of apparatus.

The miniature mercury cut-off shown in Fig. 1 was designed and found to be satisfactory. It consists of a 1-cm. No. 4 porosity sintered glass disk *A* which could be immersed in mercury by screwing down on the pressure tubing *B* with a screw clip *C*. This action was made more effective by soldering on the lugs *D* to the cross bars of the clip, giving a larger area of contact on the rubber. It should be possible to raise the mercury by incorporating bellows or a syringe, but the method described was found to be satisfactory and easy of construction.

On filling the valve with mercury, care had to be taken to leave a sufficient gap between the mercury surface and the sinter, since under vacuum this surface rises owing to slight collapse of the pressure tubing.

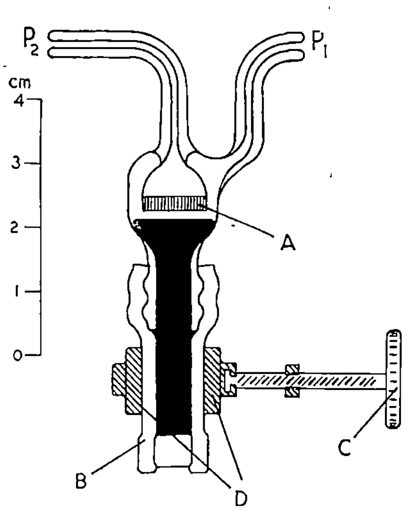

Fig. 1

If the pressure condition $P_1 \gg P_2$ was maintained, the valve was found to be vacuum-tight in the 'shut' position over a pressure difference of an atmosphere.

It was expected that very low pressures for P_2 would not be attainable, as with other sinter devices, but this is not always a necessity.

I thank Dr. V. Gold for much helpful discussion and Mr. H. Lee for help with the glass blowing.

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A Theory of Word-Frequency Distribution

The object of this communication is to show that a certain remarkably simple experimental relation governing word-frequencies in language can be explained by a simple model of the process of searching for information, about each word heard or read, in the memory of words employed in the language faculty.

The relation is as follows. If we suppose that $\varphi(\nu)$ is a distribution function giving the number of words in a given vocabulary occurring $T\nu$ times in a given text of T words,

$$\varphi(\nu) = a/\nu^2$$

where a is a constant, is found to be approximately true. This relation was pointed out by Zipf[1] and has been tested by one of us in the case of the Dewey word-count[2].

We now introduce the model which accords with this result, and proceed from the following hypotheses. The first three assumptions concern the process of searching in the memory for information about each word heard or read: (i) when searching for a word, the memory of words is scanned word by word, and only as much of the memory is scanned as is necessary to find the required word; (ii) in this process the words in the memory are scanned in order of decreasing frequency; (iii) the time required to scan a part of the memory of words is proportional to the number of words scanned. The fourth assumption concerns the language in question: (iv) a language will tend to evolve in such a way that the amount of information conveyed per unit of scanning time is a maximum.

It should be made clear that this scanning 'time' need not be physical time—it could be a monotonic increasing function of time: and we could have phrased the set of hypotheses in terms of 'room' occupied in the cortex by the memory of words, so that the average use of 'room' in scanning would be assumed to be minimized.

In order that assumption (iv) may be made strong enough to give a definite answer, we express it in the form that the frequency distribution of access-time is optimal over the whole of a finite range including the actual minimum. This makes the problem one of estimation which can be solved by an adaptation of the method of maximum likelihood. It is in fact reduced to the requirement that the condition, that the average access-time be a minimum, should provide an efficient estimate of the distribution function φ referred to above.

We assume that this function exists and has been correctly estimated, so that the expression for its likelihood will be

$$\lambda = \sum_{w}^{W} T\nu_w \log T\nu_w \qquad (1)$$

where the summation is over all the W words of the vocabulary. We now bring in two conditions: first, that the solution found be independent of the particular choice of vocabulary produced by a given text; this requires that not only the sum (1) but also each of its terms separately should be maximal; secondly, that the access-time for a word w be proportional to the number of words the frequencies of which are not less than ν_w, as follows from assumptions (i)–(iii) above; the access-time can therefore be expressed in the form

$$t_w = \int_{\nu_w}^{\nu_1} \varphi(\nu)\,.\,d\nu \qquad (2)$$

where ν_1 is the frequency in the text of the commonest word.

Now, the conditions postulated reduce to the requirement that the mean of (2) over the whole text and vocabulary be inversely proportional to the likelihood (1), for then the condition of minimum access-time becomes identical with that of maximum likelihood. The resulting equation is

$$\frac{\int_{\nu_w}^{\nu_1} \nu.\varphi(\nu) \int_{\nu_w}^{\nu_1} \varphi(\nu)\,d\nu d\nu}{\int_{\nu_w}^{\nu_1} \nu.\varphi(\nu)\,.\,d\nu} = \frac{c}{T\nu \log T\nu} \qquad (3)$$

One solution of this equation is the given empirica law $\varphi(\nu) = a/\nu^2$ This can be shown by substitution using as a principle of approximation that, except for the first few words, ν_w is small compared to ν_1.

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[1] Zipf, G. K., "The Psycho-biology of Language" (Boston, 1935).

[2] Dewey, G., "Relative Frequency of English Speech Sounds" (Cambridge, Mass., 1923).

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, December 10

British Society for the History of Science, Philosophy of cience Group (in the Joint Staff Common Room, University College, ower Street, London, W.C.1), at 5.30 p.m.—Mr. N. R. Hanson: Newton and the Logic of Discovery".

Institution of Electrical Engineers (at Savoy Place, London, .C.2), at 5.30 p.m.—Discussion on "Unsolved Problems Arising om Automation", opened by Mr. G. L. E. Metz.

Society of Engineers (at 17 Victoria Street, London, S.W.1), t 5.30 p.m.—Annual General Meeting

Manchester Literary and Philosophical Society (in the eynolds Hall, College of Technology, Manchester), at 5 45 p.m.—r. K. P. Oakley: "Dating Fossil Men" (Ramsden Memorial Lecture).

Society of Chemical Industry, Plastics and Polymer Group t 14 Belgrave Square, London, S.W.1), at 6.30 p.m.—Mr. C. Musave: "Some Problems in the Colouring of Plastics".

Tuesday, December 11

Zoological Society of London (at the Zoological Gardens egent's Park, London, N.W.1), at 5 p.m.—Scientific Papers.

Cement and Concrete Association (at the Institution of Civil ngineers, Great George Street, London, S.W.1), at 5.30 p.m.—r. R. A. Foulkes: "The Construction of a Soil-Cement Runway at hristchurch, Hants"; Mr. T. B. Hill and Mr. K. H. G. Williams: Soil Stabilized Pavements at Southend-on-Sea Municipal Airport"; r. F. R. Martin: "A Heavy-duty Airfield Pavement Embodying il Stabilization".

Institution of British Agricultural Engineers (at 6 Buckingam Gate, London, S.W.1), at 5.30 p m.—Mr. W. H. Cashmore and r. J. C. Hawkins: "Tillage Equipment and Soil Conservation".

Institution of the Rubber Industry, London Section (at the oyal Society of Tropical Medicine and Hygiene, 26 Portland Place, ndon, W 1), at 5.30 p.m.—Mr. M. G Peakman: "Statistical Quality ntrol—a Non-Mathematical Treatment". 7 p.m.—"Industrial ayon in Tyres and Belting" by Courtaulds Ltd.

Society of Chemical Industry, Chemical Engineering Group int meeting with the Oils and Fats Group, at 14 Belgrave Square, ndon, S.W 1), at 5.30 p.m.—Mr. M. K. Schwitzer and Mr. D. alcolm: "The Manufacture of Nitrogen Derivatives of Fatty Acids".

Institution of Mechanical Engineers, Automobile Division t 1 Birdcage Walk, Westminster, London, S.W.1), at 6 p.m.—Mr. E. Moulton and Mr. P. W. Turner: "Rubber Springs for Vehicle spension".

Royal Aeronautical Society (at 4 Hamilton Place, London, .1), at 7 p.m.—Prof. A. J. Murphy: "Materials for Aircraft Strucres Subjected to Kinetic Heating".

Tuesday, December 11—Wednesday, December 12

Society of Chemical Industry, Pesticides Group (in the ditorium, The Wellcome Building, Euston Road, London, N.W.1) Symposium on "The Comparison of High and Low Volume Spraying chniques on Fruit and Ground Crops".

Wednesday, December 12

University of London (at the Postgraduate Medical School of ndon, Ducane Road, London, W.12), at 2 p.m.—Dr. R I. S. Bayliss: aboratory Investigations in Endocrinology".*

Royal Society of Arts (at John Adam Street, Adelphi, London, .C.2), at 2 30 p m.—Mrs. M. Wheatcroft and Miss Joan E. Walley: cience in Kitchen Planning" (two papers).

Physical Society, Colour Group (in the Small Physics Theatre, perial College, Imperial Institute Road, London, S.W.7), at 0 p.m.—Symposium on "Colorimetry—Its Errors and Accuracy", roduced by Prof W D. Wright, Miss D. L. Tilleard, Mr. P. S. lliams, and Mr. J. W. Perry.

Geological Society of London (at Burlington House, Piccadilly, ndon, W.1), at 5 p m.—Mr. A. M. Quennell: "The Dead Sea Rift"; of. C. E. Tilley, F.R.S . "The Melting Relations of Basalt".

Eugenics Society (at the Royal Society, Burlington House, cadilly, London, W.1), at 5.30 p m.—Mr. J. W. B. Douglas: ffects of Maternal Employment on the Health and Development of ung Children".*

Institution of Electrical Engineers, Radio and Telecomnication Section (at Savoy Place, London, W.C.2), at 5.30 p.m.—. E. W. Hayes and Mr. H. Page: "The B.B.C. Sound Broadcasting vice on Very-High-Frequencies".

British Psychological Society, Industrial Section (in the partment of Psychology, Birkbeck College, Malet Street, London, C.1), at 6 p m.—Mr. M. E. M. Herford, Miss M. W. Le Mare and . Clive Williams: "The Young Worker in Industry".

ement and Concrete Association (joint meeting with the titution of Structural Engineers, at 11 Upper Belgrave eet, London, S.W.1), at 6 p.m.—Dr. L. J Murdock, Mr. W. J. ckwith, Mr. D. D. Matthews and Mr. K. M. Wood: "Concrete nstruction in the Soviet Union".

Society of Chemical Industry, Nutrition Panel of the Food Group (at the Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 6.15 p.m.—Prof. A. Neuberger, F.R.S.: "Some General Aspects of Protein Metabolism in Mammals".

British Institution of Radio Engineers (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6.30 p.m.—Dr. T. B. Tomlinson: "The Light Amplifier and Allied Devices"

Society of Chemical Industry, Corrosion Group (at 14 Belgrave Square, London, S.W.1), at 6.30 p.m.—Dr. H. R. Ambler: "Corrosion in the Tropics".

Institution of Mechanical Engineers, Steam Group (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6 45 p.m.—Discussion on "The Draft Code of Practice for Steam Turbine Installations".

Society of Instrument Technology, Control Section (at Manson House, Portland Place, London, W 1), at 7 p.m.—Dr. G. D. S. MacLellan: "Phase-plane Methods in Control System Design".

Thursday, December 13

Society of Chemical Industry, Microbiology and Chemical Engineering Groups (at 14 Belgrave Square, London, S.W.1), at 2.15 p.m.—Dr. S. Buchan, Prof. J. K. Baars and Dr. A. Key: "The Replenishment of Underground Water Supplies—Geological and Microbiological Considerations".

London Mathematical Society (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. A. Oppenheim: "Representations of Numbers by Various Algorithms".

Institution of Civil Engineers (at Great George Street, Westminster, London, S.W.1), at 5.30 p m.—Mr. R. M. Finch: "The Use of Waste Materials". (Last of a series of six lectures on "The Conservation of Natural Resources".)

Institution of Electrical Engineers, Education Discussion Circle (at Savoy Place, London, W.C.2), at 6 p.m.—Discussion on "The Teaching of the Fundamentals of Transistor Circuits to Students of Electrical Engineering", opened by Mr. P. Godfrey.

Chemical Society (in the Lecture Theatre, Royal Institution, Albemarle Street, London, W.1), at 7.30 p m.—Prof. G. Gee, F.R.S.: "Physical Properties of High Polymers in Relation to their Chemical Structures" (Tilden Lecture).

Royal Society of Tropical Medicine and Hygiene (at Manson House, 26 Portland Place, London, W.1), at 7.30 p m.—Dr. J. R. Busvine: "Insecticide-resistant Strains of Insects of Public Health Importance".

Friday, December 14

Institution of Mechanical Engineers (at 1 Birdcage Walk, Westminster, London, S.W 1), at 6 p m.—Captain G. T. Smith-Clarke: "Mechanical Breathing Machines" (James Clayton Lecture).

Prestressed Concrete Development Group (in the Lecture Theatre of the Institution of Civil Engineers, 5 Great George Street, London, S.W.1), at 6 p.m.—Prof. D. Vandepitte: "Recent Prestressed Concrete Construction in Belgium".

University of London (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6.30 p.m.—Prof. A. R. Ubbelohde, F.R.S.: "Users of Power".* (Last of ten University Extension Lectures on "Technology and Industry".)

Friday, December 14—Saturday, December 15

Committee of Vice-Chancellors and Principals of the Universities of the United Kingdom (in the William Beveridge Hall, University of London Senate House, London, W.C 1)—Conference of the Universities of Great Britain and Northern Ireland.

Saturday, December 15

Biochemical Society (in the Department of Biochemistry, St. Mary's Hospital Medical School, London, W.2), at 10.45 a.m.—Scientific Papers.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Physics Graduate in the Department of Radiotherapy, for duties which include physical investigations concerned with the clinical use of rotation therapy, multicurie cobalt units, low voltage X-rays and radioactive isotopes, and also some teaching of radiographer students—The Assistant Administrator, The Churchill Hospital, Headington, Oxford (December 15)

Physical, Analytical and Assistant Chemists at the Central Electricity Authorities' Research Laboratories, Leatherhead, Surrey, for work on problems arising from the generation of electricity in conventional and nuclear power stations—The Director of Establishments, Central Electricity Authority, Winsley Street, London, W.1, quoting Ref. N/930 (December 19).

Lecturer (Grade I), and an Assistant Lecturer, in Pure or Applied Mathematics at the University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (December 21).

Lecturer in Agriculture (Animal Husbandry) at the University College of Rhodesia and Nyasaland—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (December 21).

Lecturer (with an honours degree or a higher degree in physics, and preferably teaching or research experience) in Applied Physics, at the New South Wales University of Technology, Sydney, Australia —The Agent General for New South Wales, 56 Strand, London, W.C.2 (Australia, December 27).

Professor (preferably experienced university teacher) of Geography at the University of Ceylon—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (December 28).

Postgraduate Scholar (graduate in veterinary science, science or agriculture) in Veterinary Science—The Registrar, The University, Liverpool (December 29).

Scientific Officer (Chemist) (with a first- or second-class honours degree in chemistry or equivalent, and preferably with experience in mineral analysis, spectrographic analysis, or modern physical methods of inorganic analysis) in the Colonial Office, Mineral Resources Division, London, S.W.7, for analytical and investigational work on minerals and mineral products—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.622/6A (December 29).

J. H. Andrew Research Fellow in Metallurgy; United Steel Companies' Research Fellow in Metallurgy; and Tube Investments Research Fellow in Metallurgy—The Registrar, The University, Sheffield (December 31).

Lecturer (with some teaching experience or experience as a research worker in pest control of plants) in Entomology; and a Lecturer (with a good degree and some experience in plant pathology, either as a teacher or research worker) in Plant Pathology, in the Department of Agriculture, Kumasi College of Technology, Gold Coast—The Secretary, Advisory Committee on Colonial Colleges, 1 Woburn Square, London, W.C.1 (December 31).

Lecturer or Assistant Lecturer in Mathematical Statistics—The Registrar, The University, Manchester (January 1).

Lecturer in Organic Chemistry; and a Lecturer in Physical Chemistry—The Principal, Royal Holloway College (University of London), Englefield Green, Surrey (January 5).

Research Fellow or Senior Research Fellow in Dairy Science to carry out fundamental research on the problem of depressed butter fat percentage in cattle on certain diets—The Registrar, University of New England, Armidale, N.S.W., Australia (January 7).

Research Fellow or Senior Research Fellow in Poultry Science in the Faculty of Rural Science—The Registrar, University of New England, Armidale, New South Wales, Australia (January 7).

John Elder Chair of Naval Architecture—The Secretary of University Court, The University, Glasgow (January 11).

Drummond Fellows for Research in Nutrition—The Honorary Secretary, Drummond Trust, University College, Gower Street, London, W.C.1 (January 31).

Lecturer in Biochemistry at the University of Malaya, Singapore —The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (January 31).

Lecturer (preferably with qualifications or experience in structural geology, stratigraphy, or quaternary geology) in the Department of Mineralogy and Geology, University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, January 31).

Reader or Senior Lecturer in Statistics, at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, January 31).

Robert Blair Fellow (British subject and at least 21 years of age) in Applied Science and Technology, for one year of advanced study or research abroad—The Education Officer (EO/WA.14), The County Hall, London, S.E.1 (February 28).

Assistant Conservators (with a university degree in forestry) of Forests, Sierra Leone—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.61/15/04.

Hydraulic Engineers (B.Sc. (Eng.), and preferably subsequent experience in hydraulics) in the Department of Mines and Natural Resources—Water Resources Branch, Province of Manitoba, Canada —The Agent General, Province of Manitoba, 8 Spring Gardens, London, S.W.1.

Laboratory Technician (A.I.M.L.T. or equivalent)—The North London Blood Transfusion Centre, Deansbrook Road, Edgware.

Lecturer in the Department of Aircraft Electrical Engineering—The Recorder, College of Aeronautics, Cranfield, Bletchley, Bucks, quoting Ref. EP/L.

Lecturer (man or woman, with a horticulture qualification and preferably teaching experience) for Rural Science, at the Cheshire County Training College, Alsager—The Director of Education, County Education Offices, City Road, Chester.

Research Student (graduate in physics, engineering or aeronautics) to study the supersonic flow of gas through nozzles—R. P. Fraser, O.B.E., Chemical Engineering Department, Imperial College of Science and Technology, London, S.W.7.

Senior Mechanical Engineer (with an honours degree in mechanical engineering and have held a position of responsibility in engineering research or design) at the Central Electricity Research Laboratories, Leatherhead, Surrey, to take charge of the Mechanical Engineering Section responsible for investigating mechanical performance of materials and components, including static and dynamic stress analysis, vibration analysis, and the effect of fly-ash on the strength of concrete—The Director of Establishments, Central Electricity Authority, Winsley Street, London, W.1, quoting Ref. AE.902.

Senior Technician in the Zoology Department—The Secretary, Royal Holloway College, Englefield Green, Surrey.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Nuffield Foundation. Report for the year ended 31 March 1956. Pp. 160. (London: Nuffield Foundation, 1956.) [249

Empire Cotton Growing Corporation. Progress Reports from Experiment Stations, Season 1954–55. Tanganyika Territory, East Province. By R. Smith. Pp. 14. 9*d*. Survey of Reports By Sir Joseph Hutchinson. Pp. 12. 9*d*. (London: Empire Cotton Growing Corporation, 1956.) [249

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 962, Vol. 249 (20 September 1956): Some Ergodic Theorems for One-Parameter Semigroups of Operators. By D. G. Kendall and G. E. H. Reuter. Pp. 151–177. 8*s*. 6*d*. Series B: Biological Sciences. No. 670, Vol. 240 (20 September 1956): Tooth Replacement in Mammal-Like Reptiles of the Suborders Gorgonopsia and Therocephalia. By K. A. Kermack. Pp. 95–133. 17*s*. 6*d*. (London: Royal Society, 1956.) [249

Federation of British Industries. Industry and the Technical Colleges: a Review of Some Current Problems (F. B. I. Handbook.) Pp. iii+44. (London: Federation of British Industries, 1956.) 3*s*. [249

West of Scotland Agricultural College. Research Bulletin No. 15 Two-Year Leys for Silage. By I. V. Hunt and A. L. Gardner. Pp. 32. (Glasgow: West of Scotland Agricultural College, 1956.) [249

Report on Some Cyprus Soils. By D. A. Osmond. Pp. 81. (London: Colonial Office, 1954.) [249

British Iron and Steel Research Association. *Survey*, 1956 issue Pp. 16. (London: British Iron and Steel Research Association 1956.) [24

Other Countries

United States Department of the Interior: Geological Survey Bulletin 1021–I: Geology of Devils Tower National Monument Wyoming. By Charles S. Robinson. Pp. iii+289–302+plate 30 50 cents. Bulletin 1027–B: Geology of the Crazy Woman Creek Area Johnson County, Wyoming. By Richard K. Hose. Pp. vi+33–118+ plates 7–13. 1.75 dollars. Bulletin 1027–H: Geology of the Christia Copper Mine, Gila County, Arizona. By Nels P. Peterson and Roge W. Swanson. Pp. iii+351–374+plates 33–43. n.p. Bulletin 1028–A Geology of Pavlof Volcano and Vicinity, Alaska. By George C. Kennedy and Howard H. Waldron. Pp. v+20+plates 1–4. 65 cents Bulletin 1033–D: Geophysical Abstracts 163, October-December 1955. By Mary C. Rabbitt, Dorothy B. Vitaliano, S. T. Vesselowsk and others. Pp. iii+211–340. 25 cents. Bulletin 1039-A: Mar Deposits in the Knik Arm Area, Alaska. By R. M. Moxham an R. A. Eckhart. Pp. iii+24+2 plates. 50 cents. Bulletin 1039–B Occurrence of Diatomaceous Earth near Kenai, Alaska. By Georg Plafker. Pp. iii+25–32+plates 3–6. 75 cents. Bulletin 1048-A Geophysical Abstracts 164, January–March, 1956. By Mary C Rabbitt, Dorothy B. Vitaliano, S. T. Vesselowsky and others. P iii+92. 25 cents. Professional Paper 274-H: Palmlike Plants fro the Dolores Formation (Triassic) in Southwestern Colorado. B Roland W. Brown. Pp. iii+205–210+plates 32 and 33. n.p. Professional Paper 276: The Stratigraphic Section in the Vicinity Eureka, Nevada. By T. B. Nolan, C. W. Merriam and J. S. William Pp. iii+78+plates 1 and 2. 1 dollar. Professional Paper 277 Stratigraphy of the Mascot-Jefferson City Zinc District, Tennesse By Josiah Bridge. Pp. iv+76+2 plates. n.p. Professional Pap 278: Geology and Ore Deposits of the Baghdad Area, Yavapai Count Arizona. By C. A. Anderson, E. A. Scholz, and J. D. Strobell, J Pp. iv+103+6 plates. n.p. Professional Paper 279: Cenozo Geology of the Colorado Plateau. By Charles B. Hunt. Pp. iv+10 75 cents. (Washington, D.C.: Government Printing Office, 1956.) [24

Carnegie Institution of Washington. Annual Report of the Direct of the Department of Terrestrial Magnetism, 1954–1955. Pp. 5 (Washington, D.C.: Carnegie Institution of Washington, 1955.) [24

Centro Studi di Petrografia e Geologia del Consiglio Nazionale del Ricerche, Presso l'Università di Padova. Contributions to the Know ledge of the Flora of the Grey Limestones of Veneto: Part 1—Revision of the *Flora Fossilis Formationis Oolithicae* of 'De Zign By Alan Wesley. (Memorie degli Istituti di Geologia e Mineralog dell'Università di Padova, Volume 19.) Pp. 68+6 plates. (Padova Istituti di Geologia e Mineralogia dell'Università di Padova, 1956.) [2

Bulletin of the Museum of Comparative Zoology at Harvard Colleg Vol. 115, No. 1: Notes on American Earthworms of the Fami Lumbricidae, 3–7. By G. E. Gates. Pp. ii+46. Vol. 115, No. A Quantitative Study of the Equidae of the Thomas Farm Miocen By Robert S. Bader. Pp. 47–78. Vol. 115, No. 3: *Aneuretis Simo* Emery, a Major Link in Ant Evolution. By E. O. Wilson, T. Eisn G. C. Wheeler and J. Wheeler. Pp. 79–100+3 plates. (Cambrid Mass.: Museum of Comparative Zoology at Harvard Colle 1956.) [2

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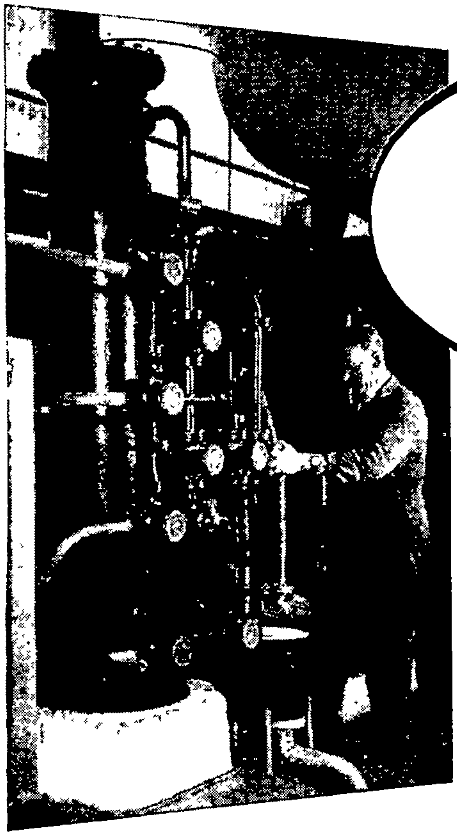

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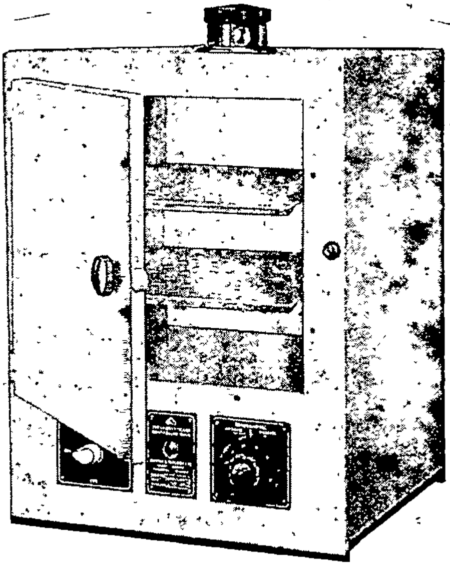

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These courses will last for one academic year; the fee is £81. A limited number of maintenance awards with remission of fees will be available in connection with each course. Applications for admission to the courses starting in October, 1957, and requests for further information, should be made as soon as possible to the Registrar, the University, Edgbaston, Birmingham, 15.

Graduates wishing to be considered for the Advanced Course Studentships of the Department of Scientific and Industrial Research must apply to the Registrar before February 1, 1957.

OFFICIAL APPOINTMENTS

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Applications are invited for a Lectureship in Electrical Engineering. Salary £650 by £50 to £1,350 per annum. Commencing salary will be at a point on the scale according to age, qualifications and experience. Membership of the F.S.S.U. and children's allowance scheme.

Further particulars may be obtained from the Registrar, University College, Singleton Park, Swansea, to whom applications (six copies), must be sent by December 15, 1956.

UNIVERSITY OF MANCHESTER

Applications are invited for the post of Lecturer or Assistant Lecturer in Mathematical Statistics. The successful candidate will be expected to assist in advisory and research work in addition to his teaching duties. Salary scales per annum: Lecturer, £650 to £1,350: Assistant Lecturer, £550 to £650; initial salary and status according to qualifications and experience. Membership of F.S.S.U. and children's allowance scheme.

Applications should be sent not later than January 1, 1957, to the Registrar, the University, Manchester, 13, from whom further particulars and forms of application may be obtained.

LONDON COUNTY COUNCIL

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Applications are invited for the award of the Robert Blair Fellowship tenable for one year of advanced study or research abroad in applied science and technology. The value of the award is subject to variation, and, if the country selected should be Canada or the U.S.A., may be up to £2,000 (subject to income tax). Candidates must be British subjects and at least 21 years of age.

Further particulars and forms of application may be obtained from the Education Officer (EO/WA.14), The County Hall, S.E.1 (stamped addressed foolscap envelope necessary), for return by February 28, 1957. (2270)

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Particulars and application forms may be obtained from the Director of Education, Education Office, Chapel Street, Salford, to whom completed forms should be returned not later than December 12, 1956.

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Salford, 3, Lancs.

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Applications, giving full details and names of two referees, should reach the Assistant Administrator within two weeks of this advertisement.

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according to qualifications and experience.

Candidates for Grades 1 to 4 should have an honours degree, A.R.I.C. or equivalent, with experience commensurate with grade. For Grade 5, H.N.C. in chemistry or equivalent experience desirable, but not essential.

Applications, stating age, qualifications, experience, present position and salary, to D. Moffat, Director of Establishments, Winsley Street, London. W.1, by December 19, 1956. Quote ref. N/930.

RUBBER RESEARCH INSTITU OF MALAYA

KUALA LUMPUR, FEDERATION OF MALAYA

The Board of the Rubber Research Institut
Malaya invites applications for the post of
of the Statistics Section of the Institute at K
Lumpur. Applicants should have high acad
qualifications and considerable statistical ex
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laboratory experiments and conduct of rese
in statistical matters relating to all branche
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officers £448 to £672. Salary and allowances
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Application forms and more detailed info
tion may be obtained from the Secretary, Lo
Advisory Committee for Rubber Research (Ce
and Malaya), Imperial Institute, London, S.
to whom completed applications should be
by January 1, 1957.

UNIVERSITY OF ST. ANDREV

The University Court of the University o
Andrews invites applications for either an A
antship in Physiology, or an appointment as T
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Physiology and Biochemistry, St. Salvator's
lege, St. Andrews. The Assistantship will b
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not medically qualified and under 26 years of
£550 by £25 to £600; over 26 years of age,
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the names of three referees should be lodged
the undersigned not later than December 21,
The appointment as Tutor, for which a me
qualification is essential, will be for one year
at a salary of £400. The primary duties w
to assist in the teaching of Human Physiology
Biochemistry to medical students, and the
offers facilities for study for a higher qualific
in medicine or surgery. This appointment
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Further particulars can be obtained from
Professor of Physiology, Bute Medical Build
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Further particulars may be obtained fro
undersigned, with whom applications, givin
particulars, together with the names of
referees, should be lodged not later than D
ber 31, 1956.

CHARLES H. STEWA
Secretary to the Univ

NATURE

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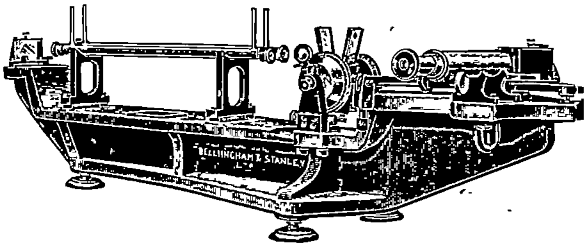

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LIBERAL EDUCATION IN TECHNICAL COLLEGES

THAT formal education in Great Britain must contain more science is now recognized as being necessary and inevitable by nearly all concerned with education. With the recognition goes the quite natural fear that in the process we shall lose some of those virtues which stem from studies based on the humanities. This has recently led to much discussion about ways in which science-based education can be liberalized, culminating in 1955 in the publication of a report prepared as a result of a nation-wide survey by the National Institute of Adult Education*.

The report attracted widespread attention and, in Yorkshire, it was decided to appoint a small working party composed of prominent industrialists and educationists who might give their views on the fundamental issues involved. These views have now been published as a pamphlet which deserves to reach a much wider audience than those members of the Yorkshire Council for Further Education for whom it was mainly intended†. Its true value is that those responsible for it are prominent in their respective fields, and yet came together not as strangers but fully aware of the difficulties confronting their colleagues in industry or education.

From the outset it was agreed that industry urgently needs men whose education is not narrowly restricted to technical matters and that the education given in technical colleges and at universities needs to be made broader and more liberal. While this view was unanimous, the report quickly and rightly describes the strong reaction among technical teachers at both colleges and universities against the tendency of many speakers and writers (usually persons trained in the humanities) to assert or assume that the technologist *ipso facto* is a philistine, who needs an injection of the humanities. The report goes further, and emphasizes that scientific education is a necessary part of cultural education.

Among a number of valuable points made in a section dealing with the teaching of science and technology in colleges is that the introduction of 'arts' subjects into curricula of science and technology is not fundamental to a liberal education. What is required is a broadening of the treatment and presentation of scientific and technological subjects. This ought to be adapted to the age and interests of the students. The approach may be through the history of the craft, a study of the structure of the industry, the philosophy of the subject, human relations in industry, or talks and discussions on industrial design. This approach to the teaching of science and technology could be greatly helped and stimulated by occasional talks by eminent personalities from science, technology and industry, capable of inspiring interest and promoting a further pursuit of this interest by the students themselves.

Ideally, all teachers of technical subjects should have an interest in the historical and philosophical aspects of their subject. Homework should be devised to develop the student's powers of expression, and if English or social history or current affairs is taught separately by a specialist, there should be the closest collaboration between this teacher and the technical specialist. To encourage a wide approach, it is recommended that in as many courses as possible 'liberal' reading should be included each session. To make this realistic, questions based on this 'liberal' reading should be set in college examinations.

Short residential courses for technical students, similar to those which have been held for management students, foremen and local government officers, but not necessarily confined to students in one subject, and dealing with the history and philosophy of science and other suitable topics, could also play an important part in developing the width of view commonly regarded as 'liberal'; this is already common practice in some parts of Britain. Many firms, for example, make considerable use of the general educational courses arranged in residential colleges as a means of 'broadening' their young employees.

It is easy to exaggerate the alleged narrowness of educational provision in British technical colleges. But there are many teachers with a width of outlook who teach their subjects supremely well, of colleges with vigorous music and drama departments, and student activities which compare favourably with those at some universities. Many full-time teachers and most part-time teachers have had no pedagogic training, but nearly all of them have earned, or at present earn, their livings in some job other than teaching, and bring their wide experience to enliven and improve their teaching.

Nevertheless, most teachers in further education are well aware that the techniques of teaching an ever-expanding and changing body of scientific and technical knowledge can always benefit from further study and discussion; it is encouraging that the Yorkshire Council for Further Education is shortly to organize a residential course for heads of departments which will be devoted to discussion of how technical subjects can be taught in a liberal manner. The place in all technical courses of the history and philosophy of science will also be dealt with.

The report recommends that more should be done to encourage travel by students, by making awards tenable at foreign institutions, and that international exchanges of technical teachers should be greatly extended. Much could be done by local education authorities by encouraging teachers to visit other institutions to study teaching methods and organization.

---

* Liberal Education in a Technical Age (Max Parrish).

† The Liberal Aspect of Technical Education. (Yorkshire Council for Further Education.) 2*s*. 6*d*.

The increasing domination of technical college syllabuses by examining and professional bodies is emphasized in the report. Fortunately, their officers often advocate more breadth and liberality of treatment. Extensions of scientific knowledge and new industrial processes, however, and the desire that nationally recognized qualification in one industry shall be as acceptable as that in other industries largely determine the views of industrial members of advisory and examining committees, and undoubtedly exert a narrowing influence. In what ways can this situation be remedied ?

First, the examining and professional bodies themselves could embark upon a bold campaign of re-orientation of syllabuses and review their examination techniques. The City and Guilds of London Institute affords examples of what is already being done. These, if not yet extensive in achievement, point the way.

If some element of history, philosophy, art, economics or human relations is to be included in technical syllabuses, examination papers should include a section on this aspect of the course. If colleges are to be persuaded to make bold experiments in the teaching of science and technology, if attempts are to be made to encourage wider interests, better English, and an appreciation of human affairs and of moral and æsthetic values, these efforts must be encouraged by professional examining committees by treating them as integral to the whole scheme and included in the examination as such.

A considerable section of industry is well aware that many of its problems are human rather than technical, and would welcome the introduction of a broader approach to the teaching of science and technology.

On what lines could industry help to stimulate such a development ? On many advisory committees of examining bodies, attempts to broaden syllabuses and examinations are not greeted with enthusiasm by some industrial representatives. Industrial organizations should see to it that their representatives on local, regional and national advisory committees, and the examiners whose names they put forward, are sympathetic to a really bold and fundamental attack on this problem. In many cases they might consider nominating persons who are near to the personal problems of the industry rather than purely technical officers.

A more immediate and practical step is to help in providing students for 'sandwich' courses and in granting day release where this is not already done. Firms, too, should be encouraged to send their young employees overseas to extend their experience ; this is probably being done to a much greater extent than the committee realizes. The iron and steel industry, for example, has for many years sent large numbers of its younger technical men to steelworks in other countries simply to give them wider experience.

Local education authorities play a large part in the liberalization of technical studies. The part could be much bigger. How many technical colleges, for example, have libraries worthy of the name ? Recent reports on this subject form depressing reading. How many colleges have adequate common rooms for students and staff ? Refectories and facilities for social events are also essential. College surveys suggest that only a small percentage of students participate actively in games and athletics. In planning the new technical education it is important that some provision should be made for physical recreation. Part-time students should take an increasing part in the social and athletic activities of their colleges.

The report stresses the importance of hostel accommodation at colleges with full-time students. A growing number of authorities have already provided hostels and from an economic point of view they may be necessary to ensure that full-time and 'sandwich' courses are filled.

Finally, the report insists that appointing committees, principals and heads of departments should ensure that candidates for posts are made aware that a liberal approach to teaching is expected and will be encouraged ; and that newly appointed teachers are encouraged, and if necessary urged, to take advantage of facilities for adapting their techniques to the needs of an ever-changing world.

The most important duty of the local education authority is the training of teachers, both part-time and full-time. If a new approach, new techniques and a new philosophy of technical education are needed, it is to the training of the right kind of teachers that most attention must be paid.

FERTILIZATION IN ORGANISMS

Fertilization

By Lord Rothschild. Pp. ix+170+5 plates. (London: Methuen and Co., Ltd.; New York: John Wiley and Sons, Inc., 1956.) 18*s*. net.

FERTILIZATION, by which is meant the spermatozoal activation of an ovum, with the subsequent fusion of the male and female pronuclei, has always been one of the most enthralling topics of biological study. Lord Rothschild's monograph takes the subject up to the formation of the zygote, but focuses mainly on the changes which take place during the phase of activation. The opening chapter deals with the visible changes of fertilization in various plant and animal forms. The next three are concerned with the fact that the spermatozoa and eggs of many animals and plants incorporate substances, sometimes called gamones, which have specific effects on the gametes of the opposite sex. Among the many topics dealt with in this section of the book are the reciprocal induction of spawning (for example, the spawning of a male sea-urchin may incite every other male urchin in a tank to start shedding its spermatozoa) ; the possibility that water in which the eggs of certain species are maintained may, in certain circumstances, stimulate increased metabolic activity in spermatozoa ; the immunological and chemical nature of different gamones ; and also the principles underlying the chemotaxis of spermatozoa towards the eggs, a process which occurs in certain species of plant, such s ferns, and in which chemical substances that diffuse rom the eggs into the surrounding medium exert an ttraction on spermatozoa. The fascinating idea merges that sperms which are subject to chemotaxis ossess "sense organs not fundamentally different rom those which cause a moth to fly towards a light".

The two chapters that follow deal with the meta-olism of eggs, particularly with the sources of energy vhich permit of the various changes that take place uring fertilization. Here the discussion is focused n the eggs of the sea-urchin and oyster, in which here are both anaerobic and oxidative pathways by vhich carbohydrate is broken down. A variety of etabolic changes of a different kind are listed and ummarized in the following chapter, which precedes n account of other changes that occur in the egg at ertilization, including changes in the birefringence nd tension of the cortical zone. The processes which hibit polyspermy are dealt with in a chapter on heir own, Lord Rothschild holding, as a tentative ypothesis, that "at the moment of attachment of he fertilizing spermatozoon to the egg surface, a hange in cortical structure passes over the egg" vhich "reduces the chance of refertilization by a actor of twenty and catalyses the production of a perm-impermeable layer at the egg surface". This mpermeable layer is established in about sixty econds, and its integrity depends, *inter alia*, on the xistence of divalent cations in the external medium. he subject of polyspermy is followed by a short hapter which summarizes certain bio-electrical bservations that have been made on the egg at rtilization, but which so far have revealed little of nportance, except that there is an increase in nembrane capacitance when sea-urchin eggs are rtilized. Lord Rothschild tells us that there is othing new to say about the specificity of fertiliza-ion, and he concludes his book with a final chapter hat lists fifteen subjects which, in his view, would epay further investigation.

There is a general index of subjects discussed, as ell as an extensive references and author index. articular attention is paid throughout to the orrect systematic designation of the plants and nimals that are referred to, and a separate index rovides synonyms and vernacular names for the ifferent species. The general biologist might have een further helped if the author had also included summary indicating which plant and animal types ad yielded what kind of information about the echanisms of fertilization. A great deal of our resent knowledge is apparently derived from work on chinoderm eggs, and it would have been helpful to now how well or widely based are the more important eneralizations that relate to the subject.

The book is concise, but is so well constructed that is always lively and readable. It is also scholarly nd critical, and the author, who is a distinguished orker in the field, does not disguise the fact that on ertain subjects his opinions are not shared by other nvestigators—although the arguments are marshalled such a way that it is difficult for the non-specialist doubt any of the conclusions that are stated. This partly because the author's approach to his subject-atter is admirably clear-cut, and because the eader is not allowed to forget that what is discussed lates to carefully formulated questions. "The most e can do," writes Lord Rothschild, "and all we need do, in describing some biological problem, is ltimately) to make a time-sequential analysis of the henomenon in the language of physical chemistry." This view may define the field of biology more rigidly than some biologists would like, but there can be no question that, having defined it in this way, Lord Rothschild pursues his theme with the strictest regard for scientific discipline—by asking real questions; by stating real answers when they have been found; and by acknowledging, where necessary, difficulties and ignorance. He provides no addition to the many theories of fertilization that have been advanced by other workers. But he goes one better by ending his story with a clear statement of the more important issues that call for elucidation before a new general hypothesis need be formulated.

S. ZUCKERMAN

AUTOMATIC DIGITAL COMPUTERS

Automatic Digital Calculators

By Dr. Andrew D. Booth and Dr. Kathleen H. V. Booth. Second revised edition. Pp. ix+261. (London: Butterworths Scientific Publications; New York: Academic Press, Inc., 1956.) 32*s*.

Automatic Digital Computers

By Dr. M. V. Wilkes. Pp. x+305+9 plates. (London: Methuen and Co., Ltd., 1956.) 42*s*. net.

It is only natural that the above two books should cover to some extent the same ground. The first of them has clearly proved its worth by having exhausted its first edition in some two and a half years, a fact which shows without further comment that a need existed for such a book, and that it met that need. As for its main contents, they have been sufficiently described and criticized by the present reviewer in *Nature* (175, 484; 1955), and there seems to be no necessity to alter or amplify what is said there. But in fact the book has been increased by a fair amount of new material, notably the description of the transistor and what it does, in the middle chapters (9, 10 and 11), and of automatic programming procedures as lately introduced, this forming a supplement to Chapter 16. There is also a description of ferro-electric matrix storage. Some idea of the amount of work published on automatic digital computers in the past three years or so is given by the more than doubled bibliography, which now extends from p. 235 to p. 244. The book, as before, can be recommended as clear and painstaking.

The second book is by the well-known director of the Cambridge University Mathematical Laboratory, and, though he gives generous and extensive acknowledgment to others, bears on every page the impress of his own hand. It begins, as it almost necessarily must, with the historical summary—Babbage, Georg and Edvard Scheutz, and so on—and moves quite quickly and naturally from this to the *ENIAC* and *EDVAC* computers. In the most thorough manner we then have the principles of logical design, leading to the principles of programme construction, by which time we are well under way. Chapters on relay computers, storage, electronic switching and computing circuits follow, concerning which it can only be said that the reader is led on in the most natural manner, and with excellent plates and tabular illustrations.

Much the most interesting chapters to the present reviewer are Chapter 7, on the design and operation of digital computers, and the five-page appendix, "Machinery and Intelligence", which is to be thought of as a short chapter. It would seem that Chapter 7, with all that it says about organization, staffing, business purposes and industrial processes, is likely to be the one of most general value in the whole book.

As for the appendix, with a certain relief the present reviewer discovers the last clause of the final sentence to be: "but I do not see them [namely, the machines] behaving like human beings". Neither do I; if ever I see a machine looking in at the door at me, and complaining at having been unsuitably programmed, I shall take suitable consultation, not about it, but about myself.

A. C. Aitken

PLANT EVOLUTION

Features of Evolution in the Flowering Plants

By Prof. Ronald Good. Pp. xv+405. (London: Longmans, Green and Co., Ltd., 1956.) 30*s*. net.

The evolution of the flowering plants is probably as great a mystery as it was a century ago, and it deserves much more critical consideration than it has hitherto received. The study of the problem now presented by Prof. Ronald Good should interest both botanists and a wider public. Those who study plants from any aspect, taxonomic, structural or physiological, can scarcely remain indifferent to the problems of the origin and evolutionary development of the plants which form the major part of the surface vegetation of the world to-day, and of which some 250,000 distinct species are recognizable. At the same time, these problems affect a wider range of studies, since the flowering plants form the ultimate source of nutrition of almost all the terrestrial animals.

At present we have very little, if any, idea as to how these forms have evolved, and Prof. Good does not attempt to present theories or speculations on how they have come to be as we see them to-day. Instead he gives a view of the group "primarily as an achievement of those processes which are called evolution". He briefly surveys the vast number of living types, indicating the general relationships between the principal groups recognized by taxonomists from a study of their floral characters. Then, selecting a large and distinct family of Dicotyledons, the Asclepiadaceae, he examines it more closely to show how evolution has expressed itself within a relatively isolated family. He discusses the difficulties which arise when we try to envisage the course and possible causes of evolutionary differentiation in this series of plants, which have a most remarkable mode of pollination. He next considers the appearance of floral aggregation in many different families, and goes on to survey the flowers of the Compositae, in which floral aggregation is most marked, and may have contributed to making this family the largest and most widely distributed group to-day. This leads to the consideration of superficial resemblances of many kinds between different plants which are apparently quite unrelated, demonstrating "that evolutionary repetition of this sort has been a feature in the history of these plants". The concluding chapter is a summary and discussion of the problems which have been presented.

Prof. Good has shown very clearly how difficult it is to explain the appearance of such a great variety of organisms in terms of the ideas advanced by different writers since Darwin. But he seems to view the question almost entirely from the aspect o floral structure and the mechanism of reproduction and from this aspect close study seems to raise more problems than it solves. Near the end of the book the author recognizes the possibility that the fact may be susceptible to some explanation other than the idea of gradual transformation. He does no suggest what other explanations there may be, bu some readers may well feel that little progress will be made until we know more about the biochemica constitution and the vital processes which go on during the life of the plant. May it not be the physiological make-up, rather than the structura characters, which determines survival and is responsible for evolutionary changes that have occurred in the group during many millions of years in a world where climatic and environmental changes have constantly taken place?

This stimulating book could have been improved by giving the reader more help to understand th illustrations. Few ordinary persons are familiar with the floral structures in the Asclepiadaceae, and the text would be followed more easily if the drawings had been labelled and more fully explained.

H. Hamshaw Thomas

COLLECTED WORKS OF LUDWIG SCHLÄFLI

Ludwig Schläfli, 1814–1895

Gesammelte Mathematische Abhandlungen. Herausgegeben vom Steiner–Schläfli–Komitee der Schweizerischen Naturforschenden Gesellschaft. Band 1: Pp 392. 56.15 Swiss francs. Band 2: Pp. 381. 56.1 Swiss francs. Band 3: Pp. 402. 59.30 Swiss francs (Basle: Verlag Birkhäuser, 1950, 1953 and 1956.)

During his long life (1814–95), Schläfli contributed in many ways to the algebra, geometry and analysis of the nineteenth century. Yet hi influence on geometry might have been much more considerable had the length of one of his greates memoirs not prevented its publication at the time o its production in 1852; this is the famous "Theorie de vielfachen Kontinuität", first made public in 1901 It occupies 220 pages in the first of the present se of volumes, and not unnaturally overshadows the rest of the contents of that volume. Essentially, it i a systematic essay on the extension of familiar metri properties of three-dimensional space to space of dimensions. The first section deals with linear space and the configurations bounded by them, leading u to the study of the regular polytopes, a topic whic has been developed on the basis of Schläfli's work b a number of contemporary mathematicians, and i particular by Coxeter. The second section discusse the hypersphere and its geometry, with speci reference to the spherical simplex and its connexion with the regular polytopes. The final section contain generalizations of quadric properties and relate topics. Had this paper appeared in 1852, would i have had any substantial effect on the general lin of geometrical development during the next hal century? Would the flow of effort on projective line have been deflected, and would Cayley have promulgated his famous phrase of 1859: "projectiv geometry is *all* geometry"? Possibly Cayley did nc intend this to be taken as literally as it often ha been taken; in any event, his line of thought wa not very far removed from that of Schläfli, for whom Cayley had a high regard—enough for him to undergo the labour of translating some of Schlafli's papers into English so that they might be published in Britain.

Volume 2 is mainly on algebra and geometry. The particular gem, by which Schläfli's name is perhaps best known, is the theorem (1858) of the 'double six', concerning the intersections of two pairs of six lines in space. This occurs in a memoir on the classification of cubic surfaces, for the double six configuration is closely related to the twenty-seven lines on the cubic surface. But the theorem does not depend on the theory of the cubic surface, and many other proofs have been given; a melancholy interest attaches to the ingenious proof which relates the result to the celebrated theorem of Miquel on the foci of a set of parabolas, for this was devised by the brilliant young English geometer, Wakeford, shortly before his death on the Western Front in 1916.

Analysis occupies most of the third and final volume. There is, for example, a paper which has the air of being much more modern than its date (1875), in which the asymptotic expansions of the Bessel functions of the third kind are investigated; Watson remarks that this does not appear to have received the attention it deserves. Another paper of importance deals with spherical harmonics. Heine had unsuccessfully attempted to give appropriate definitions of the general harmonics $P_n{}^m(\mu)$, $Q_n{}^m(\mu)$ for complex values of m and n; Schläfli solved the problem for the zonal harmonics ($m = 0$), by means of single-circuit integrals. The general problem was solved somewhat later, by Barnes and Hobson independently, the former using single-circuit integrals and the latter double-circuit integrals of the Pochhammer type.

In spite of some early struggles, Schläfli seems to have had a quiet and happy life, winning the affections of many generations of pupils, and contributing substantially to the pure mathematics of his time. These three volumes, beautifully produced by Verlag Birkhauser, and well edited with sound but unobtrusive comments by Kollros, Burckhardt and Hadwiger, are an appropriate memorial to Schlafli's versatile, polished craftsmanship.

T. A. A. Broadbent

PLANETARY NEBULAE

Gaseous Nebulae

By Prof. L. H. Aller. (International Astrophysics Series, Vol. 3.) Pp. xvi+322. (London: Chapman and Hall, Ltd., 1956.) 63*s*. net.

I HAD hoped on opening this book to find that it dealt chiefly with the diffuse gaseous nebulae, which during recent years have become of special nterest because of their connexion with interstellar matter and the problems of radio astronomy, with the formation and existence of the hot Population I tars, and through these with important problems of the history and structure of the Milky Way. Although "Gaseous Nebulae" indeed devotes some attention to these objects, its chief concern is with the planetary nebulae, and we are informed that Prof. Lyman Spitzer is at present preparing a book on interstellar matter and the diffuse nebulae. Topical interest in the planetary nebulae (which have nothing to do with planets) is less intense, although for more than half a century they have offered fascinating problems to both theoretical and observational astronomers. They are an order of magnitude smaller than the diffuse nebulae, each is centred on a hot star; although often complicated, they show regularities of shape approximating to spheroidal shells, or rings, or even helices; they appear to belong to Population II, and they have no close connexion with interstellar matter.

Nevertheless in some respects, for example, in their spectra, these two distinct classes of nebulae have much in common. Both consist of highly rarefied gas, giving a bright line spectrum, with a considerable number of 'forbidden' lines. The spectrum is produced by a fairly well understood mechanism of ionization, recombination and electron collision, dependent in the first place on dilute ultra-violet radiation from one or more hot stars. But although the general operative principles are known, detailed calculation of the spectrum, or of the physical conditions within the nebula, leads to most formidable complexities. Further, the best observers and the most powerful telescopes are unable with present techniques to give the theorist much of the information which he knows to be of vital importance, and he is too often reduced to forcing a way through his problems by the aid of drastic and not always very convincing simplifications.

Prof. L. H. Aller is a well-known expert in planetary nebulae and here we have a book by an enthusiastic specialist, for specialists. According to the preface, it is based on a much-revised manuscript twelve or more years old. I suspect that the core of the book, Chapter 4 ("Physical Processes in Gaseous Nebulae") and Chapter 5 ("The Forbidden Lines"), which also appears to be the most carefully written part, comes from this manuscript. The other chapters, dealing with types of gaseous nebulae, methods of observation, distances and dimensions, the spectra, the illuminating stars, the structure and internal motions, and the diffuse gaseous nebulae, contain a great amount of very varied and detailed information, too much for clarity, and seem to me to need more thought in arrangement and selection. The specialist, already well acquainted with the subject, may be able to browse with profit, doubtless annotating liberally as he goes. Reading critically and adding much from his own experience, he will realize once more the complexities of the subject, the weaknesses and difficulties of current theories, and the points at which more measurements are urgently needed. He will also find new and hitherto unpublished material, and will be provided with much food for thought.

But it seems to me that the less-advanced student, or the inquirer from another branch of physics, will find complicated matters presented too briefly. He is likely, too, to have difficulty in seeing the wood for the trees and may find himself somewhat bewildered. I cannot recommend the book for such a reader, unless he has a well-informed mentor near at hand to provide a running commentary of elucidation, for there is much which cannot be properly understood without a very wide knowledge of both theoretical and practical astrophysics. Even then, many questions will remain unanswered, some of them pointed out by the author, some not.

There are a number of misprints, including three curious examples on pp. 17, 20 and 229, respectively. Long and useful bibliographies are provided at the end of each chapter.

R. O. Redman

Supplement to the Dictionary of Gardening

A Practical and Scientific Encyclopædia of Horticulture. Edited by Patrick M. Synge. (Royal Horticultural Society.) Pp. x+334. (Oxford: Clarendon Press; London: Oxford University Press, 1956.) 42*s.* net.

THIS supplementary volume, published five years after the main work, is in two parts. The first contains the promised lists of recommended varieties of flowers, fruit and vegetables, and also a valuable article on fertility and infertility in fruit. The second, and rather larger, is "Additions and Corrections".

With a compilation of this nature, it must be very difficult indeed to decide when to call a halt to revisions and commit to press, and some matter must inevitably be out of date even when it appears. Also, varieties of cultivated plants are so numerous and multiplying so rapidly that it would be unfair to expect recommended lists to be entirely up to date, comprehensive, or really satisfactory to the specialists in any particular group.

Nevertheless, it is disappointing to find columns of bare names (for example, vegetable marrow), quite misleadingly fragmentary selections (for example, *Primula*, hardy), and many lists like trade catalogues in which several varieties share paraphrasings of one description, with few references to distinctive virtues, and even more important, vices. Many omissions are obvious. Where, for example, are the 'Cambridge' strawberries and brussels sprouts, or the Pacific strain of delphiniums? Yet space is devoted, in an already over-bulky horticultural reference work, to such things as detailed variation within the *Alchemilla vulgaris* aggregate.

The list of contributors to Part 2 is a guarantee of the solid worth of many articles. A more critical selection of genuinely horticultural matter is desirable when the supplement is itself revised and re-issued.

S. CLAY

An Outline of Atomic Physics

By Prof. Oswald H. Blackwood, Thomas H. Osgood and Prof. Arthur E. Ruark. Third edition. Pp. x+501. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1955.) 60*s.* net.

FOR the third edition this well-established introduction to atomic physics has been completely rewritten, and the main advances in the subject up to about 1953 are very lucidly explained. The treatment is chiefly descriptive, but the authors give a good elementary outline of what wave-mechanics is about and indeed discuss in some detail the difficulty of arriving at a theory of the deuteron. The account of cosmic rays and of the new particles discovered in this field is fuller than anything which has yet found its way into books of this standard. The final chapter on the Michelson–Morley experiment and the development of relativity theory is also very good.

Little is said about the fascinating subject of ferromagnetism, and the few lines devoted to this are rather confusing; also, it is hard to interpret the statement on p. 76 that electromagnetic radiation is the common carrier that transmits energy between electrons and nuclei. But the marks lost for these minor points are recovered (with a handsome bonus) for the treatment of the elementary particles, for the "model for visualizing their spins, charges, and masses", and for the clear explanation of the concepts of statistical character and parity. A number of problems, complete with answers, and a list of references for further reading are provided.

The preface states that the original aim of the book was to equip non-specialists to keep abreast of current progress in physics; in this it should be most successful.

G. R. NOAKES

Introduction to Chemical Engineering

By Walter L. Badger and Prof. Julius T. Banchero. (McGraw-Hill Series in Chemical Engineering.) Pp. ix+753. (London: McGraw-Hill Publishing Company, Ltd., 1955.) 71*s.* 6*d.*

THE heading of this book should surely be "Badger and McCabe's Elements of Chemical Engineering, third edition revised and enlarged by W. L. Badger and J. T. Banchero", for this is what the book is, in spite of the change of title and authors. A large proportion of the letterpress is identical with that in Badger and McCabe's second edition, both books have sixteen chapters with similar titles and many of the illustrations in the older work appear in the new volume with very minor alterations, made perhaps to substantiate the claim in the preface that "the illustrations have all been specially drawn for this book"; and yet the earlier book is not even mentioned.

Some superfluous matter has been omitted, and nearly all the chapters have been enlarged and brought up to date, especially those on evaporation, distillation, extraction, humidity and gas absorption; and the book retains the valuable characteristic of emphasizing the importance of plant and its constructional details. The problems and worked-out examples are nearly all new. In order to maintain the same thickness and reduce the weight, the paper is now thinner and the lines longer and closer together, allowing an increase of about 35 per cent in the contents. Some of the diagrams are not up to the standard usually found in this series, and the general appearance and clarity have suffered.

In spite of these minor defects, there is little doubt that the book will continue to enjoy the popularity of its predecessor of 1936, which in those days was generally regarded as the Bible of the chemical engineering student.

H. E. WATSON

The Planet Venus

By Patrick Moore. Pp. 132+8 plates. (London: Faber and Faber, Ltd.. 1956.) 15*s.* net.

THE publisher's note about this book states that it is the first serious book in any language devoted to Venus. This is not surprising, as so little is known about the physical conditions on Venus; even the period of its rotations is not known with certainty. But this book is disappointing in many ways. Space is given to the discussion of such matters as the canals of Venus, which are based on observations that are discredited, and of the ashen light, which is a purely instrumental effect, being never observed with reflecting telescopes but only with refractors that are not perfectly achromatic. In some other respects the book is quite inadequate. For example, there is no discussion of the polarization curve; no reference is made to the variation of polarization over the disk or of the appearance and disappearance of areas of abnormal polarization. Such observations have an important bearing on the nature of the atmosphere of Venus and of the clouds in its atmosphere. As an account of the present state of knowledge about Venus, this book cannot be recommended.

H. SPENCER JONES

J. J. THOMSON*

By Sir GEORGE THOMSON, F.R.S.
Master of Corpus Christi College, Cambridge

JOSEPH JOHN THOMSON was born on December 18, 1856, in a suburb (Cheetham) of Manchester. His father was a bookseller and publisher, specializing in old books, and the family was of Scottish origin. He came to be very well known to the Royal Institution, where he was non-resident professor of physics, and he often gave the Friday evening discourse.

To the student of physics of the present day he is known as the discoverer of the electron. Actually that word was coined before his work on the subject began and he preferred to use another; but as I hope to make clear, he did more than any other single person to prove the objective existence of the entity we call by that name, and to provide the theoretical ideas on the subject with experimental proof. But he was not a man of one discovery, and I wish to bring up in rapid review as many as I can of the departments of physics in which he was interested, and which sometimes were connected by unexpected sequences of ideas.

He started as a mathematician—he was second wrangler when Larmor was senior—and his earliest important work was as a disciple—he was never the pupil—of Clerk Maxwell. Maxwell's theory of electricity was not well appreciated when it came out in 1873. It was indeed rather obscure, since the physical conceptions underlying Maxwell's ideas did not appear clearly in the final mathematical form he adopted. 'J. J.', as he was always known, developed the consequences of the theory and showed in particular that a moving charged sphere had additional mass as a result of its charge—the first hint of Einstein's $E = mc^2$—and that the electromagnetic waves carried momentum as well as energy along their rays.

Then he became interested in vortex rings, of which smoke rings are a good example. Vortex rings appealed to nineteenth-century physicists, notably to Kelvin and to Helmholtz, as a possible explanation of atoms, because of their permanence. "It is indestructible and indivisible, the strength of the vortex ring and the volume of liquid comprising it remain for ever unaltered, and if any vortex ring be knotted or if two vortex rings be linked together in any way, they will retain for ever the same kind of be-knottedness or linking." So when vortex rings were set as a subject for the Adams Prize, 'J. J.' took up their theory, and the prize-winning essay published in 1883 contained some interesting suggestions as to the way in which vortex atoms might link together to form molecules. Two, three, four, five or six can be linked together in a special way, but seven or more are unstable.

This early and forgotten theory led 'J. J.' to his earliest experiments on gaseous discharges, the subject he was to make peculiarly his own, and which was to occupy his attention into advanced old age. The connexion may not be obvious, but the theory indicated that the electric discharge in a gas would be associated with dissociation of the molecules in a measurable fashion. The experiments were not in fact, very conclusive, but they led Thomson on to study other properties of the gaseous discharge, and especially the electrodeless discharge, for which he retained a life-long affection. More important than the results obtained was the experience with this kind of experiment, which was so useful to him later on.

The discovery by Röntgen of X-rays in 1895 is a turning point in physics. 'J. J.' was quick to take advantage of it and he and Rutherford showed—about the same time as some other workers—that the X-rays made a gas conducting, thus providing a manageable method of ionization, a word they used in their paper. We shall see how valuable this was in the discovery of the electron.

The fundamental importance of the electron, as was fully realized at the time, is the proof that all matter contains at least this one common constituent, and that the atoms of nineteenth-century chemistry are not separate independent entities, as was then generally supposed.

The actual approach to the electron, the first of the common constituents, came from two different directions, neither of which seemed at the time to have much to do with the structure of the atoms of ordinary matter. Faraday's laws of electrolysis early in the century had produced very strong evidence, which one now feels that the men of the time were very dense in ignoring, that electricity is somehow done up into units of which one, two or three, rarely more, may be attached to each individual atom. Towards the end of the century people woke up to this, and Johnstone Stoney coined the word 'electron' for this hypothetical unit; but as yet it had no other properties. Its magnitude could be estimated, though only very crudely. There was no evidence that it existed alone, apart from electrified matter. It might just have been a unit of exchange in Nature's bank, like the 'money of account' in those countries where the unit of accountancy corresponds to no actual coin.

There were electron theories of a kind in the nineteenth century, but the first that led to anything of importance was that of Lorentz in the early 90's, which immediately explained the discovery of Zeeman in 1896 that the spectrum of the light from a sodium flame was modified by a magnetic field. It is interesting to recall, here in the Royal Institution, that Faraday's last recorded experiment was an unsuccessful attempt to detect this, and that Zeeman, who had read Faraday's work, was deliberately repeating it with more modern equipment.

The other line of approach, in which 'J. J.' was the leader, was given by cathode rays. These can be observed when an electric current goes through a very rarefied gas. They are more familiar to-day, in a slightly modified form, as the working medium of a television tube. They had been known from the middle of the century and their nature hotly disputed. The question became international; on the whole the British and the French held the view that they were some sort of particle, whereas the Germans thought that they were waves and more akin to light. Of course, both were right, but the reconciliation was to come much later.

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* Friday Evening Discourse at the Royal Institution delivered on December 7.

Cathode rays are deflected by a magnet as a stream of electrified particles would be, and Perrin showed that if shot into a box they gave it a negative electric charge. 'J. J.' combined these two experiments and showed that the magnetically deflected rays took their charge with them. More important, he showed that the deflexion was the same for all rays produced by a discharge of the same voltage whatever the gas and the material of the cathode. This experiment, which was published in February 1897, convinced him, I think, that they were not just 'electricity', whatever that mysterious entity might be, but part, and a fundamental part, of matter as well.

But more was needed, for there were serious difficulties. Hertz had found that they were not deflected by an electric field as charged particles ought to be, and Lenard at Heidelberg had found that they would go right through a thin metal window into the air outside. This seemed impossible if they were charged atoms—and no one had thought of any smaller particle.

The dramatic occasion was a discourse in the lecture room of the Royal Institution, given on April 30, 1897. After showing the modified Perrin experiment and photographs of the deflected cathode rays, he passed to the matter of the missing electric deflexion. The observation, though right in itself, was misleading. When the field was applied (as the experimenters thought) nearly all of it was neutralized by charges produced by the rays themselves in the rarefied gas, so that the region where the rays actually went was devoid of field. The charges do not neutralize magnetic fields, hence the curious discrepancy. 'J. J.' managed to get the vacuum better and found a deflexion by electric fields. Later on he used this deflexion balanced against a magnetic field to find the ratio of the charge to the mass of the particles and their velocities in a way described in every text-book of electricity; but actually on that evening he described another way of measuring the same quantity in some ways more direct. He measured in fact for certain rays their magnetic deflexion, and the heating effect that corresponds to the transport of a unit of charge. In terms of symbols, the first gives e/mv and the second e/mv^2, from which e/m and v can be found. Now e/m is a critical quantity. The Faraday experiments had found it for ordinary atoms. It varies with the kind of matter, but even for the lightest atoms (hydrogen) the charge per unit mass, written e/m, was more than 1,000 times too small. Either each cathode ray had a charge 1,000 times the unit, or a cathode ray is more than 1,000 times lighter than the lightest chemical atom. But all the cathode rays had the same e/m, no matter what the gas or what the metal used for the cathode from which they came. Since in Faraday's experiments the charges seldom exceed 3 units, a constant value of more than 1,000 seemed most improbable, so the particles of cathode rays must have a sub-atomic mass which is the same whatever material they came from.

In the next two years, 'J. J.' brilliantly completed the proof and added new evidence of the universality of what he, not wishing to prejudge the issue of their identity with the unit charge, called 'corpuscles'. He found he could get them from hot wires, and from metals exposed to ultra-violet light. In all cases e/m was the same as for cathode rays within a reasonable experimental error, whatever the nature of the wire or metal. Moreover, he adapted a clever method, just discovered in the Cavendish by C. T. R. Wilson, of making small charges visible by collecting drops upon them, to measure the charge of the 'corpuscles' in the ultra-violet light experiment. It came out within the range expected for the Faraday unit; and though this was wide, it was clear enough that he was not dealing with something more than 1,000 times as large. Hence the corpuscle was at least 1,000 times lighter than the lightest atom. It was established as a universal constituent of all matter; not the only one obviously, since ordinary matter is electrically neutral and 'J. J.'s' corpuscles were charged, but a true universal entity, more nearly recalling the philosophies of the Greeks than nineteenth-century chemistry. In the very paper which described the now classic e/m experiment on cathode rays 'J. J.' turned to the next stage. Granted that electrons are universal constituents of matter, how do they fit in? Lenard's experimental result that the distance a cathode ray could go through matter was inversely as the density over a wide range and independent of its chemical nature or physical state, seemed to 'J. J.' to give strong support for the view that atoms contained electrons in number proportional to the mass of the atom. He considered, correctly, that the collisions of the rays in going through an atom would be rather with the individual constituent electrons than with the atom as a whole, so Lenard's relation implied that the number of electrons per gram is the same for all substances. Ever on the look-out for a model, he adopted an experiment of the American physicist Mayer, which seemed to him to suggest very strongly something like the periodic table.

Now if this has any validity, even in an order-of-magnitude fashion, there will not be many thousands of electrons in an atom, probably only a few. Therefore, the main mass of atoms cannot be due to electrons; presumably it is supplied by the positively electrified component.

Both these questions had to wait while knowledge accumulated on the behaviour of electricity in gases, on the action of X-rays, and on the behaviour of radioactivity, of which Rutherford made himself the master, using, in each case, the electron as a master key.

Much of this work was done at the Cavendish Laboratory. Here the first research school of the modern kind ever to operate in Britain was working all out. Seeing that it started with Rutherford and Townsend as the first two research students, soon to be joined by C. T. R. Wilson, Langevin, Barkla and many others, this is not surprising.

It was, I suppose, the happiest period of 'J. J.'s' life, for though he was an intense individualist in his own work, he enjoyed the companionship of other workers. His own enthusiasm stimulated them as much as his curious insight helped to exorcise the devils that inhabit physical apparatus. He got back enthusiasm in return, the enthusiasm which he so valued as the supreme quality of a good physicist.

In 1906 he was able to make an estimate of the number of electrons in an atom—corpuscles as he still called them. It was a theoretical paper based on the experimental work of Barkla and Rutherford, and using his own formulæ for the scattering of electromagnetic waves by charged particles, that is, X-rays by electrons, and of fast electrons by resting ones. Three methods, the scattering of X-rays, the penetration of β-rays through matter, and less accurately the refractive index of gases, all led to the conclusion that the number of electrons in an atom is of the same order as the chemical atomic weight.

But what then of the positives, which must therefore somehow contribute the lion's share of the mass of all atoms ? 'J. J.' supposed that the atom was like a gooseberry with corpuscles as the pips and the neutralizing positive charge spread out continuously rather like the edible part of the gooseberry. It was left for Rutherford to discover the nucleus. 'J. J.'s' reason for his choice was a rational one in the days when no one questioned Maxwellian electrodynamics. While on the inverse square law a solar system can be stable if the planets *attract* one another, it is inherently unstable—for more than one planet—if they *repel*, as electrons must. The sphere of distributed electricity gets over this objection. The Mayer experiment which gives much the same field as a distributed electric charge only works in two dimensions ; in three dimensions these rings would be unstable, but stability can be restored by making them spin.

A year before, in 1905, 'J. J.' had made his first experiments on positive rays or canalstrahlen. These had been studied by Wien, who had shown that they have values of e/m, and so probably masses, of the order of those of ions in electrolysis. However, Wien's experiment did not allow him to measure e/m with any accuracy, and indeed seemed to indicate that it varied continuously. This was due to bad vacua. By improving the technique, 'J. J.' was able to show that the rays consist of atoms and molecules which have lost electrons in the discharge and been accelerated towards the cathode by the strong electric field in the Crookes' dark space.

The positive rays were thus no new revolutionary particles, but the gaseous ions which the Cavendish had been studying now for a decade. As so often happens when a better technique is applied to something crudely known, the unexpected turned up in the end ; but the first result was to produce for the first time experimental evidence for what everyone had believed for no good reason, namely, that all the atoms of an element had the same mass, and that atomic weight was definite and was not merely a statistical property of large numbers, a mere average. The parabolæ, which appeared on the plates which his assistant Everett, and later Aston, exposed, and which he measured in a little frame sitting perched up on an office stool, each correspond to one value of e/m and so to one mass, the charge being that on an electron, with sign reversed, or a small integral multiple of it.

Some odd things certainly turned up—compounds which disobeyed the laws of valency, triple hydrogen and the like. Then it was found that when neon was in the tube two parabolæ appeared where only one should be. Was the second perhaps a hydride in spite of neon being an inert gas ? There were weighty reasons against, and when the First World War came and stopped work at the Cavendish, both 'J. J.' and Aston believed that the two parabolæ were due to two subspecies of the neon atom, like the isotopes Soddy had found among the radioactive elements. But there was no absolute proof. After the War, as is well known, Aston's pertinacity and experimental skill not only supplied the proof, but also by the greatly improved technique of his mass spectrograph showed that neon, so far from being unusual in having isotopes, was perfectly normal—that indeed its two isotopes were a modest allowance often exceeded by other elements.

'J. J.' always believed that the method of positive-ray analysis had great possibilities for chemists because of the small quantities of material required. It would have pleased him greatly to see its application nowadays to a variety of technical problems.

Though I fear this lecture has been crowded, I have had to omit much. I have only touched on his theoretical work, and said nothing of his suggestion of the 'spotted wave front', which anticipated Einstein's treatment of light quanta, nor of his important work on the electron theory of metallic conduction. Though his experimental work is better known, he started and finished as a theoretician. His fellowship thesis on the relation of dynamics to physics and chemistry helped to clarify ideas on energy. His theory of the recombination of ions is still valid. The "Conduction of Electricity through Gases", for many years a Bible of physics, contains many pieces of his own theory.

His attitude to theory is interesting. Though a first-rate mathematician, he liked something he could visualize or draw in a diagram on the back of an envelope with a halo of equations around it. Hence his life-long attraction to the concrete 'tubes of force' of Faraday and Maxwell, and truly even now there are problems for which these are the most useful picture. The research, so he told me once, that he most enjoyed doing was one on conformal representation in electrostatics. The trouble with experiments, he said, was that you had infinite labour in getting the apparatus to work, and when it did work the experiment was over too quickly. For him the apparatus existed for the experiment, never the experiment to justify the apparatus.

Though he was a man of unusually wide interests and sympathies, physics was his life. He believed that it was bad for a man to do research continuously and that interruptions were sometimes helpful, especially the interruptions of teaching, in sending a man back to his problems with a fresh mind and perhaps with fresh ideas. This made him perhaps more tolerant than he would otherwise have been of his teaching and administrative work, which he took very seriously ; but his strong sense of duty did not always extend to answering letters.

He enjoyed lecturing—but perhaps not preparing lectures—especially in the Royal Institution, and would, I think, have been glad that his centenary is honoured here.

I will conclude with a quotation which expresses his faith in the future of physics :

"A great discovery is not a terminus, but an avenue leading to regions hitherto unknown. We climb to the top of the peak and find that it reveals to us another higher than any we have yet seen, and so it goes on. The additions to our knowledge of physics made in a generation do not get smaller or less fundamental or less revolutionary, as one generation succeeds another. The sum of our knowledge is not like what mathematicians call a convergent series . . . where the study of a few terms may give the general properties of the whole. Physics corresponds rather to the other type of series called divergent, where the terms which are added one after another do not get smaller and smaller, and where the conclusions we draw from the few terms we know, cannot be trusted to be those we should draw if further knowledge were at our disposal."

RECENT WORK ON NUCLEIC ACIDS

AN informal discussion on nucleic acids, held under the auspices of the Colloid and Biophysics Committee of the Faraday Society, was held during October 12 and 13 in Manson House, London (Royal Society of Tropical Medicine and Hygiene). The chair at the opening session was taken by Prof. J. A. V. Butler, who arranged the meeting. At subsequent sessions Sir Alexander Todd, Prof. E. Chargaff and Prof. R. M. Herriott took the chair. Twenty-six papers were presented.

In the first session, Dr. J. Pouyet, J. Hermans and Dr. R. Vendrely discussed preparations of deoxyribonucleic acid of the two categories described by Sadron at the Brussels Congress in 1955. Further preparations of deoxyribonucleic acid from calf thymus have been made which are of the more compact configuration of category 2, and it has been shown that the absorption at 260 mμ is lower for these preparations than for those of category 1. Experiments suggest that the treatment of the nucleoprotein by salt and alcohol may affect the size and configuration of the deoxyribonucleic acid prepared from it. In a later paper, Dr. R. A. Welsh showed that if nuclei from calf thymus are extracted with 0·14 *M* sodium chloride, the deoxyribonucleoprotein can be dissolved in molar sodium chloride and precipitated in a non-fibrous form, in contrast to the fibrous precipitate which is obtained if the nuclei are extracted in water. To some extent the structural changes involved can be reversed, and a fibrous form can be prepared from the non-fibrous nucleoprotein. A further problem in the preparation of deoxyribonucleic acid from calf thymus was raised by Dr. K. V. Shooter, who showed that the small amounts of residual protein (less than 1 per cent) usually found in preparations may markedly influence the physical properties. Treatment with chymotrypsin suggested that 26 per cent by weight of the deoxyribonucleic acid may be cross-linked by the residual protein. A method of preparing deoxyribonucleic acid, involving the partition of a tissue homogenate between phenol and water in the presence of sodium chloride and the chelating agent *p*-amino-salicylic acid, was described by Dr. K. S. Kirby. Using this method, a high yield of deoxyribonucleic acid free from protein has been produced. The various techniques available for the isolation of deoxyribonucleic acid from the bacteriophage D_4 of *Salmonella enteritides* were discussed by Dr. R. Wahl, Dr. M. Joly and Dr. E. Barbu. Viscosity measurements in salt solutions showed that the reduced viscosity of the deoxyribonucleic acid from this phage decreases as the solution is diluted and increases if the solution is concentrated again. To account for these results, it was suggested that the particles consist of short rods (400 A.) associated parallel to each other to form much longer aggregates, the number of rods in each aggregate being dependent on the concentration.

A paper on the properties of deoxyribonucleic acid prepared from the leucocytes of patients with lymphatic or myeloid leukæmia was read by Dr. E. E. Polli. Extensive investigations have shown that many of the physical properties of these preparations are similar to those of deoxyribonucleic acid from calf thymus but that the deoxyribonucleic acid from the leucocytes of myeloid leukæmia has an extra band in the infra-red spectrum and also shows some differences in behaviour on titration to acid *p*H. In addition, the deoxyribonucleoprotein from the myeloid leukæmia leucocytes was found to be 95 per cent dissociated in salt concentrations of 0·4–0·6 *M*, in contrast to the behaviour of calf thymus nucleoprotein and nucleoprotein from lymphatic leukæmia leucocytes which are only 5 per cent dissociated at these salt concentrations.

Further work on the physical properties of calf thymus deoxyribonucleic acid was reported by Prof. P. Doty. The examination of a series of samples of molecular weights from 8×10^6 to 3×10^5, produced by sonic degradation, has shown that $[\eta] \propto M^{1{\cdot}08}$ and $S_0 \propto M^{0{\cdot}37}$. Heat-denaturation studies in the presence of salt have shown that on the addition of hydrogen-bond-breaking agents such as urea or guanidine hydrochloride, the temperature at which a marked fall in viscosity occurs is reduced. The increase in the absorption at 260 mμ increases by as much as 32 per cent if the measurements are made at the temperature of the heating experiments; but on cooling the solution, the absorption falls to only 14 per cent greater than before heating. This change was attributed to the random formation of hydrogen bonds when the solution was cooled. It was also found that the denaturation process is not a first-order reaction, since not only does the rate of denaturation increase with temperature (above the denaturation temperature) but also the extent of the reaction increases. The correspondence between this process and the progressive melting of crystallites in a polymer was discussed. Dr. P. Alexander and Dr. K. A. Stacey dealt with the denaturation of herring sperm deoxyribonucleic acid by urea. At concentrations less than 0·003 per cent, the molecular weight is reduced by about one-half. Electron microscope photographs showing the disappearance of fibrils after treatment with urea at room temperature lend support to their suggestion that the twin strands of the helix are separated under these conditions. The effect of denaturation has been studied by Dr. A. R. Peacocke using titration techniques. These experiments showed that heating or sonic degradation disrupts the hydrogen bonds between the two pairs of bases at random, whereas degradation by γ-rays or by acid treatment produces a non-random rupture of the hydrogen bonds.

Further work on the analysis of the structure of deoxyribonucleic acid and nucleoprotein was described by Dr. M. F. H. Wilkins. Another contribution was made by Dr. H. Wyckoff, who showed that the reversible change from the *A*- to the *B*-form can be produced by varying the alcohol concentration of a solution between 75 and 90 per cent, and that in 90 per cent alcohol the *B*-form can be obtained from the *A*-form by stretching the filaments. X-ray diffraction studies on the synthetic ribonucleotides, polyadenylic and polyuridylic acid, were described by Dr. A. Rich, who showed that on mixing solutions of these two polymers the molecules combine to give a twin-stranded helix. Further work on ribonucleic acid was reported by Dr. R. Franklin, who has compared the X-ray diffraction pattern of tobacco mosaic virus with that from the reconstituted protein. The results show that the ribonucleic acid of the virus lies 40 A. from the axis.

Dr. G. D. Hunter showed that the nucleic acids of *B. megaterium* can be obtained by treatment of the protoplasts with dodecyl sulphate and the ribo- and deoxyribo-nucleic acids separated by sedimentation. Some nucleic acid, mainly deoxyribonucleic acid, which is precipitated with the protein during treatment with the detergent, has been isolated by treatment with chloroform. This deoxyribonucleic acid differs in composition from that which dissolves on treatment with the detergent. Ribonucleic acid from a strain of the organism trained to grow on lactose has the power to induce β-galactosidase activity in an untrained strain in the absence of any other inducer. Dr. A. S. Jones and Dr. A. R. Peacocke reported the isolation of ribonucleic acid from *Aerobacter aerogenes* using sodium cholate as an enzyme inhibitor. Titration studies have shown significant differences between the forward and back titration curves in the acid and alkaline regions. This hysteresis implies the existence of hydrogen bonds on both the 6-amino and the 6-keto groups. Investigations of the composition of the ribonucleic acid in nucleoprotein preparations from a wide variety of organisms were described by Prof. E. Chargaff. In all cases the number of 6-amino groups has been found to be equal to the number of 6-keto groups to within a few per cent, although the ratio of purines to pyrimidines is in general significantly different from unity. Work on the proteins of the nucleoprotein complex was also reported.

New methods of fractionating deoxyribonucleic acid in nucleoprotein using polysulphates were described by Dr. M. Hickens, Dr. P. W. Kent and Dr. P. V. F. Ward. Dr. G. A. Gilbert commented on the use of electrophoresis measurements for studying the interaction between deoxyribonucleic acid and proteins, and showed how it is possible to obtain three peaks in the ascending boundary with these systems. The interaction of herring sperm deoxyribonucleic acid with amino-acids and peptides has been studied by Dr. R. Zahn, who has found that the reaction occurs in two stages: a relatively rapid reaction leading to an increase in solubility in alcohol, followed by a slower reaction in which the solubility is reduced.

Papers on the protein components of deoxyribonucleoproteins were read by Dr. P. F. Davison and Prof. K. Felix. Prof. Felix dealt with the fractionation of the protamines of herring sperm and reported results on the composition and molecular weight of the fractions. Further work on the composition of nucleoprotein of the testes of *Trutta fontinalis* at different stages of maturity has shown that nucleoprotamine appears about the mid-point of the ripening period and that its composition does not change after this stage. At all stages a second basic protein, probably a histone, is also present. These results suggest that the protamine is synthesized by a special process similar to that by which the proteohormones of the glands are formed. Dr. Davison discussed the histones obtained from nucleoprotein of ascites tumour cells. Of these preparations, 25 per cent or less is precipitated at *p*H 6·5; the properties of the remainder are found to be similar to those of histones from normal tissues. Fractionation and analysis of the material precipitated at *p*H 6·5 suggests that it is an aggregate formed from histones and a non-basic protein. There is some doubt whether this non-basic protein is a constituent of the nucleus. Photographs of the isolated nuclei show the presence of cytoplasmic contamination.

Recent work on the transforming principle of *Haemophilus influenzae* was reported by Prof. R. M. Herriott. Sedimentation and diffusion studies have given a preliminary molecular weight of 15×10^6. Investigation of the absorption mechanism using tracer techniques has shown that some of the absorbed deoxyribonucleic acid can be removed by washing or by the action of deoxyribonuclease. For every 1,000 molecules of deoxyribonucleic acid which are irreversibly absorbed, about eight cells are transformed. There is no evidence that the absorption process fractionates the transforming activity. Studies on *Haemophilus* inactivated by ultra-violet irradiation show no reactivation on exposure to visible light. If, however, a cell-free extract of *E. coli B* is added, 30–50 per cent of the original activity of the *Haemophilus* is restored.

Incorporation studies in *in vitro* systems were discussed by Mme. Y. Khouvine and by Prof. J. N. Davidson and Dr. R. Y. Thomson. Mme. Khouvine has investigated the incorporation of phosphorus-32 into the nucleic acids of cell fractions of an epithelioma of the rat under a variety of conditions, and has adduced evidence that the enzyme systems involved in the incorporation differ among the various cell fractions. Preferential incorporation into ribonucleic acid rather than deoxyribonucleic acid is found. Prof. Davidson demonstrated that the incorporation of carbon-14 formate into the nucleic acids of bone-marrow and ascites cells and a strain of mouse sarcoma cells growing *in vitro* occurs to a much greater extent into thymine than into the purines, suggesting that the nucleic acids are synthesized from preformed purines. The addition of a particle-free extract of mouse or pigeon liver results in an increase in the incorporation of carbon-14 formate into the purines, presumably by providing the enzyme system for purine synthesis. Studies on the incorporation of phosphorus-32 into the ribonucleic acid of rat liver were described by Dr. H. N. Munro. The incorporation is considerably lower in rats fasted overnight after a diet containing adequate protein than in rats maintained on protein-free diet. It was suggested that breakdown of ribonucleic acid occurs when the supply of amino-acids is stopped, and that the products dilute the isotopically labelled precursor pool. Feeding protein at the time of injection increases the uptake to that of the rats fed on the protein-free diet.

Investigations made by Dr. D. B. Dunn of the incorporation of some thymine analogues into the nucleic acids of a strain of *B. coli* suggest that there are possibly two routes for the incorporation into deoxyribonucleic acid. The growth inhibition of these analogues is ascribed to the formation of deoxyribonucleic acid in which many breaks occur in one strand of the helix, thus blocking further duplication. Further metabolism studies involving 8-azaguanine were reported by Dr. H. G. Mandel and Dr. R. Markham. The incorporation of the analogue into the ribonucleic acid of *Bacillus cereus* was demonstrated. Addition of guanylic acid to a culture inhibited by the analogue leads to an increase in growth-rate, the analogue being ejected from the bacterial cells as the nucleoside. K. V. Shooter

HYDRAULICS RESEARCH IN GREAT BRITAIN

WORK OF THE HYDRAULICS RESEARCH ORGANIZATION

By F. H. ALLEN
Assistant Director

THE Hydraulics Research Organization of the Department of Scientific and Industrial Research was brought into being in 1947 in order to undertake research into open-channel flow, and, in particular, into the manifold problems of loose-boundary hydraulics as these are met in rivers, estuaries and coastal waters. Since that time, the Organization has expanded steadily until it now has a staff of about 130 and occupies a 90-acre site at Howbery Park, near Wallingford, Berkshire. The director of the Hydraulics Research Station is Sir Claude Inglis, formerly director of the Indian Waterways Experimental Station at Poona. The Station resembles the other research establishments of the Department of Scientific and Industrial Research in that its programme is controlled by a board of eminent engineers and scientists serving in an honorary capacity.

During 1947–51 the new Organization worked in cramped and temporary quarters at the National Physical Laboratory, while the new research station was planned and constructed at Wallingford. The Organization was transferred to Wallingford from 1951 and has been operating there in full strength since the summer of 1952. The nineteenth-century Manor House of Howbery Park has been converted for use as offices, and also includes the library, drawing office and canteen. In the first years at Wallingford, much of the work was carried out on the open-air research facilities, which were available long before the main covered accommodation which is now the nucleus of the Station. These open-air facilities include two large wave basins, each measuring 80 ft. by 125 ft. and equipped with permanent wave-generating machinery, and a pair of unusually long experimental flumes or channels of rectangular cross-section, one 5 ft. and the other 12 ft. in width and both approximately 350 ft. in length. The wave basins are used for model investigations of harbours and for loose-boundary studies of the formation, development and protection of beaches. The channels are devoted to basic research into factors affecting the regime shapes and slopes of alluvial channels. For some time from 1952 it was also necessary to make use of existing temporary accommodation in the form of small precast concrete sheds. A valuable wave tank, 10 ft. wide and 54 ft. long, was constructed in one of these buildings and has since been used for a variety of investigations, including studies of the stability of various breakwater sections and experiments to determine how the rate at which water particles drift in the presence of waves varies with depth. Certain small models and experimental flumes were also built in temporary sheds at this period.

The major part of the permanent experimental accommodation of the Station became available for use only in January 1955. The Main Hall as it now stands measures 300 ft. by 200 ft., and the interior is unobstructed except for two columns supporting the roof. The ceiling is about 25 ft. above floor-level. This impressive building is known as Stage 1 of the Main Hall, and major extensions to it are planned for erection in further stages during the next decade, the overall length of the final structure being 700 ft. The Main Hall has a radiant heating system and ample supplies of water, electrical power and artificial light; it has provision for water storage and drainage below floor-level and photographic facilities at ceiling-level. Transporter gantries are also suspended from rails at ceiling height. The floor consists of consolidated earth, loosely stabilized with a cold bitumastic emulsion, and may be excavated as required for the construction of hydraulic models. As accommodation for hydraulic research, the building has won the admiration of many home and overseas visitors, and the facilities it provides in this respect are undoubtedly second to none in quality and flexibility. Attached to the Main Hall is a subsidiary block in which the various workshops and smaller general-purpose laboratories (for mechanization, development of instruments, analysis of sediments and photographic processing) are housed.

In addition to basic or background research on open-channel flow and wave action, the Station carries out a considerable amount of *ad hoc* or applied research—indeed, at the present time, about three-quarters of the total effort of the establishment is devoted to applied research on specific problems of one kind or another. Typical objectives of these investigations are the dissipation of turbulence below falls, sluices and similar hydraulic structures, the prevention or reduction of flooding, the improvement of shipping channels in ports and estuaries by the control or reduction of siltation, the damping of waves entering harbour and river mouths, and the control or retardation of coast erosion by wave action and tidal currents. These studies are carried out—usually on a repayment basis—on behalf of government departments, river boards, port authorities, coastal protection and local authorities, consulting engineers and private individuals. Work is also carried out for overseas members of the Commonwealth and for certain foreign countries.

The laws of similitude as applied to hydraulic models are sufficiently well known to need no detailed exposition. It is sufficient to say that, as gravitational forces predominate in most of the problems with which the Station is concerned, the Froude law is of over-riding importance in experimental work with scale models. In the study of problems involving the scour, transport and deposition of channel-bed material, movable-bed models—moulded in sand, pumice or some such incoherent granular substance—are used. The limitations of similitude in such models are recognized, and have indeed been the subject of controversy; but it is now well established that they are invaluable aids in the solution of complex problems of bed movement and siltation. The similitude which can be demonstrated to exist in movable-bed models has not yet been fully defined by a mathematical analysis, and experimental work on models of this type can therefore be described with some justice as being partly an art and partly a science. Certainly it is a field of work where wide experience is essential, and where results must be subjected to continual scrutiny and comparison with the known behaviour of the natural prototypes.

The concept of regime, first developed on an empirical basis from a study of canals in India, has been found to be of wide application in the field of loose-boundary hydraulics and is itself the subject of basic research at the Station. In its application to uni-directional flow in alluvial channels—an aspect of the subject which is receiving an increasing amount of attention in the United States—regime theory relates the width and depth of a channel to the water discharge, the slope of the water surface and the quantity and nature of material in movement on the bed and in suspension. The application of this theory to hydraulic models is in itself an obvious subject for research.

There would be little point in listing all the investigations now in progress at Wallingford, but some idea of the scope of the research programme may be given if a few of the major projects are singled out for mention. Thus in the realm of tidal flow in estuaries, two major investigations of siltation are in progress—one concerning the deterioration of the upper estuary of the Mersey, and the other being aimed at the stabilization and deepening of the shipping channel at and below the port of Chittagong on the Karnafuli River in East Pakistan. A tidal study of a different type is in progress in a rigid-bed model of the tidal Trent, where methods of protection against combinations of river and tidal flooding are being tested. A large proportion of the Station's effort is devoted to studies of wave action. In one of the wave basins a large model of the proposed design for the new harbour to be built at Tema, on the Gold Coast, is being examined to determine its behaviour under the influence of short-period and long-period waves. A model of a new sea wall for the Lincolnshire bank of the outer Humber is being subjected to two-dimensional tests in the 54-ft. wave tank. The formation of a sand-bar across the entrance to Eyemouth Harbour in Berwickshire is being studied in a 1/40-scale model equipped with pneumatic wave generators. Investigations of river problems and hydraulic structures also figure largely in the Station's programme of applied research and experimentation. In conclusion, mention should be made of radioactive isotopes as tracers for indicating the movements of silt and sand, in the use of which the Hydraulics Research Station, in collaboration with the Atomic Energy Research Establishment at Harwell, has carried out valuable pioneering work.

OBITUARIES

Mr. John Evershed, C.I.E., F.R.S.

By the death on November 17 at the age of ninety-two of John Evershed, we have lost the *doyen* of British astronomers. Born on February 26, 1864, at Gomshall in Surrey, he was educated privately and started to work in the chemical industry. He early developed an interest in astronomy and established his own observatory at Kenley in Surrey in 1890. In that year he became one of the founder members of the British Astronomical Association and director of the Section of Solar Spectroscopy. With a small telescope and a spectroscope of his own design and construction, and later with a spectroheliograph also built by himself, he recorded 11,000 solar prominences during his sixteen years work at Kenley. The Evershed solar spectroscope is still an instrument in use to-day.

In 1906 he was appointed assistant director of the Kodaikanal Observatory; in 1911 he succeeded Michie Smith as director, retiring to England in 1923, when he was created C.I.E. in recognition of his work in India. At Kodaikanal he continued his work on prominences and with Mrs. Evershed he published an important memoir on the distribution of prominences during the course of a solar cycle: they noted the excess of eastern over western prominences, the longward displacement of the lines in their spectra and the link between sunspots and metallic prominences. Evershed also greatly improved the quality of the spectroheliograms obtained at the Observatory. His work on sunspot spectra led to his best-known discovery, the radial motion of gases, outwards across the penumbra of a sunspot and inwards at higher levels in the solar atmosphere. This work, published in 1909, led to his election to the Royal Society in 1915 and to the award of the Gold Medal of the Royal Astronomical Society in 1918.

Other work carried out by Evershed at Kodaikanal included studies of solar rotation, of the spectra of comets, Venus and Nova Aquilæ 1918, of the displacement of lines to the red at the centre and limb of the Sun. He also chose a site for the Cawthron Observatory in New Zealand and travelled to the Vale of Kashmir to find a site with first-class seeing for a solar observatory in India. He observed eclipses in Norway, 1896; India, 1898; Algeria, 1900; Spain, 1905; Australia, 1922; and Yorkshire, 1927. Among his eclipse results were the first record of the chromospheric continuous spectrum at the head of the Balmer series and his successful securing of long exposures on the chromosphere by stationing himself close to the edge of the belt of totality.

On his return from India, Evershed settled at Ewhurst in Surrey, where he built himself an observatory for solar work, continuing to obtain high-class spectroheliograms and high-dispersion solar spectra. His chief point of interest lay in exact wave-lengths of lines in the spectra of prominences and of the centre and limb of the solar disk. In a series of papers, giving measures of the highest degree of accuracy and continuing until the year 1949, he discussed the varying displacements of lines to the red. He reached the final conclusion that the Einstein gravitational effect was the main cause of the displacements, though the result was modified by Doppler and Lindholm effects. He also examined some Mount Wilson plates that had been used to determine the general magnetic field of the Sun and concluded that the observed slight displacements were due to localized Doppler effects.

The last published report of the work of his observatory was for the year 1950. On closing it down finally, he presented some of his instruments to the Royal Greenwich Observatory at Herstmonceux.

Evershed married in 1906 Miss Mary Acworth, and she collaborated actively with him in his researches until her death in 1949. He was married a second time in 1950, to Miss Margaret Randall, who survives him.

F. J. M. STRATTON

Dr. A. J. Carlson

WHEN he died on September 2, Dr. Anton Julius Carlson bore the illustrious title of "Frank P. Hixon distinguished service professor emeritus of physiology, University of Chicago".

Carlson was born in Sweden in 1875 and went to the United States in 1891. He graduated A.B. at Augustana College, Rock Island, Illinois, in 1898, A.M. the following year, and Ph.D. in physiology at Stanford University in 1903. After spending one year as a research associate at the Carnegie Institution, he joined the Department of Physiology of the University of Chicago in 1904 and remained there until he retired in 1940 from the positions of professor and chairman of the Department. As professor emeritus he continued actively at work, and himself told a Committee of the House of Representatives in 1950 that "for the last ten years I have been emeritus or demeritus, whatever you call it; however, the only thing I retired from ten years ago was my salary". In the U.S. Army during 1917–19 he was a lieutenant-colonel in the Sanitary Corps, and while serving in Sweden was given the honorary degree of M.D. by Lund. He held honorary degrees from seven universities.

Carlson's early work was on the rate of conduction of impulses in nerves and, after some excursions into the comparative physiology of the circulation, he did his main work upon the physiology of the alimentary tract and of the visceral sensory nervous system. Apart from some two hundred papers, he wrote two books: "Control of Hunger in Health and Disease" and "The Machinery of the Body".

Carlson was honoured by many institutions. He was elected to the U.S. National Academy of Sciences in 1918, to the American Physiological Society in 1904 (being secretary during 1910–14 and president 1923–25), and to a variety of others in the United States and abroad. He had also served as president of the American Association for the Advancement of Science, the American Biological Society, the Federation of American Societies for Experimental Biology, the Institute of Medicine, the American Association of University Professors, and the National Society for Medical Research. In 1935 he lectured in China under the auspices of the Rockefeller Foundation, and he was a frequent traveller, attending seven international physiological congresses between 1909 and 1950, and the international gerontological congress in London last year.

Carlson was a great teacher, and himself said that he had taught between 8,000 and 10,000 medical students, and 75,000–100,000 other students. He was forthright, very outspoken and a keen controversialist. His work as a consultant on Government organizations (such as the Food and Drug Administration and the Office of Scientific Research and Development) often enlivened meetings; but surprising though his statements sometimes appeared, they were always backed by experimental facts, often elicited in his own laboratory.

H. M. SINCLAIR

NEWS and VIEWS

Hungary: American Scientists' Resolutions

THE U.S. National Academy of Sciences at its autumn meeting in Washington adopted the following resolution respecting recent events in Hungary: "Those members of the National Academy of Sciences of the United States of America present at a meeting in Washington on November 10, 1956, unite in expressing their profound admiration and sympathy to fellow scientists in Hungary and to all the men and women of that nation who have demonstrated their love of liberty with sacrificial devotion during the tragic events of the past few weeks. American scientists look forward with hope to a time when their Hungarian colleagues, freed from external oppression, will be able to join fully in the international exchange of information, discussion and encouragement which is essential to the progress of science". Dr. Detlev W. Bronk, president of the Academy, expressed his satisfaction that the Academy's resolution could be associated with a similar statement adopted by the American Philosophical Society. "It is appropriate," he said, "that the Academy should join with the American Philosophical Society, the oldest of the great scholarly societies of the United States, in a matter so closely related to the unconquerable yearning of mankind freely and courageously to advance its highest human and cultural ideals. The statements of the Academy and of the Society recognize with humility and deep gratitude the desperate and courageous struggle of Hungarians for those principles which are precious to all who value the right to seek truth and to teach it freely."

Institute of Metals: Awards

THE Institute of Metals have made the following awards: *Institute of Metals (Platinum) Medal for* 1957: Dr. Maurice Cook, joint managing director, Imperial Chemical Industries, Ltd., Metals Division, in recognition of his outstanding contribution to the science of metallurgy, to the non-ferrous metals industry and to the welfare of the metallurgical profession; *Rosenhain Medal for* 1957: Dr. H. K. Hardy, research manager, United Kingdom Atomic Energy Authority, Industrial Group, in recognition of his outstanding contributions to knowledge in the field of physical metallurgy.

University of Leeds Appeal

IMMEDIATELY before the War the number of full-time students at the University of Leeds was about 1,750. The number has now increased to 3,700 and, among these, the number reading science or technology has grown from 560 to 1,700. In five or six years time it is expected that there will be 5,300 students in all, of whom 3,000 will be reading science or technology. During the past sixteen years the research work of the University has developed at a rapid rate and will develop even more quickly in the next five or six years. To meet these demands, the

University has embarked on a building programme which must be completed in the next five or six years and will cost, in all, about £6,000,000. Most of this money will almost certainly come from the Government which, on the advice of the University Grants Committee, has selected Leeds as one of four universities outside London for 'major developments' in the field of scientific and technological education. The Government has made it clear, however, that it has chosen to help the University of Leeds largely because it believes that Leeds can continue to count on help from other sources; for at least £600,000 of the total needs the University has to look to industry and commerce and to private benefactors. Already £200,000 of this sum has been assured by gifts and promises. The Vice-Chancellor has now issued an appeal to many firms to help the University in its development work. There is little doubt that the appeal will be successful.

Rotherham College of Technology

To mark the twenty-fifth anniversary of the opening of the main building of the Rotherham College of Technology, a Jubilee Foundation Lecture was delivered on November 6 by Mr. R. F. Jackson, operations group leader in the Reactor Division of the Atomic Energy Research Establishment at Harwell, on "Research Reactors in the Nuclear Power Programme". During the quarter of a century since its foundation the Rotherham College of Technology has made a valuable contribution to industry in the Rotherham and Sheffield area. In carrying out extensive pioneer work in technical education it has established a high reputation, both locally and nationally; and during the past four years it has become the regional centre for south Yorkshire for powder metallurgy, furnace brickwork and for sandwich courses in mechanical and electrical engineering.

Clinica Chimica Acta

The newer biochemical techniques, in particular improved methods of separation, such as chromatography and electrophoresis, and the use of isotopic tracers, are opening endless avenues for exploration by those engaged in medical research. As a result, papers on clinical biochemistry are appearing in ever-increasing numbers. These papers are now spread among a wide variety of journals and are often regarded as too clinical by the pure biochemist and as too biochemical by the pure clinician. As a result, in several countries journals have been, or are being, initiated to cater for clinical biochemistry as a scientific discipline in its own right. Messrs. Elsevier have given substance to hopes expressed at the first International Congress on Clinical Chemistry, held in Amsterdam in September 1954, that there should be started an international journal in this field. The new journal is a commercial venture, not attached to any scientific society, and the publishers have been able to assemble an editorial board and an advisory board impressive in their high standing, and carrying assurance of a sound editorial policy (Elsevier Publishing Co., Ltd., Amsterdam, London, Houston, New York. Six issues per year, of approximately 100 pages each. £4 10*s*. per volume of 6 issues). The international flavour is shown both by the composition of the editorial board (the fourteen members of which represent eleven countries) and by the authorship of the thirty-one papers in the first three issues, contributed from ten countries. A very desirable, but probably rather expensive, feature is that summaries of all papers are given in four languages—English, French, German and Russian. This should encourage one of the subsidiary hopes of its founders, namely, that the journal will promote some degree of standardization in biochemical procedures applied to medicine, and thereby facilitate mutual interpretation of results. The format and standard of production are of the high quality which one has learnt to associate with Elsevier publications. The price, as seems almost inevitable nowadays, makes the journal more likely to be taken by libraries than by individuals. If a high editorial standard is maintained, this journal is likely to come to be considered of prime importance in all institutions concerned with clinical biochemistry.

Midwest Research Institute, Kansas City: Annual Report

The annual report of the Midwest Research Institute, Kansas City, Mo. (pp. 16; 1956), presented by the president, Dr. C. N. Kimball, to the Trustees at their eleventh annual meeting on May 14, records a 20 per cent increase in the amount of contract research, which amounted to 2,170,000 dollars in value on 503 different projects for 208 sponsors. Of the Institute's full-time staff, 175 are professional research workers and more than half the work was based on ideas originating with the Institute's own staff. Among projects noted by Dr. Kimball are the work on air pollution in Los Angeles, now in its third year, involving the determination of the effect of materials emanating from automobile exhausts; the development of industrial products, such as polymers from non-edible tallows and greases; and the design of an electromechanical device which, in a relatively small space, simulates operating conditions in an oil-well with respect to the performance of its components. In the field of automation, methods and equipment have been developed for checking practical horse-power motors to meet the requirements of the National Electrical Manufacturers Association, and among the projects on which the eleven people engaged in marketing research have been occupied is an analysis of factors affecting the market potential for anhydrous ammonia as fertilizer. Those engaged in operations research have made a study of the possibility of setting up a mathematical model which would govern inventory policy. Work has been done on the addition of chemicals to food prior to irradiation, and a group of people with extensive experience in the field of nuclear energy is being formed. Projects bearing directly on public health or wealth included broad studies of the basic economy of the Great Plains Area; methods of transmitting to the mind of the blind person information about objects beyond his reach; and the development of an artificial lung and heart to permit operations on the human heart itself. Dr. Kimball believes that in future the production of new technology will become a competitive business activity, and he also stresses the importance of new materials and techniques.

Pacific Science Board: Report for 1954

The eighth annual report of the Pacific Science Board for 1954 (pp. 61. Washington, D.C.: National Academy of Sciences—National Research Council, 1955) summarizes the progress made in studying the environmental factors affecting life on coral atolls, which has been the chief activity of the programme of the scientific investigations in Micronesia. Vegetation and soil distribution and character for thirty-three islets at Kapingamarangi in the Southern Carolines were plotted by the geographer and land ecologist, and the general ecological relations between climate, vegetation, soil character, current and wave effects were plotted on the maps as "land use formulæ" for later analyses. The total fish fauna was intensively studied, as well as the present and potential fisheries. The programme also seeks to develop criteria for estimating the carrying capacity of an atoll. The Invertebrate Consultants Committee for the Pacific continued its investigation as to whether *Gonaxis kibweziensis* snails effectively control the *Achatina fulica* snails on the island of Agiguan, and completed work on the identification of various scientific collections of importance to the ecological study of Pacific atolls. Scientific investigations in the Ryukyu Islands was limited to the preparation of reports and the completion of the nine-month study of cultural changes in Okinawa resulting from the United States military occupation. E. H. Walker's report on important trees of the Ryukyu Islands was published by the Civil Administration of the Islands. Approved field projects included studies of social and economic life in the Society Islands; of law in a primitive society in the Netherlands New Guinea; of mosquitoes in the South Pacific area; and a preliminary study of social aspects of depopulation among the Murits of British North Borneo. Among the matters discussed by the Conservation Committee for Micronesia were the extension of the season for collecting the shells of *Trochus niloticus*, the proposed Palau reserve, forestry practice in the Trust Territory, the introduction of bamboo and implications of the possible release of carrion crows and land snails on islands other than Agiguan. Details are given of Fulbright awards during 1954–55 for research or lecturing in Pacific and East Asian countries.

An Expedition to Papua

A SUMMARY of the results obtained by the fourth Archbold Expedition to New Guinea (1953)—in fact to E. Papua and adjacent islands—under the editorship of L. J. Brass has now appeared as a bulletin of the American Museum of Natural History (3, 2, 83–152; 1956). The summary report gives brief accounts of the physiography, geology and climate of the regions surveyed, together with notes on the economy of the native peoples, previous expeditions and collections and major plant communities. In conformity with previous expeditions of the Archbold series, the main purpose was the collection of biological materials and ecological and distributional studies of mammals, reptiles, amphibians, freshwater fishes, insects, spiders and plants. As the avian fauna of the region was considered to be fairly well known, less attention was given to the collection of birds. Ectoparasites of mammals and soils for screening for antibiotic-producing micro-organisms were also collected. In terms of these materials, the results of the expedition included the following collections: mammals, 1,954; birds, 91; reptiles and amphibians, 1,645; freshwater fishes, 145; insects and spiders, 80,000; ectoparasites of mammals, 750; materials for antibiotic research, 126; plants, 3,445; anthropological items, 34.

Macrolithic Culture of Florisbad, South Africa

THE explorations at the fossil springs at Florisbad in the central province of the Union of South Africa will be always associated with the name of the late Prof. T. F. Dreyer, who described the rich archæological material from the site and had the good fortune to discover the Florisbad skull. A paper on the "Macrolithic Culture of Florisbad" (*Res. Nat. Mus., Bloemfontein*, 1, Part 9, 205; 1956) was in the course of preparation by Prof. Dreyer when he died, and we owe its completion to Prof. A. J. D. Meiring. At the site there are four peats, and while the tools in the upper three are mostly made from lydianite, those from Peat I and below are almost entirely fashioned from dolerite. This early industry may well be considered, then, as a distinct culture from those which occur later on. While carbon-14 dating of the peats, frankly, has not been too satisfactory, it is clear that Peat I was laid down a very long time ago, somewhere about 35,000–40,000 years before our era. The industry here described is very coarse and such as one might expect to be made from pieces of dolerite. There are choppers, coarse points and what Meiring describes as pyramids. One or two specimens can perhaps be termed proto-hand axes; but these rough chopping and pounding tools fall into no very definite category of industry. Some of the dolerite tools were found by Prof. Dreyer in close association with the human skull fragments. Florisbad is an interesting and puzzling site. It cannot be said that we yet have enough knowledge of South African prehistory to fit it exactly into the prehistoric story.

Forestry Commission: Report for 1954–55

IN the Forestry Commission's report on forest research for the year ended March 1955 (pp. 140+12 plates. London: H.M.S.O., 1956; 5*s*. 6*d*. net), it is stated in the introduction that changes are taking place owing to the fact that problems of establishing forests are now becoming less prominent while those of maintenance, protection, management and utilization are becoming more important—an experience which every country taking up forestry seriously has been through. As regards research, there still remain several types of land on which research must be prosecuted to obtain an assurance that successful crops will be attainable. An example is the poor *Scirpus* peats of the north and north-west of Scotland. Experiments have achieved success, where the exposure is not too severe, with intensive cultivation; but more research remains to be done, which is being undertaken with the help of the Macaulay Institute of Soil Research, Aberdeen. Another type of land which has received much recent attention is the ground which lies above the Commission's present planting elevation. Here the current problem is to find out whether it is possible to plant higher and at the same time to obtain a satisfactory yield return. There are very considerable areas of this type of land available for possible treatment. A soils section has been formed at Alice Holt Research Station to carry out routine investigations in conjunction with other sections undertaking this type of work. A summary of the year's work is given by M. V. Laurie, who deals with nursery work, pilot plots for afforestation purposes, ecology, genetics, pathology and entomology and grey squirrels, with a very interesting summary of machinery research that shows the remarkable advances made under the direction of the Forestry Commission. The investigations on mycorrhiza which were commenced at Bedford College, London, are being continued. In other respects the report is on the lines of previous ones.

Fixation of Atmospheric Nitrogen by *Hippophaë rhamnoides* L.

G. Bond and J. T. MacDonnell (*Ann. Bot.*, 20, 79, 501; 1956) have shown that when *Hippophae* plants were inoculated at the six-leaf stage with a suspension of crushed nodules, they began to develop nodules in about two weeks and soon afterwards were able to grow satisfactorily in culture solution free of combined nitrogen. Some 79 mgm. nitrogen per plant was accumulated during seven months of active growth. They conclude that the nodules fix atmospheric nitrogen, and that in its nitrogen nutrition the *Hippophaë* plant shows a close similarity to the nodulated legume. They point out that *Hippophaë* and the other angiosperms with nitrogen-fixing root nodules are all woody species or belong to a family which includes woody types. They also make the interesting suggestion that the physiological property under consideration is a very ancient character and may go back to a period when only woody plants existed. In a further study, G. Bond has found that field nodules of alder, like those of plants grown in the greenhouse, regularly fix nitrogen (*New Phytol.*, 55, 2, 147; 1956).

Scintillation of Starlight

A PAPER by A. H. Mikesell on "The Scintillation of Starlight" (Pub. U.S. Naval Obs., Series 2, 17, Part 4, 143; 1955) describes the results of the observations of scintillation since 1950. The two main objects of the investigations were to measure its effects on the accuracy of stellar photometry and to locate the underlying meteorological causes of the phenomena; and a very full description is given in the paper of the equipment, reduction of observations, discussion of the results, etc., with numerous diagrams. It was found that harmonic components of scintillation decreased with frequency approximately uniformly from 0·1 c./s. to about 500 c./s. Many combinations of telescopes and photoelectric photometers were used, and it was found that the form of the optical equipment was unimportant so long as the objective aperture was circular and all incident light reached the photo-tube. Seasonal variations in scintillation plotted against different frequencies gave the largest values at high frequencies. There was a correlation between scintillation and the maximum speed of winds aloft, especially with winds at altitudes of 8–16 km., but at levels much lower than this region the correlation was not so obvious. At frequencies higher than 150 c./s. the action of the wind was most striking, and on thirty-eight nights when scintillation was observed at frequencies greater than 550 c./s. the maximum reported speed aloft was always greater than 85 m.p.h.; on sixty-two other nights when scintillation appeared only at frequencies less than 550 c./s. the maximum wind-speed exceeded 85 m.p.h. fewer than ten times, and the average maximum speed was 72 m.p.h. with a standard deviation of 23 m.p.h. Detailed examination of the distributions of winds or temperatures on each of the hundred nights of observations showed that there was no correlation of scintillation with a common weather characteristic, such as wind shear, wind direction, location of wind maximum or minimum, intermediate temperature inversion, location or minimum value of the stratospheric temperature, or temperature lapse-rate. The variation of scintillation with zenith distance *z* of the light source was found to be sensitive to frequency; while scintillation is constant at about 100 c./s., below or above this frequency it changes greatly with *z*, a fact which encourages the use of Polaris as a scintillation source in routine observations. Although there is some correlation between scintillation and seeing, more extensive observations and more definitive criteria of seeing are necessary before accurate assessment of the correlation can be made.

Smuts Collection of the Transvaal Museum, Pretoria

IN Bulletin No. 2 of the Transvaal Museum, Pretoria, it is stated that the Smuts collection has, with the consent of the Minister of Education, Arts and Science, been deposited by the Union Archives in the Transvaal Museum. The collection comprises a wealth of items belonging to the late J. C. Smuts and include his field-marshal's baton, medals and decorations, numerous freedoms of cities and other presentations, together with many personal items.

Announcements

PROF. W. T. ASTBURY, professor of biomolecular structure, University of Leeds, has been elected a foreign member of the Swedish Royal Academy of Sciences.

DR. D. S. DANE has been appointed lecturer in microbiology in The Queen's University of Belfast.

DR. G. R. HARRISON, dean of science at the Massachusetts Institute of Technology, has been awarded the first Pittsburgh Spectroscopy Award, which has been established by the Spectroscopy Society of Pittsburgh in recognition of distinguished contributions to this field of science. Among Dean Harrison's outstanding achievements are his numerous studies of line spectra, the measurements and compilations for the "M.I.T. Table of Wavelengths" and important contributions to the ruling of gratings; for ten years he has been editor of the *Journal of the Optical Society of America.*

THE Council of the Gesellschaft Deutscher Naturforscher und Ärzte has decided to establish from time to time a competition to direct attention to certain problems, in natural science and medicine, which call for special discussion, and a prize of D.M. 7,000 has been allocated this year for treatises on "The Formation of Stars by Condensation of Diffuse Matter". Entries may be in English, French or German and should be submitted by April 30, 1958, to the Hamburger Sternwarte, Hamburg-Bergedorf, Gojenbergsweg 112, from which further information can be obtained.

THE fifth International Congress of the International Association on Quaternary Research will be inaugurated at Madrid on September 30 and closed at Barcelona on October 3, 1957. Meetings will comprise sessions dealing with a wide range of subjects bearing on Quaternary geological studies. There will be excursions centred on both cities and into the country between them, to study Quaternary geology and Palæolithic sites. Further information can be obtained from Señor L. Solé Sabaris, Instituto Geological, Universidad, Barcelona, Spain.

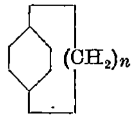
ERRATUM. The title of the communication by Dr. Winifred M. Watkins and Prof. W. T. J. Morgan in *Nature* of December 8, p. 1289, is incorrect; it should read, "Role of O-β-D-Galactopyranosyl-(1 → 4)-*N*-acetyl-D-glucosamine as Inhibitor of the Precipitation of Blood Group Substances by Anti-Type XIV Pneumococcus Serum".

HIGH-RESOLUTION NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY

HIGH-RESOLUTION nuclear magnetic resonance spectroscopy is a rather recent addition to the arsenal of the physical chemist. It has undergone a very rapid development during the past two years, due in large measure to the fact that nuclear-resonance spectrometers with a high degree of field stability are now commercially available. The term 'high-resolution' is generally used for nuclear-resonance measurements of liquid samples under conditions of magnetic-field homogeneity which permit resolution of the signals of non-equivalent nucleii in a given compound and also the fine-structure components arising from spin–spin coupling. The broad resonance signals characteristic of solids, on the other hand, are frequently termed 'broad-line' spectra. There is now ample evidence that the high-resolution nuclear-resonance technique is a very powerful one, and sufficient understanding of the basic phenomena has been gained to demonstrate its advantages as well as some of its limitations.

The basic problem in high-resolution nuclear magnetic resonance work is that of relating the various magnetic effects of the molecule which are measured to the more familiar notions of the chemist regarding electronic structure and molecular configuration. This problem was the central topic of discussion at an informal symposium held during September 6 and 7 at the National Research Council Laboratories in Ottawa. A detailed theoretical treatment of the chemical shift was discussed by Dr. J. A. Pople (Cambridge). The chemical shifts observed can be conveniently discussed in terms of circulating electron currents within the molecule which are induced by the magnetic field. These currents can be classified into three types according to their origin. First, there is the diamagnetic circulation about individual atoms of the molecule corresponding to the well-known Lamb shielding term. This type of magnetic shielding for a given nucleus can frequently be correlated with the electronegativity of neighbouring atoms in the molecule. A second type of circulation may occur in molecules where the nucleus under consideration is bonded to an atom with an electron structure which permits mixing of the ground-state with excited states, so as to give rise to an anisotropic magnetic permeability. It can be shown that this effect will dominate in certain cases where mixing involves transitions between *s*- and *p*-functions or between two *p*-functions. The simple hydrides ammonia, water and hydrogen fluoride are examples of the former, and acetylene of the latter. The chemical shifts of these molecules are anomalous. Dr. W. G. Schneider (Ottawa) reported that the chemical shifts of ammonia, water, hydrogen fluoride and hydrogen chloride, when in the free or unassociated state, lie on the high-field side of the proton signal in saturated hydrocarbons and do not differ markedly from each other. These results cannot be explained on the basis of electronegativity considerations but are readily interpreted in terms of the theory. On association (hydrogen bonding), the proton signals of these hydrides shift to lower field, the shift for hydrogen fluoride being very large, of the order of 8–9 parts per million.

A third type of circulating current is peculiar to aromatic molecules and arises from the circulation of the mobile π-electrons in a magnetic field. As a result, the proton signal of benzene will occur at lower applied field than that of ethylene. The theory provides a rather satisfactory interpretation of the observed chemical shifts of the protons of aromatic hydrocarbons. Further refinements of the theory were discussed by Dr. J. S. Waugh (Massachusetts Institute of Technology), as well as a very interesting experimental confirmation. When a proton is not in the plane of the aromatic ring as in benzene, but out of plane in the vicinity of the hexagonal axis, the chemical shift should be in the opposite direction, that is, to the high-field side of ethylene. This was confirmed by observing the relative proton shifts in compounds of the type:



Several other contributors had also independently observed proton shifts to higher field which can be satisfactorily explained by aromatic ring effects. Dr. A. Bothner-By (Harvard) reported an anomalous shift to high field of the chloroform proton in benzene solution. As a result of complex formation between chloroform and benzene, the chloroform proton signal is modified (shifted to higher field) by the ring current in benzene. This problem was also investigated in greater detail by Dr. L. W. Reeves (Ottawa), who showed that this anomalous shift in chloroform can be observed with benzene, toluene and mesitylene, which complex with chloroform, but not with nitrobenzene or *o*-dichlorobenzene. Dr. J. R. Zimmerman (Magnolia Petroleum Company, Dallas) reported that the proton signal of benzene itself shifts on dilution with hexane; this can be attributed to a preferred mutual orientation of benzene molecules causing a modification of the proton signal by the ring effect. In a dilute solution of benzene this effect will be absent.

The large chemical shifts accompanying hydrogen bonding and association were discussed by several contributors. Dr. C. Reid (University of British Columbia) found that on successive dilution of ethanol with carbon tetrachloride the proton signal of the O—H group, which in pure alcohol is shifted about 5·5 parts per million on the low-field side of the methyl group, moves to high field, until in very dilute solution it appears on the high-field side of the methyl signal. The N—H proton signal in amines shows a similar behaviour. These large shifts of the proton signal accompanying hydrogen bonding are not yet understood. Dr. Zimmerman described a careful and detailed study of alcohol–water solutions. A plot of the chemical shift of the OH proton signal (measured relative to the alcohol methyl signal) against concentration exhibits a discontinuity. Some alcohols give rise to more than one such discontinuity. The correlation time for proton exchange between water and ethanol was found to be of the order of 15 msec. Mr. A. Van Steenbergen (McGill) has studied the chemical shifts accompanying association of a number of alcohols, and the corresponding deuterated alcohols, as a function of temperature, by means of the spin-echo technique.

Nuclear resonance techniques have been very successfully applied by Dr. W. D. Phillips and his associates (Dupont Company, Wilmington, Delaware) to the problem of hindered internal rotation and *cis-trans* isomerism. Fluorine signals in halogenated ethane derivatives as well as proton signals in substituted nitrosamines were found to be double. At higher temperatures these coalesced to a single line. Assignment of the signals to individual isomers could be made. Dr. Phillips also discussed several examples of fluorine exchange in halogen fluorides. The spectrum of ClF_3, for example, which is sharp at − 60° C. but becomes broad at room temperature, can be accounted for by fluorine exchange, involving an activation energy of about 6 kcal.

Dr. P. C. Lauterbur (Mellon Institute, Pittsburgh) has been able to observe for the first time nuclear resonance signals of carbon-13 in natural abundance in a variety of organic and inorganic compounds. The resonances were observed in the dispersion mode at a fixed frequency of 8·5 mc./sec. and a field of about 7,940 gauss. Large variations in the chemical shift were found in the compounds measured, and the spin–spin coupling constant was found to be large (120–270 c./s.). The measurement of carbon nuclear resonances appears to be a very promising future development in the chemical field.

Considerable progress has been made in the problem of understanding and analysing the multiplet structure of high-resolution nuclear magnetic resonance spectra due to spin–spin coupling of the nuclei in a given molecule. The theory of multiplet splitting was outlined by Dr. J. A. Pople, as well as a detailed analysis of the interesting cases which arise when the J-coupling constant is of the same order of magnitude as the chemical shift, δ. Dr. H. J. Bernstein (Ottawa) discussed a number of observed spectra in which these conditions are met and which can be broken down into characteristic spectra of groups of two, three and four interacting nuclei. Analysis of the spectra gave excellent agreement with the theory. Although the meaning of the J-coupling constants in terms of electronic structure is as yet not understood, the values of these constants show significant differences in different classes of compounds.

Chloride ion resonances of chloride salts have been studied by Dr. J. E. Wertz (Minnesota). Large variations in line-width were observed. For example, addition of zinc chloride to aqueous sodium chloride broadens the chloride ion resonance. This is explained by interaction of the zinc ion with the chloride ion, which destroys the spherical charge distribution of the latter, resulting in quadrupole broadening of the resonance line.

The experimental problem of obtaining reliable chemical shift data has been extensively investigated by Dr. Zimmerman. Errors due to sample shape and to the use of internal reference standards were considered. It was recommended that external reference standards be used in connexion with a coaxial sample tube made from precision tubing. Dr. Bothner-By has made a thorough study of the effect of bulk magnetic susceptibility of the sample on the measured chemical shift. The effect, measured directly for a large series of aliphatic compounds and binary solutions, was found to be about 26 per cent greater than that calculated theoretically. With aromatic compounds there is a further anomalous behaviour which can be satisfactorily accounted for in terms of the induced 'ring' current mentioned earlier.

H. J. Bernstein
W. G. Schneider

INTERNATIONAL GENETICS SYMPOSIA IN JAPAN

During September 6–12 the Science Council of Japan was host to two International Genetics Symposia: one on "Applied Genetics", sponsored by the Science Council itself, and one on "Physical and Chemical Approaches to Problems in Chromosomes", sponsored by the International Union of Biological Sciences. The latter had been originally suggested by the International Genetical Society at its last conference at Bellagio, Italy.

The two symposia were held concurrently, at Tokyo and Kyoto. They were attended by some four hundred Japanese geneticists and about a hundred from other countries, the majority of these being from the United States, although there were a few representatives of each of a large number of other nations, both European (including the U.S.S.R.) and Asian. Most of the meetings were held in a fine new building in the centre of Tokyo, the Sankei-kaikan, where there are many small lecture rooms and also a large hall.

On the first morning of the conference, addresses of welcome were given by Dr. H. Kihara, the chairman of the organizing committee, by Drs. S. Kaya and T. Komai, representing the Science Council and Japanese geneticists respectively, and by the Ministers of Education and of Welfare; a reply on behalf of the foreign participants was made by Dr. R. E. Cleland. The conference then got down to business, with a simulating and lucid discussion by Dr. G. W. Beadle on the complicated problem of "Gene Function and Gene Structure", followed by a most valuable general summary, by Y. Tanaka, of the development and present state of genetics in Japan.

On the following days, the conference met in plenary session for general lectures in the mornings, and in separate smaller groups for papers on more specialized topics in the afternoons. The comparatively large number of these sectional groups (about ten) made it impossible for any participant to listen to more than a small fraction of the whole conference, but any disadvantages which might arise from this were, to a large extent, made up for by the excellent facilities for personal meetings and conversations. Not only did most of the lecture rooms open off a large lounge, but our Japanese hosts offered us a number of most delightful informal meals, visits to exhibits, and excursions. Indeed, it is not too much to say that the enormous amount of work which had been devoted to preparing really informative and thorough exhibits, combined with the exceptionally smooth organization of a series of functions which encouraged individual contacts, made this conference one of exceptional value. No one fortunate enough to see the exhibits on silkworm genetics at the State Sericultural Experiment Station, the work on rice at Hiratuka, on the morning glory at Misima, and the series of exhibits on wheat, radish and goldfish at Kyoto, will have failed to carry away a lasting impression of the peculiar strengths of Japanese genetics. Nor shall we easily forget the seedless water-melons offered us at the Institute organized by Dr. Kihara, their originator, at Yokohama.

Of the more social entertainments, which, as has been already mentioned, played a very important part in the general success of the meeting, some may have been most impressed by the visit to a Kabuki theatre, others perhaps by the trip to the famous architectural show-piece at Nikko. Personally, I think I shall treasure even more the dinner offered us on the first evening at a restaurant named the Hosigaoka-saryo. The banal word 'restaurant' conveys little of the reality of this place. The establishment is, more nearly, a park extending up a steep hill below which the lights of Tokyo stretch glittering towards the horizon. Perched on ledges of the hill are temporary marquees, and permanent pavilions with interiors of the fresh purity of line and colour characteristic of classical Japanese building. In one of these there was Japanese dancing, in another Chinese dishes were to be had, but the centre of attraction was a large terrace at which we were offered an initiation, as thorough as one wished to make it, into the delights of the Japanese cuisine. Attempts to master the trick of managing *hachi* (chopsticks), to identify the delicious but unexpected items of sea-food in the deep-fried fritters known as *tempura*, or the algae or other materials used for wrapping and flavouring the rice balls called *sushi*, to discuss whether the rice-wine *sake* is nicer warm or cold, and if it is really quite strong or not strong at all—such things provided the perfect recipe for breaking the ice on the first day of what proved one of the most pleasant and valuable occasions of international contact which has been held in the biological world for many years.

C. H. WADDINGTON

USE OF ANTIBIOTICS AGAINST PLANT DISEASES

THE title gives the theme of a symposium held on September 28 by the Association of Applied Biologists. The symposium, of eight papers, was mainly devoted to the action of two antibiotics, streptomycin and griseofulvin. The latter, a fungistatic substance produced by *Penicillium* spp., has been used solely against plant diseases. Streptomycin produced by *Streptomyces* spp., on the other hand, was originally used in medical research and has only recently been extensively tested against bacterial diseases of plants.

In some of the experiments discussed, the effects of these antibiotics might have been caused by their action at sites remote from the point of application—a property which contrasts with the action of contact fungicides at or near the point of application only.

In his paper, Mr. S. H. Crowdy (Jealott's Hill Research Station) gave proof that both these antibiotics are absorbed from culture solutions by roots of uninfected plants, and that the amount of griseofulvin taken up is simply related to the amount of water transpired and the concentration in the solution. Once within the plant, their fates vary from one host species to another. The greater proportion of griseofulvin taken up by tomatoes stays in the roots, whereas in broad beans the majority moves from the roots and is found in the lower leaves; little is found in the stems of either plant. In contrast, streptomycin accumulates freely in tomato shoots, but only traces are found in the base of broad bean shoots even after prolonged treatment. Similarly, Lelliott found that streptomycin moves only very slowly from the base of carnation cuttings, and even though the cuttings were in streptomycin solutions containing 100 p.p.m. for only 24 hr., its presence could still be detected after 73 days. The rate of decay of griseofulvin in broad beans is relatively constant—there is a straight-line relation between the logarithm of the percentage griseofulvin surviving and time; 50 per cent of the griseofulvin disappears within 5 days.

Griseofulvin affects the development of a wide range of fungal and allied diseases, for example, those caused by *Plasmodiophora brassicae*, *Fusarium* spp., *Erysiphe* spp. and *Botrytis* spp. Adding griseofulvin to mixtures of unsterilized soil and sand inoculated with resting spores of *P. brassicae* decreases the number of root-hair infections on cabbages, the percentage plants clubbed and the size, at least temporarily, of the clubbed roots. In common with the standard fungicides, griseofulvin is most effective against low concentrations of inoculum. Where griseofulvin is only sufficient to reduce club size temporarily, eventually, when its retarding effect has disappeared, bigger clubs are produced than on the untreated plants. Associated with the larger clubs is a greater weight of foliage. This result probably reflects the ability of large plants when inoculated—in this experiment equivalent to when the griseofulvin no longer inhibited—to develop bigger clubs with less disruption than small plants.

The effects of soil applications of griseofulvin given three weeks after inoculation suggest that it can act systemically against *P. brassicae*. By then infection had occurred and the early stages of club formation within the root cortex were probably taking place. A week later clubs were seen only on the untreated controls, and after a further four weeks the clubs on the untreated controls were still five times larger than on the treated plants (Drs. F. T. Last and I. Macfarlane, Rothamsted Experimental Station).

Further evidence of its systemic properties was given by Dr. A. Rhodes and Messrs. R. Crosse and R. McWilliam (Glaxo Laboratories, Ltd.), who controlled chrysanthemum powdery mildew, a leaf disease caused by *Oidium chrysanthemi*, by watering the roots with a wettable powder formulation of griseofulvin. Although no attempt was made to give equal amounts of active principle, soil applications were more effective than foliage sprays. Sprays containing 0·025 per cent griseofulvin were as effective as 'karathane' (dinitro capryl phenyl crotonate) sprays containing 0·05 per cent active principle.

Two sprays containing 0·025 per cent griseofulvin, one prepared with a wettable powder and the other with an NN-dimethylformamide liquid concentrate, were equally effective against chrysanthemum powdery mildew. The efficacy of the griseofulvin, however, was less in the wettable powder formulation since the powder alone gave significantly greater control of mildew than NN-dimethylformamide. In other small plot tests, griseofulvin controlled the incidence of *Botrytis cinerea* on lettuce and *B. tulipae* on tulips. In the control of the latter disease, tulip fire, under commercial conditions, griseofulvin sprays were more effective than 'Ferbam' sprays (ferric dimethyl dithiocarbamate) when compared weight for weight of active principle.

The results of experiments done in artificial and natural conditions do not invariably agree. Mr. J. Drew Smith (Sports Turf Research Institute) has found in preliminary trials that spray applications (0·044–0·088 per cent griseofulvin) to turf, before inoculation with *Fusarium nivale* and *Sclerotinia homoeocarpa*, give very effective control of their respective diseases, *Fusarium* patch and dollar spot. In field trials relying on natural infection, however, they appear less effective and do not give as good control as mercury and cadmium fungicides. The apparent drop in the efficiency of griseofulvin may be attributable to changes in its formulation.

Similarly, the field-results using streptomycin do not always confirm the promise shown by initial tests. Of the two materials, streptomycin and 'Agrimycin' (1 : 10 mixture of oxytetracycline and streptomycin), the former was used against *Pseudomonas caryophylli*, the cause of bacterial wilt of carnations, and the latter against *Erwinia* sp., the cause of slow wilt of carnations. The highest minimal bactericidal dose recorded for a range of isolates was 5 p.p.m. of streptomycin against *Ps. caryophylli* and 3 p.p.m. of 'Agrimycin' against *Erwinia* sp.

The effects of these antibiotics on their respective diseases vary with the substrate in which the crops are, when they are applied. By standing a mixture of healthy and infected cuttings in solutions of 50–100 p.p.m. for 24 hr., both materials eliminate transmission but do not cure the infected plants. However, solutions of 'Agrimycin' of similar concentrations do not significantly reduce the spread of slow wilt when watered to cuttings rooting in sand.

The discrepancy between the effective bactericidal doses of both streptomycin and 'Agrimycin' against their respective pathogens in culture and on the host may be attributed to many factors. As with some of the standard fungicides, for example, chloronitrobenzenes, the efficacy of the antibiotics may be affected by the substrate on which the test organism is growing (Mr. R. A. Lelliott, Plant Pathology Laboratory, Ministry of Agriculture, Fisheries and Food).

The effect of streptomycin on bacterial canker of cherry caused by *Pseudomonas mors-prunorum* varies with the stage in the host's development at application. Spraying trees with streptomycin hydrochloride (220 p.p.m.) during the spring blossom period has a large immediate effect in reducing the severity of the necrotic leaf-spotting phase of the disease, but has little persistent effect on the supply of inoculum available for infection of branches in the autumn, as measured by the numbers of bacteria present on the leaf surfaces. Autumn sprays of streptomycin reduce the amount of leaf-surface inoculum, but less effectively than 'low'-strength Bordeaux mixtures. However, despite its apparent inferiority as a surface bactericide, streptomycin is almost as effective in reducing branch infections as Bordeaux mixture. Unequivocal evidence of the systemic activity of streptomycin was not obtained, although the effects of the spring sprays for the control of the leaf-spot phase may be partly attributed to this mode of action (Dr. J. E. Crosse, East Malling Research Station).

At this symposium, there was ample evidence to show that griseofulvin and streptomycin can reduce the severity of a range of plant diseases, and in some trials, notably against chrysanthemum powdery mildew, tulip fire and the silvering disease of beet, the antibiotics were at least as effective as, if not more effective than, the materials at present in general use. The seed-borne organism causing silvering disease of beet, *Corynebacterium betae*, was as effectively controlled by soaking seeds in streptomycin solutions at 200 p.p.m. for 24 hr. as by dusting them with mercury fungicides (Dr. W. G. Keyworth, National Vegetable Research Station).

To gain the maximum advantage from these materials, emphasis should be turned to studying their accumulation within the host in relation to possible disease control. Thus with tomatoes, which accumulate griseofulvin in the roots, the probability of control is greater with root- than with leaf-infecting parasites.

Their use, as with most chemicals, does, however, present a number of hazards. Concentrations of griseofulvin unnecessarily high for the control of clubroot damaged cabbages, and the root growth of carnation cuttings, stood for 24 hr. in streptomycin solutions, progressively decreased as the concentration increased above 50 p.p.m. Rooting hormone can, however, be used as an antidote to this latter effect.

Apart from their harmful effects to plants when used indiscriminately, they may in addition detrimentally affect the health of man, a fact stressed by Dr. R. A. Shooter (St. Bartholomew's Hospital, London). In medical practice, some people, principally those dealing daily with its administration, have developed a sensitivity to streptomycin, and so cannot now avail themselves of its beneficial properties against disease unless de-sensitized. This risk has since been much reduced by making simple alterations in the handling technique. Apart from the preparation of sprays, the risk of developing sensitivity to antibiotics, if used as plant protectants, may arise from exposure to spray drift. It is, however, probably much less than in medicine, since the concentrations used are much lower. The effects described of streptomycin against plant diseases were caused by 0·02 per cent solutions; in medicine, preparations containing 10 per cent are used. Although no examples of sensitization from handling antibiotics included in animal feeding stuffs were quoted during the symposium, the effect of consuming residues persisting on and in sprayed food is still a matter of conjecture and needs investigating.

These two hazards, toxicity to plants and sensitization of man, can be minimized by (*a*) thorough research before making recommendations and (*b*) by careful handling techniques. Already streptomycin is being used against plant diseases in New Zealand and the United States. A possible third hazard, the development of parasites resistant to antibiotics, is, however, less readily combated. Although the minimal dose of a material necessary to kill or inhibit the growth of parasites *in vitro* may be known, it is impossible to maintain such concentrations continuously *in vivo*. Thus conditions occur in which the concentrations of antibiotics are sub-lethal or sub-inhibitory, and in which adjustments in the population of parasites may take place. Although this type of adaptation has not been a serious problem in the control of plant pathogens with standard fungicides in the field, in medicine, and especially with the antibiotics, it causes great difficulties. As yet, antibiotics have been used against plant disease in the field for too short a time to assess the magnitude of this hazard.

F. T. Last

INDUSTRY AND THE TECHNICAL COLLEGE IN BRITAIN

THE handbook entitled "Industry and the Technical Colleges"*, which has been issued by the Joint Federation of British Industries–Technical Colleges Committee under the auspices of the Federation's Education Committee, is based on papers prepared by the Committee as a sequel to discussions at a conference convened by the Federation in May 1954 between representatives of industry and the technical colleges. Among the points covered at the conference were co-operation between industry and the technical colleges, flexibility in technical education, recruitment from the secondary schools, the supply of teachers, sandwich courses, advanced short courses in applied science and technology, research in technical colleges, technological careers for women, the technical college and education for management, and equipment in technical colleges. The handbook, which is published as a contribution to the public discussion of these important issues, sets forth the views and recommendations of the Joint Committee.

Recognizing that a growing proportion of the technicians and technologists required by industry in Britain will come from the technical colleges, the handbook urges the need for greater co-operation, both formal and informal, between industry and the technical colleges: unless they are aware of each other's activities, the colleges will be unable to provide what is needed and industry will not reap the full benefit of the resources available. Accordingly, the Committee recommends that directors and senior executives should be prepared to serve on governing bodies, advisory committees and regional councils and that firms should plan training programmes in close consultation with colleges and expand part-time day release wherever possible. The colleges are recommended to review, where appropriate, the composition and terms of reference of governing bodies and advisory committees, and to adjust courses and teaching methods to the changing needs of industry. They should also encourage the secondment of teachers to industry, and firms are recommended to make available qualified members of their staff for part-time teaching.

As regards courses, firms are recommended to assist actively the development of 'sandwich' courses, and small- and medium-sized firms should co-operate in jointly sponsoring appropriate specialized courses. The co-operation of industrialists in the selection of management students is essential, and firms should inform colleges and regional advisory councils of the calls for special advanced courses. On their side, the colleges should see that syllabuses of vocational courses contain a proportion of liberal subjects and should see both that secondary school boys and girls are more fully informed of their facilities and that more information about advanced courses is brought to the knowledge of industry generally. Research in technical colleges should be expanded and devoted primarily, but not exclusively, to the solution of industrial problems. Teaching staffs should be encouraged to undertake research, and industry could help by grants, gifts and loans of special equipment, and of periodicals and special publications, as well as by establishing research studentships or junior fellowships. The importance of publishing industry-sponsored research whenever possible is stressed.

The handbook recommends the employment of more women in scientific and technological work and suggests that the colleges could help here by training girls for employment in such capacities as laboratory assistants. The need for better technical equipment is also emphasized, and firms are recommended to assist by donations in cash or in kind, while the establishment by the colleges of a central clearing-house for exchange of information on offers of equipment is suggested. The importance of social amenities is likewise stressed, and any help which industry can give in this respect will be a very real contribution towards achieving the aims of technical education in Britain to-day.

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* Industry and the Technical Colleges: A Review of Some Current Problems. (F.B.I. Handbook.) Pp. iii+44. (London: Federation of British Industries, 1956.) 3s.

SOCIAL AND ECONOMIC RESEARCH

A COMMITTEE with considerable if indirect influence on Great Britain's social and economic policy was set up in 1947 by the then Lord President of the Council and the Chancellor of the Exchequer. The committee is called the Interdepartmental Committee on Social and Economic Research and its members are drawn from university and government departments concerned with social and economic matters either as subjects of study and research or as branches of public administration. The Committee was given the following terms of reference and these have not been changed during the intervening years: "to survey and advise upon research work in government departments, and in particular (*a*) to bring to the notice of departments the potential value for research purposes of the material which they collect and to suggest new methods and areas of collection; (*b*) to advise on how there could be made available to research workers information gathered for their own purposes by the departments which has potential value as material for research".

The Committee has now produced its third report and, in it, surveys the recommendations it has made and the results it has achieved over the past nine years*. Various lines of approach have been used for ensuring that government departments are aware of the interest of research workers in the data assembled for administrative purposes and also in appropriate cases to suggest new methods and areas of collection. For example, general recommendations have been addressed to social and economic departments on such matters as consultation on their statistical programmes; the deposit of unpublished government papers in suitable libraries has been advocated and facilitated; the aims and activities of the Committee have been brought to the notice of a wider public through the publication of reports and "guides to official sources". The more usual procedure during the period under review, however, has been to make suggestions to particular departments after their work and the material which they collect and produce have been intensively studied by one of the specially appointed sub-committees, which are suitably strengthened for the purpose.

The second main concern of the Committee is that research workers should know what material is available and should, within reason, be helped to gain access to it. To some extent the Committee's recommendations have led to the publication of additional material by departments in annual reports or otherwise. The Committee itself has published several "Guides to Official Sources"; has circulated to a select list of university and other research libraries particulars of unpublished material which departments are willing to make available to the libraries; and, on a few occasions, the Committee has been able to put individual research workers in touch with the appropriate departmental officers.

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* Report of the Interdepartmental Committee on Social and Economic Research (H.M.S.O., 1956).

In earlier reports the Committee emphasized how difficult it sometimes was for the research worker to discover what material of relevance to his studies actually existed in government departments and how these could be made available.

Recent investigations suggest that, in general, departments publish statistics more freely than they used to and are usually prepared to deal sympathetically with requests for access to unpublished material in their possession.

The well-proved device of *ad hoc* sub-committees, made up of those members of the Committee with special knowledge or special interest in the subjects under review and reinforced with outside experts co-opted for the purpose, has again been the standard mode of procedure in the examination of the basic questions: what do departments collect; how far is it or could it be published or made otherwise accessible to students; and are there changes in present methods or treatment of the material that seem worth making in the department's own interest on one hand or in that of research workers on the other?

The work of four such sub-committees during 1951–55 is covered by the present report. They were concerned with the Board of Trade; with the proposed content of statistical tables for the reports of the 1951 Census; with local government statistics relating particularly to finance; and with the Ministry of Food.

Recommendations made to departments during the five years ranged widely. Patents, company records, insurance and bankruptcy statistics, as well as statistics relating to the administration of enemy property, are among the subjects on which recommendations were made to the Board of Trade; the Committee also conveyed its views to the Board on the question of publishing selected papers on foreign economic relations.

The registrars general were advised on tables for information obtained by the 1951 Census on birthplace and nationality, education, classification by social class, the cross-classification of occupation within industries, fertility, housing and the characteristics of private households. The Committee also made suggestions for detailed census statistics of the large conurbations (Greater London, west Midlands, south-east Lancashire, Merseyside, west Yorkshire, Tyneside and central Clydeside).

Recommendations were made to those departments concerned with local services and which publish, either in their annual reports or as separate returns, a wide range of local government statistics on such matters as finance, health education, child care, police and fire services and local elections.

The broad nature of the survey of Ministry of Food material did not preclude the committee from making recommendations on points of detail. The report refers to statistics of food supply and procurement, home production, processing and manufacture; stocks; the distribution and use of food; the administration of food controls; prices and margins; and household food surveys. In particular, the Committee pointed to the research interest in the continuance of the National Food Survey and advocated two publications on statistics of food and agriculture: a periodical for current figures and a further addition to the series of "Guides to Official Sources".

The report touches on the relevance to the Committee's work of the recommendations of the Grigg Committee on departmental records, and also emphasizes the importance to research in the social sciences of being able to obtain comparable statistics from each part of the United Kingdom. In the latter connexion, reference is made to the recent production by departments of a key to differences between English and Scottish statistics of crime.

This report serves as a reminder of the need for close co-operation between departments, as the gatherers and producers of information (particularly statistical data) on almost every aspect of economic and social conditions, and the universities and research institutes which can also use that material for the common good.

TREATMENTS AFFECTING FREE ENDOGENOUS GROWTH-SUBSTANCES IN PLANTS

BECAUSE they considered that the possible effects of synthetic auxins and anti-auxins on the metabolism of indole-3-acetic acid have been inadequately studied, L. J. Audus and R. Thresh have investigated the effects of such synthetic substances on the levels of free endogenous growth-substances in plants (*Ann. Bot.*, N.S., 20, 79, 439; 1956). Seedlings of peas, beans and sunflower were treated with the synthetic auxin, 2,4-dichlorophenoxyacetic acid, and two supposed anti-auxins, 2,3,5-tri-iodo-benzoic acid and maleic hydrazide, at non-toxic levels sufficient to cause well-marked growth responses. Estimates of the content of alcohol-extractable growth-substances were afterwards determined, after separation by paper partition chromatography. Six active natural compounds were indicated in these extracts, but only the effects of treatments on indole-3-acetic acid levels have been followed in detail.

As 2,4-dichlorophenoxyacetic acid treatment of both leaves and roots had no detectable effect on the levels of free endogenous indole-3-acetic acid, the authors conclude that it is an auxin in its own right and does not act on growth by disturbing the indole-3-acetic acid metabolism. There are indications that considerable amounts of the absorbed 2,4-dichlorophenoxyacetic acid are converted in plant tissues to a neutral detoxication product which is easily decomposed to liberate 2,4-dichlorophenoxyacetic acid during chromatographic analysis. Treatment of pea roots by 2,3,5-tri-iodo-benzoic acid is very effective in reducing their free endogenous indole-3-acetic acid content, in some cases to 1/10,000 the normal level. The implications of these findings are discussed in terms of the physiological and morphological responses of plants to 2,3,5-tri-iodo-benzoic acid treatment. The authors state that maleic hydrazide may increase slightly the level of free endogenous auxin in pea roots but that further confirmatory work is required.

THE FLIGHT OF VERY SMALL INSECTS

By G. A. HORRIDGE
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EXPERIMENTAL work on the flight of insects has in general confirmed the view that the wing of an insect in flight acts as an aerofoil[1]. However, there are available aerodynamical results[2] which indicate the existence of a lower limit to the size of an insect wing which can act effectively as an aerofoil. This proves to be near the observed limit of known wings of normal shape, though the structure of certain very small wings indicates a different mechanism of flight.

Accurate measurements of the forces on an aerofoil at very low speeds have been made by Thom and Swart[2]. Working with aerofoil *RAF 6A*, 1·24 cm. chord, 7·5 cm. span, they were able to make measurements in oil down to Reynolds numbers less than unity (calculated on the chord). It was discovered that below $R_e = 10$ the lift is no longer proportional to the square of the velocity for a given angle of incidence, but becomes proportional to the velocity of the free stream. Similarly, the drag coefficient begins to increase at $R_e = 10$, and reaches a value greater than 10 for $R_e = 1$, whereas it is about 0·5 for $R = 100$. The most relevant aspect of these results for insect flight is the ratio, recalculated from their results, of the drag forces to the lift forces, and this is plotted for various values of Reynolds numbering in Fig. 1.

It is clear from the graph that the Reynolds number must be greater than 100 if the inertial components, which ultimately produce the lift, are to be significantly greater than the viscous components, which are responsible for the drag. This means that at Reynolds numbers less than 100 the aerofoil is progressively ceasing to act in the manner that we normally expect at high Reynolds numbers.

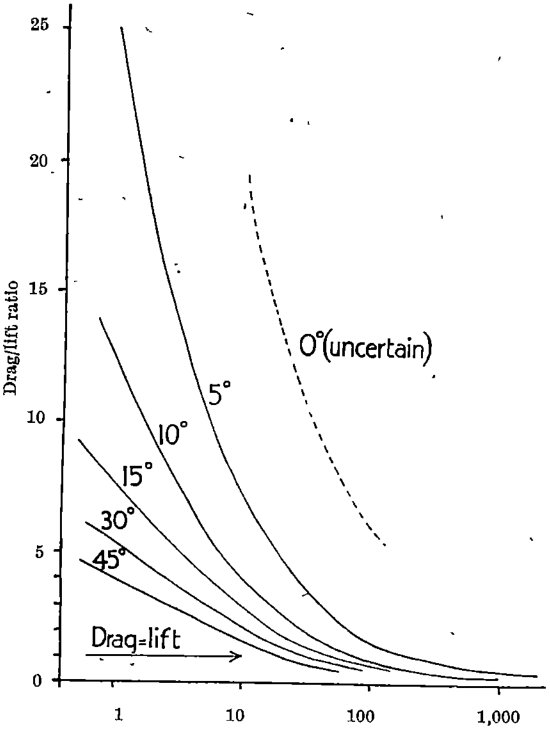

Fig. 1. The ratio drag/lift for various values of Reynolds number and a range of angles of incidence. Calculated from Thom and Swart (ref. 2)

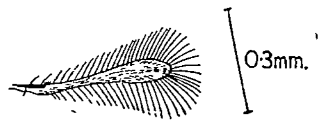

Fig. 2(*a*). Fore-wing of *Anagrus incarnatus incarnatus* Haliday from Debauche (ref. 5)

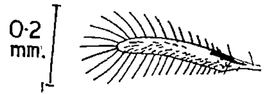

Fig. 2(*b*) Fore-wing of *Anaphes augustipennis* Debauche

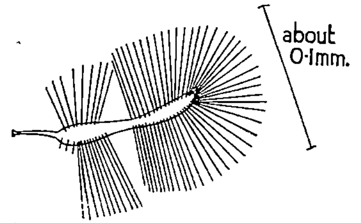

Fig. 2(*c*). Wing of the beetle *Oligella foveolata* Allib. (after Flach, ref. 6)

Now if the values of the Reynolds numbers for various sizes of insect wings with a possible range of frequencies $50 < f < 250$ are calculated, numbers less than 100 appear for the lower ranges of frequency and wing chord. The values calculated in Table 1 are based on a length/breadth ratio of 4/1 (Reynolds number calculated on the chord). As a value for the effective velocity, it is assumed that the wing moves through a distance twice its length (up and down) multiplied by its frequency. This estimate of Reynolds number inclines towards a high value, and for wings of length/breadth ratio 2/1, as in Fig. 2, the results for corresponding numbers are a half of those given.

The smallest insect wings come in a size-range where the Reynolds number alone makes them very inefficient as an aerofoil. I have not been able to discover any figure for the frequency of the wing-beat of the forms illustrated in Fig. 2, but it is unlikely that it will be above the range considered in Table 1. The peculiar fact that such small wings are made of bristles instead of a continuous membrane was noticed by D'Arcy Thompson[3], who suggested that viscous forces play a large part in the action of such wings. The convergence between the hymenopteran mymarid wings (Fig. 2*a* and 2*b*) and

Table 1. Approximate Values of Reynolds Number for Small Wings of Various Breadths
It is assumed for the effective velocity that the wing moves through a distance twice its length multiplied by the frequency per second

Length–breadth ratio = 4

Wing-breadth (mm.)	Frequency/sec. 50	100	150	200	250
0·1	3	6	9	12	15
0·2	12	24	36	48	60
0·4	48	100	150	200	250
0·8	200	400	600	800	
1·6	800				
3·2			$R_e > 1,000$		

the beetle *Oligella* (Fig. 2*c*) is noteworthy. These examples are some of the smallest insect wings, and it seems that they must be operating in the range where viscous drag forces are several times any possible lift forces. It is probable that they have abandoned altogether the aerofoil action and that they literally 'swim' in the air.

Flight would still be possible in these circumstances if there were some mechanism by which the drag on the upstroke is made less than that on the downstroke. If the ratio of downstroke drag to upstroke drag is greater than, say, 5/4, the net upward force from this source would be of the same order as the lift derived from an aerofoil action. A possible mechanism would be to have bristles or a whole wing that bends more easily on the upstroke than on the downstroke. From Thom and Swart's data, it appears that a twist of the wing would not suffice, because the drag at low Reynolds numbers becomes independent of the angle of incidence. Whatever the mechanism, it must be very wasteful of energy.

It is an interesting fact that some of the Mymaridae can 'fly' underwater, using their wings at a frequency of about two beats per second[4], for which there must be some kind of differential drag mechanism.

A feature of Thom and Swart's results is that high angles of incidence up to 45° are effective in producing lift at very low Reynolds numbers. Fig. 1 shows that a lower drag/lift ratio is achieved by high angles of incidence in the range $10 < R_e < 1{,}000$. It is tempting to consider here the general tendency for small insect wings to be without the veins which stiffen their posterior edges. This produces a greater flexibility of the trailing edge and agrees with the lift improvement at high angles of incidence, if at the same time they have given up the active twist of the wing and 'swim' through the air in much the same way as a fish if it had only a passive tail flap. The opinions here advanced can only be confirmed by observation of the insects in question; but the aerodynamical results at low Reynolds numbers certainly indicate a lower size limit to the action of an aerofoil.

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BILIRUBIN, AN UNCOUPLER OF OXIDATIVE PHOSPHORYLATION IN ISOLATED MITOCHONDRIA

By Dr. R. ZETTERSTRÖM and Dr. L. ERNSTER

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JAUNDICE, due to an accumulation of indirect bilirubin according to the van den Bergh reaction (recently established to consist of free, non-conjugated bilirubin[1,2]), is a relatively common and harmless phenomenon in new-born infants whose liver function is not yet fully developed. In prematurely born infants[3], however, or in those born with a hæmolytic disease (for example, that due to iso-immunization), hyperbilirubinæmia may attain an extremely high degree. In such cases, regardless of the etiology of the hyperbilirubinæmia[4], a syndrome of severe brain damage may develop, called kernicterus, or bilirubin encephalopathy[5]. It is also known that high levels of indirect serum bilirubin may lead to liver dysfunction[6,7]. These facts have directed attention to the possibility that free bilirubin might exert a toxic action on tissue metabolism. Working with brain homogenates, Day[8] and Waters and Bowen[9] have recently demonstrated decreased respiration in the presence of bilirubin—an effect which could be reversed[8] by the addition of cytochrome *c* or diphosphopyridine nucleotide[10]. In the present communication evidence is presented that bilirubin uncouples phosphorylation from respiration in isolated liver mitochondria and causes, as a secondary effect, a release of respiratory cofactors, such as diphosphopyridine nucleotide and cytochrome *c*, from the mitochondrial structure.

The experiments were performed with liver mitochondria prepared from white rats (Wistar) according to the method of Schneider and Hogeboom[11]; details of the preparation have been described elsewhere[12]. Mitochondria from one liver, washed twice with 0·25 *M* sucrose, were suspended in 20 ml. of a solution containing 0·15 *M* potassium chloride, 0·05 *M* potassium orthophosphate (*p*H 7·5), 0·001 *M* disodium adenosine triphosphate and 0·06 *M* glucose. The suspension was supplemented with 2 ml. 0·1 *M* magnesium chloride and with an excess of yeast hexokinase, and made up to 30 ml. with 0·25 *M* sucrose. Aliquots of 1·5 ml. of this suspension were added to Warburg vessels containing 30 micromoles substrate and further additions to be tested. The final volume in each vessel was adjusted to 2 ml. with 0·15 *M* potassium chloride. Oxygen consumption was measured at 30° C. for 15 min., including 5 min. of thermoequilibration; the oxygen consumption for this period was calculated by extrapolation. After the manometric recording, the samples were fixed with 0·5 ml. 50 per cent trichloroacetic acid and filtered. Phosphate uptake was estimated in 0·1-ml. aliquots of the filtrates by the isotope distribution method described elsewhere[13]. For the determination of adenosine triphosphatase activity, mitochondria from one liver were suspended in 30 ml. of 0·25 *M* sucrose. Aliquots of 1 ml. were added to 50-ml. Erlenmeyer flasks containing 2 ml. of 0·016 *M* disodium adenosine triphosphate in 0·25 *M* sucrose, 0·4 ml. of 0·5 *M* *tris*(hydroxymethyl)amino-methane buffer (*p*H 7·5), 0·2 ml. of 0·1 *M* magnesium chloride and 0·4 ml. of 0·1 *M* potassium chloride including the individual additions to be tested. When the effect of hypotonicity was to be investigated the mitochondria were suspended in 0·025 *M*, rather than 0·25 *M*, sucrose, and incubated at 30° C. for 15 min. before being added to the reaction mixture.

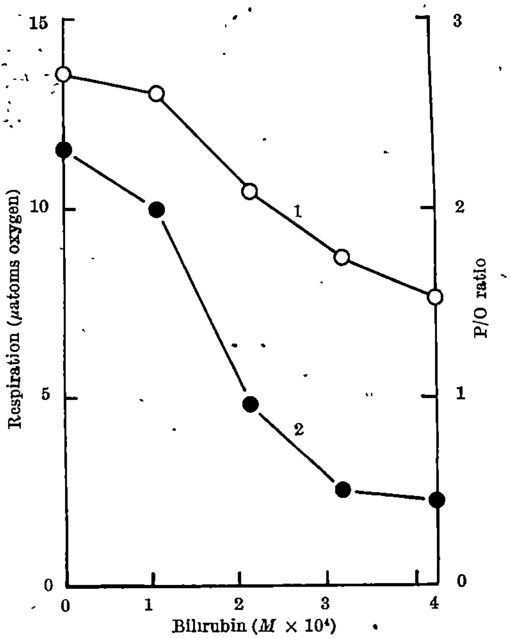

Fig. 1. Effect of varying concentrations of bilirubin on oxidative phosphorylation supported by glutamate. Curve 1, O—O, respiration; curve 2, ●—●, P/O ratio

Each Warburg vessel contained: mitochondria from 1/20 liver, 30 micromoles potassium L-glutamate, 50 micromoles potassium orthophosphate (pH 7·5), 1 micromole disodium adenosine triphosphate, 60 micromoles glucose, 10 micromoles magnesium chloride, 200 micromoles potassium chloride, 100 micromoles sucrose, and 25 microlitres of a stock solution of yeast hexokinase (cf. ref. 16), in a final volume of 2 ml. Gas phase, air; centre well, 0·2 ml. 2 M potassium hydroxide. Temp., 30° C. Time of incubation, 15 min.

The flasks were incubated at 30° C. with gentle shaking. Samples of 1 ml. were removed at 0, 10 and 20 min. and added to 2 ml. of ice-cold 10 per cent perchloric acid. After filtration, orthophosphate was determined in 1-ml. aliquots by the colorimetric method adapted[14] from Martin and Doty[15].

Solutions of bilirubin were prepared by dissolving 10 mgm. crystalline bilirubin (Merck Chemical Co., Darmstadt) in 2 ml. of 0·2 M potassium hydroxide and adjusting the pH to just below 8 by the dropwise addition of 1 M hydrochloric acid. The solution was made up with water to 4 ml. and further diluted, when desired, with 0·1 M-potassium chloride. Biliverdin was obtained by exposing an alkaline solution of bilirubin to oxidation in air, the colour shift being controlled spectrophotometrically.

Table 1. EFFECT OF BILIRUBIN ON OXIDATIVE PHOSPHORYLATION SUPPORTED BY VARIOUS SUBSTRATES

Substrate, 30 micromoles. Bilirubin, 4·3 × 10^{-4} M. Other experimental conditions as in Fig. 1

Substrate	Without bilirubin		With bilirubin	
	Oxygen (µatoms)	P/O ratio	Oxygen (µatoms)	P/O ratio
L-Glutamate	12·1	2·79	7·6	0·54
α-Ketoglutarate	10·1	2·83	12·0	0·67
Succinate	12·3	1·53	8·4	0·24
Pyruvate + 3 µmoles L-malate	12·2	2·58	12·0	0·42
DL-β-Hydroxybutyrate	8·1	2·58	9·1	0·43

Table 2. COMPARISON OF THE EFFECTS OF BILIRUBIN AND BILIVERDIN

Experimental conditions as in Fig. 1. Bilirubin or biliverdin, 4·3 × 10^{-4} M

Addition	Oxygen (µatoms)	P/O ratio
None	13 6	2·32
Bilirubin	7·6	0 45
Biliverdin	13·0	2·63

Fig. 1 shows the effect of varying concentrations of bilirubin on oxidative phosphorylation supported by glutamate. At a concentration of about 3 × 10^{-4} M, bilirubin causes an almost complete inhibition of phosphorylation, accompanied by a partial inhibition of respiration. As shown in Table 1, a similar picture is obtained if glutamate is replaced by α-ketoglutarate, succinate, pyruvate or β-hydroxybutyrate, although the effect on respiration may be less pronounced, or even absent. Among derivatives of bilirubin, so far only biliverdin has been tested and found, as shown in Table 2, to be without effect on either respiration or phosphorylation.

Table 3. EFFECT OF BILIRUBIN ON MITOCHONDRIAL RESPIRATION UNDER VARIOUS CONDITIONS

Experimental conditions as in Fig. 1. Additions: bilirubin, 4·3 × 10^{-4} M; diphosphopyridine nucleotide, 6·8 × 10^{-4} M; cytochrome c, 10^{-5} M; 2,4-dinitrophenol, 10^{-4} M

Additions	Without hexokinase	With hexokinase	
	Oxygen (µatoms)	Oxygen (µatoms)	P/O ratio
None	2·3	13 6	2·32
Bilirubin	5·1	7 6	0·45
Bilirubin + diphosphopyridine nucleotide		11·6	0·42
Bilirubin + cytochrome c		10·9	0·40
Bilirubin + diphosphopyridine nucleotide + cytochrome c	13·8	13 9	0·43
2,4-Dinitrophenol	13·7	14 1	0·33

In Table 3 some further effects of bilirubin on mitochondrial respiration are demonstrated. The partial inhibition of respiration, found at higher concentrations of bilirubin, can be prevented by the

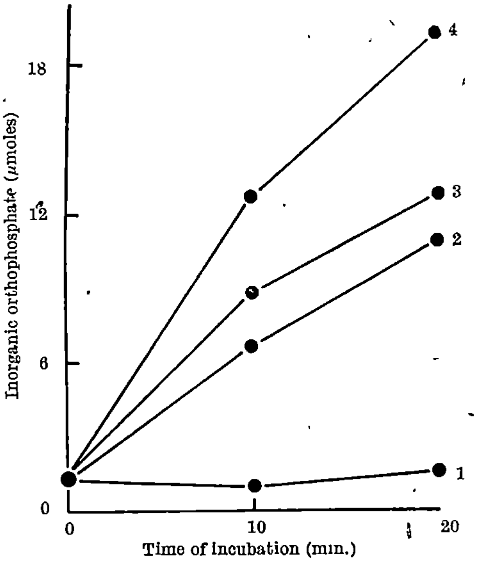

Fig. 2. Effect of bilirubin on mitochondrial adenosine triphosphatase activity

Each of the four series contained: mitochondria from 1/30 liver, 32 micromoles disodium adenosine triphosphate, 20 micromoles magnesium chloride, 200 micromoles *tris*(hydroxymethyl)aminomethane buffer (pH 7·5), 40 micromoles potassium chloride, and 750 (in series 3, 525) micromoles sucrose, in a final volume of 4 ml. Incubation at 30° C.

Series 1, no addition or pretreatment; 2, 4·3 × 10^{-4} M bilirubin added; 3, no addition; mitochondria pretreated with 0·025 M sucrose at 30° C. for 15 min.; 4, 10^{-4} M 2,4-dinitrophenol added combined addition of diphosphopyridine nucleotide and cytochrome *c* (or by cytochrome *c* alone in the case of succinate); but these additions fail to prevent the effect of bilirubin on phosphorylation, the phosphate/oxygen (P/O) ratios being invariably low. This indicates that the primary action of bilirubin consists in an uncoupling of phosphorylation from respiration. The loss of the respiratory cofactors, diphosphopyridine nucleotide and cytochrome *c*, may be a secondary consequence of this effect, possibly due to a labilization of the mitochondrial structure. A similar phenomenon has recently been demonstrated to occur when 2,4-dinitrophenol is acting as an uncoupler of phosphorylation in a mitochondrial system which has been supplemented with an extremely high level of hexokinase[16]. Bilirubin seems, however, to be more potent in evoking this secondary effect than is dinitrophenol.

A further indication that bilirubin acts primarily as an uncoupler of phosphorylation from respiration emerges from the fact, also shown in Table 3, that it, like dinitrophenol, is able to induce a maximum level of respiration in mitochondria that have been incubated in the absence of hexokinase, that is, the respiration of which is limited by the lack of a terminal phosphate acceptor[17]. Finally, as illustrated by Fig. 2, bilirubin is a potent inducer of adenosine triphosphatase activity in mitochondria, its action being similar, even in this respect, to that of dinitrophenol[17]. The adenosine triphosphatase activity elicited by bilirubin is, however, lower than that obtained with dinitrophenol; it is of about the same level as that which arises in mitochondria upon ageing in hypotonic medium.

On the basis of the present results, it is concluded that bilirubin in or above a concentration of 3×10^{-4} *M* uncouples phosphorylation from respiration in isolated rat liver mitochondria. This effect is accompanied by a marked elevation of the mitochondrial adenosine triphosphatase activity, and by a release of diphosphopyridine nucleotide and cytochrome *c* from the mitochondria, resulting in a decrease of the respiratory-rate. Although the effect of bilirubin is, at least in the two former respects, similar to that of 2,4-dinitrophenol, bilirubin seems to act more directly on the mitochondrial structure and, thus, it would appear to be premature to consider a common mode of action of the two agents. It is noteworthy that the concentration-range in which bilirubin exerts its action on mitochondrial oxidative phosphorylation coincides very closely with the level (20 mgm. per cent) at which serum bilirubin is known to become critical to the new-born infant[18]. Further aspects, clinical and biochemical, of the present findings are being investigated.

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EFFECT OF METHYLTRYPTOPHAN AND THIOURACIL UPON PROTEIN AND RIBONUCLEIC ACID SYNTHESIS IN CERTAIN HIGHER PLANTS

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THAT nucleic acids are involved in protein synthesis in micro-organisms is at present fairly well agreed. A study of several aspects of the nucleic acid metabolism of fruit trees has given results which throws some light on the relation of nucleic acids to protein metabolism in higher plants.

In previous unpublished work carried out in this laboratory, uracil and xanthine had been found to induce the synthesis of ribonucleic acid and of protein in several species of fruit trees. It was now of interest to study the effect of inhibitors of the purine and protein metabolism in plants in which this synthesis of ribonucleic acid and protein were induced.

From four groups of selected branches of olive trees and grape vines, each group comprising four replicates, one was kept for control and three were sprayed with a 50 p.p.m. solution of uracil. Three days later two of these groups were additionally sprayed with DL-5-methyltryptophan and 2-thiouracil, respectively. After two weeks, leaves were collected from each replicate, carefully washed with an acidified detergent, and analysed for protein and ribonucleic acid. The tissue from one set of samples was extracted with 80 per cent ethanol, and the nitrogen of the insoluble fraction was determined by micro-Kjeldahl[1]. This alcohol-insoluble N-fraction was considered as a preliminary indicator of the protein content. From a second set of samples ribonucleic acid was assayed by a modified alkali method, combining the Schmidt–Thannhauser method[2] and the method developed by Ogur and Rosen[3], in which perchloric acid was substituted for trichloracetic acid. Acid-soluble compounds were extracted with 0·2 *N* perchloric acid. The nucleic acids were extracted[4] with 1 *N* perchloric acid at 37° C., differentially fractionated by 0·35 *N* sodium hydroxide at 20° C., and then determined spectrophotometrically. The nucleic acids were

Table 1. The Effect of Uracil, Methyltryptophan and Thiouracil upon Ribonucleic Acid and Protein Synthesis in Leaves of Olive Trees and Grape Vines

Treatment	Olive trees			Grape vines		
	RNA	Uracil/guanine (molar ratio)	Protein-N per cent dry matter	RNA	Uracil/guanine (molar ratio)	Protein-N per cent dry matter
Control (C)	0·81	0·72	1·61	0·60	0·94	1·71
Uracil (U)	1·68	0·88	2·38	1·05	1·10	2·17
Uracil + methyltryptophan (M)	1·65	0·74	1·74	0·98	0·89	1·64
Uracil + thiouracil (T)	0·67	0·79	1·84	0·58	0·84	1·53
Standard error	0·081		0·065	0·070		0·062
Significant difference	$U = M > C = T$		$U > C = M = T$	$U = M > C = T$		$U > C = M = T$

Table 2. The Effect of Uracil, Methyltryptophan and Thiouracil upon the Amino-acid Composition of the Protein Fraction of Olive Leaves

Treatment	Amino-acid-N in μgm./gm. Dry matter					
	Arginine	Aspartic acid	Lysine	Proline	Serine	Tryptophan
Control (C)	2,309	1,472	1,864	945	858	1,215
Uracil (U)	3,938	2,651	2,888	1,261	1,440	2,337
Uracil + methyltryptophan (M)	2,501	1,500	2,131	750	910	772
Uracil + thiouracil (T)	2,117	1,274	1,958	794	712	924
Standard error	49	25	31	21	18	33
Significant differences	$U > M > C > T$	$U > M = C > T$	$U > M = C > T$	$U > C > T = M$	$U > M = C > T$	$U > C > T = M$

hydrolysed[5], chromatographed, and the spots were eluted and measured spectrophotometrically[6].

In the 'significant difference' row of Table 1 the treatments are arranged in decreasing order of protein and ribonucleic acid content. If significant (at 5 per cent level), the difference between two treatments is designated by a '>' symbol; '=' symbol designates a non-significant difference.

It may be seen from Table 1 that uracil induces an increased synthesis both of protein and of ribonucleic acid, and increases the molar ratio of uracil/guanine. The addition of methyltryptophan stopped the uracil-induced synthesis of protein, while that of ribonucleic acid remained unaffected. On the other hand, the ratio of uracil/guanine is somewhat decreased. Methyltryptophan is known to inhibit the incorporation of tryptophan into protein in certain tryptophan-requiring micro-organisms[4], and it might well be that the decreased synthesis of protein can be ascribed to a similar mechanism. In addition, it might be that methyltryptophan affects the ratio of uracil to guanine, which in turn affects protein synthesis. Since the total synthesis of ribonucleic acid is unaffected by methyltryptophan (that is, by decreased protein synthesis), it seems that it does not depend upon conditions conducive to protein synthesis.

With thiouracil, however, the situation was quite different. This compound, though an inhibitor of purine metabolism, caused a decrease in ribonucleic acid, in the ratio of uracil to guanine, as well as in protein; that is, the inhibited ribonucleic acid synthesis affected the protein metabolism and reduced its amount. Comparing the different effects of thiouracil and methyltryptophan upon ribonucleic acid and protein metabolism, it may tentatively be concluded that in olive trees and grape vines the synthesis of ribonucleic acid and a certain composition of it is apparently a pre-requisite for the synthesis of protein. A similar conclusion was reached with micro-organisms by several other workers[8-11]. The above results suggest that the ratio uracil/guanine, too, is likely to be an important factor for protein synthesis.

It was of interest to make a preliminary study of the way in which the above sprays affect the different amino-acid components of the proteinous fraction. The alcohol-insoluble fraction was hydrolysed with 4 N hydrochloric acid at 115° C., and analysed quantitatively by a chromatographic method developed by Thompson and Steward[12]. For the analysis of tryptophan, a separate batch of samples from each replicate was hydrolysed by alkali, and tryptophan was determined by Ehrlich's reagent. Table 2 gives typical variations of those amino-acids which were chiefly affected in olive leaves.

On the data for each separate amino-acid a standard randomized block analysis of variance was carried out (there were no significant block differences). In the 'standard error' row of Table 2, I have given the estimated error (with 9 degrees of freedom) of the treatment means. In the 'significant difference' row the treatments are arranged in decreasing order of acid content as in Table 1.

Table 2 shows that uracil increases significantly the amounts of all amino-acids reported in the table. Treatments with uracil + either methyltryptophan or thiouracil decreased all amino-acids (as compared with the treatment of uracil alone); but thiouracil caused a much larger decrease of arginine (46·2 per cent), aspartic acid (50·2 per cent), lysine (32·2 per cent) and serine (50·1 per cent) than did methyltryptophan.

Similar results were obtained with grape vines.

Further studies are in progress, and a full account of this work will be published shortly.

My thanks are due to Dr. J. Putter, who advised on the statistical analyses.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

The Sun's General Magnetic Field

WITH their admirable experimental technique, Babcock and Babcock have been able to measure certain very small line displacements in the Sun's spectrum, from which they deduce a general magnetic field of the order of -1 gauss. In order to draw this conclusion they use (although implicitly) two theories: (1) the theory of the Zeeman effect, connecting the line displacements with the magnetic field in a small homogeneous volume of gas; (2) the theory of magneto-turbulence in the photosphere, which, as Babcock's 'point' measurements include many thousand granulæ, is necessary for computing the average.

Whereas the first of these is in order, the second simply does not exist at present. In an answer to criticism by Alfvén, Babcock[2] declares his belief that the effect of magneto-turbulence is small, but does not give any evidence for this point of view. There are several possible mechanisms which have a reasonable chance of occurring. One has been discussed earlier[1], and another can be demonstrated in the following simple example, which does not claim to be rigorous proof but merely serves as another illustration.

Let us consider a quasi-stationary, isothermal state where the generalized pressure is constant in space:

$$nkT_0 + \frac{1}{8\pi}(\mathbf{H}_0 + \mathbf{h})^2 = n_0kT_0 + \frac{1}{8\pi}\mathbf{H}_0^2 = \text{const.} \quad (1)$$

In equation (1) n is the particle density, n_0 its value when the turbulent magnetic field $\mathbf{h}$ vanishes, $\mathbf{H}_0$ the general magnetic field and T_0 the temperature, which is constant. The total contribution to the Zeeman displacement from a region the extension of which largely exceeds the scale of the turbulence will be given by the mean value $(\overline{nH_z})/n_0$, where the z-azis is in the direction of sight. From equation 1 the following equation is deduced:

$$\frac{\overline{nH_z}}{n_0} = H_{0z}\left[1 - \frac{\overline{\mathbf{h}^2} + \overline{2h_z^2}}{8\pi n_0kT_0}\right] \quad (2)$$

It is quite reasonable that in the photosphere the turbulent field should be so strong that the expression in parentheses becomes zero or even negative. Thus, for strong turbulent fields h, the weighted mean given by equation (2) may differ from the proper value H_{0z}, both in magnitude and in the sign.

Babcock[2] cites two observational facts in support of his view: (1) No 'bias' is observed, which according to him is evidence against an influence of turbulence. Dr. Babcock writes that "According to Alfvén's arguments, the systematic effect of f and the way in which ρ and T are coupled with H should provide a large bias . . .". This is erroneous. Alfvén has never drawn this conclusion, nor has Babcock given any arguments for it. Further, according to Lehnert[3] t can be shown, even under very general assumptions, that turbulence will not give a bias.

(2) The Hale polarity law of bipolar sunspots is preserved down to very low magnetic fields. This is very interesting, but as the investigation from which this result is quoted is unpublished, it is impossible to discuss it. In view of the fact that this argument—if valid—is the only existing support for Babcock's sign and magnitude of the solar magnetic field, it is highly desirable that the details should be worked out and published, so that it may be possible to judge whether the conclusion is convincing or not.

The final verdict, whether Babcock's interpretation can be upheld or not, can only be given after a rigorous theory of the magnetic effects of granulation and their influence on the solar spectrum has been provided. No real attempt to develop such a theory has yet been published.

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Direct Measurement of Long-Range van der Waals Forces

ACCORDING to the current theory of the stability of colloids, there exists a universal force of attraction between any two particles which has its origin in the summation of the London dispersion forces between atoms in the two bodies. Although the force between colloid particles is too small to be measured directly, that between macroscopic bodies is just measurable. For example, the theoretical force, F, between two plane parallel plates separated by a gap, d, is given by[1–3]:

$$F \approx A/d^3 \quad (1)$$

if d is less than about 100 A., or

$$F \approx B/d^4 \quad (2)$$

if d is greater than about 2000 A. A and B are force constants which can be calculated. As the theoretical value of B for glass (calculated from the expression given by Lifshitz[3]) is about $1{\cdot}4 \times 10^{-19}$ erg cm., the force at a spacing of 1μ (10^{-4} cm.) should be about $1{\cdot}4 \times 10^{-3}$ dyne per cm.^{2} (that is, 1·4 μgm.).

Two previous attempts which have been made to verify the magnitude of this force experimentally have given highly discrepant results. Derjaguin and Abricossova[4], using an electronically balanced knife-edge microbalance, obtained for quartz over the range 0·1–1μ results which correspond to $B \approx 1 - 2 \times 10^{-19}$ erg cm. Independently, Overbeek and Sparnaay[5] used a method in which the force between parallel glass plates, separated by 0·7–1·5μ, produced a small measured deflexion of a spring. These authors observed a force of 2 dynes at 1μ and their results were represented by equation (1) with $A = 3{\cdot}8 \times 10^{-11}$ erg. If their results were interpreted according to equation (2), the value of B would be 2×10^{-16} erg cm.

We have now carried out a new series of measurements with an apparatus similar in principle to that of Overbeek and Sparnaay but of improved sensitivity. The results of many reproducible experiments, in which the force between glass plates (optically flat to within 300 A.) was determined over the range 0·7–1μ, indicate that the force at a separation of 1μ is 1·2 (± 0·4) × 10^{-8} dyne per cm.^{2}, and the index of d is 3·9 ± 0·3. Hence, the value of B in equation (2) is 1·2 (± 0·4) × 10^{-19} erg cm.

The theory of the dispersion forces at large distances is therefore confirmed, in full agreement with the results of Derjaguin and Abricossova. In preliminary observations we also observed large forces similar to those reported by Overbeek and Sparnaay; these disappeared on application of a high-frequency discharge or when water-vapour was admitted to the apparatus. These observations add support to the suggestion made by Derjaguin and Abricossova that such forces originate from mosaic electrostatic charges.

Details of this work will be published elsewhere.

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A General Expression for Intermolecular Potentials

A SYSTEMATIC project for the evaluation of virial coefficients (second, third and fourth) by automatic computation has been in operation on the *EDSAC* (Cambridge): tabulated results and mathematical procedures will be given elsewhere. This investigation, however, gave rise to the consideration of a related problem to which the following interesting solution has been found.

In the estimations of intermolecular potentials of spherical molecules to fit observed virial coefficients and related properties, there are a few well-known investigations[1] in which different expressions with two or three adjustable parameters have been tested and advocated. However, it appears desirable, in general, and particularly with respect to the present automatic calculations, to introduce a new expression which has an unlimited number of adjustable constants such as the coefficients of a power series. Such an expression should enable one to make further progress than by the trial of miscellaneous expressions: the agreement for any expression of tabulated functions with two or three parameters must presumably be limited and would be weakened by further improvement and extension of experimental data. This attempt at a systematic procedure seemed to be specially desirable for the most useful organization of the numerical results in the above investigation.

A few different types of expression were examined and the following was selected:

$$U(r) = \frac{4\varepsilon}{(r^2 + B^2)^3} \sum_{i=0} C_{2i} \left\{r^{2i} \exp A(1 - r^2) - 1\right\} \quad (1)$$

The intermolecular distance r is to be measured so that the potential $U(1)$ at unity is zero. The constants A and B^2 are to be assigned values about 4 and 1/10, but the constants C_{2i} are to be adjusted to fit experimental or fundamental theoretical data, and their free choice makes the expression dependent on a complete system of functions. The 4 and 1/10 choice has the surprising property that with $C_0 = 1$ and other $C_{2i} = 0$, the function is practically indistinguishable from the Lennard-Jones (12–6) potential,

$$V(r) = 4\varepsilon \left(\frac{1}{r^{12}} - \frac{1}{r^6}\right) \quad (2)$$

This degree of agreement had not been thought possible and is very gratifying, since the use of U provides thus a first term which is probably nearly as good as possible for a two-parameter expression while still permitting unlimited further adjustment.

Table 1

r	$U(r)/4\varepsilon$	
	Potential (1) with $C_0=1·0$; $C_{2i}=0$ ($i>0$)	(12–6) potential
0·80	7·948	10·737
0·90	1·511	1·659
0·94	0·623	0·652
0·98	0·144	0·146
1·00	0·000	0·000
1·02	−0·101	−0·099
1·06	−0·213	−0·208
1·10	−0·253	−0·246
1·12 (min.)	−0·257	−0·250
1·16	−0·248	−0·242
1·2	−0·227	−0·223
1·4	−0·112	−0·115
1·6	−0·053	−0·056
2·0	−0·015	−0·015
>2·0	Identical	

It does not appear likely that any powerful systematic way for evaluating C_0, C_2, C_4 from experimental data will be found. Their estimation will have to depend on solid-state and viscosity data as well as on the virial coefficients. However, some procedure of successive adjustment of the C_{2i} appears to offer for the first time a systematic way of summarizing the implications of the experimental data. It may also be hoped that this systematization of approach might be of some use in the selection of most effective experimental measurements.

In the work just performed on the *EDSAC*, the second, third and fourth virial coefficients for the basic potential with ($C_2 = C_4 = \ldots = 0$) and for two others with ($C_6 = C_8 = \ldots = 0$) have been calculated. Linear combinations of these can then be examined by means of the tabulated results to estimate the best functions to fit experimental data. It may be of interest to note that the calculation depended neither on the analytical form of the potential nor on numerical integration. It was based on an expansion of $\exp(-U/kT) - 1$ in terms of functions of the type $\exp(-ar^2)$. Practically all the organization and arithmetic of the evaluations were performed by the machine.

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Thermal Expansion Coefficients for Uranium Boride and β-Uranium Silicide

THE thermal expansion coefficients for uranium boride (UB_2) and β-uranium silicide (USi_2) have been determined by X-ray powder methods with a high-temperature camera. The mean values for the expansion coefficients between room temperature and 205° C. for different directions in the lattice are summarized in Table 1.

Table 1. THERMAL EXPANSION COEFFICIENT (PER DEG C), MEAN VALUE BETWEEN 20° C AND 205° C.

Compound	Thermal expansion coefficient	Direction in the lattice
UB_2	9×10^{-6}	*a*-axis
	8	*c*-axis
	6	U–B bond direction
β-USi_2	57	*a*-axis
	−26	*c*-axis
	16	U–Si bond direction

These two compounds were selected because of their formally identical crystal structures. They both belong to space group $C\ 6/\tilde{m}\,m\,m$ and are of the AlB_2-type (C 32)[1–3]. The uranium atoms are situated in the 000 position of the simple hexagonal cell, whereas the non-metal atoms are situated in the $\frac{1}{3}\frac{2}{3}\frac{1}{2}$ and $\frac{2}{3}\frac{1}{3}\frac{1}{2}$ position. The structure may be regarded as formed by plane hexagonal sheets of uranium atoms (A) and plane hexagonal networks (H) of boron or silicon atoms. The sequence of the sheets in the [001] direction is $AHAHAH$ ..... The lattice constants and the interatomic distances for the two compounds are summarized in Table 2. MeB_2-lattices have also been discussed from several aspects by Post *et al.*[4].

Table 2 LATTICE PARAMETERS AND BOND-LENGTHS FOR UB_2 AND β-USI_2 (IN A.)

Compound	Lattice parameters	Distance U–U		Distance U–B (or U–Si)	Distance B–B (or Si–Si, network H)
		In sheet (A)	Between sheets (A)		
UB_2	$a=3{\cdot}136$ $c=3{\cdot}988$	3·14	3·99	2·69	1·81
β-USi_2	$a=3{\cdot}85$ $c=4{\cdot}06$	3·85	4·06	3·01	2·22

A study of the bond-lengths shows that, although uranium boride and β-uranium silicide are isostructural and formed by the same metal atom, several fundamental differences exist which depend on the difference in radius between the boron and the silicon atoms. If the small boron atom (r_B = 0·86 A.) is taken up between the hexagonal uranium sheets, the distance U–U between the sheets of 3·14 A. is still within the limits for a metallic bond to be formed between the uranium atoms. (In the α-, β-, γ-phases of uranium the distances between nearest neighbours of metal atoms varies within the limits 2·75–3·30 A.) The silicon atom (r_{Si} = 1·17 A.), however, is accommodated between the metal sheets only if the uranium atoms are considerably separated (distance U–U = 3·85 A. in the sheets). There is thus probably no bond-formation between the uranium atoms in the metallic sheets of β-uranium silicide.

In the hexagonal networks (H) of non-metal atoms in uranium boride, the boron atoms have a separation of 1·81 A., which is 5 per cent larger than the sum of the atomic radii. In β-uranium silicide, however, the silicon–silicon distance of 2·22 A. is 5 per cent smaller than the sum of the atomic radii.

The U–B distance in uranium boride is 11 per cent bigger than $r_U + r_B$ and the U–Si distance in β-uranium silicide is 10 per cent bigger than $r_U + r_{Si}$, using 1·50 A. as the radius for the uranium atom.

The difference in the nature of the bonds in the isostructural compounds uranium boride and β-uranium silicide is clearly reflected in the thermal expansion coefficients for the two lattices. The lattice of uranium boride, with a radius ratio of $r_B/r_U = 0{\cdot}57$, expands uniformly. The coefficient of thermal expansion is nearly equal in different bond directions, indicating that the lattice is held together by bonds of the same nature. It is thus conceivable that the atoms in the same uranium sheets (A) are held together by metallic bonds, whereas the distance between the uranium atoms in different sheets is too big (3·98 A.) to permit any direct bond formation. The sheets are held together by the boron atoms, forming uranium–boron–uranium bonds in addition to the boron–boron bonds in the networks (H). A possible way might be that electrons from the boron atoms are taken up by the unfilled 6*d*-levels of the uranium atoms and the lattice stabilized by electron oscillation in different bond directions.

For β-uranium silicide the radius ratio r_{Si}/r_U is 0·78. The extraordinarily big thermal expansion of the uranium sheets (the direction of the *a*-axis) probably depends on the facts that no direct binding forces exist between the uranium atoms in the sheets and that the hexagonal networks of silicon atoms parallel to the sheets are considerably 'compressed'. The lattice is held together by silicon–silicon and uranium–silicon–uranium bonds. The negative expansion coefficient between the uranium sheets (*c*-axis) is remarkable and shows that the type of bonding in the β-uranium silicide lattice is different from the bonding in the uranium boride lattice.

Other studies of the thermal expansion coefficients for pairs of isostructural compounds are planned. Uranium boride and chromium boride[3] form, for example, a pair of isostructural compounds where the size of the metal atom is varied for the same non-metal atom. The isostructural pair uranium silicide[2] and iron boride[3] might show other aspects of the nature of the bonds within silicides and borides.

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Symbols for Lattice Disorders

MODERN concepts of crystal physics and chemistry have made it necessary that appropriate symbols should be evolved to designate all kinds of disorders occurring in a crystal lattice. Though several sets of symbols are in use, they are not universally accepted and they are not self-explanatory; indeed, authors often include a glossary of their symbols, which shows that they do not expect the reader to understand or recognize their symbols. It is never sure whether the sign and number of electric charges in the symbol are meant to express the true charge of the particle at a given site or the difference in charge caused by the disturbance.

The choice of an appropriate symbolism is important for the development of a young branch of science. In the present case, I think it should fulfil the following conditions: (1) It should state which particle is really there at the site in question, indicating its true electric charge. (2) It should state what kind of site is in question: that of a normal lattice cation, or a lattice anion, or an interlattice site. No other legitimate site exists in an ideal crystal, therefore it is misleading to speak, for example, of a vacant bromine *atom* site in a silver bromide crystal where only bromine ions are expected to exist in the ideal case. (3) It should state the difference in electric charge at the given site caused by the disturbance as against the undisturbed ideal lattice, taking care, however, that this difference in charge should not get mixed up with the effective charge of the particle. (4) Symbols which have been more or less generally accepted hitherto should be retained so far as possible, to minimize confusion in the interim period. Thus the symbol $\square$ could be retained for a vacant site, the symbol $\bigcirc$ for an interlattice site, with suffixes if necessary when more than one kind of interlattice site can occur. Probably a strained lattice site around an interlattice atom would deserve a separate symbol for itself, but this problem is generally neglected. The symbol $\ominus$ should, of course, remain for an electron, but the converse symbol $\oplus$ should be dropped altogether, because no positrons are to be expected and the 'charge difference' of + 1 against the ideal lattice is simply designated by +, just as a difference of + 2 is indicated by + +.

Several systems of symbols conform with the conditions set out above. I do not venture to decide in favour of any one of them in particular; however, I will direct attention to some which I regard as acceptable. All have in common that the first three points demanded above are provided for at well-defined parts of the aggregate symbol. Further, the whole symbol might be enclosed in rectangular brackets with the real particle first, the site of the particle next and the difference of charge caused by the disturbance at the right higher corner of the end-bracket. The following lattice disorders could be symbolized by one of the four subsequent symbols, taking, for example, a silver bromide lattice:

Vacancy at the site of a silver ion:

$$[\square, Ag^{+}]^{-}; \quad [\square; Ag^{+}]^{-}; \quad [\square, \mathbf{Ag}^{+}]^{-}; \quad [\square/Ag^{+}]^{-}$$

Vacancy at the site of a bromine ion:

$$[\square, Br^{-}]^{+}; \quad [\square; Br^{-}]^{+}; \quad [\square, \mathbf{Br}^{-}]^{+}; \quad [\square/Br^{-}]^{+}$$

An electron at the site of a bromine ion:

$$[\ominus, Br^{-}]; \quad [\ominus, Br^{-}]; \quad [\ominus, \mathbf{Br}^{-}]; \quad [\ominus/Br^{-}]$$

A silver ion at an interlattice site:

$$[Ag^{+}, \bigcirc]^{+}; \quad [Ag^{+}; \bigcirc]^{+}; \quad [Ag^{+}, \boldsymbol{\bigcirc}]^{+}; \quad [Ag^{+}/\bigcirc]^{+}$$

A sulphide ion at the site of a bromine ion:

$$[S^{--}, Br^{-}]^{-}; \quad [S^{--}; Br^{-}]^{-}; \quad [S^{--}, \mathbf{Br}^{-}]^{-}; \quad [S^{--}/Br^{-}]^{-}$$

A cadmium ion at the site of a silver ion:

$$[Cd^{++}, Ag^{+}]^{+}; \quad [Cd^{++}; Ag^{+}]^{+}; \quad [Cd^{++}, \mathbf{Ag}^{+}]^{+}; \quad [Cd^{++}/Ag^{+}]^{+}$$

Symbols for other disturbances follow naturally from this system. An electron in the conductive band would be simply represented by the symbol of the electron, $\ominus$; an ion at its own lattice site by its symbol in brackets. Thus the sequence of photoionization of a bromine ion and the capture of the freed electron from the conductivity band by a silver ion could be written as:

$$[Br^{-}] + h\nu \rightarrow [Br, Br^{-}]^{+} + \ominus \text{ and }$$
$$\ominus + [Ag^{+}] \rightarrow [Ag, Ag^{+}]^{-}$$

The dislocation of a silver ion into an interlattice site or its return therefrom into its vacancy would read:

$$[Ag^{+}] \rightleftarrows [Ag^{+}, \bigcirc]^{+} + [\square, Ag^{+}]^{-}$$

I think it is high time that specialists on these problems should attempt to obtain international agreement on a set of symbols that will be universally accepted and as clear and self-explanatory as compatible with the complexity of the situation.

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Spectrophotometry of Granulated Materials, with Particular Reference to Blood Corpuscles

Although expressions have been developed[1,2] for the interpretation of spectrophotometric measurements on granulated materials, little consideration has been paid to the effects of scattering of the incident radiation. Measurements may be made with varying amounts of the scattered radiation received.

(1) *No scattered radiation received* (this is ideally achieved using a parallel beam of radiation with the detecting device subtending zero angle at the suspension). The transmission of a parallel beam through a layer of disks may be calculated by considering the interference between the wave-fronts transmitted by the particle and the medium. If a suspension contains n disk-like particles per c.c. having a thickness t parallel to the beam and an area s perpendicular to the beam, and if the particles are absorbing, having an extinction coefficient E, then the amplitude of the wave emerging from the particle will be reduced by a factor $10^{-Et/2}$ and its phase will differ from that of the remainder of the beam by some angle φ. Considering radiation $A \sin \omega t$ incident on unit area, the wave emerging from a layer of thickness δl will be:

$$A(1 - ns\delta l) \sin \omega t + A\, ns\delta l\, 10^{-Et/2} \sin (\omega t \pm \varphi)$$

and the resultant intensity will be given by the sum of the squares of the coefficients of $\sin \omega t$ and $\cos \omega t$: neglecting terms in $(\delta l)^2$, and integrating over a finite thickness l, the optical density d of the suspension is:

$$d = 2 \log_{10} e.\, nsl\, (1 - 10^{-Et/2} \cos \varphi) \qquad (1)$$

For transparent particles ($Et \rightarrow 0$), the optical density will therefore be a maximum when $\varphi = \pi$, that is, when there is destructive interference between the radiation transmitted through and around the particle: for opaque disks (large Et) no interference can occur and the optical density is reduced. An absorption band will therefore be evident as a decrease in optical density—the exact reverse of normal behaviour.

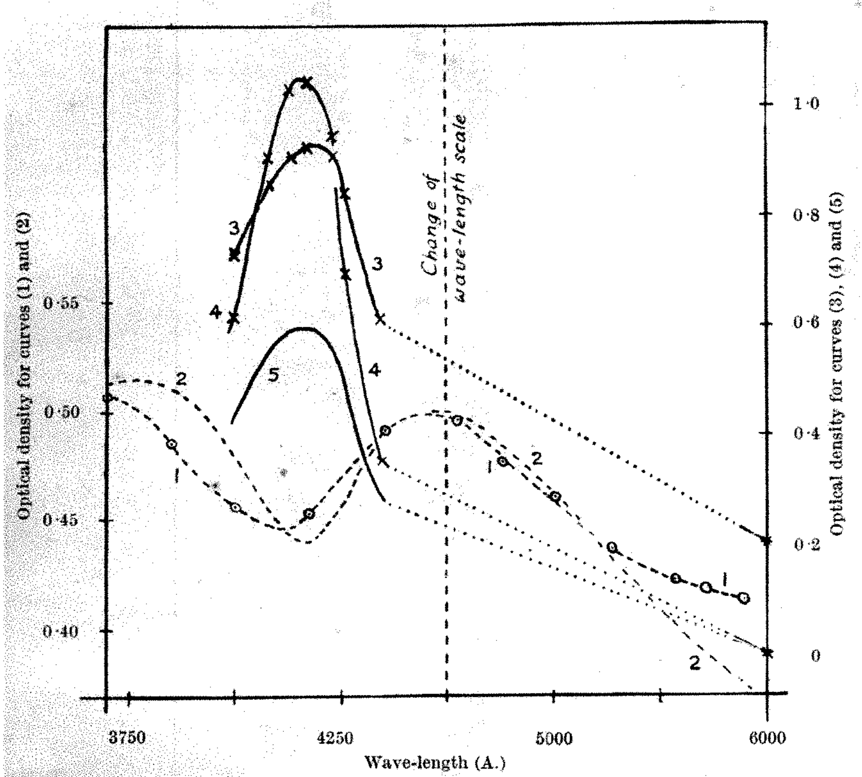

Fig. 1

Blood corpuscles in normal saline are approximately disk-shaped, and calculation shows that $\varphi = \pi$ at a wave-length of 3600 A.—near the γ- or Soret band: measurements were therefore made on a suspension of corpuscles which had all settled to show a circular section to the beam of radiation (the incident and measured beams were parallel[3] to within 1°). The results (curve 1) do show the Soret band inverted, but do not conform to equation (1); a closer approximation to the shape of the corpuscle, namely, two contiguous concentric disks each of area $\frac{1}{2}s$ with the outer ring twice the thickness of the inner disk, leads to an analogous equation which gives curve 2 in fair agreement with experiment.

(2) *All scattered radiation received.* The intensity transmitted through a layer of oriented disks is now the sum of the intensities transmitted through the disks and through the intervening spaces. This leads to an expression[1,2] for the optical density:

$$d_{\text{suspension}} = \log_{10}e.\ nsl\,(1 - 10^{-Et}) \qquad (2)$$

whereas if the absorbing material were uniformly dispersed in the same volume, then the optical density of the solution would be

$$d_{\text{sol.}} = n.\ s.\ t.\ El \qquad (3)$$

These equations indicate that the peak of an absorption band will be depressed when measured on a suspension.

Measurements have been made on oriented blood corpuscles in saline using a converging beam with $F/1{\cdot}5$ lenses above and below the cell, and with the base of the cell ground on both sides so that some of the scattered radiation is collected. (Similar measurements on the alga *Chlorella* have recently been reported[4].) Curve 3 shows a typical absorption curve for a suspension with measurements (curve 4) on the same sample after hæmolysis. Calculation of the optical density from equation (2) gives curve 5. The difference in optical density between curves 3 and 5 may be ascribed to the radiation scattered backwards by the corpuscles; this difference is not, however, independent of wave-length or absorption. The displacement of the maximum of the corpuscular suspension may be at least partly explained by the anomalous dispersion around an intense absorption band[5].

(3) *Some scattered radiation received.* In this intermediate case the minimum of curve 1 and the depressed maximum of curve 3 will tend to cancel out: this would explain the failure of early measurements[6] on corpuscular blood to show the Soret band. This effect is of importance if measurements on powders in disks of potassium bromide, etc., are to be comparable to measurements on a uniform specimen. As much scattered radiation as possible should be collected; and the powder should be ground so finely that the absorption of a single particle is small ($Et \to 0$), when equations (2) and (3) become identical.

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'Clean-up' of Radioactive Gases used for Surface Studies

THE gradual decrease of the gas pressure in discharge tubes due to the capture of the gas on the walls and on the electrodes of the tube (electrical clean-up) has been the subject of numerous investigations (for reviews, see refs. 1 and 2). Use of radioactive gas for these studies has several advantages as shown, for example, by Harris and Hawkins[3], who used krypton-85 in measuring gas clean-up rates in switching devices for radar duplexers.

We have now found that the 'clean-up' of radioactive gases can be used as a valuable tool for surface studies because the quantity of the gas cleaned up into the surface, for example, of a glass plate depends to a large extent on the quality of the surface and is affected by the presence of traces of other substances on the surface.

In our experiments radon or radioactive xenon-131 was 'cleaned up' into the surface of a glass plate by a high-frequency discharge produced in a cell consisting of the glass plate and a brass plate held apart by a ring-shaped rubber spacer 2 mm. thick. This cell could be filled with air containing several microcuries of radon or xenon at a pressure of 15–20 mm. mercury. Gas discharge was maintained in the cell for about 30 sec. by simply connecting a plate electrode attached to the outside of the glass wall to the coil of a high-frequency vacuum tester.

The discharge causes a fraction of the radioactive gas to become embedded in the glass plate, and its areal distribution can be checked by taking autoradiographs. Treating the surface of the glass plate with water, organic solvents or concentrated sulphuric acid does not remove an appreciable fraction of the gas from the surface. It is, of course, partially removed by concentrated alkali and completely liberated by hydrofluoric acid. At normal temperature the 'effective' half-life of the cleaned-up radon was found to be about 3 days because of its partial escape by diffusion. Heating the plate for 10 min. to 310° C. caused 60 per cent of the radon activity to escape. The depth of the glass layer in which atoms of radon are embedded can be estimated from recoil phenomena accompanying its alpha-decay. On bringing a glass surface (*A*) with the cleaned-up radon in vacuum into contact for about four hours with a second glass plate *B*, 45 per cent of the equilibrium amount of the short-lived products of radon are found on the plate *B*. Such a high transfer of the decay products by recoil is possible only when most of the atoms of radon are located within a distance from the surface which is small compared with the recoil range of the radium-A atoms in the glass, which is of the order of 200 A.

Areal concentration of the cleaned-up gas is fairly homogeneous over the whole glass surface cleaned chemically, for example, with sulphuric acid potassium permanganate solution, rinsed with re-distilled water and dried. Traces of impurities or various substances such as grease, solid hydrocarbons or polymers covering the surface in the form of thin films inhibit, according to their thickness partially or completely, the ability of the surface to clean-up radioactive gas, and their presence is easily revealed by autoradiographs. Disturbing the surface layer of the glass by grinding it with fine 'Carborundum' powder or by treating it with hydrofluoric acid also modifies the ability of the surface to clean-up gas. Typical examples of these effects are demonstrated in Fig. 1. This is an autoradiograph of a glass surface on which, previous to radon clean-up, a drop of 2×10^{-3} *M* solution of stearic acid in petroleum ether had been evaporated and a strip of its surface about 2 mm. wide was ground with 'Carborundum' powder.

Stepwise deposition of odd numbers of monomolecular layers of calcium stearate on the glass surface (Langmuir–Blodgett technique) resulted in clean-up radiographs with steps of decreasing density corresponding to various thicknesses of the deposited film. A single monolayer of stearate of about 25 A. thickness is sufficient to cause a distinct decrease in the ability of the surface to clean-up radioactive gas. This can be understood on the basis of a mechanical type of clean-up mechanism: the film prevents low-energy inert gas ions, accelerated during the discharge towards the glass surface, from reaching it and from being occluded there.

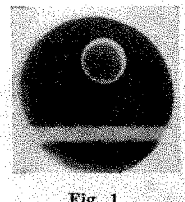

Fig. 1

Clean-up can thus be used as a very simple means for the study of deposited monomolecular films, and its use for evaporated metal films also seems promising. This method can also be used for the preparation of samples of radioactive gases when measuring their soft radiation and for obtaining a very convenient radon source for demonstrating and investigating the alpha recoil phenomena.

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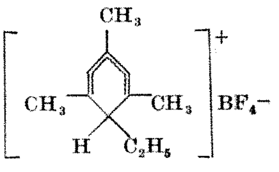
Isolation of the Stable Boron Trifluoride-ethylfluoride and Boron Trifluoride-formylfluoride Complexes of the Methylbenzenes : Mechanism of the Friedel–Crafts Reactions

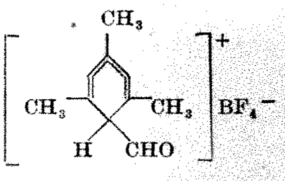
IN an earlier communication[1] we have reported the isolation of the stable boron trifluoride–hydrogen fluoride complexes of the methylbenzenes and described the carbonium ion salt (or σ-complex) structure of these compounds.

We have now succeeded in isolating the stable complexes from the methylbenzenes with ethylfluoride–boron trifluoride and formylfluoride–boron trifluoride. On dissolving equimolecular quantities of ethylfluoride in toluene, *m*-xylene and mesitylene at − 30° to − 80° a homogeneous clear solution is obtained. Introduction of boron trifluoride into the solution leads to the separation of a bright-coloured lower phase, and by continuing the addition of boron trifluoride the quantity of this phase is increased. The solution removes one mole of boron trifluoride, after which we obtain again a homogeneous bright-coloured substance with a measurable melting point and a very significant electric conductivity.

Formylfluoride is only partly soluble in the methylbenzenes. The equimolecular methylbenzene–formylfluoride mixture becomes immediately brightly coloured on introduction of boron trifluoride and becomes homogeneous by losing one mole.

The 1 : 1 : 1 molecular complexes can be formulated, for example, in the case of mesitylene, in the following manner :





In this case we have been able to isolate the intermediate complexes of the Friedel–Crafts ethylation and formylation of aromatic compounds.

By the slow thermal decomposition of the complexes the homogeneous substance separates again into two phases: an upper organic phase, which was identified after washing and distillation as an ethyl methylbenzene and formyl methylbenzene respectively, with nearly quantitative yield; and a lower phase, which contains the stoichiometrical quantity of hydrogen fluoride with a negligible quantity of the dissolved aromatic. By the action of the hydrogen fluoride on the aldehyde produced in the formylation reaction some tarry material is formed, probably by the polymerization of the aldehyde.

The properties of the isolated $ArHC_2H_5^+BF_4^-$ and $ArHCHO^+BF_4^-$ complexes are given in Table I.

Table 1

$ArHC_2H_5^+BF_4^-$

Ar	Melting point (°C.)	$\varkappa(\Omega^{-1}.cm.^{-1})$	Colour
$CH_3C_6H_5$	−80	$0{\cdot}2 \times 10^{-2}$	Yellow
$m(CH_3)_2C_6H_4$	−75	$0{\cdot}1 \times 10^{-2}$	Red
$s(CH_3)_3C_6H_3$	−15	$0{\cdot}2 \times 10^{-2}$	Orange

$ArHCHO^+BF_4^-$

Ar	Melting point (°C.)	$\varkappa(\Omega^{-1}.cm.^{-1})$	Colour
$CH_3C_6H_5$	−70	$0{\cdot}4 \times 10^{-2}$	Red
$m(CH_3)_2C_6H_4$	−52	$0{\cdot}5 \times 10^{-2}$	Cherry-red
$s(CH_3)_3C_6H_3$	−16	$0{\cdot}7 \times 10^{-2}$	Red
$as(CH_3)_4C_6H_2$	−10	$0{\cdot}7 \times 10^{-2}$	Cerise

As a result of the foregoing investigations, we have been able to investigate the ethylation and formylation of a methylbenzene, for example, toluene with the boron trifluoride-catalysed action of ethylfluoride and formylfluoride, so to say in elementary steps.

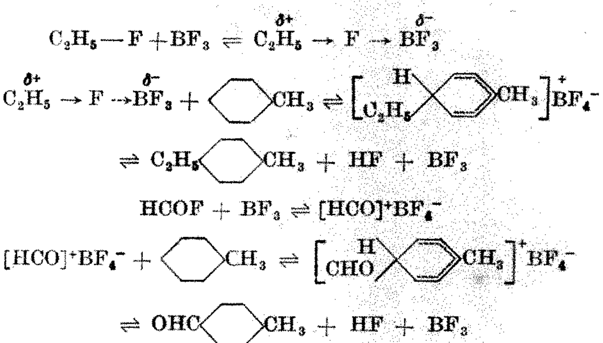
In earlier work[2], we have demonstrated that ethylfluoride forms at low temperature a 1 : 1 molecular complex with boron trifluoride. This molecular complex has at above − 95° a specific conductivity of $\varkappa = 0{\cdot}5 \times 10^{-6}\ \Omega^{-1}.\ cm.^{-1}$ in the melted state. From this low conductivity value it is evident that the complex has mainly a polarized covalent character and can be only to a very slight degree ionized. This is in full agreement with H. C. Brown's[3] suggestion of the first step of the alkylation reaction of aromatics by the aluminium halide-catalysed reaction with ethyl halides.

Also in earlier work[4] we have demonstrated that formylfluoride forms at low temperature a 1 : 1 molecular complex with boron trifluoride. This complex has at − 110° a specific conductivity of $\varkappa = 0{\cdot}1 \times 10^{-2}\ \Omega^{-1}.\ cm.^{-1}$ in the melted state. From this high conductivity value it is evident that the complex has a carboxonium ion salt structure similar to the acetyl tetrafluoroborate isolated earlier by F. Seel[5].

The ethyl borofluoride complex which we have prepared at a low temperature is a colourless compound which melts with decomposition at about − 95° and has—as mentioned—a very small specific conductivity. If we add now—also at low temperature—an equimolecular quantity of cold toluene to the ethyl borofluoride complex, the colour is changed immediately to bright yellow, the specific conductivity increases to a value of $\varkappa = 0{\cdot}2 \times 10^{-2}\ \Omega^{-1}.\ cm.^{-1}$ and we obtain the homogeneous well-identified complex as in the case of the one-step complex formation described earlier in this communication.

In the case of the formyl tetrafluoroborate the complex we have prepared is a colourless compound, which decomposes at about − 110°. If we add now, also at low temperature, an equimolecular quantity of cold toluene to the formyl tetrafluoroborate complex, the colour is changed immediately to bright red. The specific conductivity increases to $\varkappa = 0{\cdot}4 \times 10^{-2}\ \Omega^{-1}.\ cm.^{-1}$ and we obtain the homogeneous well-identified complex as in the case of the one-step complex formation between toluene, formylfluoride and boron trifluoride.

We formulate, on the ground of the direct preparative proofs of the isolation of the two intermediate complexes, the electrophilic alkylation and formylation mechanism in the following manner (for the sake of simplicity we indicate only the formation of the *para* product :


$C_2H_5—F + BF_3 \rightleftharpoons \overset{\delta+}{C_2H_5} \rightarrow F \rightarrow \overset{\delta-}{BF_3}$
$\overset{\delta+}{C_2H_5} \rightarrow F \rightarrow \overset{\delta-}{BF_3}$ + CH₃ ⇌ H C₂H₅ CH₃ + BF₄⁻
⇌ C₂H₅ CH₃ + HF + BF₃
$HCOF + BF_3 \rightleftharpoons [HCO]^+BF_4^-$
$[HCO]^+BF_4^-$ + CH₃ ⇌ H CHO CH₃ + BF₄⁻
⇌ OHC CH₃ + HF + BF₃

We believe that the isolation of the onium-ion salt intermediate complexes makes possible a better understanding in general of electrophilic aromatic substitutions.

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Super-Acid Formation in the Pyridine–Acetic Acid System

A STUDY of the physico-chemical properties of mixtures of pyridine and acetic acid in all proportions ranging from 0 to 100 per cent by various workers and very recently by us[1] showed that the equivalent conductivity, viscosity, contraction in volume, and refractive index exhibited in each case a maximum at a composition of 83 mol. per cent of acetic acid. Previous workers ascribed the maxima to the formation of a complex at that composition. A consideration of the dynamics of ionic atmospheres in relation to the effect of an electrolyte dissociating into ions on the viscosity of a solution and other factors (*loc. cit.*) led us to assume that no compound-formation occurs, and that, instead, at that composition acetic acid attains maximum ionization. At least 17 mol. per cent of pyridine is necessary for complete ionization of acetic acid in pyridine.

The hydrogen ions thus obtained from the acetic acid dissociation must be assumed[2,3] to exist as pyridinium ions involving one pyridine molecule for each hydrogen ion. But when the number of pyridine molecules is insufficient to form pyridinium ions some free hydrogen ions have to be assumed to exist, and necessarily so at 83 mol. per cent composition of acetic acid, where the dissociation is complete. It is to be expected that a study of *p*H at different compositions of the mixture starting from 0 to 100 per

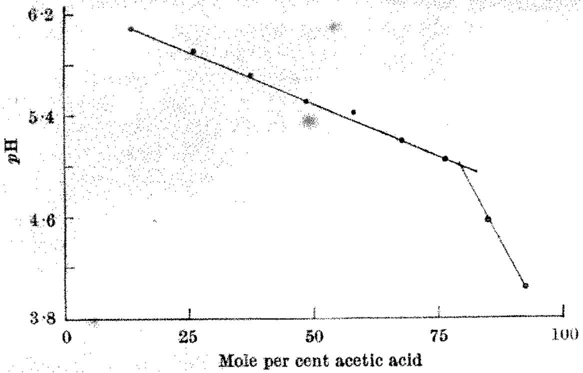

Fig. 1. Graph showing pH of pyridine–acetic acid system

cent pyridine should indicate a minimum at 17 mol. per cent of pyridine, at which composition acetic acid dissociates completely.

We have studied the pH of mixtures of pyridine and acetic acid and the results are represented graphically in Fig. 1. The measurements were made with a glass electrode in conjunction with a saturated dip-type calomel electrode in a Morton's glass electrode assembly unit with a Cambridge pH meter. The values obtained were quite reproducible. Surprisingly, the pH behaviour between 83 and 100 mol. per cent of acetic acid is quite the reverse of our expectation. In this region, for conductance as well as pH, the same downward trend makes it inevitable that the free hydrogen ions left over, due to an insufficient number of pyridine molecules to form pyridinium ions, must be assumed to have attached themselves to undissociated acetic acid molecules, forming $CH_3COOH_2^+$ ions exhibiting the well-known super-acid behaviour[4-6]. The pH curve thus proves the existence of undissociated molecules of acetic acid in the region 83–100 per cent acetic acid, as well as super-acid formation.

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Structure of a Grass Pollen Flavonoid Glycoside

A flavonoid glycoside, dactylin, was found to occur in pollens of timothy and orchard grass in 1931 by Moore and Moore[1]. Until this present study, there existed no complete structural data on dactylin. An abstract by Johnson *et al.*[2] indicated that dactylin was not chromatographically similar to simultaneously processed *iso*quercitrin, quercitrin and quercetin. They also report that spectrographically dactylin aglycon and quercetin, individually and mixed, have identical patterns in three solvent systems.

For the studies reported here[3], dactylin was re-isolated from timothy pollen. It was obtained as a light yellow solid from a 1955 crop of defatted pollen. It was readily recrystallized from water, and paper chromatography revealed only one spot in three solvent systems. The methoxyl content was 3·60 per cent, and the dactylin aglycon (obtained by 2 N sulphuric acid hydrolysis of dactylin) revealed 6·93 per cent methoxyl content. Infra-red and ultra-violet spectra and melting-point data suggested the aglycon to be impure *iso*rhamnetin. Acetylation of the aglycon gave 3,5,7,4′-tetra-acetoxy-3′-methoxy-flavone that had an infra-red spectrum identical in every respect with a known sample. On admixture with the known sample, no depression of melting point was observed. Methylation of the aglycon with diazomethane gave 3,7,3′,4′-tetramethoxy-5-hydroxy-flavone that also had an infra-red spectrum identical in every respect with a known sample. On admixture with a known sample, no depression of melting point was observed.

When dactylin was methylated with diazomethane and hydrolysed, 5,7,3′-trimethoxy-3,4′-dihydroxy-flavone was obtained that was identified by mixed melting point and identical infra-red spectrum with a known sample. The reference sample was kindly supplied by Dr. Richard Kuhn, of the Max Planck Institute for Medical Research. Therefore, the structure of dactylin was shown to be *iso*rhamnetin 3,4′-diglucoside and identical with the flavonoid glycoside isolated and characterized by Dr. Kuhn from the pollen of *Crocus* Sir John Bright[4].

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Chromatographic Study of Jute α-Cellulose

A number of papers and communications have been published by different workers in recent years on the chromatographic study of jute α-cellulose, and conflicting views have been expressed regarding its association with different sugar residues. Sarkar *et al.*[1] consider the material to be entirely composed of glucosan, while Das and co-workers[2] contend that it is intimately associated with both xylose and arabinose residues. Adams and Bishop[3] believe that, in addition to these pentosans, jute α-cellulose contains uronic acid residue, the presence of which is yet to be confirmed by the chromatographic analysis.

Although Sarkar and others[1], and Adams and Bishop[3] have employed the same hydrolytic procedure of 72 per cent sulphuric acid, the failure of the former authors to detect pentoses in the hydrolysate appears to be due to interference caused by the presence of a large amount of glucose which has, however, been preferentially removed by the latter authors by the action of an enzyme preparation. Das *et al.*[2], and more recently Adams and Bishop[4], have applied a method of selective hydrolysis with formic acid to identify pentosans in jute α-cellulose, although Mazumdar and Sarkar[5], on using the same procedure, have failed to substantiate this observation.

It was noted, during the preliminary experiments carried out in this laboratory, that only glucose and xylose could be detected on the chromatogram of the jute α-cellulose hydrolysate obtained with the 72 per cent sulphuric acid method. The work described in

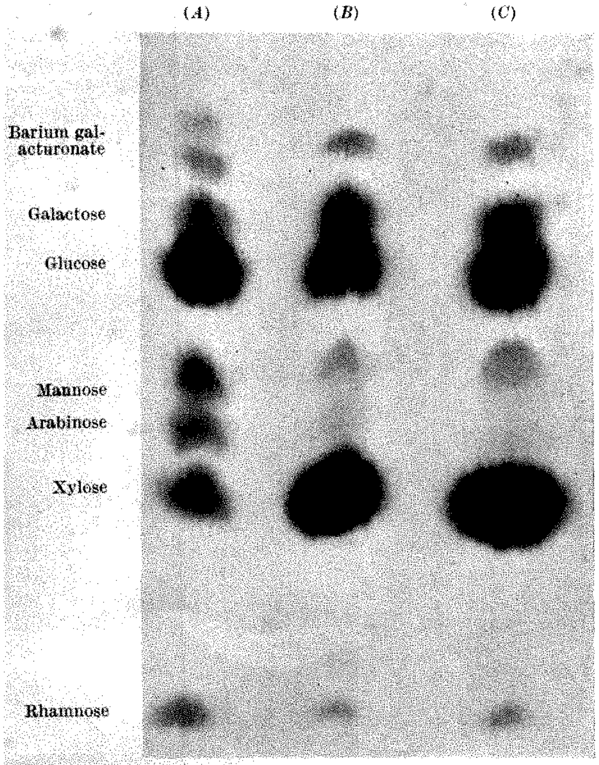

Fig. 1. Chromatogram with three successive runs of 56, 36 and 30 hr.: (*A*) reference sugars; (*B*) α-cellulose isolated by 9·5 per cent alkali; (*c*) α-cellulose isolated by 17·5 per cent alkali

this communication, however, has shown that on changing the hydrolytic procedure, that is, by using a dilute sulphuric acid solution instead of strong acid to effect only a partial hydrolysis, the conversion of glucosan to simple sugar is greatly restricted and, on following the technique of interrupted development of the chromatogram, it is possible to identify a number of associated sugars in addition to those already reported[2-4].

A small quantity of α-cellulose (0·5–2 gm.) is usually hydrolysed for the chromatographic analysis; but in the present investigation, a larger amount of the sample (10 gm.) was employed with the view of obtaining a more concentrated extract of associated sugar residues, particularly of those occurring in small proportions. Jute α-cellulose was prepared by treating the isolated chlorite holocellulose with sodium hydroxide solution under two different conditions, namely, (1) 17·5 per cent alkali at 20° C. according to the A.C.S. method and (2) 9·5 per cent alkali at room temperature. The sample was partially hydrolysed on heating with *N* sulphuric acid (200 c.c.) by immersing the reaction vessel in boiling water for 1 hr., when the material suffered a loss in weight of 4–6 per cent. The extract was further hydrolysed by refluxing for 6 hr., neutralized with barium carbonate to *p*H 5·6, concentrated at 35° C. to a small bulk and chromatographed on Whatman No. 1 filter paper with *n*-butanol – acetic acid – water (1 : 0·24 : 1) as the solvent, sugars being detected on spraying with aniline hydrogen phthalate. When the chromatogram was run at a stretch over a prolonged period (96–120 hr.) in order to effect separation of individual components, the spots of sugars occurring in small amounts became too faint to be detected with certainty by visual examination. On interrupting the flow of the chromatogram, that is, by subjecting the paper to three successive runs, initially for 56 hr. and then twice for 36 and 30 hr., sugars could be easily identified, although the shape of the spot suffered a considerable change from that obtained after a single run.

A typical chromatogram (Fig. 1) of the hydrolysate obtained from white jute α-cellulose, prepared by two different procedures, shows the presence of barium uronate, galactose, mannose and rhamnose in addition to glucose, xylose and arabinose already identified; the spot of arabinose is particularly faint in the case of the sample prepared with 17·5 per cent alkali. The hydrolysate from tossa jute α-cellulose also yielded a similar chromatogram and, from the size and intensity of the spots obtained, the material appeared to be associated with increased amounts of both xylose and arabinose. Individual sugars were isolated after separation on Whatman No. 3 *MM* filter paper and confirmed by measuring the respective R_F values, further confirmation of uronic acid being obtained from naphthoresorcinol and that of galactose from mucic acid tests. Jute α-cellulose, therefore, appears to be associated, irrespective of its method of isolation, with mannose in addition to the other sugars so far detected in the holocellulose fraction[6].

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Rise of Serum Folic Acid-Levels after Injection of Vitamin B_{12} in Nutritional Macrocytic Anæmia

Although certain similarities between folic acid and vitamin B_{12} as agents involved in hæmopoiesis, nucleic acid synthesis and single-carbon transfers are well known, there is very little information on the manner in which these two chemically dissimilar vitamins affect each other. We wish to make a preliminary report of observations which show that the administration of vitamin B_{12} causes a rise in the serum folic acid-level in patients with nutritional macrocytic anæmia.

The total vitamin B_{12} content in the serum was determined by a modification of the microbiological (*Euglena*) method of Ross[1] using the extraction procedure of Shenoy and Ramasarma[2]; the folic acid content was determined microbiologically with *L. casei* as the test organism[3].

In some of the earlier cases of nutritional macrocytic anæmia treated with daily injections of 10 mgm. of folic acid, a definite increase in serum vitamin B_{12} concentration was noticed 24–72 hr. after commencement of therapy, whereas in others no significant changes could be seen. If this increase was due to mobilization of vitamin B_{12} from tissue stores, it is reasonable to expect a bigger rise in patients who have larger stores of vitamin B_{12}. In order to test this

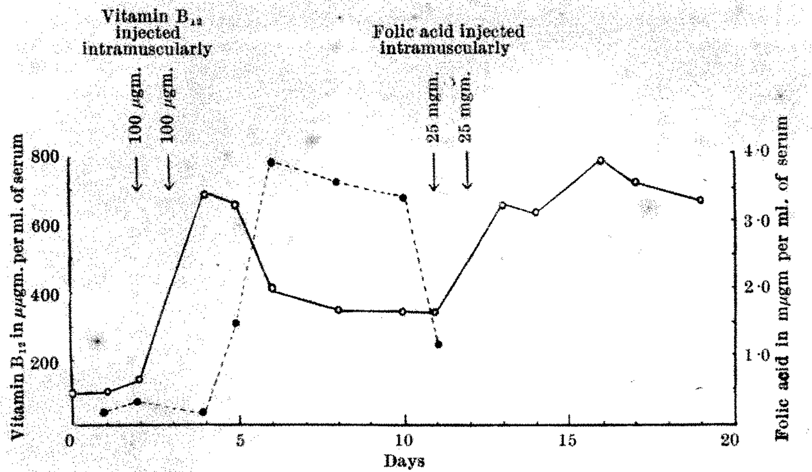

Fig. 1. Changes in serum concentrations after injections of vitamin B_{12} and folic acid in a patient with nutritional macrocytic] anæmia. ○——○, vitamin B_{12}; ●——●, folic acid

hypothesis and also to test the effect of parenteral vitamin B_{12} on serum folic acid-levels, the following general plan was adopted.

After a control period of five to nine days, each patient was given two intramuscular injections of 100 μgm. of vitamin B_{12} on consecutive days. Eight days later, he was given two intramuscular injections of 25 mgm. of folic acid on consecutive days and was kept under observation for a week or more. The results are summarized in Table 1, and a striking example is shown in Fig. 1.

The pretreatment values for serum folic acid were within the range 0·28–2·55 mμgm. per ml. However, these values increased several-fold after the administration of vitamin B_{12}, the peak-levels being usually reached within three to seven days. These results confirm the observations made by Nieweg *et al.*[4].

The initial concentrations of serum vitamin B_{12} in most of the patients were subnormal (less than 100 μμgm./ml.) or marginal. The injection of vitamin B_{12} caused a sudden rise in the serum-levels which, as can be expected, showed a rapid fall during the next three or four days. Thereafter the values declined slowly or remained practically constant. Of particular interest was the observation that, in every case studied, the trend of falling vitamin B_{12}-levels was reversed in 24–48 hr. after the injection of folic acid. In all cases the subsequent rise was sustained and of high statistical significance. The peak value was reached about the sixth day after injection of folic acid. The changes in the free B_{12} levels (not included in Table 1) were small and, therefore, the observed increases in the total vitamin B_{12} were obviously due to the combined vitamin, which is released only after digestion with papain.

Table 1. SUMMARY OF DATA ON SERUM FOLIC ACID AND VITAMIN B_{12} LEVELS IN 13 NUTRITIONAL MACROCYTIC ANÆMIA PATIENTS DURING TREATMENT

	Folic acid content (mμgm./ml.)		Vitamin B_{12} content (μμgm./ml.)	
	Before B_{12} injection (*a*)	After B_{12} injection (*b*)	Before folic acid injection (*c*)	After folic acid injection (*d*)
Range Average	0·28–2·55 0·94	1·37–5·85 2·87	180–598 414	269–978 662
Mean difference *t* *P*	1·93 6·4 < 0·1 per cent (highly significant)		248* 6·5* < 0·1 per cent (highly significant)	

a, Mean of values for three consecutive days; *b*, mean of six values during 8 days; *c*, mean of three values during 4 days; *d*, mean of five values during 7 days.

* In another series of nine patients in whom only the serum B_{12} concentrations were studied, the mean difference of 123 μμgm./ml. was found to be highly significant ($t = 5·7$, $P < 0·1$ per cent).

Although the observed rises could be explained on the basis of increased absorption from the gut or decreased urinary excretion, the fact that folic acid elicited a more striking increase of serum B_{12} in those patients whose B_{12} stores were augmented by prior medication suggests that its action is one of mobilization of vitamin B_{12} from the body stores. Such a conclusion is also compatible with Vilter's theory of 'mass action effect'[5], and the numerous clinical observations on the use of folic acid in the treatment of pernicious anæmia[6] as well as the recent findings by Harris[7].

A detailed report of this work will be sent to the *Indian Journal of Medical Sciences.*

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Effects of Chlorpromazine and Dinitrocresol

THE observations of Berger, Strecker and Waelsch[1] on the action of chlorpromazine on oxidative phosphorylation of mitochondria prompt us to report that chlorpromazine has been observed to potentiate the action of 2,4-dinitro*ortho*cresol (DNC) in white mice. Mice weighing 16–21 gm. were given this substance subcutaneously, followed immediately by chlorpromazine hydrochloride intraperitoneally. The results obtained (at a room temperature of 25° C.) are as follow:

Dose	No. of animals	No. dead after 24 hr.
20 mgm./kgm. DNC	10	1
20 mgm./kgm. DNC + 5 mgm./kgm. chlorpromazine	10	6
25 mgm./kgm. DNC	10	6
25 mgm./kgm. DNC + 5 mgm./kgm. chlorpromazine	10	8
25 mgm./kgm. DNC + 10 mgm./kgm. chlorpromazine	10	9
5 mgm./kgm. chlorpromazine	10	0
10 mgm./kgm. chlorpromazine	10	0

These figures suggest that the effects of chlorpromazine and 2,4-dinitro*ortho*cresol are additive.

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Antibody Formation by Protein Components of Bee Venom

IT is not yet known for certain whether the physiological responses to bee venom include the formation of antibodies. Earlier investigators have obtained divergent results when investigating immunization against different effects of the venom. This is probably in part due to the fact that a series of pharmacological and enzymatic reactions are caused by quite different constituents of the venom[1]. In recent years, several proteins with various biological properties have been isolated: first, the pharmacologically highly active toxin-fraction (so-called 'fraction I')[2]; then the enzymes phospholipase *A*[3] and hyaluronidase[4], which on electrophoresis migrate in the so-called 'fraction II'. From these findings arises the question whether antigenic properties may be found with these substances.

Solutions of cautiously dried bee venom were injected intravenously into rabbits at intervals of one to two weeks. Before every injection samples of serum were obtained and stored at − 6° to − 8° C. Repeated doses of 0·2 or 1·0 mgm./kgm. caused increasing formation of antiphospholipase and antihyaluronidase in the sera (cf. Fig. 1). On the other hand, the effects of bee venom on the isolated guinea pig auricle or frog heart, the frog sartorius, guinea pig gut or uterus, and also its systemic toxicity in white mice and the (direct) hæmolysis of human erythrocytes by fraction I, were not diminished by the sera of the immunized rabbits to a greater degree than they were by normal rabbit serum.

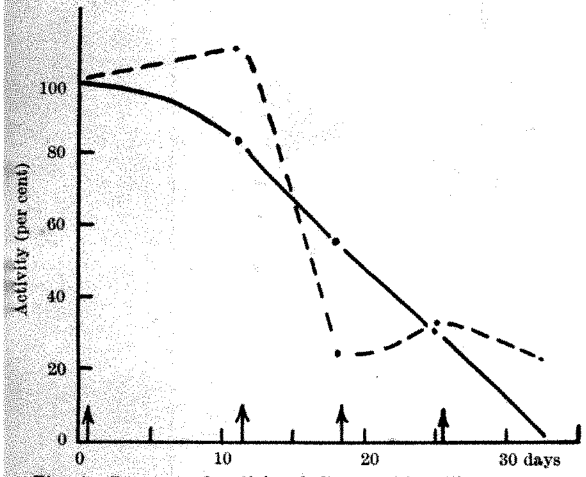

Fig. 1. Increase of antiphospholipase and antihyaluronidase potency of rabbit serum after repeated intravenous injections of bee venom. At arrows: 1 mgm./kgm. bee venom. Activity is given as a percentage of the activity of a control (venom + stored normal serum). ·——·, hyaluronidase (ref. 5); venom, 1 : 20,000, serum, 1 : 40. ·– – –·, phospholipase *A* (ref. 5); venom, 1 : 336,000, serum, 1 : 42

The experiments show that two enzymes—phospholipase *A* and hyaluronidase—of bee venom give rise to immunization, whereas the non-enzymatic but pharmacologically highly active toxin-fraction I seems to be non-antigenic.

The investigations will be extended, and a detailed description of methods and results will be published in the dissertation of one of us (El K.).

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Formation of Erythulose from Hydroxypyruvate in the Presence of Yeast Carboxylase

HYDROXYPYRUVATE is a metabolite which can arise from the biological oxidation of glycerate[1], transamination of serine[2], or decarboxylative condensation of glyoxylate[3]. In the presence of cocarboxylase, magnesium ions and transketolase, it yields 'active' (cocarboxylase-bound) glycolaldehyde, capable of forming a ketopentose 5-phosphate with D-glyceraldehyde 3-phosphate[4,5] or sedoheptulose 7-phosphate with D-ribose 5-phosphate[5,6]. Transketolase decarboxylates hydroxypyruvate only when a suitable acceptor aldehyde is present[5] (acetaldehyde will not serve[7]) and does not decarboxylate pyruvate[5,7]. Crude yeast pyruvate carboxylase, on the other hand, has been stated not to decarboxylate hydroxypyruvate[8].

The conclusions of Akabori *et al.*[9] that muscle minces cause a decarboxylative acetoin type of condensation of dihydroxyfumaric acid, leading by way of a hydroxypyruvate intermediate to the formation of tetrose and hexose sugars, led us to re-investigate the action of partially purified yeast carboxylase, prepared from several varieties of yeast, on pure lithium hydroxypyruvate[1]. Contrary to the experience of Meister[8], we observed a slow steady decarboxylation at *p*H 5, and this became vigorous at *p*H 6·5. Colorimetric estimation[1] confirmed the disappearance of hydroxypyruvate, with little or no formation of free glycolaldehyde. A neutral reducing substance accumulated in good yield, having R_F on paper chromatographic analysis in phenol/water of 0·695, identical with that of pure L-erythulose and distinct from that of erythrose ($R_F = 0{\cdot}65$). This enzymically synthesized tetrose gave a crystalline *o*-nitrophenylhydrazone (found N = 16·5 per cent, calc. 16·5 per cent), melting point 150°, unchanged on admixture with authentic erythulose *o*-nitrophenylhydrazone. Determination of the optical rotation in ethanol of this derivative gave $[\alpha]_D = + 48° \pm 3°$, thus characterizing the sugar as L-erythulose. The output of carbon dioxide in relation to the loss of hydroxypyruvate indicates the reaction to be:

$$2\,CH_2OH.CO.COOH \rightarrow CH_2OH.CO.CH(OH).CH_2OH + 2\,CO_2$$

As with pyruvate decarboxylation, the activity is lost on dialysis of the alkaline enzyme-complex, and restored by the addition of cocarboxylase and magnesium ions. Although free glycolaldehyde does not itself yield tetrose, nor does it increase the rate of hydroxypyruvate decarboxylation, free glyceraldehyde can act as an 'acceptor', yielding a ketopentose with these preparations. The possible synthesis of hexose from tetroses and hydroxypyruvate is now being studied, as is also the interesting question of the relationship of these two cocarboxylase-requiring enzymes—carboxylase and transketolase—in the biosynthesis of free sugars from hydroxypyruvate.

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Effect of Size and Age of Female Rats on their Response to the Methæmoglobinogenic Action of 3′-Methyl-4-dimethylaminoazobenzene

DURING a study of the methæmoglobinogenic activities of various carcinogenic agents, it was observed that a standard dose of the azo dye, 3′-methyl-4-dimethylaminoazobenzene (16·5 mgm. in ~0·55 ml. of arachis oil per 100 gm. body-weight), induced a greater and more persistent methæmoglobinæmia in old female albino rats than in young female rats.

In the experiment given in detail in Table 1, blood was withdrawn from the tails of four non-fasted rats and checked for the absence of methæmoglobin. Most of our normal rats were methæmoglobin-free but a few showed methæmoglobinæmia of a low order (less than 1 per cent). Two hours later each rat received an injection of the azo dye, and blood (~0·2–0·4 ml.) was taken from the tail at 3, 7, 22 and 28 hr. following the injection. Each fresh heparinized blood sample (0·1 ml.) was mixed with Sörensen buffer (10 ml.; *p*H 6·6) and the percentage of methæmoglobin was determined by a modification of the method of Vandenbelt *et al.*[1]. For convenience of handling, the rats were anæsthetized with ether at each bleeding and in the period 7–22 hr. the animals had access to rat cubes and water.

For statistical calculations, the area which the methæmoglobin-time graph makes with the time axis was found to be a convenient measure of the response of the animal. Alternatively, the sum of th methæmoglobin percentages (Σ per cent) at 3, 7, 22 and 28 hr. could be used. Scatter diagrams o methæmoglobin-time (Fig. 1) or Σ per cent plotted against rat body-weight for 13 young and 11 old animals showed strong linear relationships. Correlation coefficients (r) of $+0·84$ were obtained wit t values of 7·248 and 8·644 respectively, which exceed the 0·1 per cent probability-level. The results ar highly significant.

Table 1

Rat		Per cent methæmoglobin at the stated times (hr.) after injection of the azo dye					Methæmoglobin-time (cm.^{2})
Wt. (gm.)	Age (mon.)	0	3	7	22	28	
245	18	0	16·4	34·5	13·1	6·2	60·7
230	18	0	23·1	32·0	5·7	4·1	57·0
125	2	0	5·9	14·6	2·1	1·5	23·5
125	2	0	4·3	8·2	1·7	1·1	14·1

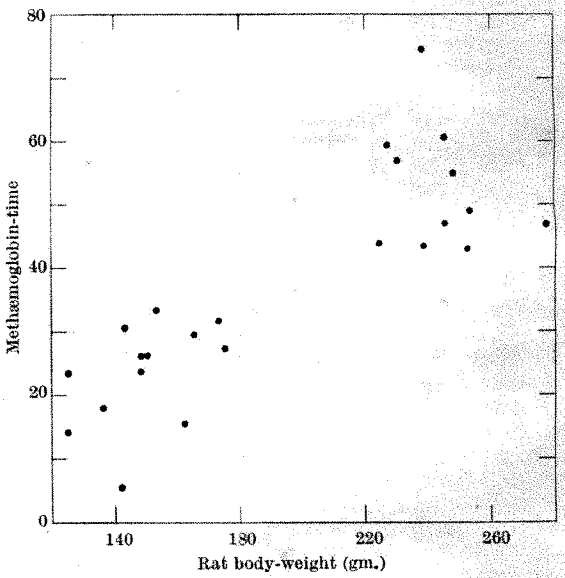

Fig. 1

A complete correlation between methæmoglobin time and age could not be made owing to uncertaint about the ages of most of the old rats. However, th ages of the young animals were known precisely an a linear correlation was found for this group. Her r was $+0·61$ with $t = 2·521$, which exceeds the 5 pe cent level and indicates that the result is probabl significant. The susceptibility of female rats to th methæmoglobinogenic action of the azo compoun appears to increase rapidly during the first fe months of life.

Further information about the groups is given i Table 2. From the methæmoglobin-time varianc figures quoted there, the best estimates[2] of populatio variation were found to be 95·459 and 65·961 fo the old and young groups respectively. The varianc

Table 2

Rat		Age		Body wt. (gm.)		Methæmoglobin-time (cm.^{2})		
Group	No.	Range	Mean	Range	Mean	Range	Mean	Variance
Old	11	8–18 mon.	—	227–277	245·3	42·9–74·6	52·7	86·781
Young	13	56–72 days	64·7 days	125–175	149·6	5·4–33·4	23·5	60·887

ratio, F, is therefore 1·447 (95·459/65·961), which is lower than the 5 per cent level for 10 and 12 degrees of freedom, so that the difference between the standard deviations of the groups is not significant. Thus "Student's" t may be used for investigating the difference between the sample means. The best estimate for the standard error of the difference of the means was 3·650. Since the difference of the means is 29·255, "Student's" t is 8·015 (29·255/3·650), which greatly exceeds the 0·1 per cent level. Therefore, the difference between the mean values of methæmoglobin-time for old and young groups is highly significant.

It is already known that old rats may exhibit markedly different responses to certain drugs as compared with young animals[3]. It would be of interest to determine whether there is a difference in response of young and old rats to the carcinogenic action of 3′-methyl-4-dimethylaminoazobenzene. Some observations of Druckrey and Küpfmüller[4] suggest that old rats require less 4-dimethylaminoazobenzene than do young rats for liver tumour formation.

Since very little work appears to have been done on the methæmoglobinogenic action of azo compounds, it may be noted here that, mole for mole, 4-dimethylaminoazobenzene has been found to be a more potent methæmoglobinogenic agent for rats than its 3′-methyl derivative. The non-carcinogens, azobenzene, 4′-methyl-4-dimethylaminoazobenzene and 4′-hydroxy-4-dimethylaminoazobenzene, had no methæmoglobinogenic activity, but rats which received the last-mentioned compound succumbed to pulmonary œdema. The non-carcinogen, 4-diethylaminoazobenzene, which also produced pulmonary œdema in rats, gave rise to a transient methæmoglobinæmia.

It has also been found that the methæmoglobinogenic activity of 3′-methyl-4-dimethylaminoazobenzene is suppressed when the carcinogenic hydrocarbon, 20-methylcholanthrene, is incorporated in the azo dye–arachis oil solutions. In these circumstances, the methæmoglobin level in the blood invariably drops during the 3–7 hr. period after injection. Further studies of this effect are in progress because it may be related to other effects which have been observed when methylcholanthrene is given to rats receiving the azo dye, namely, inhibition of liver tumour formation[5], diminution in azo dye binding by liver proteins[6] and increase in amounts of liver enzymes which are able to affect demethylation and azo linkage reduction of 3′-methyl-4-dimethylaminoazobenzene[7].

This work was supported by the Melville Trust, to which my thanks are due. It is hoped to publish a more detailed account later.

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Biological Activity of Benzoxazine-1,3 Derivatives, particularly against Experimental Sarcoma

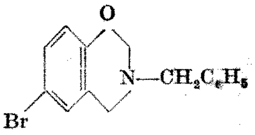
IT has already been shown by Šlopek and one of us (T. U.) that 1,3-oxazine derivatives have a marked antituberculous activity *in vivo*. However, those compounds which are derivatives of nitroparaffins and contain a nitro-group show a relatively high toxicity on prolonged administration. This led one of us (T. U.) to look for less toxic derivatives of 1,3-oxazine[2].

Continuing further this line of research, a number of derivatives of benzoxazine-1,3 have been prepared according to Burke[3] and examined from the point of view of their antituberculous activity.

All of them show a tuberculostatic action *in vitro* at concentrations 8–31 mgm. per cent[4].

It has now been found that benzoxazine-1,3 derivatives reduce tumours produced by experimental Crocker sarcoma in mice.

The experiments were carried out by determining the lethal doses when administered subcutaneously. The substances were as follows:



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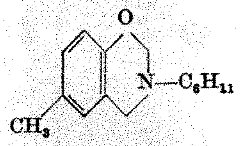

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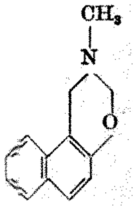

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Their lethal and therapeutic doses are given in Table 1.

Table 1

	Concentration (per cent)	Lethal dose for mice of 18–22 gm.	Therapeutic dose for mice of 18–22 gm.
T 339	1·5	30 mgm.	5·0 mgm.
T 375	2·0	5 mgm.	0·2 mgm.
T 356	1·5	10 mgm.	1·2 mgm.

All mice were grafted with Crocker sarcoma. Administration of the drugs subcutaneously was started the day after inoculation. Ten injections of *T* 339 and *T* 375 and eleven of *T* 356 were given during fourteen days. After that, the animals were killed and tumours were examined histologically. The weight of tumours was determined and served to estimate the activity of the drugs.

The results are shown in Table 2.

Table 2

Substance	Total amount of drug (mgm.)	No. of mice				Average weight (mgm.)		Ratio of tumour weights $\frac{c}{e}$
		Experimental		Controls		Experimental *e*	Control *c*	
		♂	♀	♂	♀			
T 339	50	10	—	10	—	855	1,377	1·6
T 339	50	—	10	—	9	1,500	3,093	2·0
T 375	2	8	12	9	10	576	1,441	2·50
T 356	13·2	9	10	9	11	298	944	3·17

It is evident that the substances *T* 375 and particularly *T* 356 inhibit growth of experimental sarcoma tumour. The relatively high toxicity of the substance should, however, be emphasized.

Detailed description of the experiments, including histological examination, will be reported elsewhere.

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Œdema Formation in Rat's Skin

It is known that histamine liberators such as 48/80, egg white and dextran produce in rat skin œdema and capillary changes which lead to accumulation of circulating colloidal dye. These changes show a characteristic distribution and occur in skin regions, such as those of feet and face, which are particularly rich in histamine[1]. However, the part of histamine in these changes has been questioned. When discussing these changes it is necessary to deal separately with the œdema formation and the dye accumulation. The œdema is a sign of greatly increased capillary permeability. Concerning the accumulation of a circulating colloidal dye such as trypan blue, the present concept is that the dye is bound in the bloodstream to plasma proteins which penetrate the dilated capillary wall, moving through the dilated capillaries into the damaged area. The mechanism for this penetration is the phagocytic activity of the endothelial cells, histiocytes and fibriocytes which take up the proteins. The accumulation of circulating dye thus indicates an increased local phagocytic activity. The present experiments show that release of histamine is responsible for the œdema formation but that the accumulation of circulating dye is independent of histamine release.

According to Feldberg and Talesnik[1] the œdema in the feet of the rat produced by intraperitoneal injection of 48/80 or egg white is due to release of histamine, because it no longer occurred when the skin had been depleted of its histamine by repeated intraperitoneal injections of 48/80. In contrast, Kramer[2] found that the histamine content of the rat's skin did not influence the œdema produced by egg white and that the œdema occurred also when the skin had been depleted of its histamine.

Using the technique of Brocklehurst *et al.*[3], rats were treated with intraperitoneal injections of 48/80 for eight days. After treatment for five days 48/80 no longer produced œdema, and after treatment for eight days egg white (2 ml. intraperitoneally) also failed to cause œdema. These results agree with those of Feldberg and Talesnik and differ from those of Kramer. They show that the œdema formation is dependent on the histamine release.

In rats in which the skin histamine had been depleted by repeated intraperitoneal injections of 48/80 and in which injections of histamine liberators no longer caused œdema, intradermal injections not only of histamine and of 5-hydroxytryptamine, but also of 48/80 and of egg white, retained the property of causing accumulation of circulating dye at the site of the injection. Intradermal injections of saline solution were ineffective. The dye used was trypan blue, which was injected into the tail vein immediately after the intradermal injections. The rats were killed 60 min. later and the inside of the abdominal skin examined for local dye accumulation. Similar results were obtained in two other series of experiments in which either the histamine in the rat's skin was depleted by dextran or egg white instead of by 48/80, or in which the trypan blue was replaced by indian ink. These results show that the changes responsible for the accumulation of dye or indian ink are independent of histamine release and therefore not an effect of histamine. A similar conclusion was reached by Brocklehurst *et al.*[3] for the dye accumulation of passive cutaneous anaphylaxis in rats in which the skin had been depleted of its histamine by 48/80.

Indian ink and trypan blue accumulation was not caused by the liberation of histamine or 5-hydroxytryptamine since these latter two substances were no longer present after the first day during repeated treatments with 48/80, dextran or egg white. Even in the absence of histamine or 5-hydroxytryptamine the reaction of accumulation continues, showing an unchanged functioning of the inflammatory defence mechanism.

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Effect of Blood on the Viability of Dried Cultures of Cholera Vibrios

Between 1949 and 1954 twenty-two strains o *Vibrio cholerae*, grown at 37° C. on 'Lemco' agar and suspended in 'Mist. desiccans'[1], were dried by the spin-freeze method developed by Greaves[2]. Viable counts were made by the Miles and Misra[3] technique on the suspensions used for drying, and on ampoules of dried material reconstituted at intervals afte drying. In routine tests reconstitution was in 'Lemco broth, which was also used as diluting fluid. Al counts dropped rapidly, thus confirming the experience of others[4,5] that the vibrios were unduly susceptible to drying by sublimation.

Experiment showed that higher viable counts could be obtained (*a*) by using 5 per cent blood broth a diluent, or (*b*) by plating 'Lemco' broth dilutions or blood agar. This suggested that blood provided some essential factor for the recovery of cholera vibrios

Table 1. Viability of *V. cholerae* (N.C.T.C. 8021) on 'Lemco', Serum and Blood Agar

	No. of colonies growing at dilutions					
	10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-6}
'Lemco' agar	cc.	11	0	0	0	0
Serum agar	cc.	unc.	29	4	1	0
Blood agar	cc.	cc.	unc.	27	6	0

cc. = confluent colonies. unc. = uncountable

from the dried state, a factor which was not adequately supplied by serum.

It is possible that the population of *V. cholerae* culture is not homogeneous, and that there are cells able to grow on agar and others unable to do so without the addition of blood. To test this point, subcultures were made from the highest dilutions surviving on blood and on 'Lemco' agar and these were redried by the same method. So far there is no evidence to support the theory of a heterogeneous population, but long-term experiments are continuing.

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Coenurus of *Taenia brauni* Setti parasitic in Man and Animals from the Belgian Congo and Ruanda-Urundi

In 1952 I was able to observe for the first time the ife-cycle of *Taenia brauni* Setti (1897).

This tapeworm lives, in the adult stage, in the ntestines of dogs and jackals in the Belgian Congo, and its larvæ, of the *Coenurus* type, have been found n Nature in wild rodents (*Lemniscomys striatus* L.).

On feeding laboratory-bred white mice with proglottids found in the droppings of parasitized dogs, I have succeeded in observing the development within them of *Coenurus*. On the other hand, I was successful in obtaining adult worms by feeding non-infected young dogs with fragments of *Coenurus* collected from wild rodents which were naturally nfected with the parasite[1].

Afterwards I discovered the *Coenurus* of this tapeworm in numerous other wild rodents in Ruanda-Urundi (*Rattus r. rattus* L., *Tachyoryctes ruandae* Lönnb. and Gyld., *Otomys irroratus vulcanius* Lõnnb. et Gyld., *Grammomys surdaster* Thom. et Wrought., and *Dendromus pumilio lineatus* Hell.) as well as in a monkey (*Cercopithecus mitis doggetti* Poc.) and in man (native). I never found it in sheep or goats nor n the wild rabbit, although this animal is very common in the region.

In wild rodents the *Coenurus* is most often found under the skin; but it may be found also on other parts of the body, namely, in the pleural and abdominal cavities and in the brain. The percentage of nfected rats varies very much according to the places investigated, but in certain places it may reach up to 20 per cent of the animals examined.

Cerebral coenurosis of rodents has been found only on three *Rattus r. rattus* in the vicinity of Astrida. These *Coenuri* were rather big and situated in different parts of the brain. Two of the three infected rats had also *Coenuri* on other parts of the body.

The case of cerebral coenurosis of the ape was discovered in the region of the Akanyaru (near Astrida). A globular *Coenurus*, 2 cm. in diameter, was found embedded in the parietal lobe. This ape carried two other *Coenuri*: one, of the size of a large pea, was in part nestled in the apex of the heart; the other, much larger, was found in the region of the parotid gland.

In man (native) I have observed eight cases of coenurosis between the years 1948 and 1956, all situated under the skin. Of these eight cases, seven were children, the ages varying between 11 months and 5 years; the last one was a boy of fourteen.

In four children the tumour was found along the ribs, in the four others it was found elsewhere on the trunk. The *Coenurus* was a solitary one in all patients. The dimension of the tumour varied from the size of an almond to that of a large plum; the form being globular or elongated.

The morphological study of all *Coenuri* showed that they belonged to *Taenia brauni* Setti. This tapeworm is extremely frequent in dogs and jackals throughout the Ruanda-Urundi area and Ituri region (Eastern Congo) and it is, together with *Taenia hydatigena* Pallas, the only cestode of the *Taenia* genus found in the dog of these regions[2].

It is my opinion that the *Coenurus* found by Taramelli and Dubois under the skin of a native woman (of the Belgian Congo) belongs also to *Taenia brauni*[3].

It is known that *Coenuri* of *Taenia serialis* or of *Taenia multiceps*, as parasites of man, occupy on this accidental host the same site as on the habitual intermediary host: respectively under the skin for *Coenurus serialis* and in the brain for *Coenurus cerebralis*.

The larva of *Taenia brauni* is less specific in the choice of its location in its natural hosts than those of the preceding species. It seems to me most probable that it would behave in the same manner in man, and that, besides its normal location under the skin, one may expect to find it in the inner organs as well as in the brain. In this connexion it may be pointed out that, during recent years, four cases of human cerebral coenurosis have been described in South Africa all attributed by the authors to *Taenia multiceps*[4]. It could be that these *Coenuri* belong, in fact, to *Taenia brauni*.

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Histological and Histochemical Observations on the Intestinal Cells of Lambs and Kids absorbing Colostrum

It has been known for many years that intact colostral globulins are absorbed from the intestine of the young ruminant[1] and recently it has been shown[2], in the calf, that labelled globulins from colostral whey passed from the intestinal lumen into the intestinal lymphatics. Histological examination of the intestinal epithelium of calves in which absorption of protein was taking place revealed the presence of numerous globules with similar staining properties to the protein of the whey, and hence it was suggested that the protein, which was absorbed without change, passed through the cells of the epithelium of the small intestine[3].

We have recently carried out a histological and histochemical study of the intestinal epithelium of young lambs and kids which were killed shortly after receiving colostrum. As in the calf, the epithelial cells of the villi of animals up to 36 hr. old contained large numbers of eosinophilic globules of varying size (2·5–15μ), while the cells of older animals did not contain globules. The globules were present throughout each cell, the majority occupying an infranuclear position since most of the nuclei were close to the free border of the cell.

As described by Comline *et al.*, colostral whey with similar staining and histochemical properties to the globules was present in the lumen of the gut and between the intestinal villi. In this position the whey was in a finely granular form. Moreover, finely granular material with similar staining and histochemical properties was demonstrable in the lacteals within the villi. Examination of suitably stained sections (periodic acid – Schiff) revealed numerous small granules just within the free border of each epithelial cell. These granules had similar staining properties to the globules and hence it appeared that the material in the lumen of the intestine was absorbed in a finely divided form and that globule formation occurred within the cell. Although in mounted paraffin sections the globules appeared homogeneous, examination in water of sections stained with methylene blue revealed that each large globule was made up of a number of smaller globules. Breakdown of the globules apparently occurred within the cell since none could be demonstrated in the lacteals.

Table 1

Histochemical test	Lumen content	Globule	Lacteal content
Periodic acid – Schiff (PAS)	+	+	+
PAS after diastase	+	+	+
PAS after hyaluronidase	+	+	+
Metachromasia	−	−	−
Methylene blue extinction	Faint or nil below *p*H 4·0	Faint or nil below *p*H 4·0	Faint or nil below *p*H 4·0
Alcian blue	−	−	−
Sudan III and IV	+	−	+
Sudan black *B*	+	−	+
Nile blue sulphate	+	−	+
Millon reaction	+	+	Faint +
Feulgen reaction	−	−	−
Pyronin	+	+	+
Pyronin after ribonuclease	+	+	+

The results of the histochemical tests are presented in Table 1. They showed that the material in the lumen of the gut, the globules in the epithelial cells and the material in the lacteals was muco- or glycoprotein. It seems reasonably certain, therefore, that the globules were, in fact, the colostral proteins. That the protein was present as a conjugated protein was not unexpected since highly purified preparations of colostral globulin have been shown to contain residual carbohydrate material[4,5], and fractions of serum globulin have also been shown to fall into the group of glycoproteins[6]. It is possible, however, that the colostral globulin became associated with the mucus secreted by the digestive tract prior to absorption. This point is being investigated.

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Tracheæ of *Acheta domesticus* Linn.

WE have recently been examining the testes o *Acheta domesticus* Linn. in the electron microscop (Siemens Elmiskop 1), using osmium-fixed ultra-thi

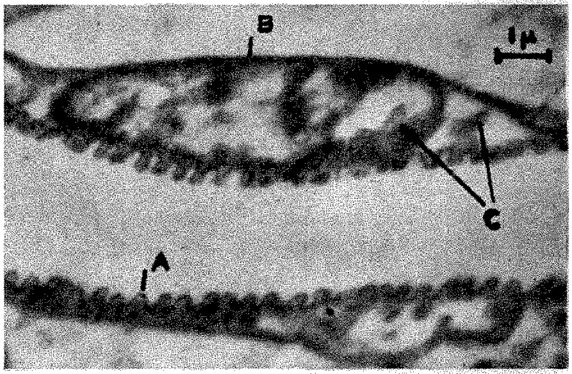

Fig. 1. Longitudinal section approximately through the long axis of a trachea

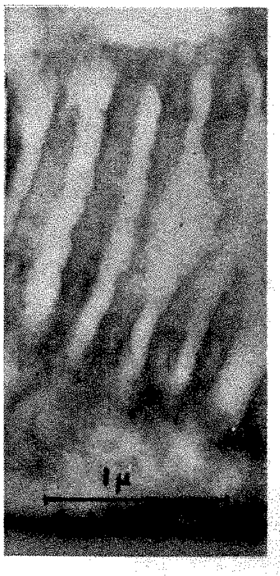

Fig. 2. Longitudinal section through the 'endocuticular' folds of a trachea.

ections of about 250 A. In the course of this work we ave made a number of observations on tracheæ vhich supplement earlier findings[1-5]. Fig. 1 shows a ongitudinal section of a trachea which appears to onsist of a folded 'endocuticular' layer (*A*), and an exocuticular' layer (*B*) which surrounds both the rachea and the accompanying cell (*C*). Fig. 2 shows section through the 'endocuticular' folds. The endocuticular' layer itself is about 100 A. thick. The olds are ring-like or possibly helical, and are separated rom each other by a few thousands of angstroms. he 'exocuticular' layer is also about 100 A. thick.

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Terminology of the Insect Integument

A WORKER proposing to investigate the covering ayers of the Insecta quickly finds that he has to contend with a confused and often contradictory terminology. This state of affairs derives from three principal ources ; a detailed knowledge of the coverings has ecome possible only through technical advances nade over the past thirty or so years ; students have requently accepted, rather uncritically, the older erminology ; and, as yet, relatively little is known of he coverings throughout the class, and the necessary omologies on which a standard terminology must be ounded are therefore wanting.

While these are undeniable facts, it is equally ndeniable that unless some action is taken, confusion vill be augmented as time goes on. Moreover, there re sufficient, even though elementary, data on which o base a consistent terminology, simple yet capable of xpansion to meet future needs. To be acceptable uch a terminology demands that the introduction f new terms be minimized, and that those which are vell established be clearly defined, or, if necessary, e-defined to avoid ambiguity.

The term 'integument' as denoting the unicellular ayer with its internal limiting membrane and its uter secreted covering is now in general use. 'Basement membrane' is also the standard term for the nternal bounding membrane of the cellular layer. or the latter, 'epidermis' and 'hypodermis' are about qually popular. Indicating as it does the location of he cellular layer with reference to the secreted part f the integument, and being used in a less general ense than is 'epidermis', 'hypodermis' could well be ccepted and 'epidermis' dispensed with.

To all entomologists the external secreted part of he integument is known as the 'cuticle'. The value f this term has to some extent been lessened by the hoice of 'epicuticle' for the thin outer non-chitinous art of the cuticle. However regrettable this may be, t is now too late to effect any change. For the larger nner chitinous part of the cuticle, the 'procuticle' of Richards[1] appears to be the only term yet proposed, though it has not attained the currency it merits.

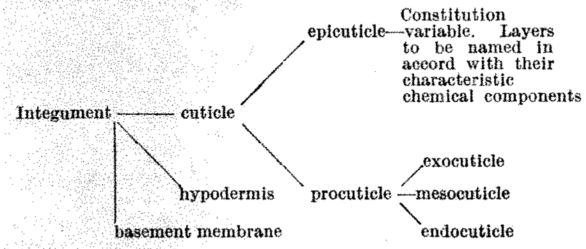
Both procuticle and epicuticle consist of zones variable in number, size, and composition. The only consistent terminology for the procuticle is that of Richards[1] including the modification of Schatz[2] which Richards[3] accepts. He regards the procuticle as consisting of from one to three zones. He restricts the term 'exocuticle' to the hardened part of the cuticle, commonly amber, brownish or black in colour, which is both impregnated and sclerotized. The 'mesocuticle' is that part which is impregnated but not sclerotized, and which is stained by acid dyes, for example, the acid fuchsin of Mallory's stain. The 'endocuticle' is that part of the cuticle which remains chemically unchanged after it has been deposited. This terminology is used in the United States, on the Continent, and in Australia, and it is to be hoped that its adoption eventually becomes general.

It is the terminology of the least-known part of the cuticle, the epicuticle, that is most unsatisfactory. Wigglesworth distinguished four layers in the epicuticles of *Rhodnius*[4], *Tenebrio*[5], and *Periplaneta*[6]. Beginning with the outermost, he named these the 'cement', 'wax', 'polyphenol', and 'cuticulin' layers respectively. Following his example, his followers have exercised considerable ingenuity in interpreting the epicuticles of the insects they have studied in terms of this system. Wigglesworth's terminology was not accepted by Richards[1] nor Dennell and Malek[7,8]. As a result of their work, Dennell and Malek accepted the presence of the cement, wax and cuticulin layers but considered the evidence for the presence of a distinct polyphenol layer insufficient. In place of it they claim that there is a thin 'paraffin' layer. While this is the most recent authoritative pronouncement on the subject, it must still be accepted with reserve. Even among the relatively few species which have been adequately studied, there is a considerable proportion of the epicuticular layers which cannot be homologized in accord with any one proposed scheme. Richards outlined a terminology similar in some respects to that of Dennell and Malek. He proposed the substitution of the term 'tectocuticle'[1] for the earlier 'cement layer' on the grounds that the use of 'cement' in this manner was contrary to histological practice. His term is unfortunate since it suggests the presence (not intended by Richards) of a third major division in the cuticle. Further, he does not propose to use it in the strict sense that 'cement layer' is used, for he himself points out (p. 170) that his term can apply equally to the thin outer protecting layer overlying a wax layer as in *Rhodnius* and *Tenebrio* (that is, as a synonym for 'cement layer'), to the wax layer of the Aleurodidae, to the secretion of the 'peristigmatic' glands of insects, and to the grease layer of ixodid ticks. Obviously, such a term is too general to have any value. Whatever its demerits, the term 'cement layer' is innocuous and non-committal, and as used by Wigglesworth and Dennell and Malek refers only to the thin external layer which overlies the wax layer in a four-layered epicuticle.

In the present state of our lack of knowledge, nothing can be a greater hindrance to progress than an attempt to erect a rigid terminology for the epicuticle. The wisest course to follow is to begin the study of each species with a minimum of pre-conceived ideas as to the constitution of its epicuticle, to determine the number and composition of its layers as found, and to name these according to their characteristic chemical components. This was Dennell's method in dealing with *Sarcophaga*[9] and no better has yet been suggested. Such a method will eventually accumulate data sufficiently comprehensive for precise generalizations to be made.

Finally, a term is needed for the 'skin' shed by an immature insect when it moults. 'Exuviae' is a Latin plural having no singular form. The word itself is ugly, and the various singular forms coined from it are even more so, as well as being etymologically indefensible. None of these is accepted by anyone except its user. Until a generally acceptable term is proposed my own practice is to use the words 'slough' and 'sloughs' with their ordinary English signification.

Based on what has been said above, the following system of terminology is presented for consideration :


Integument
cuticle
epicuticle
Constitution variable. Layers to be named in accord with their characteristic chemical components
hypodermis
basement membrane
procuticle
exocuticle
mesocuticle
endocuticle

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Gibberellic Acid and the Growth of Crop Plants

GIBBERELLIC acid has been found to increase the height of a wide variety of plant species in small-scale experiments[1,2]. We summarize here the results of larger-scale experiments on crops growing in the field which began in July 1953 and continued for the next three years.

Preliminary work showed that 2 oz./acre o gibberellic acid in 100 gallons of water was th optimum rate of application, and this was afterward used in most of the randomized and replicated plo experiments. Lower spray-rates and dust application were less effective. Four to ten weeks after treatmen each plot was cut, the grass weighed and sample for dry weight and crude protein (total nitrogen determinations.

The experiments were carried out on varied sward at four different centres. Nevertheless they all gav basically similar results. Gibberellic acid increase the growth-rate of all components of the swards Dicotyledons had longer internodes and petioles while grasses produced longer, though narrower leaves. These effects were observed even unde conditions when there was little or no response t fertilizer alone. Typical dry-weight yield increase are shown in Table 1. The considerable variation were not unexpected, because of differences in th nature of the experimental sites, the grass species the prevailing weather conditions and the length o time between treatment and cutting. The nitroge content of the grass was lowered by about 2 per cen after treatment with gibberellic acid, so that th yields/acre of crude protein were not increased t the same degree as the dry-weight yields.

The initial growth response to gibberellic acid wa more rapid than that to nitrogenous fertilizers. Th difference persisted longer in the spring and autumn when the natural growth was slow, than at othe times of the year. Eventually, however, the yield obtained with fertilizers became greater than thos obtained with gibberellic acid. For example, in th spring, 2 oz./acre of gibberellic acid and 2 cwt./acr of fertilizer gave approximately the same increase yields if the grass was cut within five weeks of treatment ; but if the cut was delayed longer, the increases obtained with fertilizer were up to thre times those obtained with gibberellic acid.

The increase of growth obtained after treatmen with gibberellic acid was accompanied by a temporar chlorosis of the grass. The normal green colou returned within six to eight weeks, or, if a nitrogenous fertilizer was applied together with th gibberellic acid, within a much shorter time. Th yield increases given by gibberellic acid and fertilizer applied together, were additive.

If, after cutting, the grass was allowed to gro again without further treatment with gibberellic acid the dry matter and crude protein yields at a secon cut were depressed by approximately the amount o the increase at cut 1 (Table 1). Consequently, th total yield over the two cuts was not significantl

Table 1. DIFFERENCES IN THE DRY-WEIGHT YIELDS OF GRASSLAND AT TWO CUTS FOLLOWING TREATMENT WITH GIBBERELLIC ACID

Date of treatment	Dry weight yields at cut 1			Dry weight yields at cut 2		
	Untreated control (cwt./acre)	Increase due to 2 oz./acre gibberellic acid (cwt./acre)	Increase as percentage of control	Untreated control (cwt./acre)	Decrease due to initial gibberellic acid treatment (cwt./acre)	Decrease as percentage of control
March 1, 1955	19·8	3·1	16	30·8	3·9	13
,, 4, 1955	12·2	4·0	31	13·5	3·0	22
,, 14, 1955	29·8	4·3	14	29·2	3·7	13
,, 18, 1955	9·1	3·9	43	13·2	2·4	18
,, 18, 1955	11·3	1·6*	14	16·7	2·0	12
April 13, 1955	25·1	5·0	20	30·3	7·0	23
,, 13, 1954	17·1	7·9	46			
,, 13, 1954	19·3	6·4	33	40·0	9·9	25
July 10, 1953	15·4	4·1*	27	4·4	0·5*	11
August 5, 1954	21·8	1·2	6			
,, 18, 1954	22·9	3·2	14			

All differences, except those marked with an asterisk, were significant at the 1 per cent level.

increased. There were no significant differences at subsequent cuts.

The causes of the reduced growth-rate after the first cut are not fully understood. Depletion of soil nutrients by initial rapid growth is unlikely to be a factor, since application of fertilizer between the cuts had no effect. There was, however, more bare ground on the plots treated with gibberellic acid than on the controls after the first cut, which would indicate that a greater proportion of top growth, particularly of clovers, was removed. This may have checked the re-growth[3]. On the other hand, large decreases of yield at cut 2 were occasionally obtained when the increase at cut 1 was small. This suggests that gibberellic acid had some direct influence on re-growth. It did not, however, cause any permanent change in the composition of the sward.

Experiments on arable crops showed that greater growth of aerial parts of the treated plants was not accompanied by increases in crop yields. For example, wheat treated in the early spring showed a rapid initial increase in growth-rate, but the grain and straw yields at harvest were not greater than those of untreated plants. Similarly, the crop size of tomatoes, peas, runner beans and blackcurrants was not increased when the plants were sprayed with gibberellic acid during flowering or early fruit-set, in spite of a marked increase in the vegetative growth. In other experiments the yield of root crops, including potatoes, turnips and carrots, was even decreased in spite of stimulation of the growth of the tops.

If gibberellic acid could be used in practice for the production of early- and late-season grass, it would be of interest to the dairy farmer only where conditions allow the herbage to be used efficiently. It is difficult to assess the economic return from extending the growing season in this way, particularly since the total yields from swards treated with gibberellic acid are not increased. The use of gibberellic acid in grassland practice seems unlikely.

A fuller account of this work is being prepared for publication elsewhere.

D. G. Morgan
G. C. Mees

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Jealott's Hill Research Station,
Bracknell, Berks.

Nov. 9.

Brian, P. W., Elson, G. W., Hemming, H. G., and Radley, M., *J. Sci. Food Agric.*, **5**, 602 (1954).

Marth, P. C., Audia, W. V., and Mitchell, J. W., *Plant Physiol.*, Supp., **31**, xliii (1956).

Crider, F. J., *Tech. Bull. U.S. Dep. Agric.*, No. 1102 (1955).

Action of Day-length upon the Formation of Adventitious Buds in *Bryophyllum tubiflorum* Harv.

In recent experiments I have found that day-length strongly influences the formation of adventitious buds in *Bryophyllum tubiflorum* Harv.

Two series of young plants were selected: one was grown during short days (8 hr.), the other during long days (16 hr.), in an ordinary greenhouse in summer. The plants of the two series grew normally; however, progressively, the 8-hr. plants began to differ from the 16-hr. plants in two principal respects: (1) their stems and leaves remained somewhat smaller; (2) already in the first months of culture, the former were totally unable to produce new adventitious buds, whereas in the same time, the long-day plants produced a great number of such buds.

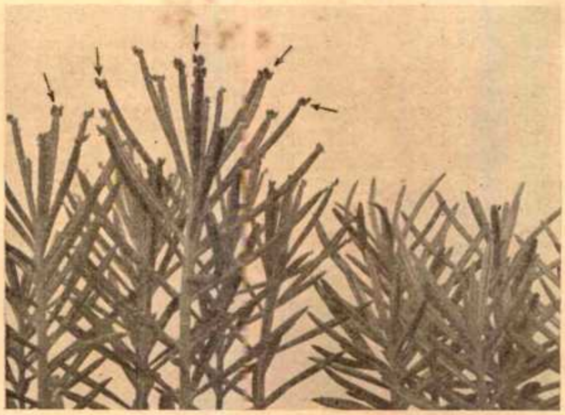

Fig. 1. Adventitious buds on *Bryophyllum tubiflorum* Harv. leaves after 4-month culture. Left, 16-hr. plants; right, 8-hr. plants. Only the long-day plants produce buds (arrows)

The situation became still more marked during the following months until the end of the experiment (4 months): only the leaves of the 16-hr. plants had initiated adventitious buds (Fig. 1).

It could be demonstrated that this effect is related to differences in the internal properties of the leaves of the two kinds of plants, caused by the day-length they had received. This is particularly evident in the following experiment.

After 4 months culture, all the leaves were removed from the 8-hr and 16-hr. plants and placed horizontally on a moistened sand surface. The culture was placed in an ordinary greenhouse in summer with sufficient humidity. One series of leaves were subjected to long-day treatment, and the other to short-day treatment. Thus four series were formed: (1) leaves taken from long-day plants and given long-day treatment; (2) leaves taken from long-day plants and given short-day treatment; (3) leaves taken from short-day plants and given long-day treatment; (4) leaves taken from short-day plants and given short-day treatment.

Only the long-day leaves (series 1 and 2) were able to produce new adventitious buds; these buds were normally situated at the apical end. At the same time, the short-day leaves (series 3 and 4) remained incapable of initiating such buds. However, after one month of culture on moistened sand, these short-day leaves began to develop a certain number of young buds at their basal end, where the long-day leaves had produced very few after several months.

It should be noted that the result was the same when the separated leaves were given either long-day

Table 1. Effect of Day-length upon Bud Formation by *Bryophyllum* Leaves. Number of Buds made by 50 Cut Leaves per Series, in a Period of Three Months

Series	*Bryophyllum* mother-plants cultivated in:	Cut leaves placed in:	No. of apical buds	No. of basal buds
1	16 hr.	16 hr.	63	6
2	16 ,,	8 ,,	57	5
3	8 ,,	16 ,,	9	18
4	8 ,,	8 ,,	0	11

(series 1 and 3) or short-day (series 2 and 4) treatment. This indicates that after the cutting of the leaves the day-length has no noticeable action upon bud formation; only the day-length given to the mother-plant before cutting has a decisive effect (Table 1).

There is no doubt that day-length influences profoundly the properties of the *Bryophyllum tubiflorum* leaves, modifying specially their polarity in regard to adventitious bud formation.

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Sept. 25.

Biosynthesis of Citric Acid in Citrus Fruits

No detailed study has so far been made to find out the mechanism of the formation and accumulation of citric acid in citrus fruits even though studies on the change of acidity and *p*H during ripening have been reported[1]. Investigations are in progress in this laboratory to study the biosynthesis of citric acid in citrus fruit (*Citrus acida*), as a preliminary to which an attempt has been made to locate the stage during the growth of citrus fruit at which citric acid can be detected. The results of the investigation are recorded here.

Fruits used in this investigation were obtained from a plot of thirty trees from a citrus fruit farm. A large number of fruit buds, all of 0·4 cm. diameter, were selected for the investigation, and at different stages of their growth fruits were removed and analysed for acidity and citric acid content. Chromatographic studies were also carried out to detect the different organic acids present.

The samples of the fruit were collected fresh from the trees, the outer skin removed, and a known weight of the tissue immediately homogenized in a Waring blendor for 3–4 min. with a minimum known amount of water. An aliquot of this homogenate was filtered through a funnel and this filtrate made up to a known volume. The filtrate was then suitably diluted and the free acidity estimated by titrating against standard sodium hydroxide using phenolphthalein as indicator. The citric acid was estimated by the method of Saffran and Denstedt[2]. The results are expressed as percentages of total dry weight of the samples taken. Fig. 1 shows the changes in free acidity and citric acid content at different stages of development of the fruit.

The concentrated samples of the filtrates were chromatographed to detect the presence of different organic acids. Descending one-dimensional paper chromatography with Whatman No. 1 filter paper was used for this purpose. The solvent employed was a mixture[3] of butanol, formic acid and water in the ratio of 5 : 1 : 4. The developed chromatogram was sprayed with bromocresol purple reagent. The chromatogram is shown in Fig. 2.

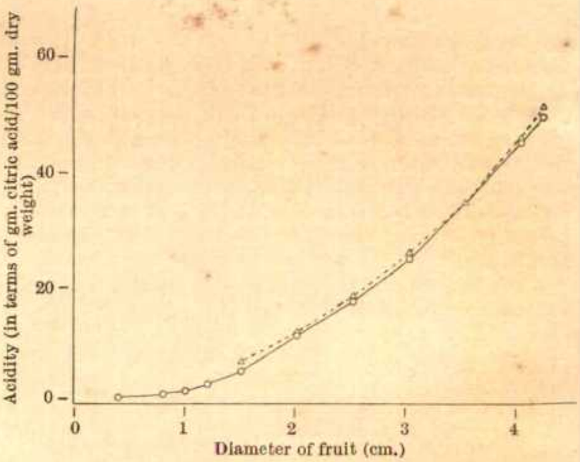

Fig. 1. △ — — △, Citric acid; ○ —— ○, free acidity

It is clear from the chromatogram that in the case of fruits having a diameter of 1·5 cm. and greater, citric acid is the predominant acid with small amounts of malic acid, whereas at younger stages of growth succinic acid is the predominant one with small amounts of two other acids (x_1 and x_2) which are yet to be identified. This shows that the fruit tissues are specialized tissues regarding the formation and accumulation of citric acid and that they are different from those of leaves or stems where citric acid is detected at all stages of their growth (unpublished results). Further, citric acid formation and accumulation in fruits may not be due to translocation from the leaves but to the conversion of sugars into acids by

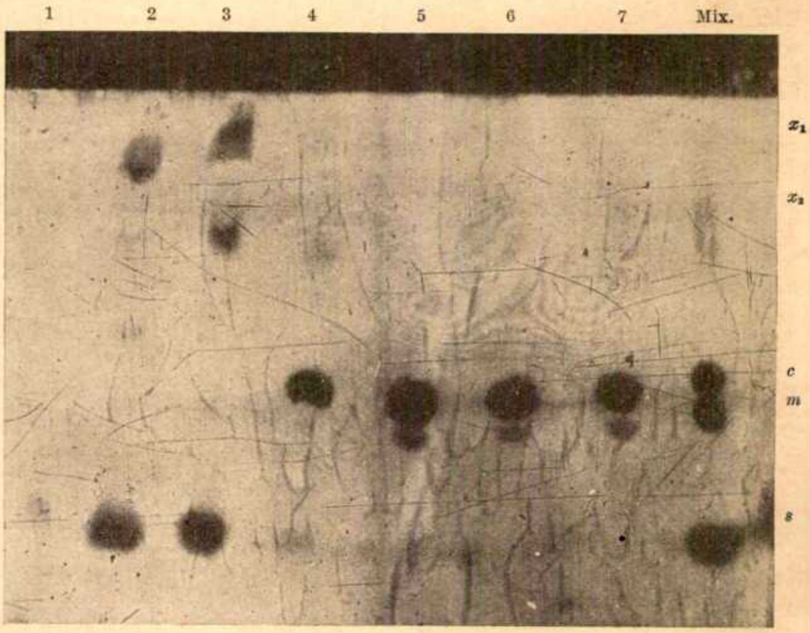

Fig. 2. Chromatogram showing different organic acids present at various stages of development of citrus fruit. Mix. = standard mixture consisting of citric, malic and succinic acids; 1 = 0·4 cm.; 2 = 0·8 cm.; 3 = 1·2 cm.; 4 = 1·5 cm.; 5 = 2·5 cm.; 6 = 3·5 cm.; 7 = 4·4 cm.-diameter fruit extracts

the enzyme system present in the fruit tissues. Details will be published elsewhere.

Our thanks are due to the authorities of the University for financing this project and for the award of a research assistantship to one of us (T. N. S. V.). Our thanks are also due to B. N. Patel and Sons for the generous supply of citrus fruits and to Dr. V. G. Pathak and Mr. Y. K. Sane, of the Botany Department, for taking the photograph of the chromatograms.

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C. V. Ramakrishnan

Department of Biochemistry,
University of Baroda,
Baroda.
Aug. 27.

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[1] Sinclair, W. B., and Eny, D. M., *Bot. Gaz.*, 107, 231 (1945).

[2] Saffran, M., and Denstedt, O. F., *J. Biol. Chem.*, 175, 849 (1948)

[3] Sekhara Varma, T. N., and Ramakrishnan, C. V. (communicated to *Current Science*).

Dormancy in Barley

A recent communication[1] suggests that high results in germination tests on barley, carried out in moist sand for 7–10 days, necessarily indicate the absence of 'dormancy' in the sample. It further claims that the 'dormant' condition in barley can be eliminated by desiccation.

The purpose of the present communication is to point out that a live barley corn must be regarded as 'dormant' if conditions can be found under which it fails to germinate but which permit the germination of fully mature grain. A convenient test which meets the latter requirement is as follows[2]: Two filter-paper circles (9·0 cm. diam.; Whatman No. 1 or No. 29) are firmly flattened into the bottom half of a Petri dish (4 in. diam.). The papers are next wetted evenly with water (4 ml.) added from a pipette or burette. One hundred corns of the sample to be examined are then added in such a way that each corn makes full contact with the moist paper. The covered dish is kept in the dark at 18° C. The final count is made after 72 hr.

The result obtained in this test is referred to as the 'germinative energy' of the sample. In the case of a fully mature sample not only is this high but the result is not affected by varying within wide limits the quantity of water available[3]. Less mature barleys frequently respond adversely to increases in the amount of water present during germination and such barleys are termed 'water-sensitive'.

On the above basis, a barley may have low germinative energy[4] even though most of the corns germinate in the prolonged test described by Wellington[1]. Moreover, even if its germinative energy be high, a barley may still prove to be 'water-sensitive' and so appear 'dormant'. For example, in material which had been rigorously dried for seven days at 40°–24° C. and then stored for eighteen days, only 56 per cent of the corns germinated in a water-sensitivity test[3] even though the germinative energy was 95 per cent. Indeed, although it is recognized[5] that desiccation has a marked influence on the 'rate' of disappearance of dormancy in barley during subsequent storage, it is my experience that drying by itself is almost invariably insufficient to convert a dormant barley into a fully mature one.

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[1] Wellington, P. S., *Nature*, 178, 601 (1956).

[2] Essery, R. E., Kirsop, B. H., and Pollock, J. R. A., *J. Inst. Brew.*, 61, 25 (1955).

[3] Essery, R. E., Kirsop, B. H., and Pollock, J. R. A., *J. Inst. Brew.*, 60, 473 (1954).

[4] Pollock, J. R. A., Kirsop, B. H., and Essery, R. E., *J. Inst. Brew.*, 61, 301 (1955); Proc. Eur. Brew. Conv., Baden-Baden, 203 (1955).

[5] Essery, R. E., and Pollock, J. R. A., *J. Inst. Brew.*, 62, 327 (1956).

When applied to germination, 'dormancy' and 'maturity' are not precise terms, and their meaning therefore depends on the particular test which is used. The data in my communication[1] relate to tests in which the conditions were optimal, in all respects, for the germination of barley grains. Complete germination was obtained immediately after the drying treatment, and must necessarily be attributed to the removal of inherent dormancy in the grains which would not otherwise germinate. There is the further significant fact that this response was not only obtained during storage after harvest, but also when the grains were ripening, and at the harvest-ripe stage.

P. S. Wellington

Official Seed Testing Station,
Cambridge.

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[1] Wellington, P. S., *Nature*, 178, 601 (1956).

A New Species of *Branchiocerianthus* from a Norwegian Fjord

A specimen of the remarkable hydroid genus *Branchiocerianthus* was caught on July 6, on muddy sand at about 210–240 m. depth in the inner part of the Hardangerfjord on the Norwegian west coast. Previously this genus was known only from the Pacific (Japan, northern Pacific, Gulf of Panama), the Indian Ocean (Somali coast, coasts of Oman and Baluchistan), the Mediterranean (Naples), and the Atlantic (Davis Strait). The new record is thus the first from the eastern Atlantic.

The measurements of the specimen were taken after it had been fixed; but as it did not contract when alcohol was gradually added to the sea water, the measurements are probably valid also for the living animal.

The specimen is apparently fully grown. The hydrocaulus is 110 mm. long and about 2 mm. in diameter, ending below in a small bulb with numerous filaments. The hydranth is diskiform and has the outline of a tennis racket. Its longitudinal diameter is 9 mm., its transverse diameter about 7·5 mm. It is very distinctly bilateral and is attached to the hydrocaulus by its pointed ventral end.

Along the margin of the hydranth are found 54 filiform proximal tentacles. The whorl is interrupted ventrally. The tentacles at the broadest part of the hydranth are about 65 mm. long, the dorsal ones about 30 mm. Towards the ventral margin the tentacles grow gradually shorter, the shortest being almost microscopical.

From the distal third of the hydranth the hypostome emerges. It is about 5 mm. high and ends in numerous filiform distal tentacles 4–5 mm. long, around the transversally placed mouth opening. These tentacles stand in several rows, and are so crowded that it is impossible to count them without destroying the animal; but the number has been estimated at about 50–60.

Between the proximal tentacles and the hypostome, thirty-four blastostyles (four of which are fused) were found, arranged in horseshoe-shape, the row being interrupted ventrally. The smallest blastostyles are situated nearest to the hydrocaulus, the largest ones laterally and dorsally, where they are arranged in two rows. The blastostyles are dichotomously branched and each end branch has the shape of a cluster of grapes.

The colour is pale pink, the blastostyles being pale salmon-red.

Between the blastostyles and the marginal tentacles unbranched radial canals are seen through the transparent wall of the disk. This proves that the specimen is a *Branchiocerianthus* and not a *Branchiaria*. Apart from the radial canals, nothing is known of the internal anatomy; but the external morphological characters alone reveal that the specimen cannot be referred to any of the *Branchiocerianthus* species hitherto described, namely, *B. imperator* (western and northern Pacific, Indian Ocean), *B. urceolus* (Gulf of Panama) and *B. reniformis* (Davis Strait). Nor can it be identical with the underscribed *B. italicus* (Naples), which has a colouring very different from that of our specimen. The Norwegian *Branchiocerianthus* thus undoubtedly belongs to a new species, which has been given the name *B. norvegicus*.

A more detailed description of this interesting form will be given elsewhere.

HANS BRATTSTRÖM

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Oct. 4.

Potassium–Argon Dating of Plio-Pleistocene Intrusive Rocks

THE potential of the potassium–argon technique in the dating of young rocks can be evaluated by applying it to intrusive igneous rocks which are well dated by conventional geological methods. Because of their possible interest, we are reporting the dating of two such igneous rocks. They occur at Sutter Buttes in the Sacramento Valley, forty miles north of Sacramento, California. Rhyolite plugs of Plio-Pleistocene age intrude and upturn sedimentary formations of late Cretaceous to early Pliocene age. Erosion uncovered the rhyolite plugs before the ensuing period of andesitic intrusions and extrusions, suggesting that the entire igneous cycle covered many thousands of years. Canyons 1,500 ft. deep have since been incised in the sedimentary complex, and much of the volcanic debris which once covered the area to a depth of 500 ft. or more has been stripped by erosion during the time since igneous activity ceased. One of the rhyolite plugs and the youngest andesite block-lava flow were dated. Biotite was used for the age determinations, essentially pure concentrates being obtained by bromoform and diiodomethane methods. Tyler mesh sizes were $-35+150$. A branching ratio of 0·110 and a decay constant of $0{\cdot}558 \times 10^{-9}$ gm. were used. The pertinent age data are given in Table 1.

Table 1

Number	Rock	Mineral	Weight (gm.)	K (%)	^{40}A (10^{-10} moles)	Age (10^{6} yr.)
KA 101	Sutter Buttes andesite flow	Biotite	16 696	4·04	1·78	1·57±0·24
KA 65	Sutter Buttes rhyolite plug	Biotite	18 734	6·61	3·53	1·69±0·10

The radiogenic ages are thus in agreement with a Plio-Pleistocene age for the rocks and actually place them in the correct order. However, it must be pointed out that, within the errors of the experiment, the ages are the same. Because of the small fraction (0·08) of argon-40 which is radiogenic in *KA* 101, a 1 per cent error in the determination of the ^{36}A/^{40}A ratio gives rise to a 12·5 per cent error in the age. This error in the ^{36}A/^{40}A ratio arises from mass discrimination effects in the spectrometer and from limitations on the accuracy of measurement of the argon-36 peak. In future runs, we will attempt to minimize the influence of these factors by running a normal air-argon sample in the spectrometer immediately after the rock-argon, and by more sweeps (twenty-five) on the spectrometer. This work was supported by the Atomic Energy Commission.

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JACK F. EVERNDEN

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Sept. 26.

Lavoisier's Laboratory Note-books

IN the review of the first part of the *Correspondance* of Lavoisier in *Nature* of November 17, p. 1081, it is said that "M. Fric has also traced the missing volume of Lavoisier's note-books". This is based on a statement in the book reviewed. The second volume of Lavoisier's laboratory note-books is still sometimes said to be missing, although its location was pointed out in 1902 by Brocard in the *Comptes Rendus*[1]. It is *MS.* 61, *ancien* 59, in the library of Perpignan and was presented by Arago, who has written on the cover: "offert respectieusement à la Bibliothèque publique de la ville de Perpignan, par F. Arago". Arago, the distinguished physicist, was born in Perpignan. The document consists of 122 leaves, covering the period September 9, 1773, to March 5, 1774, and a note by Arago says: "Ce cahier renferme les célèbres experiences sur la calcination des métaux en vases clos, et les premières tentatives de Lavoisier sur le combustion du diamant". In the same note, Brocard gives a list of libraries in France containing documents by Lavoisier. Brocard's note seems to have been overlooked, but my attention was directed to it many years ago by the late Dr. Max Speter, who had an unrivalled knowledge of Lavoisier. M. Fric promises to publish the document in full "some day"; a summary only of its contents was given by Berthelot[2].

J. R. PARTINGTON

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[1] *C.R. Acad. Sci., Paris*, **135**, 574 (1902).

[2] *C.R. Acad. Sci., Paris*, **135**, 549 (1902), mentioning Brocard.

FORTHCOMING EVENTS

Monday, December 17

Institute of Metal Finishing (at the Northampton Polytechnic, t. John Street, London, E.C.1), at 5.30 p m.—Annual General eeting. 6.15 p.m.—Mr. D. R. Newman and Mr. J. E. Entwhistle Mr. L. Edridge: "Metal Cleaning".

Royal Geographical Society (joint meeting with the Alpine lub, at 1 Kensington Gore, London, S.W.7), at 8.30 p.m.—Mr. lbert Eggler: "Swiss Ascent of Everest and Lhotse".

Tuesday, December 18

Institution of Civil Engineers (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. Andrew Young, Mr. . A. Longden and Mr. B. L. Metcalf: "Post-War Developments the Coal Mining Industry".

Institution of Electrical Engineers, Measurement and ontrol Section (at Savoy Place, London, W.C.2), at 5.30 p.m.—iscussion on "Breakdown in Dielectrics", opened by Mr. G. G. arton and Mr. J. H. Mason.

Institution of Mechanical Engineers, Industrial Administration and Engineering Production Groups (at 1 Birdcage Walk, estminster, London, S.W.1), at 6.45 p.m.—Discussion on "Case udies from the Application of Planned Maintenance".

Wednesday, December 19

Royal Meteorological Society (at 49 Cromwell Road, London, .W.7), at 5 p.m.—Mr. G. N. Plass: "The Influence of the 9 6 Micron zone Band on the Atmospheric Infra-red Cooling Rate"; and The Influence of the 15 Micron Carbon-dioxide Band on the Atmospheric Infra-red Cooling Rate"; Mr. P. Hughes: "A Determination the Relation between Wind and Sea-surface Drift".

Royal Statistical Society (at the London School of Hygiene d Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), 5 15 p.m.—Prof. M. S. Bartlett: "Measles Periodicity and Comunity Size".

Royal Microscopical Society (at Tavistock House South, avistock Square, London, W.C.1), at 5 30 p.m.—Dr. N. H. Hartsorne: "Some Applications of Polarization Microscopy".

British Psychological Society, Medical Section (at the Royal ciety of Medicine, 1 Wimpole Street, London, W.1), at 8.30 p.m.—r. John H. Hambling: "The Psychology of High Blood Pressure".

Thursday, December 20

Royal Aeronautical Society (at the Institution of Mechanical ngineers, Birdcage Walk, London, S.W.1), at 10 a.m.—All day ction Lecture on "Transonic Wind Tunnel Testing Techniques".

Institution of Mining and Metallurgy (at the Geological ciety, Burlington House, Piccadilly, London, W.1), at 5 p.m.—r. H. C. Curwen: "A Field Method for the Rapid Estimation of e Oxides of Niobium and Tantalum in Black Sand Concentrates"; r. P. I. A. Narayanan and Mr. G. V. Subramanya: "Laboratory udies on the Beneficiation of some Ferruginous Manganese Ores India for the Production of Ferromanganese".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or fore the dates mentioned:

Research Worker (with a medical or biological qualification and me research experience) to assist in the investigation of the minute ucture and development of nervous and other tissue, including nsitometry and electron microscopy—Prof. G. Causey, Department Anatomy, Royal College of Surgeons, Lincoln's Inn Fields, London, .C.2 (December 19).

Assistant Experimental Officer (male, preferably with a degree chemistry, botany or agriculture and experience of the analysis of dioactive materials, or at least G.C.E. (advanced level) with two ientific subjects) in the Radiobiological Laboratory, for duties ich include the analysis of biological samples for radioactive isotope ntent and associated field work—The Secretary, Agricultural search Council Field Station, Compton Newbury, Berkshire ecember 22).

Lecturer (with a degree in mathematics and teaching experience) the Mathematics Department—The Registrar, The Technical llege, Sunderland (December 22).

Senior Lecturer in the Department of Mathematics; Senior cturers (2) in the Department of Physics; Senior Lecturer d a Lecturer in the Department of Metallurgy—The Registrar, llege of Technology, Suffolk Street, Birmingham 1 (December 22).

Technical Assistant (with Inter.B.Sc. or equivalent, and preably previous experience) at the Central Laboratory, Chiswick, r chemical work—The Recruitment and Training Officer (F/EV. 598), ndon Transport, 55 Broadway, London, S.W.1 (December 22).

Assistant Engineer (with a degree in a scientific subject, and enly interested in the application of scientific methods of research the solution of industrial problems) in the Operational Research ction at Headquarters, London, S.E.1—The Director of Establishents, Central Electricity Authority, Winsley Street, London, W.1, oting Ref. A.E.940 (December 27).

Chief Laboratory Technician (male, with wide experience of laboratory work, and able to produce evidence of administrative capabilities and experience), for duties which include the general overall supervision of laboratory technicians, responsibility for laboratory service units and stores, and the care and maintenance of laboratory equipment—The Secretary, Research Institute (Animal Virus Diseases), Pirbright, Surrey (December 31)

Lecturer in Engineering (Civil)—The Registrar, The University, Manchester 13 (December 31).

Lecturer in the Department of Physics, Queen's College, Dundee—Joint Clerk to the University Court, The University, St. Andrews (December 31).

Principal (with high academic qualifications and appropriate educational and administrative experience in a University College or Technical College)—The Clerk to the Governing Body, Woolwich Polytechnic, London, S.E.18 (December 31).

Research Assistant in the Department of Chemistry, for work on the fundamental chemistry of grass conservation—The Secretary, The University, Edinburgh (December 31).

Research Microbiologist in the Domestic Food Preservation Section, Long Ashton Research Station—The Registrar and Secretary, The University, Bristol (December 31).

Head (with high academic qualifications and considerable statistical experience) of the Statistics Section of the Rubber Research Institute of Malaya at Kuala Lumpur, for duties which will include the design of field and laboratory experiments and the conduct of research in statistical matters relating to all branches of the Institute's work—The Secretary, London Advisory Committee for Rubber Research (Ceylon and Malaya), Imperial Institute, London, S.W.7 (January 1).

Lecturer in Experimental Physics—The Registrar, The University, Liverpool (January 2).

Lecturer in Education at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, January 4).

Research Officer or Senior Research Officer (with a university honours degree in science or agricultural science or equivalent qualifications with entomology as a major subject, and preferably with research experience) in the Division of Entomology, Commonwealth Scientific and Industrial Research Organization (Commonwealth of Australia), to take part in investigations into the biological control of skeleton weed, *Chondrilla juncea* L.—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting Appointment No. 180/116 (January 4).

Assistant Lecturer or Lecturer (with special interests in general or inorganic chemistry) in Chemistry—The Registrar, The University, Sheffield (January 5).

Superintendent (science graduate) of the Chemistry Laboratories—The Registrar, The University, Sheffield (January 7).

Assistant Lecturer or Lecturer (preferably with special qualifications and interests in mineralogy and petrology) in Geology—The Registrar, University College of North Staffordshire, Keele, Staffs (January 12).

Graduate (with suitable training in physiology, biochemistry, pharmacology or chemistry) in the Department of Pharmacology and Therapeutics, to assist in research on the effect of drugs on gastric function—The Registrar, The University, Sheffield (January 12).

Polymer Corporation Research Student (with a good honours degree in chemistry or general science, including chemistry), to register for a higher degree, working on cationic polymerization under the direction of Dr. P. H. Plesch—The Registrar, University College of North Staffordshire, Keele Staffs (January 12).

Reader in Mathematics at Queen Elizabeth College—The Academic Registrar, University of London, Senate House, London, W.C.1 (January 14).

Senior Scientific Officer (with an honours degree in physiology or with veterinary qualifications and postgraduate research experience in physiology) in the Physiology Department, for work concerned with the physiology of temperature regulation—The Secretary, Hannah Dairy Research Institute, Kirkhill, Ayr, Scotland (January 16).

Official Fellow in Philosophy—The Vice-President, Trinity College, Oxford (January 18).

Reader or Senior Lecturer (highly qualified in statistical theory and widely experienced in the application of statistics to practical problems) in Statistics at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, January 31).

Senior Lecturers (2) in Physics at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, January 31).

Senior Lecturer (with a good honours degree in psychology or equivalent) in Psychology at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, February 8).

Lecturer (with a research degree in nutrition, biochemistry or chemistry, followed by specialization in nutrition or biochemistry) in Biochemistry and Nutrition, at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, February 15).

Lecturer (preferably with interests in the experimental aspects of ecology or taxonomy) in Botany in St Salvator's College—The Joint Clerk to the University Court, College Gate, St. Andrews (February 18)

Imperial Chemical Industries Research Fellows in Biochemistry, Chemistry, Chemotherapy, Engineering, Metallurgy, Pharmacology, Physics, and subjects allied to chemistry or physics—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 30).

Turner and Newall Research Fellow in Engineering, Inorganic Chemistry, Physics or an allied subject—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 30).

Assistant Chemist, Experimental Officer grade, for analytical work on crops and soils—The Secretary, Rothamsted Experimental Station, Harpenden, Herts, quoting Ref. No. 1052/9.

Assistant Experimental Officer (female, with a degree in biological science or equivalent qualifications, and also good secretarial qualifications) to be Personal Assistant to the Head of the Physiology Department—The Secretary, National Institute for Research in Dairying (University of Reading), Shinfield, Reading, quoting 56/9.

Chemist (aged 20–30, with a second-class honours degree in chemistry or A.R.I.C., and a genuine interest in the technical aspects of colonial development) in the Chemist's Department, Government of Tanganyika, for general and analytical research work in toxicology, food and drugs, and waters, and the supervision and training of African Assistant Chemists and Chemical Assistants—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.97/8/01.

Chemist (with a first- or good second-class honours degree in chemistry) in the Geological Survey Department, Uganda, for the analysis of ores, rocks and minerals, with particular reference to the ores of tungsten, beryl, niobium and tantalum, and analyses of limestones, and to work in close co-operation with the Department's ore-dressing laboratory—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.105/9/06.

Hospital Biochemist (Senior grade) at Llandough Hospital, Penarth, Glamorgan—The Secretary, United Cardiff Hospitals, Cardiff Royal Infirmary, Newport Road, Cardiff.

Professor of Chemical Engineering—The Head, Department of Chemistry, University of Saskatchewan, Saskatoon. Sask., Canada.

Research Worker (with some postgraduate experience in research), to take part in a programme of research on the behaviour of normal and malignant cells in tissue culture—The Secretary, University College, Gower Street, London, W.C.1.

Scientific Officer (honours graduate, preferably with some previous research experience) in the Bacteriology Department, to take part in research on the intestinal flora of the pig—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, quoting Ref. 56/13.

Senior Botanist (male, with at least a second-class honours degree in natural science or biological science, and at least eight years postgraduate experience in the fields of botany and plant pathology) in the Department of Agriculture, Uganda, to take charge of the Botany and Pathology Section, and to be responsible for all research and advisory services under these heads—The Director of Recruitment, Colonial Office, London, S.W.1, quoting Ref. BCD. 63/9/06.

Technician in the Geology Department—The Secretary, The University, Exeter.

Zoologist (or otherwise suitably qualified biologist, B.Sc.), to assist in tissue culture work and implantation of tumours in connexion with studies of radiation effects—The Director, M.R.C. Experimental Radiopathology Research Unit, Hammersmith Hospital, Ducane Road, London, W.12.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

National Institute of Agricultural Botany. Farmers' Leaflets. No. 5 (Revised July, 1956): Strains of Sugar Beet, Recommended List. Pp. 4. No. 11 (July, 1956): Varieties of Linseed. Pp. 2. (Cambridge: National Institute of Agricultural Botany, 1956.) [249

Industry and the Technical Colleges: a Review of some Current Problems. (F.B.I. Handbook.) Pp. iii+44. (London: Federation of British Industries, 1956.) 3*s*. [810

Ministry of Fuel and Power. Reports of H.M. Inspectors of Mines, under the Coal Mines Act, 1911, for 1955. North Western Division. By G. Hoyle. Pp. ii+32+6 plates. 2*s*. 6*d*. net. Scottish Division. By W. Widdas. Pp. ii+26+4 plates. 2*s*. 6*d*. net. Durham Division. By W. Brown. Pp. ii+34+6 plates. 2*s*. 6*d*. net. North Eastern Division. By C. W. Scott. Pp. ii+33+6 plates. 2*s*. 6*d*. net. (London: H.M. Stationery Office, 1956.) [1710

The Secret Police and You. Pp. ii+16. (London: Campaign for the Limitation of Secret Police Powers, c/o Stanley Mayne, 28 Broadway, S.W.1, 1956.) 9*d*. [1710

Department of Scientific and Industrial Research: National Physical Laboratory. Notes on Applied Science No. 17: High Voltage Impulse Testing. Pp. iv+10. (London: H.M. Stationery Office, 1956.) 1*s*. 6*d*. net. [1710

Water Research News, No. 1. Pp. 30. (Redhill: Water Research Association, 1956.) [1710

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Iodine Information. No. 49: Iodine in Rocks and Soils, with Notes on Common Salt and Chilean Nitrate of Soda. Pp. 40. (London: Chilean Iodine Educational Bureau, 1956.) [1710

Thermodynamic Tables and Other Data. Edited by R. W. Haywood. Pp. 23. (Cambridge: At the University Press, 1956.) 2*s*. 6*d*. net. [1710

British Museum (Natural History). The Functions of the Natural History Museum. Pp. 10. (London: British Museum (Natural History), 1956.) [1710

Bulletin of the British Museum (Natural History). Zoology. Vol. 4, No. 4: Variation, Relationships and Evolution in the *Pachycephala Pectoralis* Superspecies (*Aves*, *Muscicapidae*). By Ian C. J. Galbraith. Pp. 131–222. (London: British Museum (Natural History), 1956 24*s*. [17

Ministry of Agriculture, Fisheries and Food. Oyster Cultivation i Britain: a Manual of Current Practice. By Dr. H. A. Cole. P 43+43 plates. (London: H.M. Stationery Office, 1956.) 5 net. [17

Spectrovision. No. 1 (Autumn, 1956). Pp. 8. (Cambridge: Unica Instruments, Ltd., 1956.) [171

Automation Progress: The Journal of Automatic Production an Control. Vol. 1, No. 1 (October, 1956). Pp. xxviii+48. Publishe monthly. Annual subscription, 50*s*. (London: Leonard Hill Technic Group, 1956.) [17

Other Countries

Bechuanaland Protectorate: Geological Survey Departmen Annual Report, 1955. Pp. 46. (Lobatsi: Geological Survey, 1956 3*s*. [171

Marketing of Fruit and Vegetables in Europe. Pp. 328. (Proje No. 249 C.) (Paris: European Productivity Agency of the Organiza tion for European Economic Co-operation; London: H.M. Statione Office, 1956.) 600 francs; 12*s*.; 2 dollars. [171

Universidad Nacional del Cuzco. Leyes Geneticas de los Element Quimicos: Neuvo Sistema Periodico. Por Oswaldo Baca Mendoz Pp. 24. (Cuzco, Peru: Universidad Nacional del Cuzco, 1956.) [17

Polish Medical History and Science Bulletin. Vol. 1, No. 1 (July 1956 Pp. 48. (Chicago, Ill.: Polish Medical Alliance, 1956.) 1. dollars. [17

Republic of Egypt. Ministry of Commerce and Industry: Mine Resources Department. Geological Survey. Topology, Geology an Iron-Ore Deposits of the District East of Aswan. By M. I. Att Pp. xii+262+90 plates. (Cairo: Ministry of Commerce and Industry Mineral Resources Department, 1955.) P.T. 225. [171

Metropolitan Life Insurance Company. Statistical Bulletin, Vol. (August 1956): America's Children. Pp. 12. (New York: Metr politan Life Insurance Company, 1956.) [17

Astronomical Papers prepared for the use of the American Ephemer and Nautical Almanac. Vol. 15, Part 3: Coordinates of Venu 1800–2000. By Paul Herget. Pp. x+217+524. (Washingto D.C.: Government Printing Office, 1956.) 2.50 dollars. [17

Tokyo Astronomical Observatory. Tokyo Astronomical Bullet Second Series. No. 78 (March 5, 1956): Meridian Observation Right Ascension of Equatorial Stars made with Repsold Trans Instrument. Preliminary Results. No. 9 (July-December 1954 By Konosuke Tuzi. Pp. 763–806. No. 81 (March 20, 1956): Meridia Observation of Right Ascension and Equatorial Stars made wi Repsold Transit Instrument. Preliminary Results. No. 10 (Januar June 1955). By Konosuke Tuzi. Pp. 817–846. No. 82 (May 2 1956): Observations of the Contact Times of the Solar Eclipse of Ju 20, 1955. By M. Utida. Pp. 847–854. No. 83 (June 20, 1956) Instruments and Programmes of the Solar Eclipse Expedition to Ceyl on June 20, 1955. Pp. 855–870. No. 84 (June 20, 1956): Photograph Observations made with the Brashear Astrograph (32). By H. Hiro and K. Tomita. Pp. 871–874. (Tokyo: Tokyo Astronomical Observ tory, 1956.) [17

Centro Brasileiro de Pesquisas Fisicas. Notas de Fisica. Vol. No. 11: Radiation Field of an Oscillating Dipole—1. By Erasn Madureira Ferreira. Pp. 20. (Rio de Janeiro: Centro Brasileiro Pesquisas Fisicas, 1955.) [17

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Memoirs of the India Meteorological Department. Vol. 30, Part A Study of Fifty Years' Rainfall of Visakhapatnam. By K. P. Ram krishnan and J. Narayanan. Pp. ii+155–186+3 plates. (Delh Manager of Publications, 1955.) Rs. 3 As. 6; 5*s*. 6*d*. [17

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Annals of the Tokyo Astronomical Observatory. Second Seri Vol. 4, No. 3: Tables for the Approximate Special Perturbations means of the Variation of Parameters. By Tadao Takenouchi. Photoelectric Study of the Atmospheric Extinction at Tokyo Astr nomical Observatory. By Masatoshi Kitamura and Tsuyoshi Nak mura. Pp. ii+157–188. (Mitaka, Tokyo: Tokyo Astronomic Observatory, 1956.) [17

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MIDDLESEX COUNTY COUNCIL EDUCATION COMMITTEE

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HIGH STREET, ACTON, W.3

Principal: J. Topping, M.Sc., Ph.D., D.I.C., F.Inst.P.

The following Special Courses will be held during the Spring Term, 1957:

1. Recent Advances in Physical Organic Chemistry. A course of Nine Lectures on Wednesdays, at 7.30 p.m., commencing January 16, 1957 Lecturers: Specialists from Universities. Chemistry of Free Radicals. Reactions of Organic Cations. Aliphatic Substitution. Theories of Autoxidation. Reduction and Hydrogen Transfer. Reactivity in Aromatic Systems. Fee for the course: £1.

2. Modern Aspects of Chromatography. A course of Twelve Lectures on Fridays, at 7.30 p.m., commencing January 11, 1957. Lecturers: Specialists from Research Institutions and University Staffs. Modern Theoretical Aspects. Paper Chromatography. Desalting Techniques. Steroid Chromatography. Chromatography in Medicine and in Inorganic Chemistry. Adsorption Column Chromatography. Vapour Phase Chromatography. Fee for the Course: £1.

3. Modern Chemistry and Technology of Waxes. A course of Twelve Lectures on Thursdays, at 7.30 p.m., commencing January 10, 1957. The courses will cover the complete Modern Chemistry and Technology of Waxes and Wax Containing Materials and their Utilization. Fee for the Course: £1.

4. Laboratory Course on Paper Chromatography. Short Four-day Courses for Industrial Chemists and Research Workers are held each term. Next Course commences December 18, 1956. Fee for the Course: £4.

Further particulars and forms of application may be obtained from the Principal.

COLLEGE OF AERONAUTICS

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Further particulars and details of the procedure for enrolment may be obtained from: The Warden, College of Aeronautics, Cranfield, Bletchley, Bucks.

CITY OF BIRMINGHAM EDUCATION COMMITTEE

COLLEGE OF TECHNOLOGY

DEPARTMENT OF PHYSICS

POSTGRADUATE COURSES

Evening Courses in the following subjects begin on Wednesday, January 16, 1957.

Vacuum Technique. Course of Lectures and Laboratory work intended for physicists and engineers engaged in using vacuum techniques and others who require theoretical and practical background knowledge of vacuum processes.

Acoustics and Noise Measurement. Course of Lectures and Laboratory work including the theory and use of acoustical measuring instruments Applicants should have a knowledge of physics to about degree or H.N.C. standard.

Fee: £2 2s. for each course.

Further details and application forms may be obtained from the Registrar, College of Technology, Suffolk Street, Birmingham, 1.

E. L. RUSSELL,
Chief Education Officer.

CHELSEA POLYTECHNIC

(Provisionally designated College of Advanced Technology)

DEPARTMENT OF CHEMISTRY

SANDWICH COURSE IN CHEMISTRY

A Sandwich Course in preparation for the examinations leading to Graduateship of the Royal Institute of Chemistry will commence in January, 1957. The course will be of four years' duration, and will involve six-months study at College and six-months industrial experience The normal requirements for admission to the course will be successes at A Level (G C E), or comparable examinations, in Chemistry, together with Physics and/or Mathematics, and three suitable ordinary level subjects.

Inquiries from individual students, industrial firms, research organizations and government departments will be welcomed Particulars from the Clerk to the Governors, Chelsea Polytechnic, Manresa Road, S.W.3.

UNIVERSITY OF BIRMINGHAM

FACULTY OF SCIENCE

M.SC. COURSE IN RADIOACTIVITY

A course of lectures and practical work in general radioactivity leading to the degree of M.Sc. by examination, is available in the Department of Physics. The course is suitable for honours graduates in physics wishing to obtain special experience in radioactive techniques, including radiochemistry. Graduates in subjects other than physics and graduates who have not obtained honours will also be considered for admission to the course.

M.SC. COURSE IN REACTOR PHYSICS AND TECHNOLOGY

A course of lectures and practical work in reactor physics and technology, leading to the degree of M.Sc. by examination, is available in the Faculty of Science The course is suitable for graduates with a good first degree in pure or applied science (normally physics, mechanical engineering or chemical engineering). Some introductory lectures and tutorial assistance will be provided to bring entrants to the necessary standard of knowledge in relevant branches of both physics and engineering.

These courses will last for one academic year; the fee is £81. A limited number of maintenance awards with remission of fees will be available in connection with each course. Applications for admission to the courses starting in October, 1957, and requests for further information, should be made as soon as possible to the Registrar, the University, Edgbaston, Birmingham, 15.

Graduates wishing to be considered for the Advanced Course Studentships of the Department of Scientific and Industrial Research must apply to the Registrar before February 1, 1957.

THE POLYTECHNIC

REGENT STREET, W.1

DEPARTMENT OF MATHEMATICS AND PHYSICS

The following series of lectures will be held on Tuesdays, from 7 to 8.30 p.m., commencing on January 8, 1957.

THE PHYSICS OF SEMICONDUCTORS
commencing January 8, 1957
SEMICONDUCTOR CIRCUIT ELEMENTS
commencing February 26, 1957

Application for prospectuses and enrolment forms should be made to the Director of Education as soon as possible.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

S.W 7

A course of eight lectures on the Measurement of Temperature in Flames will be given by Drs. A. G. Gaydon and F. J. Weinberg on Mondays at 2.30 p.m., commencing January 21, 1957.

Further particulars from the Deputy Registrar, City and Guilds College, Exhibition Road. S W.7

UNIVERSITY COLLEGE, LONDON, Gower Street, W.C.1 Applications for admission to the B.Sc. (Special) Degree Course in Zoology commencing in October, 1957, must reach the Tutor to Science Students not later than Thursday, January 31, 1957. Selected applicants (who will be notified individually) will be required to take a written and practical test in the Department of Zoology on Thursday, March 21, 1957, from 10 a.m. to 5 p.m. The final selection of candidates for admission will, with certain rare exceptions, be made from those successful in this test.

BOROUGH POLYTECHNIC

BOROUGH ROAD, S.E.1

DEPARTMENT OF ELECTRICAL ENGINEERING AND PHYSICS

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The lectures include: detection and mea ment of nuclear radiations, radio-isotope ap tions and health physics and instrumentation.

The course fee is £2. Full particulars and plication forms from the Secretary, Borough I technic, Borough Road, S.E.1.

OFFICIAL APPOINTMEN

UNIVERSITY OF MANCHEST

Applications are invited for the post of Lec or Assistant Lecturer in Mathematical Stati The successful candidate will be expected to a in advisory and research work in addition t teaching duties. Salary scales per annum: turer, £650 to £1,350: Assistant Lecturer, £55 £650; initial salary and status according to q fications and experience. Membership of F.S. and children's allowance scheme.

Applications should be sent not later than J ary 1, 1957, to the Registrar, the Univer Manchester, 13, from whom further partic and forms of application may be obtained.

UNITED OXFORD HOSPITAL

THE CHURCHILL HOSPITAL, HEADINGTON, OXFORD

A Physics Graduate is required in the De ment of Radiotherapy, Churchill Hospital, for pointment in the salary scale £710 to £845. post is expected shortly to be given a Se Physicist grading with a salary scale £910 £1,230, and, if satisfactory, promotion would be made to this grade. The duties include p cal investigations concerned with the clinical of rotation therapy, multicurie cobalt units, voltage X-rays and radioactive isotopes, and some teaching of radiographer students. The partment is expanding and there will be the portunity for original work.

Applications, giving full details and name two referees, should reach the Assistant Adm trator within two weeks of this advertisement

---

UNIVERSITY OF SHEFFIELD

A graduate, with suitable training in physiol biochemistry, pharmacology or chemistry, is quired to assist in research in the Departmen Pharmacology and Therapeutics, on the effec drugs on gastric function. Salary in the r of £550 to £750, depending on qualifications experience. The appointment will be for year initially, renewable for a further two y

Applications, with details of age, qualificat and experience, and the names and addresse two referees, should be sent to the Registra January 12, 1957.

UNIVERSITY OF LIVERPOOL

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Applications, stating age, academic quali tions and experience, together with a list of lications and the names of two referees, sh be received not later than January 2, 1957. the undersigned, from whom further partic of the conditions of appointment may obtained.

STANLEY DUMBELL,
Registra

UNIVERSITY OF OTAGO

DUNEDIN, NEW ZEALAND

The University proposes to appoint a Lect in Biochemistry and Nutrition at the H Science School. Applicants should hold a rese degree in nutrition, biochemistry, or chemis followed by specialization in nutrition or chemistry. Salary range £985 to £1,235 annum.

Further information may be obtained from Secretary, Association of Universities of the Br Commonwealth, 36 Gordon Square Lon W.C.1. Applications close in New Zealand London on February 15, 1957.

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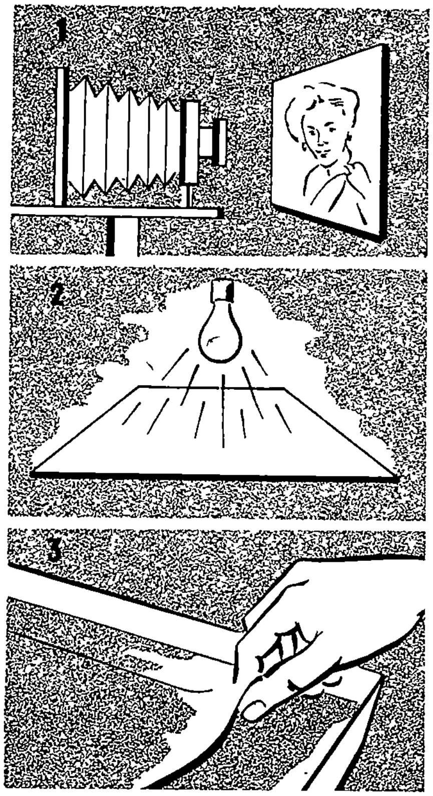

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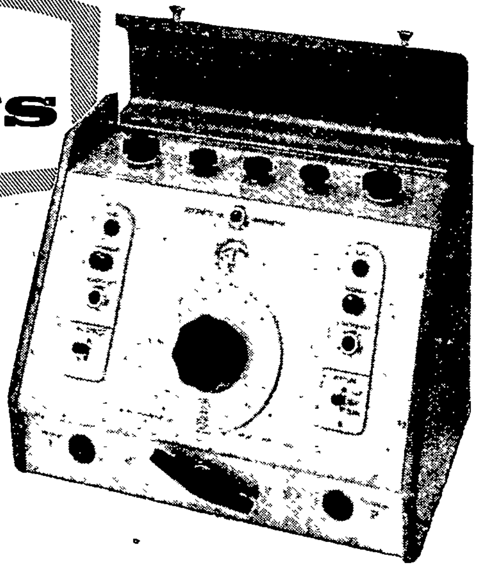

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MAN-POWER PROBLEMS IN THE FACTORY INSPECTORATE OF BRITAIN

In a statement in the House of Commons on May 18, Mr. Robert Carr, the Parliamentary Secretary to the Ministry of Labour and National Service, said that the Minister had just received the report of an inquiry by three senior officers into the staffing and organization of the factory inspectorate, and that it was proposed to increase the strength of the engineering and chemical branch of the inspectorate from eighteen to forty-four, thus permitting one engineering inspector and one chemical inspector to be stationed in each division; further, the strength of the general inspectorate was also to be increased so as to enable inspectors to pay more attention to building operations and engineering constructional work. The report, which was prepared by the Under-Secretary in charge of the Safety, Health and Welfare Department of the Ministry, the Director of Organizations and Establishments and the Chief Inspector of Factories, gave a factual survey of the work and staffing organization of the factory inspectorate and made certain recommendations on some problems likely to arise in the light of future developments. Although the full report has not been published, a White Paper which was issued in October* gives a sufficiently full summary of the results of the survey for a reasonably informed judgment as to the adequacy of its recommendations, some of which, as Mr. Carr announced in May, were immediately accepted by the Minister.

The White Paper is in fact of scientific interest for several reasons. It gives, in the first place, a concise but clear summary of the functions and work of the inspectorate, which enables an independent judgment to be formed as to the importance of technical and scientific knowledge on the part of the inspectors. This chapter also includes a comparison of the work before the War and that to-day, and discusses the factors that have changed or increased its work, and future changes that are likely to affect the work of the inspectorate. It would be difficult to improve on this admirable description of the work of the inspectorate; and since it indicates the place of the inspectorate in the industrial life of Britain and its contribution to industrial efficiency as well as to welfare and safety, it deserves to be read by every scientist engaged in industry. Little imagination on the part of the reader is required to appreciate how much depends on the co-operation of the scientist and technologist if the work of even the strongest and most efficient inspectorate is to have full effect.

The primary duty of the factory inspectorate is to promote and enforce the uniform observance of the provisions of the Factories Acts, and regulations made under the Acts, though inspectors have also duties under the Truck and other Acts in relation to factories. Inspection may take the form of special visits to inquire into particular problems, or may be substantial inspections of a routine character to ensure that there is general compliance with the Acts; and it will be recalled that it was the revelation of a widespread failure to comply with the regulations in regard to precautions against fire that shocked Parliament when Mr. Carr made his statement in May. In these routine visits, attention must be paid not merely to general precautions against fire but also to particular safety problems such as the guarding of machines, the proper maintenance of lifting tackle, boilers, air receivers, etc., and the committee of inquiry considered that thoroughness of inspection was far more important than frequency of visits.

Until December 31, 1954, the inspectorate endeavoured to comply with the general standards of inspection recommended by the departmental committee of 1928 and to visit the more important factories and workshops at least once a year and the less important works at least once in every two years, and to give every works in Britain a thorough inspection within an average period of four years. The standard of an annual visit has never been, and is unlikely to be, achieved, and the revised scheme introduced on an experimental basis on January 1, 1955, appears to receive the unreserved support of the committee of inquiry. Under this scheme the general principle of inspection once in every four years is maintained; but the district inspector, under the direction of the superintending inspector, decides which factories shall be accorded priority for a thorough inspection during the year, having regard to such factors as the nature of the processes, the standard of compliance with statutory requirements, the period since the last thorough inspection, the numbers employed, etc. A small factory with serious risks may have higher priority than a much larger factory where conditions are good, and a factory accorded priority one year may or may not receive priority in the next year.

In view of the subsequent discussion of the work of the inspectorate and its possible reorganization, the figures quoted in the report regarding visits from 1928 to 1955 should be noted. Between 1928 and 1933 there was a comparatively large increase in visits to factories with power, following the increase in staff recommended by the departmental committee. Since then, the number of visits has fallen by 7 per cent, while the number of factories has increased by more than 33 per cent; but taking all factories together, between 1928 and 1955 the number of factories has decreased by 11 per cent, while visits have declined by nearly 22 per cent.

Besides this routine inspection, however, inspectors are instructed to investigate serious accidents, or accidents and cases of disease where there is reason to suspect a breach of the law or some unusual circumstance calling for investigation, and here their function is primarily to ascertain the cause of an accident. This involves visiting the site of the accident and examining any plant or machinery involved as well as questioning witnesses and any informed person, and interviewing the occupier of the factory and other persons in authority. Here clearly technical knowledge can again be of decisive importance; but there is no clear distinction between the inspectorial and the advisory functions of the inspectorate, and such advisory work can lead to much saving of time in the long run, for example, if the advice of the inspectorate is sought when new factories or extensions to existing factories are planned.

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* Staffing and Organisation of the Factory Inspectorate. Pp. 48. (Cmd. 9879.) (London: H.M. Stationery Office, 1956.) 2s. net.

Although the total number of factories has declined from some 260,000 in 1928 to 230,000 in 1955, the number of power factories has increased by some 64,000, and these factories involve substantially more work in inspection; and the more extensive safety requirements of the 1937 Act have added considerably to the work of inspection. Moreover, to play their part in securing improved conditions, inspectors must keep abreast both of advances in knowledge of the effects of certain dust and fumes on the health of those working in their presence and of the efficacy of precautionary measures. The 1948 Act has also added to the work of inspection, and there have been other developments affecting the work of the inspectorate.

On balance, the increase in the number of works doctors increases the work of the medical inspectors, and a principal reason for seeking to increase medical supervision is to encourage an informed and co-operative approach to problems of industrial health. Industries which present special health hazards are being encouraged to extend their medical services, and to press on with investigations into the reduction of the hazards, either by preventive measures or, where possible, the substitution of less dangerous substances. As a result, inspectors on their visits to factories are required to pay increasing attention to ensuring that the health of the workers is adequately protected, and increasing attention to medical supervision may be necessary in the future.

Some developments in industrial processes have increased, and some have reduced, the work of the inspectorate; but there seems to be little doubt that, on the whole, since 1928 industrial developments have increased the volume and complexity of the work of the inspectors. The report notes the growth of consultation with industry and the work in which such consultation has led to a pooling of technical experience and the improvement of conditions on a practical and scientific basis. Most of this work has fallen on the headquarters staff, and particularly on members of the technical branches, who not only serve on the various committees but also carry out the secretarial work. Furthermore, the report refers to some future developments, such as the Ionizing Radiation Regulations at present under consideration and those relating to the use of inflammable substances, which are likely to add to the volume of the work and to its complexity, if not also to the technical knowledge required of the inspectorate. Mr. Carr said in the House of Commons on October 30, for example, that there is at headquarters a physicist engaged full-time on advising the inspectorate and industry on precautions to be taken in regard to radiation hazards, and that fifteen inspectors have already been to courses on radiological protection at Harwell and an engineering inspector was attending a course on the design of nuclear reactors. Inspectors make special visits to factories where there are known to be radiation hazards, and the Atomic Energy Authority informs the inspectorate of all firms to which isotopes are delivered.

To deal with these changes, the inspectorate has increased from a total of 200 in 1928, which included 5 in the medical, 5 in the electrical and 6 in the engineering and chemical branches, to 378 in 1956, of which 18 were in the medical, 14 in the electrical and 18 in the engineering and chemical branches. Moreover, while about 61 per cent of those entering the inspectorate before the War had technical degrees and 68·8 per cent previous industrial experience, only 13·8 per cent of those entering since the War had technical degrees and 48·8 per cent technical experience. As a result, the proportion of technically qualified persons is much higher in the senior grades of the inspectorate than in the junior.

The problems of the Medical Branch are not considered in any detail in the White Paper, and no recommendations are made regarding the organization and size of the medical inspectorate. This is considered as, for practical purposes, a distinct problem; and while much thought is being given to the best way of developing industrial health services, it would be inopportune to make fundamental changes in the organization of the medical inspectorate in advance of decisions on these questions of policy. None the less, the analysis of the problems and conclusions which constitute Part 2 of the White Paper is of general scientific interest, particularly in view of the fundamental approach to the problems which characterizes its analysis and recommendations. It is not disputed that the inspectorate is too small; but it is emphasized that the decision as to the size of the inspectorate must be realistic and determined in relation to the national shortage of scientists and engineers. No government department should compete for such persons beyond the extent that this can be shown to be essential for the prosecution of its work.

It is refreshing to find such emphasis placed on the decisive importance of making proper and economical use of man-power resources in a context in which the impossibility of conceiving a limit beyond which recruitment of an extra inspector could contribute nothing to improve the safety, health and welfare of factory workers; for it can easily lead, as in the debate last May, to proposals which disregard the consequences of failure to use wisely and fully the special skills of scientists and technologists. Moreover, the White Paper keeps constantly in mind that factory inspection is only a means and not an end, though admittedly a most important means, of achieving the objectives of national expenditure in this field—the promotion of health, safety and welfare in factories. Its recommendations come with reater force in that it envisages the possibility that ew developments in industrial processes, an ineasing proportion of modern well-built factories, ie continuing development of the co-operative pirit in industry and the cumulative effect of the ork of the inspectorate over many decades may ermit a substantial reduction in the resources of ian-power and money devoted to factory inspection.

That time has not yet come; but while the White 'aper admits the necessity for some small overall icrease in the size of the general inspectorate, it does ot suggest that exceptional efforts need be made to icrease the recruitment of technically qualified ersons. Persons with and without technical qualications are both required in the general inspectorate, nd there is no objective answer to the question in hat proportions the two elements should figure. he work of the general inspectors is one and inivisible, and although the range of technical roblems is wide, not all the work is technical, and ie non-technical officers have the assistance of olleagues, and particularly of senior colleagues, who ave technical qualifications. Even the technical fficers have often to deal with many matters outside ieir particular specialities.

While it may well be that a general scientific back-round and attitude of mind will enable an inspector o deal better with technical questions, whether or ot they fall within his special subject, and while it iay also be true that failure to recruit a reasonable roportion of technically qualified inspectors may ead to a serious drop in the quality of the inspectorate s a whole, the committee does not think that the oint has been reached which would justify special fforts to increase such recruitment. Every effort iould be made to increase interest among technically ualified persons at the universities and elsewhere, ut the main effort should be to relieve the inspectors f routine or other work which can be handled elsehere and to provide them with more efficient ervices. Greater advantage should be taken of the pportunities to streamline administration resulting om the fact that the inspectorate is now part of a Ministry, with a nation-wide organization of regional nd local officers, and the inspectorate's boundaries iould be re-aligned to run with those of the Iinistry's regions, subject to exceptions where ecessary.

The detailed work required to give effect to these ecommendations has already been initiated, and a etailed study is also being made of the possibility f relieving inspectors of the non-technical work of nforcing the provisions regarding hours of work. hese are sensible proposals which should reduce the isk of wasting the special knowledge or experience f the inspectorate; and the increase in the Enginering and Chemical Branch already announced hould also help. The posting of a specialist engineer nd a specialist chemist in each division is suggested rimarily to reduce delays and relieve the burden on he specialist inspectors at the central office; but it s probable that some saving of the time of general ispectors should also result. More particularly, owever, it should maintain and develop the technical resources of the inspectorate in the way that makes the most economical demand for the services of professionally qualified scientists and engineers. Lastly, a full-scale review of staff training is now in hand with the object of formulating a policy which takes full account of post-war problems.

The immediate reason for undertaking this survey was the difficulty experienced in recruiting to the factory inspectorate as many men and women with technical qualifications as had been customary in the past. The White Paper does not differentiate between men and women, nor examine the question whether in the present situation increased use might be made of women, particularly of those with technical qualifications. Nevertheless, as a survey of the staffing and organization of the inspectorate it is excellent; its analysis is clear and concise, and its recommendations are sound and practicable. But it is as an appendix to the recent report on Scientific and Engineering Man-power in Great Britain that it is of even greater importance and significance, for it demonstrates the approach to the use of such man-power that is imperative in industry and elsewhere as well as in government departments, if Great Britain is to achieve any solution of its man-power problems.

THE CHANGING FACE OF ORGANIC CHEMISTRY

Perspectives in Organic Chemistry

Edited by Sir Alexander Todd. Pp. x+527. (New York: Interscience Publishers, Inc.; London: Interscience Publishers, Ltd., 1956.) 7.50 dollars. 55s.

THIS year chemists have celebrated the centenary of Sir William Perkin's discovery and the manufacture of the first synthetic dyestuff, mauveine. They were celebrating also the real birth of organic chemistry, since it was the manufacture of this and of other dyestuffs which provided the real stimulus to investigations into the detailed structure and reactions of organic compounds. A perusal of Perkin's original memoirs and other publications of this period shows that in 1856 chemists had no knowledge of the structure of organic compounds and it was not until nine years later, in 1865, following Kekulé's classical paper on benzene, that any real progress was possible.

During the past fifty years it is doubtful if any individual chemist has made a greater contribution to our knowledge of organic chemistry than Sir Robert Robinson. His early interests lay in the determination of the structure and the synthesis of natural products. This followed from his association with his teacher, Prof. W. H. Perkin, a master of experimental method. Robinson's classical paper on the biosynthesis of alkaloids, published in 1917, provided the guide to much of his future work, culminating in his determination of the structure of strychnine and his synthesis of the sterols. This work alone would place him in the first rank of organic chemists; but he is unique in that he, unlike his teacher, was greatly interested in organic chemical theory. During the years 1920–26 he laid the foundations of the modern theories of organic chemistry and of the mechanisms of organic reactions. The younger school of organic chemists fails at times to recognize this major contribution to their science.

On September 13 Robinson attained the age of seventy, and as tribute to his friend and former teacher Sir Alexander Todd has edited a series of essays entitled "Perspectives in Organic Chemistry". The contributors include not only his former students and collaborators, Sir Alexander Todd, Profs. Wilson Baker, E. L. Hirst, H. Erdtman, E. Schittler, Dr. J. W. Cornforth, but also many foreign friends, L. Pauling, K. Folkers, A. Butenandt, L. Ruzicka, K. Ziegler and R. B. Woodward. It would be impossible in any short review to do justice to this remarkable series of essays; each of them is in its own way masterly, and they should be read and re-read by all organic chemists. They suggest that organic chemistry is at the cross-roads. In the past two decades the techniques available to the organic chemist have been greatly refined. New methods of purification, such as paper chromatography, vapour-phase chromatography and counter-current distribution, have been developed, while increased assistance can also be obtained from infra-red and ultra-violet absorption spectra. Yet the recent reliance on R_F values and of infra-red spectra alone as a proof of identity, in the absence of direct chemical evidence, must be deplored. As Prof. Woodward points out in his brilliant essay "Synthesis", this branch of our science, apart from its intellectual attraction, has still a major function to perform. Will not these new techniques enable the organic chemist to attack more successfully the chemistry of life? Dr. Cornforth, in concluding his essay on "Isotopes in Organic Chemistry", rightly suggests that organic chemistry and biochemistry can no longer be regarded as distinct disciplines. This is well illustrated by the contributions of Dr. Folkers' "Micro-organisms in Organic Chemistry", Sir Alexander Todd's "Nucleic Acids" and Prof. Erdtman's "Organic Chemistry and Conifer Taxonomy".

We feel that all chemists will be grateful to Sir Alexander Todd for having edited this remarkable tribute to a great chemist. It is beautifully produced, and an excellent coloured photograph of Sir Robert Robinson forms a frontispiece. It is unfortunate that its somewhat high price may limit its circulation.

J. L. Simonsen

ZOOLOGY OF ICELAND

Zoology of Iceland

Four volumes (65 parts). (Copenhagen: Ejnar Munksgaard, 1937–1955.)

The publication of this ambitious work started in 1937, and by July 1956 sixty-five parts, divided into four volumes, had appeared, and the preparation of six more was announced. It will doubtless be several years yet before the end is in sight. The "Zoology of Iceland" is already of great value to zoologists working in many fields of their subject, and when complete it will be the standard work for a century or more. Its scope is wider than usual with similar faunistic surveys, for it aims at a complete description of the occurrence, range, and biology, so far as they are known, of every species of animal—terrestrial, freshwater and marine—that has been found in Iceland and the surrounding seas: a truly colossal task.

All the parts are written by authorities in their respective fields; most of the writers are Danish or Icelandic, but the editors have enlisted the help of those of other nationalities wherever desirable. The editors have also wisely ensured the widest availability of the work to zoologists by publishing it entirely in the English language.

Each part of volumes 2, 3 and 4 deals with a separate group of animals, generally an order, though in some the group is larger and in others smaller. The general plan is to start with a short historical introduction and then to provide a full synopsis of the species, giving status, records of occurrences, distribution outside Iceland, and short notes on biology. This is followed by a section of general remarks and discussion on the biology of the forms concerned and their zoogeography, and by synoptic tables. Each part concludes with a full list of references.

Volume 1, however, contains the papers of widest interest: Part 4, "The Hydrography of Icelandic Waters", by Helge Thomsen, Part 6, "The Benthonic Animal Communities of the Coastal Waters", by R. Spärk, and Part 11, "The Hot Springs, their Animal Communities and their Zoogeographical Significance", by S. L. Tuxen. The last is a very thorough account of the subject, and the author concludes that some of the members of the hot-spring fauna have probably been present for some 100,000 years because their warm environment enabled them to survive the last ice age. Indeed, he goes further and suggests that they may have survived the earlier ice ages too, and thus have perhaps been present throughout the whole of the Pleistocene period. This paper is illustrated with a number of interesting photographic plates.

When this great work is complete, no similar region of the globe will have such a comprehensive written history of its fauna. It will be an example and an inspiration to zoologists all over the world to work towards producing like surveys of the regions with which they are familiar.

L. Harrison Matthews

PHYSIOLOGY OF REPRODUCTION

Marshall's Physiology of Reproduction

Edited by Dr. A. S. Parkes. Vol. 1: Part 1. Third edition. Pp. xix+688. (London and New York: Longmans, Green and Co., Ltd., 1956.) 150s. net.

The first edition of the late Dr. F. H. A. Marshall's "Physiology of Reproduction" appeared in 1910. The second, which was published in 1922, was described in these columns as the best treatise on the subject that we have. The reviewer went on to say that "it is because it is so good and so valuable that its beneficiaries are so concerned in its further development. It must remain the best book on the subject and a memorable contribution to British scientific literature". His hope has without doubt been realized in the third edition, now enlarged to three massive volumes, of which the first appeared in 1952, and the second is now under review. A third volume, dealing mainly with the male, is still to come.

The new edition is edited by Dr. A. S. Parkes and numbers among the contributors many of those who have been responsible for the advances that have been made since the second edition. Vol. 1, Part 1, which in spite of its numerical description has appeared after Vol. 2, contains two chapters contributed by Dr. Marshall himself and in collaboration with Dr. Harrison Matthews. These give a general account of breeding periodicity and also describe cyclic changes in the lower vertebrates. About half the volume, by Dr. P. Eckstein and Sir Solly Zuckerman, is concerned with the morphology of the male and female non-pregnant reproductive tracts and provides a systematic account of the œstrous cycle in different groups of mammalia. Most of these chapters will be used for reference rather than read from beginning to end, and there is no doubt that students of reproduction will find them more up-to-date and comprehensive than any other statement about the topics with which they deal. The remaining chapter in this volume (by Prof. F. W. R. Brambell), which is concerned with the development of the ovary, the process of oogenesis, and the changes in the ovarian follicle during the course of the reproductive cycle, provides an excellent review of these perennially controversial matters.

The book remains unique for the reason that it supplies comprehensive and critical surveys of all aspects of the physiology of reproduction—something which no other single work attempts. In recent years fashion has tended to shift the focus of research to the chemical investigation of the sex hormones. Marshall's "Physiology", and especially this volume, is a reminder that, however eclectic the chemical story of reproduction becomes, its meaning is derived only from its relevance to biological phenomena, about which we understand very much more to-day than we did at the time when Dr. Marshall conceived of his gargantuan task.

P. L. Krohn

AN INDIAN HISTORY OF SCIENCE

Bijnaner Itihas (A History of Science)

In Bengali. By Sri Samarendranath Sen. Pp. xv+348+13 plates. (Calcutta: Indian Association for the Cultivation of Science, 1955.) 8*s*. Rs. 10.

THIS book is the first of a series which the author hopes to publish on the history of science. It takes the history from earliest times up to the Dark Ages in Europe and the end of ancient science. Although it is not the first book dealing with this subject to be written in an Indian language, it is certainly a far more serious attempt than any of its predecessors. As such it deserves to be considered from two points of view: that of its place in the literature of the history of science and that of its place in Indian writing.

From the former point of view it is evident that the author has drawn largely upon the writings of Sarton, Singer, Childe, etc. He frankly admits that his work is mainly based upon that of others, and reference to his bibliography will show that his sources are all in European languages. Any special interest which the book may hold for the European is thus likely to be on account of its taking a new approach to familiar problems. In fact, the author's breadth of vision is such that he rarely attempts to depart from accepted formulations, and only very rarely does his approach seem strange. It is when we consider the place of the book in Indian writing that its importance becomes apparent. The history of science is a very young child in Europe and America, but in India (at least in Indian languages) it owes its birth to Mr. Sen. Since India received independence, there has been an increasing expansion of education in the vernacular languages and a corresponding decline in the knowledge of English: this is only natural. At the same time, there has been an ever-increasing demand for technical and scientific education: if this demand is to be met, text-books will be required in the vernaculars. In view of the very wide attention which the history of science has recently attracted and of the growing belief that it is important for students of the humanities no less than students of science, the production of this book is an important landmark in Indian literature.

The plan of the book is simple. In the first chapter the author discusses the meaning of science and the relationship of science and society. He makes it clear that he is no adherent of the school which seeks a narrow fixed definition of the word and urges the need for progressive re-definition in dealing with different periods. He is also not prepared to adopt any extreme position in discussing the relationship of science and society. In the second chapter he draws upon archæological materials to outline the progress of man through the Old Stone Age and up to the Neolithic Revolution. In the third chapter the civilizations of the ancient river valleys are considered, together with the various branches of knowledge which then developed—writing, mathematics, medicine, etc. Here the author has made a bold but not altogether happy choice in describing the Indus civilization in more detail than those of Egypt and Mesopotamia. As our knowledge of the latter is so much greater and is aided by written sources, they appear inevitably to be more worthy of description. The next three chapters are devoted to an outline of Greek science from the beginnings down to the Alexandrians, the concluding two to Roman science and to the decline of ancient science and the causes for it.

We can only applaud this balanced and well-produced book, and look forward with interest to the further volumes the author has promised.

F. R. Allchin

STRUCTURAL GEOLOGY

Structural Geology

By Prof. L. U. de Sitter. (McGraw-Hill Series in the Geological Sciences.) Pp. viii+552. (London: McGraw-Hill Publishing Company, Ltd., 1956.) 67*s*. 6*d*.

THERE is no other book like this available in the English language; its appearance is as notable an event as was that of the "Einführung in die Geologie", by Hans Cloos, in 1936. The work is planned for a broad canvas, and details as well as the most prominent aspects have received careful treatment. Microstructures, minor folds, single mountains and great mountain systems are all grist to the mill. At the very least the book provides a convenient reference to an assemblage of world-wide, recent and sometimes rather inaccessible works upon most aspects of structural geology, and presents them with fair and fearless criticism; and what is much rarer, it risks a definite opinion upon most issues. But it does more, for it presents the considered views upon the architecture of the Earth of an erudite, philosophical but still active field geologist. "As a field geologist", Prof. L. U. de Sitter writes, "I tend to believe what I see more than what I read", and his readers may think that they do too. Nevertheless, what he has written will stir up argument and shake up some time-honoured but not very sound opinions held by all varieties of geologists.

There are three parts. In the first the theory of strained materials is reviewed with more mathematical analysis than is usual in most geological literature. This may lead to some floundering in a morass of equations and may encourage the reader to pass on quickly to the account of models illustrating sundry structures, only to find that there are slippery patches here too. Distortion in oolites and other rocks, cleavage, schistosity and preferred orientation are dealt with in turn. Some space is devoted to the processes of compaction of loose and water-logged sediments showing how an unstable equilibrium may be disturbed and result in a sudden and catastrophical increase in fluid pressure. A similar process is considered later as a possible source of energy to set going magmatic intrusions. Part 2 records the results of stresses in the Earth's crust which lead to the suite of faults and folds that are familiar features in most mountain ranges. Complications which ensue when vertical uplifts affect the strongly folded rocks are referred to under the heading of gravitational gliding and collapse structures. It is argued also that the thickness of competent strata has an important part to play in setting up a pattern of folds and determining the size of individuals. Folds, once formed, are reluctant to give way to a new set of forces, but ideally they should, and cases are described where such things seem to have happened. The largest features on the Earth, like the Alpine and the circum-Pacific mountain chains, come in for discussion in Part 3. Magma is injected along such lines and helps in their formation, and is a clue to the course of events which took part in producing the complicated structures which are the final result. By contrast, the nature of the areas of unfolded rocks which appear within these great mountain chains is described.

To round off the book, Prof. de Sitter trails his coat by airing his views about a history of the Earth which he makes attractive by telling us of the youthful stage when, without a heavy core, convection currents within the Earth held sway and carried continents around the surface of the Earth. Growing older, its heavy core increased in size and obstructed these lively convection currents so that the continents came to rest a long time ago, during the pre-Cambrian in fact. Since then the Earth has been provided with permanent ocean basins and continents which have not changed their position essentially, although their margins have suffered some alteration through wear and tear, which is always taking place.

The book is deplorably edited. Slips in spelling abound. The inconsistent use of sometimes English and sometimes American words, and the invention of words that are not in the English language, like 'basculate', mar the presentation. The noun 'basin' is made to masquerade as a verb. Several diagrams are reduced too much, and some stand in need of more adequate explanation. The changes introduced into the sections shown through Iranian oilfields, Fig. 133, are so radical that the figure should not be printed as if it had the authority of the late G. M. Lees.

J. V. Harrison

FUNCTIONAL ANALYSIS

Functional Analysis

By Frigyes Riesz and Béla Sz.-Nagy. Translated from the Second French edition by Leo F. Boron. Pp. xii + 468. (London and Glasgow: Blackie and Son, Ltd., 1956.) 65s. net.

THE French version of this book, the first edition of which appeared in 1952, has already become widely known, and the English translation deserves the warmest of welcomes. The senior author, F Riesz, who died earlier this year (see *Nature*, 177, 870 1956), was one of the pioneers of functional analysis, and his collaborator, B. Sz.-Nagy, has made many valuable contributions to the subject.

The book opens with an exposition of Lebesgue integration, following a method devised by F. Riesz himself. The idea is to avoid any preliminary discussion of measure theory, the integral being defined first for step functions, and then for limits of monotone sequences of step functions. Once the principa properties of the integral have been established, the reader is introduced to some of the ideas of functiona analysis, as they are exemplified in the L^p spaces these include the Riesz–Fischer theorem, orthonorma systems, linear functionals, weak convergence and weak compactness. The Stieltjes integral is also treated.

Attention is next directed to the theory of linear integral equations. The method of approximation by kernels of finite rank, introduced by E. Schmidt and developed by J. Radon, is used to prove the theorems about the Fredholm alternative. After a brief account of the Fredholm determinants, the alternative theorems are proved again, the proof now being founded on the complete continuity of the integra operators; the whole Riesz–Schauder theory is thus obtained. The authors return to integral equations again later with the Hilbert–Schmidt theory of symmetric kernels, treated as a special case of the theory of completely continuous symmetric operators in Hilbert space.

Hilbert space theory is carried as far as the spectra theorem and the functional calculus for unbounded self-adjoint operators. Other topics treated are perturbations of the spectrum, the extension of symmetric operators, von Neumann's theory of spectra sets, groups of unitary and of self-adjoint operators and the basic ergodic theorems. In Banach space theory the Hahn–Banach extension theorem and it consequences are discussed; the theory of semigroups recently created by E. Hille and others i outlined; and there is a brief account of the spectra theory of F. Riesz and N. Dunford, where the resolven of an operator is treated as an analytic function in th complex plane.

The aim of the authors is to introduce the reade step by step to the fundamental ideas of functiona analysis, rather than to plunge him straight into an axiomatic account of its abstract logical structure for example, the notion of linear functional appears in several concrete cases (the Hilbert space of function of integrable square, the L^p spaces, the space o continuous functions) before the general definition for an abstract Banach space is given. There are numerous illustrative examples, which enable one to obtain a firm grasp of what the ideas mean and how they can be used. The book is extremely readable and the translator has done his work well; anyon who wants to know what functional analysis i about would do well to begin here.

F. Smithies

Chemical Pilot Plant Practice

By Donald G. Jordan. (Chemical Engineering and Technology Library, Vol. 1.) Pp. viii+152. (New York: Interscience Publishers, Inc.; London: Interscience Publishers, Ltd., 1955.) 3.50 dollars.

THE opening chapter of this small book contains an interesting discussion of the general factors to be taken into account before building a pilot plant; these include, among others, cost estimation, the size and location of the plant, and the type of men required to operate it. It is also emphasized that pilot plants are not always required for checking and correcting the theories used for the design of full-scale plant, but may be used for small-scale production in order that the properties and commercial value of new materials may be studied and sufficient quantities of by-products may be obtained for the assessment of their utility. An analysis of the scale-up problem follows, and a chapter on the handling of materials on the pilot scale. In the next two chapters, various types of reactors and separation processes are discussed, and finally the important subjects of report writing and cost estimation are dealt with in detail.

Very little space is given up to theory, as it is assumed that readers are already conversant with the theoretical side; at the same time it would be unfair to describe the book as consisting of 'hints and tips'. Although these abound, they are presented as part of a reasoned discussion in which it is clear that the author is writing from practical experience. All who are concerned in any way with pilot plant are recommended to read this book, for very few will fail to derive some benefit from it.

H. E. WATSON

General School Physics

Heat and Light. By R. Stone, N. Bronner and J. Lawrence. (Grammar School Series.) Pp. ix+374. (London: English Universities Press, Ltd., 1955.) 9*s.* 6*d.*

WITH the senior science master of Manchester Grammar School as editor and part author, one former member of the staff collaborating, and another participating with advice, this excellent textbook for middle school use has the hall-mark of thoroughness and sound teaching that would be expected. It should help pupils to a real understanding of these parts of the subject, and stimulate their awareness of the application of physical principles in the world around them.

Mr. R. Stone's predecessor, the late H. S. Newbould, used to caution his younger colleagues not to try to teach too much; and there is always the temptation in elementary work to carry one's own interests to a level a little above the pupils' heads. Here the authors have not concealed their enthusiasm, but they have taken the greatest care to keep within the capacity of fifth-form boys in their explanations.

The diagrams, drawn with the clarity and simplicity of blackboard figures, are unusually good. In optics, great attention is given to ray diagrams, and this is clearly the method that the authors prefer at this stage for the solution of problems. Many teachers also may feel that algebraic formulæ are best deferred until a later stage, when they have to be repeated in any event; those addicted to their use will certainly approve the authors' analysis of the schoolboy's difficulties, and may find an answer to their own in the treatment advocated here.

G. R. NOAKES

Textile Testing

By James Lomax. Third edition. Pp. xiii+218+14 plates. (London and New York: Longmans, Green and Co., Ltd., 1956.) 30*s.* net.

THE arrangement and content of the third edition of this book are substantially the same as in the second edition. New material has been introduced in a few places in the text and, in seven pages of "additional notes", at the end. An introduction has been added. It is to be regretted that the author has not taken the opportunity of including descriptions of yarn-irregularity meters, methods of yarn inspection, or the newer automatic single-thread testers. Other important omissions are the use of the thread-crimp tester, the determination of threads per inch, cloth handle, creasability and tearing strength.

The author illustrates most of the calculations by examples worked out in detail. Such assistance is a luxury in a book of this kind. On the other hand, there is a lack of scientific and technological background, and of advice on the proper application of the methods described. In any future edition this balance should be corrected. British Standards Handbook No. 11 (to which the author frequently refers) now provides a manual for nearly all the routine work of a textile laboratory, and a modern text-book on textile testing could well be written with the aim of providing the basic information required to understand the techniques and apply them intelligently.

The book cannot be recommended unreservedly to a young student as his only guide because of a number of statements that are either inaccurate or inadequate.

H. M. TAYLOR

The Mechanical Properties of Textile Fibres

Edited by R. Meredith. (Deformation and Flow: Monographs on the Rheological Behaviour of Natural and Synthetic Products.) Pp. xii+333+4 plates. (Amsterdam: North-Holland Publishing Company, 1956.) n.p.

TEXTILE fibres are a class of technologically important materials with interesting mechanical properties: they are non-linear, strongly time-dependent and sensitive to humidity and temperature. Their various chemical structures, and the physical and chemical treatments they receive in processing and manufacture, result in many variations on the general pattern of behaviour.

Dr. R. Meredith and his co-authors Dr. L. Peters and Mr. H. J. Woods have written a welcome book in which they describe the mechanical properties of the various fibres and report the current position in the interpretation of those properties in relation to fibre structure. Cellulose, protein and synthetic fibres are discussed in separate sections which follow similar patterns for ease of cross-reference. There are chapters on structure, stress relaxation and creep, load-extension curves and on dynamic properties, each section ending with a chapter on properties which have received attention because of their practical importance: the strength of cellulose fibres, setting effects in keratin fibres, and resilience and creasing of synthetic fibres. Separate chapters are devoted to reaction-rate theory in two sections, and the theory of linear viscoelasticity is treated in connexion with stress relaxation and dynamic properties. There is a comprehensive bibliography.

IRRADIATION LABORATORY OF THE BRITISH INSULATED CALLENDER'S CABLES, LTD., RESEARCH ORGANIZATION

By DR. R. M. BLACK

IT is now fairly well known that, when polymeric materials are exposed to high-energy radiation in atomic piles or from sources of beta- or gamma-radiation, they undergo profound changes in their physical properties. These changes are the result of a series of intermolecular reactions or rearrangements induced by the ionization and free-radical formation phenomena associated with the absorption of the radiation.

A study of the effects of irradiation of vinyl polymers and related hydrocarbons has shown that the radiation chemistry of the process involves a number of fundamental chemical changes: (*a*) formation of carbon-carbon bonds between the molecules accompanied by the liberation of hydrogen to give a three-dimensional polymer network; (*b*) formation and hydrogenation of carbon-carbon double bonds; (*c*) molecular degradation by fracture of the main polymer chain by a disproportionation reaction resulting in a product of lower average molecular weight; and (*d*) fracture of chemical bonds in the side-chains or branches of the polymer, with the production of low molecular weight hydrocarbons.

The balance between these reactions is not the same in all polymers and, in practice, it is found that either cross-linking or molecular degradation predominates, depending upon the molecular structure. Thus, dielectric materials can be classified into two categories: those in which cross-linking predominates (such as polyethylene, polystyrene, polyvinyl chloride and the silicones) and those in which degradation predominates (such as polyisobutylene, 'Perspex', polytetrafluoroethylene and cellulose). Some materials, by virtue of their chemical structure and the possibility of energy transfer and resonance effects, are more resistant to the effects of radiation than others. Polymers which contain aromatic side-chains (phenyl groups) are particularly resistant to radiation.

The behaviour of polymeric dielectric materials on irradiation is of interest for two main reasons. First, it may prove possible, by irradiation, to induce changes in the structure of the material which cannot be achieved by other methods and which will result in a product with improved properties. Second, if the material is to be used in a locality in which it will be subjected to constant irradiation, such as the biological shield of a nuclear reactor, the expected service life and a knowledge of the changes in electrical properties likely to take place are important considerations.

In order to investigate and, if possible, to exploit the properties produced in dielectric materials on irradiation, the Research Organization of British Insulated Callender's Cables, Ltd., has recently established an irradiation laboratory. This laboratory is equipped with a 2-million volt Van de Graaff electrostatic particle accelerator supplied by the High Voltage Engineering Corporation of Cambridge, Massachusetts, which serves as a versatile source of electrons, gamma- or X-rays, positive ions and neutrons. In addition, there is available a comprehensive radiochemical laboratory, equipped with a wide range of counting equipment and radioactive isotope sources, for the development of new techniques for testing and process control.

The Irradiation Laboratory is divided roughly into three parts by the central, two-story, radiation block. The latter consists of a target room on the ground floor with the generator room situated immediately above it. The walls of the target room are of concrete, 3 ft. in thickness, to prevent hazardous amounts of radiation entering the adjoining laboratories, and entrance to the room is by means of a safety door, connected to an interlock system, and a concrete labyrinth.

The target room is of sufficient size to enable a variety of irradiation experiments involving the use of conveyor belts and pulley systems, etc., to be carried out and, in addition, houses the pressurizing gas supply (carbon dioxide and nitrogen) for the generator.

The generator itself, which is designed to project a beam of electrons or positive ions vertically downwards, is installed in the room above, access to which is obtained by means of a spiral stairway from the target room. As the radiation intensity is consider-

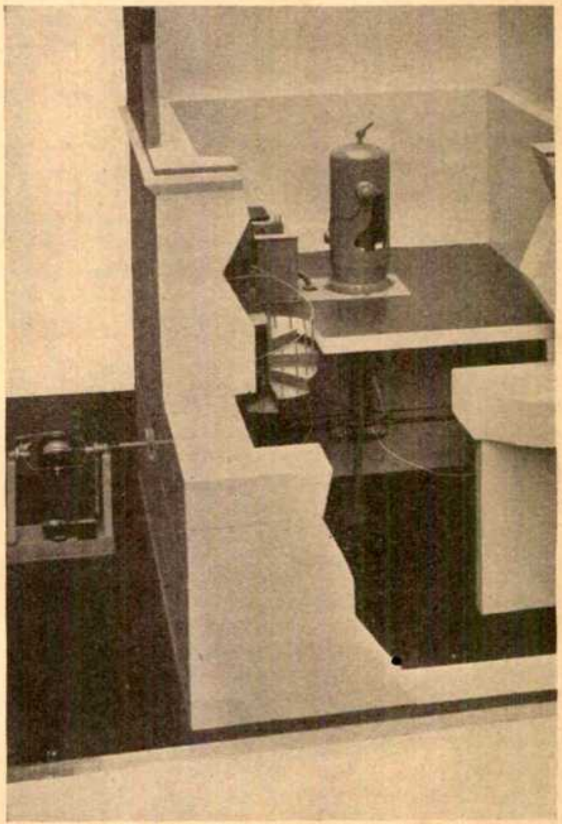

Fig. 1. Model of irradiation block, showing scanning assembly

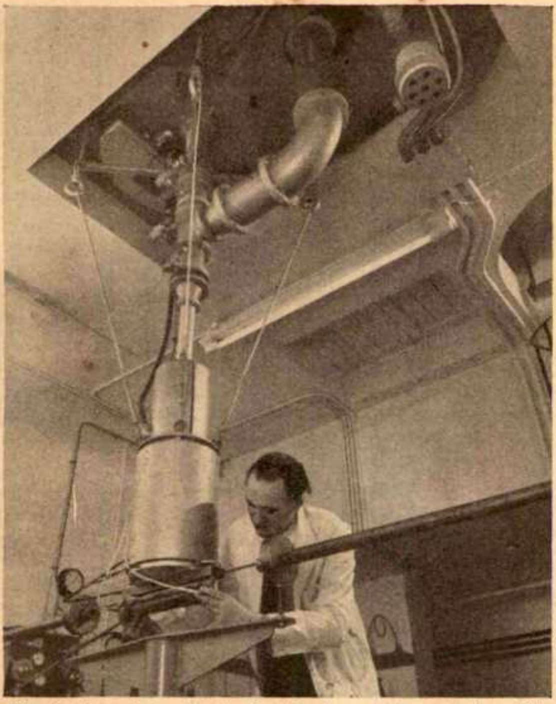

Fig. 2. Scanning unit, showing the base of the generator with diffusion pump and vacuum system

ably lower than in the target room, the thickness of the generator room walls needs to be only 2 ft.

The water supply for the laboratories and for the generator is provided by two large tanks situated on the roof of the radiation block, and the necessary pressure for the cooling system of the Van de Graaff accelerator is obtained with boost pumps.

The generator block is flanked on both sides by laboratories which contain the control panels of the generator and various types of cable-handling machinery; and they are equipped for carrying out the various evaluation tests necessary and investigations upon the irradiated products.

Of the irradiated dielectric materials so far studied, one of the most interesting is polyethylene, as this polymer is cross-linked by high-energy radiation to give a polymer network which has a greatly reduced solubility in hydrocarbon solvents and which exhibits rubber-like elasticity at higher temperatures (greater than 115° C.) instead of melting. This elastic behaviour and non-flowing property at high temperatures would suggest that irradiated polyethylene has considerable possibilities as a high-temperature dielectric and, while the chemical changes accompanying the cross-linking tend to render the polymer more susceptible to thermal oxidation, investigation has shown that this can be reduced by the prior incorporation of a suitable antioxidant.

Radiation effects such as cross-linking and degradation are not, of course, limited to materials of high molecular weight. Hydrocarbons such as hexane and decane show a similar behaviour, and a study of simple materials is beginning to throw light upon some of the mechanisms of electrical breakdown phenomena. Similarities exist between radiation effects and the ionization effects which sometimes occur in high-voltage equipment under conditions of electrical stress. The well-known phenomenon of waxing or 'cheese' formation in some types of solid cable is only another form of cross-linking by electron bombardment, while the radio-oxidation which takes place during the irradiation of materials in the presence of air bears a direct relationship to the stress-ageing effects encountered in insulating oils contaminated with oxygen.

High-energy particle accelerators serve not only as a source of radiation for industrial processing but also as valuable laboratory tools for fundamental research. There is no doubt that the new techniques which have arisen during the development of atomic energy in the past ten years will find increasing application in the solving of technical problems which arise in the electrical industry.

PROPERTIES AND USES OF FERRITES

CONFERENCE IN LONDON

IT is difficult to-day to name a branch of the sciences or a field of industry or of human endeavour in which electronic devices play no part. During the past twenty-five years the electronics industry throughout the world has expanded at a very great rate, and new discoveries can be of major commercial value. It is not surprising, therefore, that reports ten years ago of the successful preparation of new magnetic materials with obvious applications in electronics and light electrical engineering were received with marked interest.

The use of ferromagnetic materials in coils and transformers had hitherto been restricted to the low-frequency region because of eddy-current losses in the metallic ferromagnetics available. Some improvement had been achieved by the use of fine metallic powders in a non-magnetic matrix—'dust cores'—but while eddy-current losses were thereby reduced, hysteresis losses were usually considerably increased. In 1946, some results were announced of work carried out under great difficulties at the Philips Laboratories in Holland during the German Occupation. The late Dr. J. L. Snoek and his colleagues had succeeded in preparing oxide materials with strong ferromagnetic properties, high electrical resistivity and low hysteresis loss. These materials were ferrites (in fact, mixed crystals of different ferrites) which had first been prepared by Hilpert in 1909; but Hilpert's materials, though ferromagnetic, had shown high losses in the presence of alternating magnetic fields and low permeability, and had no commercial value. Snoek's materials had considerable value and were soon made available commercially by Philips under the name of 'Ferroxcube'; later they were manufactured in the United States under the trade name 'Ferramic'.

The engineer was reasonably content, at first, to devote his skill and ingenuity to the use of the available materials, but the physicist and the physical chemist found much that was perplexing, particularly in the magnetic behaviour of these new ferrites. Their chemical composition was known to be of the form MO, Fe_2O_3 where M is a divalent metal, and the crystal structure was that of the mineral spinel, $MgAl_2O_4$; but little else was certain. In 1948, a major contribution to the explanation of the magnetic properties came from Prof. L. Néel, who introduced the term 'ferrimagnetism' to describe these properties which he showed could arise from the subdivision of the magnetic moments in the material into two groups. In each group or sub-lattice, the moments were aligned parallel, as in ferromagnetic materials; but it was assumed that the moments of the two sub-lattices were oppositely directed, so that the observed macroscopic magnetic moment was not the sum of the individual moments, but the difference of the moments of the two groups of ions.

Since 1948, ferrites have been the subject of a vast amount of work, both on fundamental theory and experiment and in practical application; and so nearly a thousand scientists and engineers from more than a dozen countries gathered in London at the Institution of Electrical Engineers, during October 29–November 2, to review and to discuss some of the investigations.

In an introductory lecture the vice-president of the Institution, Dr. Willis Jackson, gave a detailed review of the development of ferrites up to the present date and surveyed the background to the conference. The meeting was thereafter divided into sections, each of which covered a different aspect of the very broad field of study. Each session of about two and a half hours followed roughly the same pattern. Pre-prints of the papers had previously been sent to those attending the conference, and authors were allowed merely a short time for the formal presentation of their work. The major part of each session was therefore available for general discussion, which was always interesting, sometimes stimulating and occasionally heated. It would not be feasible to comment upon all the papers presented or to attempt a résumé of the many discussions, particularly as two sections were often run concurrently during the last three days of the meeting. The subjects covered can best be outlined in general terms, and reference made to only a few contributors in each section.

Fundamental properties and processes in ferrites were discussed under Section A, which was subdivided into sessions on the preparation and general chemical and physical properties; magnetic spectra; molecular interactions; magnetic properties in steady and slowly varying fields; and the properties of new oxide magnetic materials. A review was given by A. J. E. Welch (Imperial College of Science and Technology, London) of the chemistry and crystal structure of ferrites and other magnetic oxides, while in the session on magnetic spectra J. K. Galt (Bell Telephone Laboratories) discussed the problem of losses in ferrites with particular reference to his examination of domain wall movements by the use of 'picture frame' single crystals in which a single wall was studied. The several earlier contributions made by G. T. Rado and his colleagues at the Naval Research Laboratory, Washington, D.C., to the study of the frequency-dependence of initial permeability were briefly summarized and extended in a paper on the effect of magneto-crystalline anisotropy upon the magnetic spectra of magnesium iron ferrites. R. Nathans (Brookhaven National Laboratory) reported the results of a neutron diffraction study of ferrites of the magnesium manganese system. Precise crystallographic data were obtained, including the distribution of the manganese ions between the tetrahedral and octahedral lattice sites. The power of this technique was very apparent, and it is to be hoped that similar investigations with other ferrite systems will be made.

The final session in this section included contributions by E. W. Gorter and his colleagues, of the Philips Laboratories, on oxide magnetic materials with hexagonal crystal structures, and by F. Bertaut and R. Pauthenet (Grenoble) on ferrimagnetics with the garnet structure having the general formula $5Fe_2O_3$–$3M_2O_3$.

It is significant that the second largest section of five sessions, with seventeen contributed papers, was that dealing with the theory and applications of ferrite materials at microwave frequencies. With the increasing importance of microwave techniques much effort has been devoted to measuring the properties of ferrites in wave-guide circuits and to finding, usually empirically, ferrite compositions with the most suitable properties for application in microwave components. What is the effect upon an electromagnetic wave in a guide when it meets a magnetic material that has a high dielectric constant (10–20) and a permeability which is, among other things, dependent upon the direction and magnitude of the applied magnetic field? Analytical solutions are usually reached only after great labour, and the papers in this section might be said, in general, to be contributions to the experimental answer to this question.

The section was opened with a paper by P. J. B. Clarricoats, A. G. Hayes (both of the General Electric Co., Ltd.) and A. F. Harvey (Radio Research Establishment, Malvern) which reviewed the general properties of ferrites at microwave frequencies and dealt briefly with the various types of components in which ferrites are used. A feature of the printed paper which many workers will appreciate is its extensive bibliography with 195 entries. The second session was devoted to microwave theory and measurements; it included contributions by I. G. Macbean (General Electric Co. Ltd.) and by R. A. Waldron (Marconi's Wireless Telegraph Co., Ltd.) on the measurements of permeability tensor components using resonant cavity techniques. Three sessions on microwave properties and applications followed. The Faraday rotation of the plane of polarization of an electromagnetic wave by a magnetized ferrite formed the basis of (*a*) the measurements reported by R. Derry and M. S. Wills (Royal Naval Scientific Service) using nickel ferrites and ferrite aluminates; (*b*) the rotation isolator described by P. E. Ljung (Sweden) for use in the 6 cm. wave-length region; (*c*) the isolator for the 8–9 mm. region produced by Dr. Elizabeth Laverick and Miss Ann Rivett-Carnac (Elliott Bros.); and (*d*) the 45° rotation isolator discussed by A. Langley Morris (Malvern). A. G. Fox reported on several of the current research projects of the Bell Telephone Laboratories, including the use of the permanent-magnet material 'Ferroxdure' (mainly $BaFe_{12}O_{19}$) for giving broad-band properties to a circulator used in the 3-cm. wave-length region.

Section C of the conference was devoted to the theory and application of ferrites which exhibit almost rectangular hysteresis loops. J. B. Goodenough (Lincoln Laboratory, Massachusetts Institute of Technology) examined the various factors influencing the shape of B/H loops, the coercivity and the permeability of the materials, while O. Eckert (Germany) described the occurrence of constricted loops in ferrites containing cobalt oxide and showed the extent to which this property was affected by heat treatment in the presence of a magnetic field. Other contributors dealt with the applications of square-loop materials in digital computors ((B. Bambrough (Decca Radar) and W. Renwick (Cambridge)) and in data-handling systems (E. P. G. Wright (Standard Telecommunication Laboratories, Ltd.) and C. J. Quartly, A. L. Cain and R. W. Clarke (Mullard)), while W. Six and R. A. Koolhof (Philips) discussed the importance of the high-speed switching which can be carried out with ferrite materials, particularly when used in combination with transistors. Applications included electronically controlled telephone exchanges and an automatic reservation system for airline companies.

Section *D* of the conference was concerned with the application of ferrites to radio and television and included papers by R. H. C. Morgan (Mullard, Ltd.) and V. A. Jones and G. Campbell (Plessey Co.). Section *E* was devoted to carrier-frequency applications; in a review of the properties and general field of application to transformers and coils of high *Q*-factor and stability, W. F. Glover and S. E. Buckley (Standard Telephones and Cables, Ltd.) showed that ferrites can have distinct advantages over other materials at operating frequencies greater than 30 kc./s.

During the meeting there was an exhibition of some of the equipments and devices referred to briefly above. There were some thirty or forty exhibits, ranging from examples of ferrites fabricated into a wide variety of shapes and sizes through the often complicated wave-guide units involving ferrite isolators, attenuators, circulators and modulators to the simple ferrite rod aerial. To the worker in a limited field, the exhibition gave a rapid and striking picture of the wide range of application of the material the conference was discussing.

In the five days of the meeting nearly sixty papers were read which will be published with synopses of the discussions in the *Proceedings of the Institution of Electrical Engineers*, during 1957. The Institution is to be congratulated upon its decision to hold such a meeting. It was undoubtedly most successful and a tribute must be paid to its smooth and courteous organization; in particular, the strict adherence to the stated time schedule excited the admiration and envy of more than one of our overseas visitors.

It would be out of place for the writer of a review of this nature to comment critically upon any of the papers presented, but it is hoped that a general observation may be allowed. The number of scientists and engineers attending the meeting was striking testimony to the importance attached to ferrites. Although British workers were well represented as contributors in those sections dealing essentially in measurements and in applications using materials of the standard ferrite type, it does seem significant that, of the nineteen papers presented in Section *A*, only eight were from British workers and eleven, including most of those on fundamental processes and new materials, came from overseas visitors. Yet, as the conference made abundantly clear, there is much fundamental knowledge yet to be acquired.

K. J. STANDLEY

DECAY OF PLANT LITTER

IN opening the series of papers under this title at a joint session on August 31 of Section K (Botany) and Section K* (Forestry) at the meeting of the British Association at Sheffield, Dr. J. G. Boswell described observation which had been made on the chemistry and microbiology of some natural soils in the neighbourhood of Sheffield and on similar soils in northern England and southern Scotland. The local areas included the Ringinglow Bog, the surface vegetation of which is largely *Eriophorum* spp., Lady Canning's Plantation containing *Pinus sylvestris* and *Sorbus aucuparia* with *Deschampsia flexuosa* and *Galium saxatile* in the field layer, and Ladies Spring Wood with *Quercus petraea* and *Betula pubescens*. Fractionation with solvents showed that the ligno-cellulose residue from the peat of Ringinglow Bog contained 25 per cent of the total acidity and in the form of strong acids. The humus from the podsol of Lady Canning's Plantation had a lower total acidity than that of the *Eriophorum* bog in spite of a lower *p*H value, and 55 per cent of the total acidity was located as strong acids in the ligno-cellulose complex.

Microbiological examination showed that there existed in all the soils a group of active protein decomposers, but that from Ringinglow Bog nitrifiers and nitrogen fixers were never isolated. The soluble nitrogen present in this soil was in the form of ammonia, and this was a limiting factor in cellulose decomposition by fungi since while species of a number of genera, *Cephalosporium*, *Pullularia*, *Cladosporium*, *Trichoderma*, *Aspergillus* and *Penicillium*, were isolated, those which in pure culture would decompose cellulose did so only when nitrogen was supplied in the form of nitrate. The humus layer from Lady Canning's Plantation contained a number of sugar-fermenting bacteria of which the most important was a species of *Clostridium* which fixed nitrogen in pure culture, the activity being confirmed by the use of nitrogen-15. Four genera of fungi capable of decomposing cellulose were isolated, of which a species of *Aspergillus* was by far the most active.

Dr. Scurfield had examined the distribution of *Holcus mollis* and *D. flexuosa* in Ladies Spring Wood in relation to the structure of the soil profile. C/N and C/O ratios of the horizons of the profiles showed that with increasing depth, the residue under *D. flexuosa* becomes poorer in nitrogen although with an unchanged oxygen content, while under *H. mollis* the residue becomes progressively richer in both nitrogen and oxygen. The *D. flexuosa* profile contains nitrogen only in the form of ammonia, but under *H. mollis* both ammonia and nitrate are present. This, together with the facts that nitrogen-fixing bacteria appear to be more abundant under *H. mollis* than under *D. flexuosa* and that the plants of the former have a nitrogen content about 50 per cent greater than those of the latter, suggests that nitrogen relationships are an important factor in profile development.

The wide survey of soils from the northern parts of Britain amplified the observations recorded above. Further correlations were made between the E_5 potential of the soil, the activities of the nitrifiers and cellulose-decomposing bacteria, and the nature of the surface vegetation. A very widespread distribution of the nitrogen-fixing species of *Clostridium* was found.

Dr. J. Webster read a paper entitled "The Grass withereth". He pointed out that although the process of decay had hitherto been extensively studied in soil and composts, there was little published information on the succession of organisms which colonize plant remains before they are incorporated into the soil. The colonization of flowering stems of cocksfoot (*Dactylis glomerata*) by fungi was described. About two hundred species of saprophytic fungi had been collected on cocksfoot in three localities near Sheffield. Among the more common fungi found were: (1) *Cladosporium herbarum*, *Epicoccum purpurascens*, *Alternaria tenuis*, *Leptosphaeria microscopica* and *Pleospora vagans*, which were among the first fungi to fruit on moribund tissues. Although present for a limited period on lower internodes, they only persisted for long periods (up to a year) on the upper internodes. (2) *Leptosphaeria nigrans* and *Mollisia palustris* formed fruit bodies on the basal internodes within the tussock during the summer following flowering. (3) *Helminthosporium hyalospermum* and *Tetraploa aristata* also appeared at the tussock base with *L. nigrans* and *M. palustris*, but continued to fruit throughout the following winter and the second summer after flowering on collapsed stems. (4) *Acrothecium* sp.: confined to the lower internodes during the first few months following flowering. (5) *Selenophoma donacis* and *Mycosphaerella recucita* fruited on the upper internodes during the summer following flowering. These fungi were common on other grasses, and work by Mr. H. J. Hudson has shown that on *Agropyron repens* their distribution paralleled that on cocksfoot. Isolations from *Agropyron* stems also showed that the distribution of the mycelium of these fungi resembled closely the distribution of fruit bodies.

In analysing the distribution patterns further, evidence was presented that the water content of the stems was an important factor controlling distribution. Determinations of the water content (as percentage dry weight) showed that the value for the upper internodes frequently fell below 15 per cent, which was probably a limiting value for mycelial growth, while the value for lower internodes was consistently high. The water-content gradient could be destroyed by cutting stems down and placing them on the ground. This results in an upward spread of fungi in groups 2, 3 and 4 (above), and a more rapid disappearance of fungi in group 1. There was evidence, however, that other factors were important.

Dr. P. W. Murphy described the role of "Soil Acarina" in the decomposition of leaf litter. The organic detritus of the forest floor consists of stems, branches, roots, bark, fruits and seeds together with the remains of shrubby and herbaceous vegetation. The Acarina often occur in large numbers in these remains, and field observations and culture experiments have shown that certain mite species, especially the Oribatoidea, feed on leaf litter. In laboratory cultures the amount of leaf material ingested is dependent upon tree species, moisture content of the leaves and certain unknown factors, some of which may be concerned with the microfloral and microfaunal populations of the litter. Concerning the first, it is known that certain plant species show well-marked tendencies to form mull or mor, and the leaf comminuters among the fauna show a preference for mull-forming plants. For example, when cultures of *Steganacarus magnus* (Nic.) are provided with *Fraxinus*, *Betula*, *Pseudotsuga taxifolia* (Poir) and *Pinus sylvestris* L., a series chosen to represent broadleaf and conifer species which have reputations for 'rapid' and 'slow' decomposition respectively, a definite preference is shown for broadleaf as opposed to conifer litter, and ash to birch. An exception to the above situation was found in the case of *Nothrus sylvestris* Nic. cultured on *Calluna vulgaris* Salisb. and *Picea sitchensis* Trautv. and Meyer, when there was very little difference in preference, and quite large quantities of *Calluna* were ingested. This result is rather unexpected in view of the nature of *Calluna* litter, and the length of time it remains apparently little altered under natural conditions. The reasons for these preferences are not at present clear, but there is some evidence that the physical properties of the litter are of importance.

At present little is known about the metabolism of these creatures, and thus the chemical changes taking place during the passage of leaf material through the gut. The average size of the leaf particles in the excrement was about 5μ × 3μ, and it is evident that apart from any chemical transformations the part played by these mites in the physical disintegration and comminution of the leaf litter is of a high order.

The excrement is deposited usually in the form of round or cylindrical pellets, and it is probable that they provide sites for further decomposition by plants and animals. With certain 'humus forms', moder, for example, these pellets are very numerous, and indeed in the *H* layer of protorendzina soils practically all the organic matter may be present in this form. In mull soils, on the other hand, although mites may be very numerous, the amount of recognizable excrement elements is not great, and it is likely that the further decomposition stages are much more rapid under these conditions.

Dr. J. D. Ovington read a paper on "The Importance of Litter Breakdown in the Woodland Ecosystem". The formation of a surface layer of organic material is a characteristic feature of many British woodlands. In some woodlands, particularly of hardwoods, the litter may almost completely disappear before the next leaf-fall; in others, usually but not always conifers, the litter forms a permanent cover over the mineral soil. The amount and type of humus formed varies considerably, depending upon many factors, and has been regarded as an indication of the ecological status of the woodland, particularly from the point of view of nutrient supply and biological activity.

The litter is derived from a variety of sources, for example, from the tree canopies and roots, from the associated shrubs and ground flora and from the forest animals. Because of the dynamic nature of the woodland ecosystem the relative amounts of litter contributed by each of these may vary considerably from woodland to woodland and also at different stages of development of the same woodland.

From studies in an age series of Forestry Commission plantations of *Pinus sylvestris* grown at Thetford Chase, it has been possible to determine the annual fall of litter from the trees as cone, branch and leaf material. At forty-seven years of age the litter fall from the trees is about 5,000 kgm. of oven-dry matter per hectare or about twice the total weight of litter over the forest floor. When heavy thinning and pruning take place the annual deposition of litter may increase to 15,000 kgm. of dry matter per hectare and branch material forms a much greater proportion of the litter. In all, the total oven-dry weight of litter falling from the crop of *Pinus sylvestris* during fifty-five years of afforestation is approximately 300,000 kgm. per hectare, about half of this being leaf material.

The contribution of the ground flora to litter formation varies considerably, depending upon the density and nature of the tree crop. In old plantations the ground flora may be heavier than the weight of leaf carried on the trees, so that the death of the shoots of the associated herbs results in a significant annual contribution to litter formation.

Considerable amounts of plant nutrients are contained in the organic matter falling each year in woodlands. Since the accumulation of litter after forty-seven years of afforestation with *Pinus sylvestris* only equals the litter fall for two average years, it is evident that a large proportion of the plant nutrients has been released into the ecosystem by the decomposition of the litter. The release and circulation of plant nutrients may be much greater in an actively growing woodland with a mor humus layer than in a slower growing woodland having a mull humus. A more dynamic approach to litter formation in woodlands by studying the diverse aspects of nutrient turn-over is needed and should be closely linked with the biological activity of the micro-flora and fauna.

J. G. BOSWELL

VIGILANCE

A SYMPOSIUM on "Vigilance—the Nature of Alertness and the Problem of its Maintenance during Long Spells of Work" was held by Section J (Psychology) of the British Association during the recent meeting there. Dr. N. H. Mackworth (Medical Research Council Applied Psychology Research Unit), the opening speaker, defined vigilance as a state of readiness to detect and respond to certain specified small changes, occurring at random time-intervals, in the external environment. In real life, the problem was to discover why people failed to notice and act on a signal which they were normally quite able to detect. Although they knew what they were looking for, they did not know when to expect this signal. Experimentally it had become customary to measure inspection performance by considering (1) the average number of signals neglected over a given period, or (2) the intensity to which a given signal had to be raised before it was reported.

The main factors in vigilance were either environmental or motivational. The environmental factors included the work situation as well as the general surroundings.

The environmental variables in the work situation were mostly concerned with the dimension of time. For example, Deese[1] had demonstrated how the probability of detection depended on the frequency of signals per hour. Baker[2] had shown that the uneven spacing of signals along the time scale was of even greater importance. This unpredictability in time was thought to carry more weight than any other single environmental factor in causing a loss of alertness during prolonged work. Long working spells were known to be a further factor; Wyatt[3] had demonstrated this in industry, as had Mackworth[4], Broadbent[5], Baker[2], Whittenburg and others[6], and Adams[7] in the laboratory. According to circumstances, alertness began to deteriorate anywhere between a few minutes to one hour from the start of the spell, but usually about half an hour from the beginning. The duration of the signals was also of importance in some cases[7]; but Saldanha[8] had demonstrated that there could be a marked decline in accuracy of response even when the signal remained available until response was made. Aspects of the working situation not yet studied in any detail were the possible effects on alertness of having to neglect many unwanted signals. Regularity in the temporal spacing of wanted signals helped performance; but perhaps regularity in the unwanted signals might hinder it. Little was also known about the effects of systematically increasing the frequency of unwanted events.

The environmental factors in the general surroundings that reduced watchfulness were continuous noise[9], high atmospheric temperatures[10] and isolation[11].

The motivational variables were less clear although of equal importance; the increased motivation of immediate knowledge of results could keep vigilance at its initial level for two hours[4]. Reducing motivation by lack of sleep gave a marked increase in the number of unreported signals during a 45-min. test[12].

Mr. E. Elliott (Admiralty Research Laboratory) discussed the change of the effective threshold during the day. The classical threshold for detecting a stimulus was the level at which the stimulus was detected on half the presentations, but this assumed the optimal conditions of expectancy and perception. In real life, such optimal conditions were not present and men did not detect the stimulus at the classical level but at some higher level which could be called the effective threshold. This was measured by giving the subject at random intervals an auditory signal the strength of which was equal to the classical threshold for that subject. The effective threshold was regarded as zero decibels if the subject gave a response at that level. If he did not detect this signal it was repeated about 30 seconds later one decibel louder than the classical level. If still undetected, the signal was repeated after about the same time-interval two decibels above the classical level, and so on until the signal was detected and reported by a key being pressed. The effective threshold was the amount the signal had to be increased above the classical threshold for detection.

This ascending series was given at intervals about ten times during the two-hour test. This technique was used for examining effective auditory thresholds in six subjects tested daily for three weeks. In the morning they were given ten measurements of effective thresholds in two hours, and in the afternoon they were given ten signals per minute each 1 decibel above threshold. The average effective threshold was found to be about 4 db. above the classical threshold; 10 per cent of the time it was less than 1 db.; but 10 per cent of the time it would exceed 8 db. It was found that there was a large improvement in the effective thresholds for each subject (as measured in the morning) as time went on, but the improvement did not affect the 5–10 per cent period during which effective thresholds were 8 db. or worse.

Other subjects were first tested only by the morning procedure and then the faster presentation of the afternoon was added later. This improvement in the morning results seemed to depend on the presence of the afternoon tests, suggesting a transfer effect. However, the commissive error rate was roughly doubled by the introduction of the afternoon sessions. In fact, the subjects were trained by the frequent but weak signals of the afternoon to listen down to the noise itself.

Thus when a high probability of detection of a signal in noise was required, a high commissive error rate should be encouraged. But the really serious problems of vigilance were related to the larger peaks in effective threshold curves, when the signal strength had to be 8 db. or more above the classical threshold to be detected. These peaks could lead to very expensive mistakes and dangerous accidents.

When a man was asked to do a vigilance task, he had to stop his normal behaviour of scanning rapidly from one set of stimuli to another and concentrate on one set only. It was desirable that his effective threshold for these stimuli should be very low, although his natural living threshold might be very high. It was therefore necessary to study normal vigilant behaviour outside formal test periods.

Mr. D. E. Broadbent (Medical Research Council Applied Psychology Research Unit) discussed the relation between the failures of the vigilant man who was only watching for an occasional signal to which he had to react, and those of the active man who was keeping up a steady stream of activity which had to be related to random changes in his environment. There was considerable evidence that failures in perception could occur with the active job just as with the passive one, and lead to poor performance or accidents. For example, the studies by Saldanha[8] had demonstrated that in accurately setting a Vernier gauge by means of a small handwheel, less accurate settings were being accepted after only 15 min. The accuracy with which a man could keep a pointer on a mark by turning a handle at a constant speed had been investigated by Siddall and Anderson[13]. Again, the errors became greater as time went on. In both these active tasks there was deterioration in performance, just as there was in the passive vigilance tasks.

Other workers had also shown that continuous activity did not maintain alertness in a passive vigilance task. Moreover, Adams[14] had reported that a rest pause was not so helpful to performance at an active task when the rest was spent watching someone else do the work, as when it was taken right away from the work.

It was therefore clear that failure of observation was an important element in active as well as in passive tasks. This suggested that active tasks could be usefully employed to study perceptual failure. In self-paced tasks the speed of response to a signal depended on the probability of that signal. Although the average rate of work might remain the same, there might be an increased unevenness in response shown by pauses and spurts in the activity. It seemed likely that these irregularities in performance represented fluctuations in perception and that similar fluctuations might occur in a pure vigilance task. A brief signal might occur during a brief failure of attention and therefore be missed. If, however, the signal were prolonged or repeated it would exceed the moment of failure and so be detected.

In addition to its considerable theoretical interest, vigilance was also of great practical importance, particularly as regards accident prevention.

Dr. D. H. Irvine (Army Operational Research Group) discussed vigilance in industry in relation to machine-minding and to inspection tasks, and also touched on the reliability of clinical judgments. He pointed out that the signal to be identified might be very brief, or machine paced, or it might persist until attention was paid to it. In the latter case, the signal might become more urgent as time went on, as with the warning light indicating to a motorist that his oil was low, or it might remain static, as with many inspection tasks, where the operator could take his own time to decide whether each item was faulty or not.

Inspection tasks might involve a yes/no decision, where the faulty item had to be identified and rejected, or they might involve grading into classes, or finally, they might involve accurate determinations of measurements along an apparently continuous scale. This visual inspection was affected by factors of vigilance, subjective judgments and decision taking.

Several experiments had been carried out on the variations of subjective judgments between one person and another, even when these people were experts in their own field. Moreover, they varied widely in their judgments on the same materials repeated on two successive occasions. Many of these experiments concerned clinical judgments of disease, since this was a field where the single opinion of an expert could be vitally important. This variability in diagnosis had been extensively surveyed in the examination of X-rays by experts[15–17]; the experimenters found that the use of standards reduced the variability, and that reduction of the number of possible categories also improved consistency. They recommended that for anything as important as a medical opinion at least two examinations of the material should be employed.

One of the major difficulties in investigation of inspection work in industry was the difficulty of finding out how many potential rejects were missed by the operator. Dr. Irvine had carried out an experiment in which subjects were asked to grade pharmaceutical ampoules, first for impurities, and secondly by the nature of the impurities, and each subject graded the ampoules four times, while the batch of 200 ampoules was graded by 24 different subjects, and also 32 times by the author. There was considerable variability in the grading, but it appeared that accuracy of grading improved as the results for many inspections were pooled. As with the clinical material, where high accuracy was essential, it appeared that the same material should be examined several times, if possible by several people.

This experiment also showed that the rejection-rate depended on the batch size; that is, a higher rejection-rate was obtained when the material was examined in two sessions of approximately half an hour each, than when it was all examined in one session. There was no correlation between the time each person took to complete the examination and the reject rate.

Mr. D. Wallis (Admiralty) emphasized some of the more important aspects of the papers. He pointed out that when signal frequency was increased, performance was improved in terms of probability of detection; indeed, the percentage success rose from about 40 to 90 per cent. But the absolute number of signals missed remained about the same, that is, 4 per hour, in the experiment under discussion[1]. Thus, if missing a signal was due to a fluctuation of attention, then these brief but serious lapses might be thought to occur at the same rate whatever the speed of signal presentation.

Mr. Wallis also saw a wide application of the technique described by Mr. Elliott, as this enabled an investigator to sample the precise level of vigilance throughout lengthy periods.

Among the various methods of improving performance in vigilance or inspection tasks the most effective in practice was the use of two operators at the same time, since the lapses suffered by two individuals were uncorrelated in time. In a recent study, Mr. Wallis had found that detection probabilities could be doubled by this approach. There was also the possibility of transfer from tasks specially designed to maintain vigilance to the actual task. Finally, there was the possibility that some people who liked to be quiet and alone might be better at vigilance tasks that require this than would more extroverted people.

Dr. P. Bakan (U.S. National Science Foundation) discussed his experiments on vigilance[18]. The occurrence of performance decrement over time was a result of an increase in the effective threshold for the discrimination required for the task. Repeated effective threshold measurements for the detection of occasional brighter flashes had shown that the required increase in intensity had to be raised after 15 min. Variables related to sleep were also related to a loss of vigilance in performance tasks. Monotonous environments might produce either of these states, while amphetamine sulphate could counteract them. Moreover, physiological changes such as electroencephalogram changes and reduction of muscle potentials were common to both states. However, the subject in a vigilance task would usually make efforts to keep awake by self-generated stimuli, for example, the characteristic increase in restlessness, singing or day-dreaming. It was important also for the experimenter to try to raise vigilance by introducing external stimuli in order to avoid a state of sensory deprivation[19]. Such external stimulation could be irrelevant to the particular vigilance task, yet had to be compatible with it.

Mr. D. C. Fraser (Institute of Aviation Medicine) said that three conditions were needed in a vigilance task: (1) the presence of neutral signals which had to be disregarded but throughout which the significant signals were randomly interspersed; (2) stress conditions were also required in terms of speed, load, duration, etc.; (3) knowledge of results had to be minimal. Tests of effective threshold were therefore of a different nature from the classical vigilance test. Two kinds of vigilance had been found, the alertness needed throughout a long test to detect the occasional significant signals among many other slowly presented signals, and that needed in a short test for detecting the occasional signal among many rapid neutral signals.

Actual sampling during the work itself was even more promising than effective threshold techniques. Recent experiments at Farnborough had shown that vigilance fell off after 40 min.—which was very close to the earlier findings[4].

A full study was now needed of the relationships between vigilant behaviour and neurophysiological measures. The chairman of the meeting (Prof. J. Drever) had developed electroencephalogram techniques which Mr. Fraser suggested should be used to detect changes in the neurophysiological pattern during vigilance tasks.

N. H. MACKWORTH

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OBITUARIES

Dr. H. R. Kraybill

HENRY REIST KRAYBILL, who died in Chicago on September 30 at the age of sixty-five after several months illness, was particularly well known for his research studies on meat and meat products over the past fifteen years.

After graduating in agricultural chemistry at Pennsylvania State College in 1913, Dr. Kraybill took his doctorate at the University of Chicago in 1917. He organized and developed the Departments of Agricultural Chemistry first in the University of New Hampshire from 1919 until 1924 and then in the Purdue University from 1926 until 1941. During this period, he also served as State chemist for New Hampshire and Indiana and held appointments at the Boyce Thompson Institute and the United States Department of Agriculture.

He returned to Chicago in 1941 as director of the Department of Scientific Research of the American Meat Institute and as professorial lecturer in the

Department of Biochemistry at the University of Chicago. When the American Meat Institute Foundation was formed in 1947, it was a natural consequence that he should become its first director of research and education. In 1955 he became in addition vice-president of the research organization of the Institute. At different periods, he held office as president of the Association of Agricultural Chemists, the American Association of Feed Control Officials, and the American Society of Plant Physiologists, and as chairman of the Division of Agricultural and Food Chemistry of the American Chemical Society.

From his earlier work in the fields of plant biochemistry and physiology, Kraybill turned in 1941 to pioneer work in the chemistry of meat and meat products. One of his most important contributions in this field was the discovery and development of two antioxidants for animal fats which not only inhibited development of oxidative rancidity in the fat alone but also inhibited the development of rancidity in manufactured products containing the fat. He learned just before his death that for this work he had been chosen for the Dodge and Olcott Award for 1956.

Earlier in the year, the Purdue University had conferred on him an honorary degree of doctor of science in recognition of his service to the University and his achievements as a scientist, teacher and administrator in the science of agriculture.

Dr. Kraybill was of a quiet, retiring disposition and always gave a very warm welcome to visitors from Britain to the United States. J. G. SHARP

Prof. James M. Sherman

PROF. JAMES M. SHERMAN, professor of bacteriology in Cornell University since 1923 and head of the University's Department of Dairy Industry, died on November 5 at the age of sixty-six. He had relinquished his administrative duties as departmental head on July 1, 1955, in order to devote his full time to writing and research.

Prof. Sherman was a graduate of the North Carolina State College and the University of Wisconsin. Before going to Cornell, he held teaching posts in the University of Wisconsin and Pennsylvania State University, and he was bacteriologist in the U.S. Department of Agriculture during 1917–23. He was a past-president of the American Dairy Science Association and of the Society of American Bacteriologists.

Prof. Sherman was the author of more than a hundred research papers, and published a book on laboratory methods in bacteriology and a monograph on the streptococci. His major research work concerned general biological studies of micro-organisms, systematic studies of some of the important groups of bacteria, especially the streptococci, and investigations of the micro-organisms of importance in milk, food products, soil and industrial fermentations. He served as editor-in-chief of the *Journal of Bacteriology* (1944–51), and associate editor of the *Bacteriological Reviews* (1937–44), and at the time of his death he was a member of the editorial committee of the "Annual Review of Microbiology".

NEWS and VIEWS

Agriculture in the University of Melbourne: Sir Samuel Wadham

SIR SAMUEL WADHAM retires at the end of 1956 from the chair of agriculture in the University of Melbourne after thirty years in that position. Sir Samuel took his first degree at Cambridge (Christ's College), and after the First World War, when he served in the Middle East, he returned to Cambridge as a senior demonstrator in botany. He was invited in 1926 to go to Melbourne as the first professor in a reorganized Department of Agriculture. During his occupancy of the chair some four hundred students have taken their degrees (B.Agr.Sc.), and his graduates comprise a hundred of the scientific staff of the Victorian Department of Agriculture. His own career has been especially marked by the calls that have been made by governments on his skilled services as an adviser in the field of land utilization; in particular, he played a major part in two Commonwealth Commissions, one into the wheat, flour and bread industries during the mid-1930's, and the other the Rural Reconstruction Commission, 1943–45, which advised on policies of post-war land settlement. The chief lines of work carried out in the School under his direction and stimulus have been surveys of soil and land utilization and standards of living. His "Land Utilization in Australia", first produced in 1939 in collaboration with Prof. G. L. Wood, has become an accepted text-book, and is now in its third edition. Apart from his work for agriculture, Sir Samuel has played a major part as a university administrator and in interpreting the university to the public. Through personal visits and regular broadcasts he has become widely known and loved throughout the Australian agricultural community. His exceptional services to Australia were recognized by the award of a knighthood in the New Year Honours in 1956.

Dr. H. C. Forster

DR. H. C. FORSTER, who succeeds to the Melbourne chair of agriculture, is a graduate of the school of which he now becomes the head. His published work deals with factors determining the yield of wheat, and his degree of Ph.D. in statistics was taken at the University of Iowa during the tenure of a Commonwealth Fund Fellowship in 1935–37. He first joined the Victorian Department of Agriculture, in which he became senior cereal research officer, and for many years he has been a part-time lecturer on cereal crops in the University's School of Agriculture. He was president of the Australian Institute of Agricultural Science in 1955, and chairman of the central executive of War Agricultural Committees during the Second World War. Since 1949 he has been assistant executive officer of the Commonwealth Scientific and Industrial Research Organization. He brings to his new post an exceptionally wide knowledge of agriculture and agricultural research throughout the Commonwealth.

Awards for University Education

IN a debate in the House of Commons on November 29 on university awards, Mr. J. C. Jennings, Mr. F. Mulley and Lord Balniel pressed for the establishment of a working party to examine the possibilities of a central award-giving body, and to advise the Minister in connexion with the forthcoming triennial review of awards. Mr. B. Vosper, Parliamentary Secretary to the Ministry of Education, declined to commit himself, but agreed that the problem is due for review. He said that the Minister is considering the probable effect of the projected university expansion on awards policy, but he sees no reason why the system of awards should fail to meet the proposed expansion, and he accepts the view that our policy should be to ensure that young persons desiring and capable of receiving university education should not be deprived of it. In 1955, he pointed out, 15,900 of the 18,000 United Kingdom students entering the English and Welsh universities held Ministry or local authority awards, and of these, 12,500 held local authority awards, an increase of 25 per cent on the figures for 1951. Moreover, every local authority has now come into line so far as awards and the basis of assessment are concerned, and there has been a considerable advance towards uniformity in vacation allowances and like matters. Complete uniformity has also been secured in regard to consideration of candidates with two passes in the General Certificate Examination at the advanced level.

Scientific and Technical Co-operation in Africa

An admirable record of scientific and technical co-operation has been issued by the Commission for Technical Co-operation in Africa South of the Sahara and by the Scientific Council for Africa South of the Sahara, the secretariats of which were amalgamated on January 1, 1955, to ensure maximum co-ordination between two complementary organizations. In 1955 the Commission extended its inter-African consultations to include the social sciences and convened the first meeting of the Inter-African Conference on the Mechanization of Agriculture as well as scientific meetings on the control of quelea birds and the use of irrigation water in drainage and agriculture. Recommendations have been submitted to member governments which may lead to the adoption of a standard system of meteorological and climatological data for the African continent, while studies have continued on strictly regional problems in soil conservation, land utilization and the scientific aspects of geology. The work of the two organizations to 1955 is reviewed in a series of chapters covering pedology, agriculture and forestry; meteorology, climatology, irrigation and drainage; physical hydrology; animal resources; protection of natural resources and of agricultural production; geology; cartographic and statistical data; co-operation in the field of health; inter-African co-operation in social welfare and education; inter-African co-operation in the field of labour; joint action in the social sciences. They show that the activities of the Commission and of the Council now cover practically the whole scientific and technical field, while international contacts are also being widened. Chronological extracts from the annual reports of the Scientific Council for Africa, 1949–55, and from the technical conferences held under the ægis of the Commission, 1948–55, are also included, and there is a general index.

Life-History of the Desert Locust

"The Ruthless One", a new film on the desert locust made by the Shell Petroleum Co., Ltd., succeeds in the short screen time of 18 min. in being equally interesting to the lay viewer and to the advanced student and teacher. The life-history of the desert locust is splendidly shown in colour, with close-up sequences of mating and egg-laying, and all stages of growth from the new hatchling to the winged adult. Since no amount of patient preparation can ensure demonstration of these processes on living material, this cannot fail to be of value to teachers. The nature and size of the locust problem are illustrated briefly, and some sequences made in the Anti-Locust Research Centre in London show the work of that organization, particularly in the collection and dissemination of information. Some shots show research in the laboratory and in wind tunnels. With commendable self-effacement, the film does not deal at length with the practical achievements in field-methods of locust control. Scientists are inevitably divided in their attitude to all steps at popularization. The slightly melodramatic title is explained as a translation of *Al Garad*, one of the Arabic names given to the locust. Then the question of musical background: Can the public never absorb information without it? However, it is well-composed music and anyone who has enjoyed, say, "Peter and the Wolf", will enjoy the background to the courtship scene. Issued in conjunction with the film is an illustrated booklet, 'The Hungry Thief"; this will help the layman—and perhaps the administrator—to understand the recent progress made in the locust problem.

A New Reactor Course at Harwell

New opportunities for industry to acquire basic knowledge of nuclear energy are offered by a special course which has been arranged at the Harwell Reactor School. The standard Reactor School course is one of fourteen weeks duration, giving instruction primarily in reactor physics and engineering. Present arrangements enable some students to attend only the first six weeks of this course, during which time the basic principles of these subjects are taught; but the numbers of these students have had to be limited because the demand for places on the standard course has been high.

During June 3–July 12, 1957, a special six weeks course is to be run entirely separately, and some sixty places will be available. Besides covering the basic principles of the physics and engineering of reactors, lectures will be given on such subjects as reactor metallurgy, shielding and health physics. In addition, emphasis will be placed on special topics such as the instrumentation of reactors and the use of radioisotopes in industry. This special course is designed primarily for people of degree standard who are not directly concerned with overall reactor design. It should appeal especially to members of firms whose interest lies in the making of ancillary equipment for reactors. Application forms can be obtained from the Reactor School, Atomic Energy Research Establishment, Harwell, Berkshire.

Conference of Farm Historians

Sir James Scott Watson took the chair at the winter conference of the British Agricultural History Society held in December in co-operation with the Association of Agriculture at the Institute of Education, University of London. The conference listened to three papers: one by Mr. F. C. Payne, of the Welsh Folk Museum, St. Fagans, on "The Plough in Britain", and a second by Miss E. M. Marston, lecturer in horticulture at the University of Nottingham, on

"The History of Plant Propagation in England". The third was by Mr. G. E. Fussell, on "The Grasses and Grassland Cultivation, 1500–1900".

All three papers were devoted to some aspect of the history of farming technique, and this is in accordance with the policy of the Society. At the annual conference normally held at the end of April, papers on local history or on some aspect of economic or social history are presented. If local, the lecturers usually try to deal with the neighbourhood in which the conference is held. At the winter conference in December, papers on technical history are read. Papers read at the conferences are not necessarily printed in the *Agricultural History Review*, which is published by the Society and distributed free to members. It appears twice a year and includes notes, original papers and book reviews. It can also be purchased by non-members. The honorary secretary, Mr. J. W. Y. Higgs, Museum of English Rural Life, 7 Shinfield Road, Reading, will welcome inquiries from anyone interested.

Toxic Hazards of Pesticides to Man

THE development of strains of insects which are resistant to the usual pesticides may make it necessary to change over to the use of more dangerous substances, for example, in the control of malaria. This is one reason why it is important that the study of the toxicity of modern pesticides and of the precautions necessary in handling them should be actively pursued. A study group set up by the World Health Organization under the chairmanship of Dr. J. M. Barnes (Serum Research Institute, Carshalton, Surrey) has just summarized its findings (World Health Organization: Technical Report Series 1956, No. 114; pp. 51. H.M.S.O; 3*s.* 6*d.*). The report contains useful information on the pesticides containing chlorine and phosphorus and on their toxicity to man and the higher animals, and makes suggestions for safeguards in their use, both indoors and outdoors. Further lines of investigation are suggested. Blood cholinesterase estimation is the most reliable test of harmful exposure to the organo-phosphorus insecticides, such as parathion. An appendix gives the names of the institutions and their individual workers in the different countries where problems of insecticide toxicity towards vertebrates are being studied. Information is included on the compounds being investigated and the general types of work being done in the different centres.

Amino-acid Metabolism in Detached Leaves

C. D. Nelson and G. Krotkov (*Canad. J. Bot.*, 34, 4, 423; 1956) have investigated the metabolism of carbon-14 amino-acids and amides in detached leaves of the broad bean. Leaves were placed with their petioles in 0·01 *M* ammonium nitrate and allowed to carry on photosynthesis in carbon-14 dioxide for various periods from 12 to 125 min. The radio-activities of the various amino-acids were degraded by decarboxylation with ninhydrin. From the specific activity data it was concluded that the amino-acid closest to the site of carbon dioxide fixation in photosynthesis was alanine, followed by aspartic and glutamic acids, with the amides farthest removed. From the intramolecular distribution of label it was concluded that asparagine and glutamine were formed from their corresponding amino-acids. The labelling in aspartic and glutamic acids was not consistent with the view that these two amino-acids are formed from their corresponding α-keto acids produced by operation of the conventional tricarboxylic acid cycle. A C_2 plus C_2 condensation is postulated for the formation of aspartic acid. A shift in the double bond in the aconitase reaction of the tricarboxylic acid cycle would account for the observed labelling in glutamic acid. When acetate-1-carbon-14 was fed to detached broad bean leaves in the light or dark, the distribution of label in glutamic acid supported the suggestion that there is such a shift in the double bond in the aconitase reaction. Sodium arsenite, infiltrated into tobacco leaves, inhibited the biosynthesis of asparagine but not that of glutamine.

Proceedings of the Fifth Colloquium Ampère

THE texts of the twenty-four contributions to the Fifth Colloquium Ampère, held in Geneva during March 21–23, are printed in a special number of Vol. 9 of the *Archives des Sciences*. Nine different countries are represented. Most of the contributions are brief, being only one or two pages in length, and the main topics of discussion are the properties of dielectrics at high frequencies, ferrites, and paramagnetic and nuclear resonance. Review articles are contributed by C. J. Gorter (Kamerlingh Onnes Laboratory, Leyden) on investigations on magnetic resonances during the past twenty years in the Netherlands; L. Guilotto (University of Pavia) on recent work on the time of nuclear relaxation performed at Pavia; A. Losche (Physikalische Institut, Leipzig) on work on paramagnetic nuclear resonance at Leipzig; P. Grivet (University of Paris) on the development of nuclear resonance in France and on recent progress in experimental methods in the United States; and C. H. Townes (École Normale Supérieure, Paris) on recent developments regarding the measurement of time. The contributions are all in French, and no abstracts are provided.

Functions of the Natural History Museum

SIR GAVIN DE BEER, director of the British Museum (Natural History), has served a useful purpose by preparing some observations on the functions of natural history museums in general and of the Natural History Museum in particular. It was appropriate that it should appear during "Museums Week" (October 7–13), which was sponsored by the International Council of Museums. Sir Gavin describes the purpose and object of natural history museums and then details their educational function. Stress is laid on the importance of scientific research in natural history museums and the claim is justly made that they are indispensable instruments of modern civilization and human welfare. Apparently this exceedingly useful paper is not a publication in the usual sense of the term, but no doubt copies can be obtained from the British Museum (Natural History) by those interested.

Textile Institute Award for Technical Teachers

THE Textile Institute has decided to make a special award of a medal and £20, which, by arrangement with the City and Guilds of London Institute, is offered in that organization's Technical Teachers' Certificate examination to the most successful candidate who is a part-time teacher of textiles. The first recipient is Mr. Robert Noel Ward, of Liverpool, a research chemist with British Enka, Ltd., and part-time lecturer in the manufacture of rayon and plastics at Mount Street Institute of Further Education, Liverpool.

University of Glasgow

THE following appointments have been made in the University of Glasgow. To the newly created Simson chair of mathematics: Ian M. Sneddon (see *Nature*, 177, 1109; 1956). To senior lectureships: D. R. Bowes (geology) and W. R. Rees (agricultural chemistry, in succession to F. E. Moon). To lectureships: P. V. March and Helmut Mykura (experimental physics), R. H. Pritchard (genetics), D. R. Powell and D. S. Weedon (geology) and J. S. Gillespie (physiology). To Imperial Chemical Industries Fellowships: R. N. Thomson (biochemistry), A. I. Scott and G. A. Sim (chemistry), and R. E. Azuma (physics). To a Nuffield Fellowship in chemistry: C. R. Narayanan. To a Fellowship in natural philosophy: R. V. Hesketh.

Prof. D. H. R. Barton has been granted leave of absence to visit the United States during April 1957, to receive the Fritzsche Medal of the American Chemical Society. For the present session, 412 new students (290 men and 122 women) have been admitted to the science departments, compared with 343 in 1955. In the University as a whole, the total number of matriculated students has increased by about 200 to 5,910.

Oversea Service Division: Colonial Office

THE following appointments have recently been made in the Oversea Service Division, Colonial Office: P. Adams (principal agricultural officer, Sierra Leone), assistant director of agriculture, Western Nigeria; D. A. Donald (senior agricultural officer, British Solomon Islands Protectorate), principal agricultural officer, Northern Nigeria; J. W. D. Goodban (director of agriculture, British Honduras), director of agriculture, Sierra Leone; G. B. Gregory (agricultural officer, Fiji), senior agricultural officer, Fiji; K. Landskrower (agricultural officer, Gold Coast), senior agricultural officer, Gold Coast; G. E. O. Okiy (agricultural officer, Eastern Nigeria), principal, School of Agriculture, Eastern Nigeria; W. V. Rose (deputy director of agriculture, Barbados), assistant director of agriculture, Western Nigeria; M. J. Smith (agricultural officer, Federation of Malaya), agricultural officer, North Borneo; E. C. Clarke (assistant conservator of forests, British Guiana), assistant conservator of forests (class 2), Cyprus; T. W. Hussey (senior assistant conservator of forests, Federation of Nigeria), conservator of forests, Southern Cameroons, Federation of Nigeria; P. B. H. Bailey, D. Bleackley and P. H. A. Martin Kaye (geologists, Geological Survey Department, British Guiana), senior geologists, Geological Survey Department, British Guiana; C. G. Dixon (senior geologist, Geological Survey Department, British Guiana), deputy director of geological surveys, Geological Survey Department, British Guiana; J. F. Archibald (senior scientific officer, Uganda), principal scientific officer, Uganda; J. T. Davey (entomologist, Department of Agriculture, Federation of Nigeria), senior scientific officer for posting to the Organisation Internationale contre le Crequet Megratem, Africa; A. L. Wharton (scientific officer, West African Cocoa Research Institute), senior scientific officer, West African Cocoa Research Institute; W. Wilkinson (scientific officer, Commonwealth Institute of Entomology), scientific officer, West African Termite Research Unit; J. F. Hart (provincial veterinary officer, Kenya), assistant director (field services), Veterinary Department, Kenya; R. W. E. Lewis (provincial veterinary officer, Kenya), assistant director (field services), Veterinary Department, Kenya.

Announcements

AT the annual general meeting of the Photoelectric Spectrometry Group the following officers were elected: *Chairman*, Dr. E. M. F. Roe (Chester Beatty Research Institute); *Vice-Chairman*, Mr. J. R. Stansfield (Hilger and Watts). Mr. R. A. Ford (British Nylon Spinners, Ltd.) and Mr. A. W. S. Tarrant (National Physical Laboratory) were elected to the two vacancies on the committee of the Group.

THE Fifth International Low-Temperature Conference on Physics and Chemistry will be held at the University of Wisconsin, Madison, Wisconsin, during August 25–31. Further details will be issued in due course.

AN International Congress on prestressed concrete will be held in Berlin during May 5–10, 1958. Contributions, which should not exceed 4,000 words, must be in one of the four languages, English, French, German or Spanish, and must contain a brief summary in all four languages. Six copies are required and should be received by the general secretary of the Fédération Internationale de la Précontrainte, Mr. P. Gooding, c/o Cement and Concrete Association, Terminal House, 52 Grosvenor Gardens, London, S.W.1, not later than August 1, 1957.

AN International Symposium on "Purity Control by Thermal Analysis" will be held in Amsterdam during April 24–26, 1957, under the auspices of the International Union of Pure and Applied Chemistry and the Commission on Physicochemical Data and Standards. Papers covering all aspects of the subject will be presented by recognized specialists from several European countries and from the United States. Those wishing to attend should apply to the secretary, Dr. W. M. Smit, Centraal Instituut voor physische-chemische Constanten, Biltstraat 172, Utrecht, Holland, for a form of application for membership. Those who register before December 31, 1956, will receive a set of preprints of the papers.

THE Worshipful Company of Glass Sellers of London is offering up to four scholarships in glass technology, tenable at the University of Sheffield. In suitable circumstances, these qualify for supplementation by the Ministry of Education up to the full value of State Scholarships. Further information can be obtained from the Registrar, University of Sheffield, Sheffield 10.

APPLICATIONS are invited for the Helen Putnam Fellowship for Advanced Research, a postdoctoral resident fellowship for women, with research facilities at Harvard University. The research may be in any field related to genetics or mental health, including psychology, child development and other fields of social science. The stipend will be 3,000 dollars a year, with possibility of renewal. Application forms may be obtained from the Secretary, Graduate School, Radcliffe College, Cambridge 38, Massachusetts, U.S.A. Completed applications should be returned not later than January 15, 1957. Announcement of award will be made on or before February 15, 1957.

MAGNETIC RESONANCE

SYMPOSIUM AT BANGOR

A SYMPOSIUM on "Magnetic Resonance" was held at the University College of North Wales, Bangor, during September 26–27, the meeting being sponsored by the Liverpool and North Wales Branch of the Institute of Physics. A hundred and twenty persons attended, of whom twelve came from overseas. The growing appreciation in Britain of the value of nuclear and electron magnetic resonance as analytical and structural tools was revealed by the presence of many chemists and physicists from industry.

The meeting opened with a lecture by Mr. R. Kamper (Clarendon Laboratory, Oxford), who gave an account of resonance experiments on free atoms, in which resonance is detected by enclosing the atoms in a resonant microwave cavity, and measuring the absorption of power as a function of the applied magnetic field. In this way the structure of the magnetic energy-levels is explored, yielding the same kind of information as that provided by atomic beam resonance experiments, but without the attendant difficulties of detection. He went on to describe some current work of Dr. Bleaney's group at Oxford on two isotopes of iodine, free atoms of which are obtained by photo-dissociation of the molecular gas within the cavity itself. This method should be applicable to a large number of atoms and free radicals.

Dr. J. G. Powles (Queen Mary College, London) explained with the aid of a film the formation of spin echoes in nuclear magnetic resonance. The nuclear magnetic moments in a specimen which is usually liquid are first aligned by a steady magnetic field. A pulse of radio-frequency power is then applied which tips the aligned moments through an angle so that they now precess freely about the direction of the steady field with their Larmor frequencies. Since the steady field is never quite uniform, the Larmor frequency is different for different parts of the specimen; the individual moments, therefore, soon get out of phase with each other. At a time τ, a second radio-frequency pulse is applied which turns the nuclear moments round; they now pick up their phase differences at the same rate that previously they had lost them, and come into phase coherence again at a time 2τ. In this temporary condition of recovered phase coherence, the nuclear moments induce a signal in a coil wound around the specimen; this signal is the spin echo. By studying the size of these echoes and of other echoes formed by additional pulses, the two relaxation times T_1 and T_2 can be measured. If a nucleus diffuses from one part of the liquid specimen to another part where the steady field is different, its Larmor frequency changes, and it no longer recovers its original phase at time 2τ and is unable to contribute to the echo. A study of the reduction of echo amplitude due to this cause gives information about the rate of diffusion of molecules in liquids. The latent phase 'memory' in the specimen between the initial pulse and the echo can be used as an information storage device for digital computers.

Mr. G. S. Waters (Signals Research and Development Establishment, Christchurch) explained how the free precession of nuclear moments in a steady magnetic field provides a method for accurately measuring the Earth's field. The protons in a vessel of water are aligned in a field of about two hundred gauss produced by passing current through a coil wound around the vessel. When this field is suddenly switched off, the protons precess in the very uniform field of the earth and induce a signal at their precessional frequency (roughly two kilocycles) in the coil wound on the vessel. By accurately measuring this frequency, the Earth's field-strength can be measured absolutely to about one part in 40,000; relative values at different times of day or in different places can be obtained with even higher accuracy. Mr. Waters and his colleagues demonstrated to the conference a nuclear free precession magnetometer which they had built.

Prof. E. R. Andrew (University College of North Wales, Bangor) reviewed current work in physics at Bangor. He reported measurements of the quadrupole-split spectrum of sodium nitrate, and the verification of first- and second-order theory. The second moment of the centre line has been measured and is in fair agreement with recent theoretical predictions. The relaxation mechanism in this crystal is being studied and a new method was described for determining whether the mechanism is magnetic or quadrupole in origin. When applied to sodium nitrate, the mechanism is found to be quadrupolar. The results were reported of a calculation of the spectrum expected from triangular groups of protons slightly distorted from equilateral form. It was shown that in certain acid hydrates the oxonium ion must be very nearly equilateral in form, the possible departure consistent with experiment being not more than about ten per cent. The traditional X-ray work on metals and alloys is being maintained in the department. Work was reported on a range of alloys similar to the ferromagnetic Heusler alloys, but with silver or gold replacing copper, and also on binary alloys of manganese with silver and gold; the structure and magnetic susceptibility have been measured over a wide range of temperature. A critical temperature of 190° C. for the order–disorder transformation in $CuAu_3$ has been found by X-ray and resistivity measurements. An increase in resistivity of disordered Cu_3Au near the critical temperature, found by pulse-anneal measurements, is attributed to short-range order. Work on nickel–zinc ferrites has shown that the resistivity obeys the simple exponential dependence on temperature characteristic of semiconductors, with no discontinuity at the ferrimagnetic transformation temperature. On the other hand, the magneto-resistance is closely associated with the ferrimagnetism.

All magnetic resonance work requires a magnetic field, and the provision of a suitable magnet is usually the most difficult problem confronting the experimenter. Dr. R. E. Richards (Physical Chemistry Department, Oxford) summarized the desirable attributes of magnets for electron magnetic resonance and for low- and high-resolution nuclear magnetic resonance. Uniformity of magnetic field to 1 part in 10^5 over a volume of 1 cm.^{3}, coupled with a stability rather better than this, generally suffices for electron work and for low-resolution nuclear work, and can be provided at modest cost by permanent magnets or electromagnets. On the other hand, high-resolution nuclear magnetic resonance spectroscopy demands a uniformity of one part in 10^7 and stability to better than this. A large carefully engineered electromagnet with first-class electronic regulation will meet the requirements, and indeed such a magnet is marketed in the United States. A large carefully engineered permanent magnet with temperature stabilization is equally satisfactory. In either case the cost is high. Dr. Richards outlined Purcell's method of smoothing out irregularities of field caused by inhomogeneity of the magnet alloy; the pole caps are made of layers of soft iron and diamagnetic material which attenuate the irregularities in much the same manner that electrical fluctuations are reduced by the successive sections of a filter. In the discussion which followed, diverse views were expressed on most aspects of design—pole-cap contour and figuring, shims, pole-cap material, magnetic material, yoke configuration. It seems that much has yet to be learnt before one can confidently assert what are the best and most economical designs of magnets suitable for high-resolution work.

At a business session held during the symposium, a proposal was approved to form a Radiofrequency Spectroscopy Group which would arrange future occasional meetings. For this purpose radiofrequency spectroscopy was deemed to cover work at all frequencies up to about 10^{11} c./s., and therefore includes electron- and nuclear-resonances and also microwave spectroscopy of gases.

E. R. ANDREW

ANNUAL CONFERENCE OF THE PHILOSOPHY OF SCIENCE GROUP

THE first annual conference of the Philosophy of Science Group of the British Society for the History of Science was held during September 21–23 at Ashburne Hall, University of Manchester, under the chairmanship of Dr. G. J. Whitrow, chairman of the Group, and was attended by about fifty members and guests. Mr. R. F. J. Withers acted as conference secretary.

Symposia were held on "Cybernetic Models and Thought Processes", "The Nature and Scope of Scientific Method", "The Status of Irreversible Processes in Physical Theory" and "The Role of Historical Explanations in Science".

In the first symposium, papers were read by Dr. W. Mays and Dr. W. Ross Ashby, and Prof. J. H. Woodger took the chair. Dr. Mays raised the question of the adequacy of cybernetic models for human thinking and learning behaviour. He held that the question, 'Can machines think ?' is not simply a semantic but a factual one; and the answer is 'Yes' only if machines and humans reach their conclusions by similar processes. Dr. Ashby was interested in giving a clear account of 'model' as something that is from a relevant point of view similar to that which is modelled, so as to lead to results which can be tested. To be tractable, however, a model must also be an over-simplification. Hence, all models of the brain have been inadequate, but they have thrown light on aspects of it; in particular they have focused attention on the basic question, 'How much information is involved in this process ?' Subsequent discussion centred around the concept of model, its nature and role. There seemed to be a general consensus of opinion that, although mental processes have not so far been adequately represented by cybernetic models, some models have proved useful.

A connecting link developed between this discussion and the next one, for in discussing models attention was directed to the role of theories in science. This question figured prominently in the second symposium. For this the chair was taken by Dr. J. O. Wisdom, and the opening paper was given by Dr. G. W. Scott Blair on "Scientific Method as a Specialized Intellectual Activity". He considered that the mental processes involved in scientific activity consist of observing, selecting, relating and deducing. He pointed out that there are parallel processes involved in tests of general intelligence, and therefore claimed that the specialized mental activity that goes to make science is not unique but is shared by other intellectual activities. Prof. R. O. Kapp followed with a paper on "What is a Law in Physics ?" He laid great stress on what he called the principle of minimum assumption. He showed with examples that this is not merely a method of economy but also provides a means of deriving important results in theoretical science. He considered, for example, that Dirac could not have predicted the positron without (though perhaps not overtly) relying on this principle. Mr. Z. M. T. Tarkowski then spoke on "The Interaction of Experiment and Theory in Science". After giving an account of the general way in which theories are used, he contended that Galileo's experimental results did not bear out his kinematical hypotheses, and inferred that a theory may have the right to be regarded as possibly true even though the evidence is against it.

The third symposium was more specialized. The chairman of the Group took the chair, and Prof. M. S. Bartlett read a paper on "Irreversibility and Statistical Theory", in which he presented a survey of the development up to the present day of the concepts of irreversibility and entropy. He pointed out that the paradoxes of reversibility reappear in statistical mechanics. He suggested that statistical reversibility for very small systems is consistent with their possible lack of any intrinsic time-direction. Mr. L. L. Whyte then spoke on "The Mathematics of One-way Processes", the traditional problem being to account for one-way processes moving towards equilibrium on the assumption that elementary atomic processes are reversible. This he regarded as over-simplified, since owing to the effect of magnetic fields no single electronic process is reversible unless all electronic motions are simultaneously reversed. A more fertile problem may be to determine conditions under which certain constant parameters can provide satisfactory approximations in a theory of one-way processes. In the discussion which followed, a short note was presented by the chairman from Prof. K. R. Popper, who argued that no logically satisfactory version of the second law of thermodynamics exists. He suggested a possible reformulation of the law, but directed attention to the serious logical difficulties in the way of any reformulation.

In the final symposium, Mr. R. P. Gould discussed "The Place of Historical Propositions in Biology". He contrasted explanation in science with explanation in history. After describing similarities and differences between the kinds of statement found in science and history, he aimed at showing how scientific explanatory hypotheses can be used to explain what has happened in the past. In this way it is possible to give scientific explanations about the evolution of extinct organisms; but he considered that, because of inadequate information, statements about the physiology, biochemistry, and so on of extinct organisms must be treated with caution. Mr. J. W. N. Watkins then spoke on "Historical Explanations in the Social Sciences". He advocated 'methodological individualism' as an essential principle for social science. According to this principle, there are no 'holistic' sociological laws that are irreducible to laws about the situations, dispositions, aims, etc., of individual persons. He claimed that the principle could account for organic-like social behaviour, and he described ways in which explanations of social regularities and of unique historical events could be framed in accordance with it. Mr. R. F. J. Withers, who took the chair, pointed out that there is a difference between scientific explanation and the use of techniques; and the general discussion showed that several biologists were loath to look on scientific explanation, when applied to evolution, as historical.

Animated discussions took place in each symposium. The conference was generally felt to have justified the efforts of those responsible for organizing it, particularly as it became evident that greater clarity concerning problems of scientific method and explanation could facilitate further progress in science itself. Plans for future conferences outside London were discussed. It was provisionally arranged that the next will be held at a week-end towards the end of September 1957. An announcement will be made in *The British Journal for the Philosophy of Science* early in 1957.

NUFFIELD FOUNDATION

REPORT FOR 1955–56

THE eleventh report of the Nuffield Foundation, covering 1955–56*, specially emphasizes in its introduction the general ideas on which the Foundation attempts to plan its operations. Concerned to finance projects that may yield dividends not in terms of cash but of public good, the Foundation inquires first into the credit-worthiness of the applicant; second, into the originality of his idea; and third, into the soundness of his project. It is least interested in investments which will produce a modest return, and with depressing frequency it may find that the number of good projects exceeds the number of good men to execute them. Moreover, the Foundation must also go out and seek profitable investment. It is not its job to sustain work which everybody agrees ought to be done; it dare not even continue to support indefinitely its own successful schemes, lest it quickly consume resources out of which new ones can be attempted. In this seeking of new and rewarding ventures, the Foundation is greatly helped by its visitors and advisers, including those from the universities, learned societies, research institutes, philanthropic societies, hospitals and government departments, who bring ideas as well as information. The Foundation must be free to make rapid changes of emphasis in its interests, and it is important that the size of a grant should be nicely judged so as not to stunt nor stifle. Its funds, too, should not be scattered over a wide range of unrelated schemes, and its policy should be neither vague nor rigid, its programme neither shapeless nor fixed.

Grants for biological research in the United Kingdom include a further grant of £2,410 for one year to The Queen's University of Belfast for studies on population genetics in Northern Ireland under Prof. A. C. Stevenson which are gradually building up a detailed knowledge of the frequency and distribution of specific genes. A grant of £4,800 over five years has been offered to the Plant Breeding Institute, Cambridge, for the salary of a plant cytologist with some knowledge of biochemistry to work mainly at the Institute under the joint supervision of its director, Dr. G. D. H. Bell, and of Prof. J. S. Mitchell, of the Department of Radiotherapeutics, on the modification by chemical means of radiation effects in plants such as broad beans and barley. A further grant of £4,500 over 1956–59 has been made to the University of Glasgow for the work under Prof. G. Pontecorvo on the genetics of micro-organisms, which it is hoped may lead to the discovery of a chemical basis for the genetical phenomena of 'crossing over'. A further grant of £14,200, payable in declining amounts over five years to the Royal Anthropological Institute, London, is to enable the Nuffield Blood-Group Centre to continue its work until other financial provision can be made, and the grant to the Lister Institute of Preventive Medicine, London, for the work on the chemical analysis of immunity-provoking agents has been renewed at the rate of £3,000 a year for a further five years.

A grant of £4,850 over three years has been made to the University of Oxford in support of Dr. A. E. M. Weddell's study of free nerve terminals in the cornea of untreated leprotic patients, and an additional grant of £12,000 over three years has been made to University College, London, for work on the problems of analogues for the cerebral mechanisms involved in the learning processes of the octopus; £6,300 over three years to the Institute of Psychiatry, University of London, is for Prof. H. McIlwain's work on the control of metabolism in normal mammalian cerebral tissues. Another grant to University College, London, of £4,246 over three years, is for the construction of a micromanipulator which will transmit the sense of touch. The Foundation has provided £2,500 for the Department of Agricultural Botany, University College of Wales, Aberystwyth, for equipment to control light, temperature and humidity in research on the influence of environment on the mechanics of growth and inheritance. A final grant of £2,700 over three years has been made to the University of Cambridge for Dr. J. W. Millen's and Dr. D. H. M. Woollam's work on hydrocephalus in rabbits due to deficiency of vitamin A, and a grant of £2,530 has been offered for work on the flight muscles of the bumble bee and on the electric discharges from fishes. The Foundation has also offered £1,500 a year for a further two years to the University of Durham in support of Prof. J. Baddiley's work on the structure and synthesis of co-enzyme *A*.

Other scientific grants include £1,750 a year for two years for the establishment of a lectureship in polar studies at the University of Durham; £8,000 over four years to the Imperial College of Science and Technology, London, for Prof. R. M. Barrer's work on the synthesis and properties of natural and synthetic minerals, especially aluminosilicates; £600 for special equipment and £1,200 over three years for a research assistant for work in the Department of Physics, University of Cambridge, on the use of X-ray diffraction methods to measure electron density distribution in chemical bonds; and a further £880 to the University of Cambridge for Dr. D. J. Price's work on the history of scientific instruments. The Division for Architectural Studies of the Nuffield Foundation has now taken up a study of tropical architecture in relation to human comfort and has been invited to design halls of residence and a dining hall for students of the Imperial College of Tropical Agriculture, Trinidad. Its survey of requirements in laboratories in England and Scotland was to be completed in mid-September, 1956, and its study of the environment to be provided for children in hospital has led to the delineation of a series of problems needing special study, while at Musgrove Park Hospital, Belfast, the Division's experimental work has brought down the cost of efficient and attractive accommodation to about £1,000 a bed.

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* The Nuffield Foundation. Report for the Year ended 31 March, 1956. (Eleventh Report.) Pp. 160. (London: Nuffield Foundation, 1956.)

Apart from chronic rheumatic diseases, to which the Foundation devotes the income of the Oliver Bird Fund and a like amount from its other resources, the Foundation does not normally assist the study or treatment of specific diseases. In this field the Foundation's financial help during the present period goes mainly to the Rheumatism Research Centre in the University of Manchester and to the Rheumatic Unit at the Northern General Hospital, Edinburgh. Besides additional grants of £70,000 over eight years and £65,750 over five years a new grant of £10,000 over three years was made during the year to the Department of Chemical Pathology, St. Mary's Hospital Medical School, London, for further fundamental work under Dr. A. Neuberger on the tissues of the body which are involved or damaged in the rheumatic diseases. Other grants during the year for medical research include £3,000 to the Royal National Throat, Nose and Ear Hospital, London, in support of a pilot course of one year to discover the best kind of training and the best form of preliminary education of a new type of worker who will be primarily concerned with training the pre-school deaf child; £2,000 to the University of Oxford to re-equip Dr. Peter Daniel's general work, with £1,000 for equipment and £3,840 over two years for a special study, on the after-effects of tuberculous meningitis; £20,000 over five years to the University of London for the maintenance of the biomechanical unit established by the Institute of Orthopaedics and King's College to apply the methods of mechanics to the study of forces and actions in the living body; £10,000 to finance the production of a further six Melrose heart–lung machines; and £3,000 a year for two years to the Department of Surgery, University of Bristol, for work on congenital heart disease, involving the establishment of a fully documented register of cases and experimental work to correct congenital abnormalities of the heart while circulation is maintained by a pump.

In social research and experiment the largest grant during the year was £200,000 over six years to Nuffield College, Oxford, to complete the building, which is expected to be substantially finished in three years time, when the College will become residential. The group which the Foundation sent to North America in June and July 1955, to report on the agricultural advisory services in the United States, issued its report last June. The team noted that, in proportion to the value of agricultural output, the United States spends half as much again as Britain on advisory services; it was impressed by the American system of co-ordinating agricultural teaching, research and advice by basing all three on the State land-grant college; by the co-operative arrangement whereby the advisory service is jointly financed by Federal, State and County governments; and by the system of planning the year's programme in consultation with the farmers of the community, and of measuring results against defined goals. The report suggested that, if it were impracticable for university departments of agriculture in England and Wales to take responsibility for the advisory service, a strong working liaison should be established between the advisory service and university departments, agricultural colleges, and farm institutes.

Two further grants have been made to the Department of Social Anthropology of the University of Edinburgh: one of £1,500 over two years for a study of racial problems in Brixton, which appears to be an unofficial reception area for working-class immigrants from the West Indies; and £750 for a general survey of recent research into racial problems in Britain. A grant of £2,500 over two years was for Prof. C. A. Mace's investigation at Birkbeck College, London, into the aspirations of school-leavers, and £9,000 over three years has been offered to Political and Economic Planning for a study of family needs and the social services. A further grant of £5,000 was made to the Administrative Staff College, Henley, for a study of the machinery through which the relations between industry and government are conducted and an investigation into the characteristic pattern of enterprises in Britain and ways in which general policy is made, especially under the impact of change; and £1,700 a year for three years has been offered to the Department of Economics and Commerce of the University of Leeds to enable its unit for industrial management to benefit from a visiting professor or comparable expert from the United States or Canada.

A grant of £1,500 a year for two years to the University College of Swansea is for sustaining its social welfare service for overseas students to the end of the university quinquennium.

Grants for education include £3,000 to the Royal Institution, London, for its work in overcoming the shortage of science teachers; £10,000 to enable a Nuffield collection of children's books to be added to the library of children's books of the National Library for the Blind, and up to £50,000 to the Police College Trust to build and equip a dining-hall at its new premises at Bramshill House, near Hartley Witney. Grants amounting to £60,000 over three years have been offered to voluntary bodies providing chiropody for the old at reduced rates; the grant in support of Dr. D. A. Hill's gerontological research fellowship and unit, which has extended its studies to include collagen, has been renewed at the rate of £6,000 a year; besides a further grant of £2,610 over three years for Mr. F. Le Gros Clark's studies on the employment of older workers, a grant of £2,000 over two years has been made to the Slough Industrial Health Service for a study, under Mr. Le Gros Clark's supervision, to assess the possibilities of employment open to the older worker no longer able to carry on with his normal work.

Grants for the British Commonwealth overseas include £2,080 over two years to the University of Melbourne for research on the enzymes of the endocrine glands, and £1,600 for two years for Dr. V. D. Hopper's study there of heavy primary cosmic-ray particles with nuclear emulsions; £1,600 for one year for Dr. S. S. Angyal's study, with carbon-14 labelled inositol, of biochemical applications which would illuminate the role of inositol in living organisms; £18,000 towards the capital cost of a primary health unit being built by the Christian Medical College and Hospital at Vellore, affiliated to the University of Madras, to provide comprehensive care for a rural community of thirty thousand people; £3,150 during 1955–57 to the Bernard Price Institute of Geophysical Research, University of the Witwatersrand, for its study of the age of the granite of the Bushveld Igneous Complex; £7,000 for wider family studies in Jamaica; and £3,000 for capital expenditure and £2,500 for the maintenance costs over three years of an experimental farm attached to the Gayaza Girls' High School, Uganda, where progressive agriculture will be practised and taught in conjunction with dietetics.

Travel grants include £1,500 to enable Prof. E. B. Verney, of the Department of Pharmacology, University of Cambridge, to spend four months in Melbourne in research on surgical technique and another to bring to Britain for a year's postgraduate experience, Dr. Ijaz-ul-Haque, of the De Montmorency College of Dentistry, Lahore. In Britain one award was made in medicine, six in dentistry and two in biology; three fellowships were given to Home Civil servants. The scheme of travelling scholarships and bursaries for United Kingdom farmers has now come to an end, but eight scholarships were awarded during the year and four bursaries. The Foundation is now offering for a limited period each year one or two travelling fellowships to enable selected builders, building scientists or architects to study abroad at a recognized institute or with an organization of international standing. Twenty awards were made in 1955 under the Royal Society and Nuffield Foundation Commonwealth Bursaries Scheme, and the Foundation will continue its contribution of £3,000 for a further three years. On the recommendation of the Foundation's advisory committees in the Commonwealth, eleven fellowships were given in medicine, eight in natural science, four in social science and humanities, and one in engineering.

THE FLORAL MERISTEM AS A REACTION SYSTEM*

By Prof. C. W. WARDLAW

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FLORAL ontogenesis has long been a preoccupation of morphologists. In trying to understand the physiological mechanism that underlies and determines the orderly formation of the several kinds of floral organs, it is essential to consider the organization and functional activities of the apex of the antecedent leafy shoot. The most general characteristic of the growing shoot apical meristem is that it gives rise to a succession of regularly spaced leaf primordia, sometimes of very variable form and structure, these having their inception in loci of special metabolism, or growth centres. The latter typically originate in the subdistal region of the meristem. The initial state of this region, which consists of equivalent embryonic cells, may be such that the reacting metabolic substances are homogeneously distributed in it. A contemporary chemical theory of morphogenesis envisages the possibility that a reaction system of this kind, in obedience to the laws of physical chemistry and mathematics, and on being activated, can give rise to a patternized distribution of metabolites, for example, of growth centres, this constituting the chemical basis for the ensuing morphogenetic developments. This general property of the apex is maintained throughout the floral development, however much it may be modified in other ways. It is also known that the positions of new primordia are affected by those already present around the meristem.

At a certain stage in the development of a flowering plant, and often in direct relation to exposure to some characteristic photoperiod, it is held that new metabolic substances enter the apical reaction system. This substance (or substances) has not yet been specified or isolated, but it may be hormonal or enzymic in nature or action. Important, usually irreversible, changes ensue. The allometric growth pattern of the apex is radically changed; in particular, the elongation of the axis is greatly curtailed, so that the growth centres, and the lateral organs to which they give rise, are now formed in closely associated groups, either whorls or condensed helices, on an abbreviated floral axis. A characteristic feature of floral ontogenesis is that the apical reaction system passes through a sequence of well-defined phases. Physiological correlations are almost certainly involved in the changing phases of floral development, just as they are in the antecedent vegetative developments. As a result of the initial change in the state of the reaction system, the action of specific genes, hitherto inert, is induced. The changes thereby effected in the system lead to further specific genic action; and so on, until flower formation terminates with the utilization of all of the residual distal meristem. It is probably to the action of particular genes (or groups of genes), as components of the reaction system, that the clear delimitation of the several organogenic phases, that is, the formation of calyx, corolla, androecium and gynoecium, should be attributed. These several conceptions appear to afford a basis for the conspicuous features of floral ontogenesis, namely: (1) that the several floral organs are homologous with leaves; (2) that they are formed in a characteristic pattern on the meristem; (3) that the successive groups of growth centres, formed during the course of floral ontogenesis, have each distinctive physiological properties and accordingly give rise to organs which differ in form and structure from each other.

Among the advantages of the theory as outlined above are: (*a*) that it attempts to bring the morphological facts of floral ontogenesis into direct relation with physiology, genetics and the dynamic geometry of the embryonic apical region; (*b*) that many of the former highly controversial issues, for example, of homologous and non-homologous floral organs, of organs *sui generis*, of morphological 'transitions', etc., disappear as consideration of the relevant phenomena is transferred from the morphological to the physiological plane; and (*c*) that it suggests important opportunities for new observational and experimental work on floral ontogenesis, both in its more general as well as its more specific aspects. Recent investigations of the relation between metabolic factors and heteroblastic leaf development support the theory now advanced.

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* Abstract of a paper read before the Royal Society of Edinburgh on November 5.

THE BALD EAGLE OF NORTH AMERICA

ATTACHED to the bald eagle is a degree of popular interest far beyond that normally associated with other birds of prey. Early in the history of the United States the bald eagle, of all the varied forms of wildlife in North America, was selected as the national emblem. By act of Congress, on June 20, 1782, a design for the national coat-of-arms displaying the bald eagle was adopted.

In a paper published by the Fish and Wildlife Service of the United States Department of the Interior*, Ralph H. Imler and E. R. Kalmbach have reviewed the economic status of the bird. Information has been assembled from reliable sources, from the examination of a series of stomachs and crops of bald eagles, and food remains at nests, to permit a current appraisal of the economics of the bird both within the borders of the United States and in the Territory of Alaska. Study of the economics of the bald eagle was prompted largely by the need for information to appraise the merits of bounty and other legislation affecting the eagle in the Territory of Alaska, where it long has been the subject of controversy. Although the bald eagle was noticeably reduced in south-eastern Alaska during the years of bounty payments after 1917, there are indications that the bird is now regaining its numbers and may again assume its former abundance in favoured areas.

As a basis for laboratory food studies, 435 stomachs of Alaskan bald eagles were collected and examined. In addition, data are available from thirty-one stomachs collected in the United States, and six stomachs collected in Canada. Nearly two-thirds of the food of Alaskan eagles was composed of fish, and of this about one-sixth (16·9 per cent) was salmon. Imler and Kalmbach believe that most of the salmon was carrion when found by the birds. An appreciable, but uncertain, portion of the other fish consumed was known to be dead when located by the eagles. Less than one-fifth (18·8 per cent) of the Alaskan eagles' food was derived from birds, the remainder being various marine species plentiful in the north Pacific.

Stomach examination has substantiated to a limited extent the reported predation of the bald eagle on deer. There is no evidence that the bald eagle exerts an appreciable effect on the population of small mammals unless it should be during winter when numbers of these birds may congregate in areas where jackrabbits are abundant.

Only in Alaska is the bald eagle abundant enough to constitute a significant hazard to domestic livestock, and even there its most important relation is with the semi-domesticated blue fox. During recent years, this problem has been materially alleviated, the more progressive raisers confining their animals under screens. Within the United States, the bald eagle has occasionally preyed on domestic poultry, but here again the small number it takes makes the total effect insignificant.

* Fish and Wildlife Service of the United States Department of the Interior. Circular 30: The Bald Eagle and its Economic Status. By Ralph H. Imler and E. R. Kalmbach. Pp. ii+295–330. (Washington, D.C.: Government Printing Office, 1955.) 30 cents.

ORIGIN OF THE CHARACTERISTIC ENERGY LOSSES OF ELECTRONS IN SOLIDS

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THE characteristic energy losses of electrons passing through thin foils[1] have been interpreted in terms of collective oscillations by Bohm and Pines[2] and in terms of high-lying 'quasi-stationary' excited states by Hayasi[3]. It is the purpose of the present article to outline an alternative explanation in terms of individual atomic ionization and excitation processes according to the Bohr–Bethe theory for the stopping of charged particles.

On this interpretation, the principal energy loss occurring for all substances between approximately 12 and 22 eV. represents the ionization of the bound shell next to the valence-level, for which the binding energies range from about 10 to 20 eV. throughout the atomic table. The weaker loss lines below ~ 12 eV. are considered to represent excitations and ionizations of the valence electrons. As indicated schematically in Fig. 1, the ionization processes give rise to a characteristically asymmetrical energy loss peak of the same form as the known energy distribution curves of the secondary electrons[4]. The form of the secondary electron energy distribution curve and the location of the peak at about 2 eV. above the zero energy vacuum reference-level is predicted by the theory of ionization[5] and has been observed to be essentially the same for gases[6], metals[4] and insulators[4]. Since the half-width of these curves is only about 2–4 eV., the narrow peak is equivalent to a rather well-defined final state required to explain

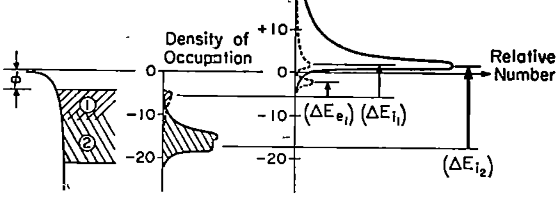

Fig. 1. Schematic diagram illustrating the fundamental energy-loss processes

the sharpness of the observed loss lines in some elements such as aluminium.

The dominance of the processes involving the bound shell next to the valence-level follows directly from the expression for the number of inelastic collision with a given shell per unit path-length according to the Bohr–Bethe theory. In the approximation used by Bohr[7], this quantity is given for the (n,l)-shell by the expression

$$s_{n,l} = \frac{2\pi\varepsilon^4 N}{V}\left[\frac{Z_{n,l}}{E_{n,l}}\ln\left(\frac{2V}{E_{n,l}}\right)\right] \qquad (1)$$

where V is the volt-energy of the incident electron of charge ε, N is the number of atoms per unit volume, $Z_{n,l}$ the number of electrons in the (n,l)-shell and $E_{n,l}$ is the excitation energy, roughly equal to its binding energy $I_{n,l}$.

Examination of equation 1 shows that for $V \gg E_{n,l}$, $s_{n,l}$ varies almost directly with $Z_{n,l}$ and inversely with $E_{n,l}$. It follows that especially in the heavier elements, the number of collision processes with the bound outer shells will dominate. Thus, for the case of copper, taking $E_{n,l}$ as approximately equal to $I_{n,l} + \overline{E}_{se}$, where $\overline{E}_{se}$ is the average energy carried away by a secondary ($\sim$ 6 eV.), one gets $E_{4s} \simeq 12$ eV. and $E_{3d} \simeq 23$ eV., making $s_{3d}/s_{4s} \simeq 5$. The same dominance of the interaction with bound electrons has recently been suggested as explaining the associated phenomenon of secondary electron emission[8].

Since transitions from the filled levels terminate predominantly in the continuum, the strongest energy-loss line corresponds to ionization or secondary electron formation from an outer bound shell. The most probable value of the associated energy loss (ΔE_{i_2}) would be expected to be a few eV. greater than the binding energy of the peak density point in the filled shell as determined by X-ray results. For the valence shell, excitation has a probability comparable to ionization, giving rise to an energy loss (ΔE_{e_1}) of the order of the work-function φ. The ionization of the valence shell itself must lead to a loss (ΔE_{i_1}) greater than φ by $\sim$2–4 eV.

It appears that all the observed losses of higher energies can be explained as simple multiples or combinations of the dominant three fundamental processes (ΔE_{e_1}), (ΔE_{i_1}) and (ΔE_{i_2}). Since the successive collisions are statistically independent, the relative weight of the various possible combinations is determined by simple probability considerations, which will govern the intensities of the higher energy-loss peaks.

The condition that all the observed loss peaks represent simple combinations of two or three fundamental losses is found to be remarkably well confirmed for all metals and insulators for which data are available[1]. As an example, the case of gold is presented in Table 1. The fit to the simple scheme so far as location of the peaks is concerned is surprisingly close, well within the experimental uncertainty of $\pm$ 2 eV. Furthermore, it should be noted that the particular combinations actually observed experimentally follow the pattern expected from probability considerations. Thus, there are never more than two events of small cross-section $(\Delta E_{e_1}$ and $\Delta E_{i_1})$ required to account for any peak and never more than three events of any type making up a single loss line, with the exception of the event with highest expected cross-section (ΔE_{i_2}), for which there are as many as four repetitions.

Table 1

Observed energy losses	Present interpretation		Plasma theory interpretation
eV.	Type No.	eV.	eV.
$3{\cdot}0^a$	A^1	3·0	—
$5{\cdot}2^c$, $5{\cdot}8^a$, $6{\cdot}5^d$	A	5·2	—
$8{\cdot}6^e$, $7{\cdot}3^a$	$A + A^1$	8·2	$h\nu_{pl} = 9{\cdot}0$
$10{\cdot}1^a$	$2A$	10·4	—
$16{\cdot}1^e$, $14{\cdot}4^c$, 15^b	B	15·7	—
$17{\cdot}5^d$	$B + A^1$	18·7	$2h\nu_{pl} = 18{\cdot}0$
$20{\cdot}0^e$	$B + A$	20·9	—
$23{\cdot}9^c$, $24{\cdot}0^a$, 25^d	$B + A + A^1$	23·9	—
$25{\cdot}9^a$, $27{\cdot}5^e$	$B + 2A$	26·1	$3h\nu_{pl} = 27{\cdot}0$
$30{\cdot}0^b$, $32{\cdot}0^c$, $32{\cdot}2^e$	$2B$	31·4	—
34^d, $35{\cdot}2^a$	$2B + A$	36·6	$4h\nu_{pl} = 36{\cdot}0$
45^b, 49^d, $47{\cdot}5^e$	$3B$	47·1	$5h\nu_{pl} = 45{\cdot}0$
60^b	$4B$	62·8	$7h\nu_{pl} = 63{\cdot}0$

Note: $A^1 \equiv (\Delta E_{e_1})$, $A \equiv (\Delta E_{i_1})$, $B \equiv (\Delta E_{i_2})$.

(a) Rudberg, E., *Proc. Roy. Soc.*, A, **127**, 111 (1930); *Phys. Rev.*, **50**, 138 (1936).

(b) Mollenstedt, G., *Optik*, **9**, 473 (1952).

(c) Marton and Leder, *Phys. Rev.*, **94**, 203 (1954).

(d) Watanabe, H., *J. Phys. Soc. Japan*, **9**, 920 (1954).

(e) Gabor and Jull, *Nature*, **175**, 718 (1955).

The present explanation may be tested by calculating the expected form of the loss spectrum for the principal loss (ΔE_{i_2}) in the case of aluminium at two different energies. To obtain the relative contribution of each multiple collision, it is necessary to find the expected number of collisions $(s_{n,l})d$ in a thickness d from equation 1, and then to calculate the probability of the occurrence of 0,1,2,3 . . . collisions according to the Poisson distributing law. This has been done for aluminium using $E_{n,l} = I_{n,l} + \overline{E}_{se} = 19$ eV. and $Z_{n,l} = 2$ for the $3s$-shell, giving $\lambda_{n,l} = (s_{n,l})^{-1} = 140$ A. at 7·6 keV. and 460 A. at 30 keV. The resulting curves are shown in Fig. 2,

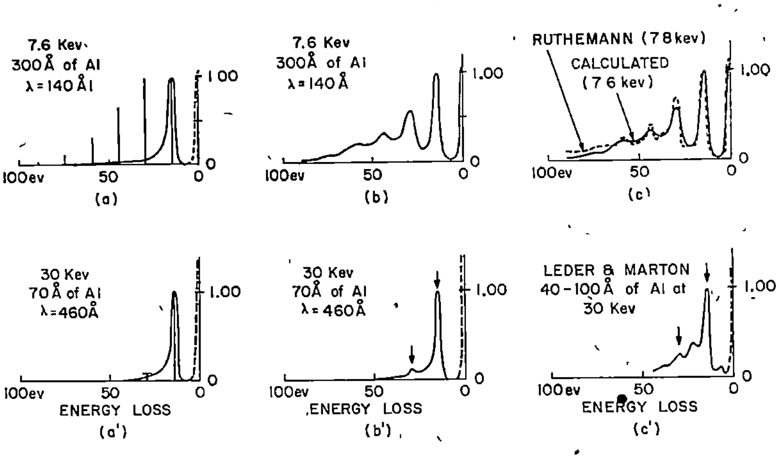

Fig. 2. Comparison of calculated and observed loss spectra in aluminium at two different energies. Curve (*a*) shows the assumed shape of the principal loss, and vertical lines the heights of which represent the expected numbers of single, double, triple, etc., events expected in a 300-A. layer. Curve (*b*) shows the sum of all the losses derived from repetition of the properly weighted principal loss curve of (*a*). Curve (*c*) shows the comparison with observed spectra. Curves a^1, b^1, c^1 are similarly derived for a thinner layer and higher bombarding voltage

calculated for $d = 300$ A. as used by Ruthemann[9] and $d = 70$ A. used by Leder and Marton[1]. The form of the fundamental loss curve (a) was taken from typical secondary electron energy spectra. The shapes of the higher order loss peaks were determined by carrying out a numerical convolution process weighted according to the Poisson distribution shown by the vertical lines in (a) and (a^1). It is seen that the calculated spectra due to the principal loss at 14·7 eV. satisfactorily reproduce the observed number of peaks as well as their relative amplitudes and shapes.

Although this agreement strongly supports the hypothesis that the observed losses represent combinations of only a few types of independent atomic collisions, thus making it unnecessary to postulate a whole series of high-lying 'quasi-stationary states'[3], it does not by itself rule out the explanation involving excitation of plasma oscillations[2]. This is due to the fact that the form of the expression for the mean free path obtained in plasma theory is essentially the same as that of equation 1, and that, for the case of aluminium, a quantum of the plasma oscillation has an energy roughly equal to $E_{n,l}$, while at the same time the number of valence electrons is very nearly equal to $Z_{n,l}$ for the $3s$-shell. As a result, plasma theory leads essentially to a similar mean-free-path and amplitude distribution in the loss spectrum for aluminium, although it must be noted that the characteristic asymmetry in the shape of the loss peaks does not seem to be explained by any simple plasma resonance mechanism.

A more definite distinction between the two proposed mechanisms can, however, be made in the case of the heavier elements, where $Z_{n,l}$ for the filled shells is much larger than the number of free conduction electrons. Thus, for the case of copper $(s_{n,l})^{-1} \simeq 80$ A. at 30 keV. according to equation 1, and $\simeq 760$ A. according to the plasma theory, using the usual assumption of one conduction electron per atom. Essentially the same situation holds for all the noble metals, so that according to plasma theory, one would not expect to find the high-order multiple loss-peaks in the case of gold (Table 1) for the energies and layer thicknesses used ($\sim$100–200 A.)[1]. Thus, to account for a loss peak at 60 eV. with a fundamental plasma loss $h\nu_{pl} = 9\cdot0$ eV.[9], approximately seven repeated events would have to occur. But this would require a mean-free-path at least ten times smaller than calculated from plasma theory.

Inasmuch as the collision cross-section for the bound outer shells cannot be expected to be affected strongly by changes in the state of aggregation or the bulk properties of the solid, it is also no longer surprising that characteristic losses of essentially similar type have been observed in metals and insulators. For the same reason, a crucial test that can clearly decide between the individual atomic and collective loss mechanisms would be provided by measurements on metal vapours.

In view of the close correlation of the characteristic losses with the fine-structures of X-ray absorption edges and short-wave limits noted by other investigators[1], it appears possible to explain these effects also in terms of the energy loss mechanism outlined above.

A more detailed discussion of this problem will be presented elsewhere. I am indebted to Mr. L. B. Leder and Drs. L. Marton, E. N. Adams, J. W. Coltman and R. L. Longini for helpful discussions of this problem.

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GENETIC STUDIES OF THE RELATIONSHIP OF TUMOUR—HOST CELLS

Detection of an Allelic Difference at a Single Gene Locus in a Small Fraction of a Large Tumour-Cell Population

A SERIES of experiments is being carried out in this laboratory with the view of inducing mutations at certain gene loci in tumour cells, either by non-specific means such as X-rays, or in a more specific way by treatment with deoxyribonucleic acid of specific origin. The basic material of this study consists of tumours induced in F_1 hybrid mice, produced by crossing the inbred A-strain with one of the three isogenic sublines $A.SW$, $A.BY$ or $A.CA$ (kindly provided by Dr. G. D. Snell). These sublines have been developed by Snell[1,2], and they are known to differ from the A-strain by one gene only, having a different allele at the histocompatibility-2 (H-2) locus. This difference makes all three sublines resistant against grafted tissues and tumours of all other sublines and the A-strain itself, in spite of their genetic identity with regard to all or most other loci.

An F_1 hybrid produced by crossing the A-strain with one of the isogenic resistant sublines is theoretically homozygous with respect to all loci except H-2, which presents the heterozygous condition. Tumours arising in such F_1 hybrids should be transplantable to other F_1 hybrids of the same genetic composition, but not to any of the parental sublines, since the latter would be able to produce a homograft reaction against the antigenic products of the foreign H-2 allele derived from the other parental subline and contained in the tumour cells in a single dose.

We have induced a series of sarcomas in such F_1 hybrids by methylcholanthrene. The majority of these tumours was found to behave according to expectation and with great rigidity. There were some exceptional tumours, however, that grew in one or both parental strains from the beginning or after

Table 1

Tumour I				Tumour II				Mixture I + II		Result	
Name	Induced in	Genotype	No. of cells inoculated	Name	Induced in	Genotype	No. of cells inoculated	Inoculated into	Genotype of hosts	Ratio of mice killed by tumour to total number inoculated	Percentage killed by tumour
DSWB	$A \times ASW\ F_1$	$H\text{-}2^aH\text{-}2^s$	$\sim 5 \times 10^7$	—	—	—	—	A	$H\text{-}2^aH\text{-}2^a$	0/30	0
DSWB	$A \times ASW\ F_1$	$H\text{-}2^aH\text{-}2^s$	$\sim 5 \times 10^7$	—	—	—	—	$A \times ASW\ F_1$	$H\text{-}2^aH\text{-}2^s$	30/30	100
—	—	—	—	*S4A*	A	$H\text{-}2^aH\text{-}2^a$	20	A	$H\text{-}2^aH\text{-}2^a$	2/16	12·5
DSWB	$A \times ASW\ F_1$	$H\text{-}2^aH\text{-}2^s$	$\sim 5 \times 10^7$	*S4A*	A	$H\text{-}2^aH\text{-}2^a$	20	A	$H\text{-}2^aH\text{-}2^a$	15/20	75
—	—	—	—	*S4A*	A	$H\text{-}2^aH\text{-}2^a$	200	A	$H\text{-}2^aH\text{-}2^a$	13/16	81
DSWB	$A \times ASW\ F_1$	$H\text{-}2^aH\text{-}2^s$	$\sim 5 \times 10^7$	*S4A*	A	$H\text{-}2^aH\text{-}2^a$	200	A	$H\text{-}2^aH\text{-}2^a$	20/20	100
MSWG	$A \times ASW\ F_1$	$H\text{-}2^aH\text{-}2^s$	$\sim 5 \times 10^7$	—	—	—	—	A	$H\text{-}2^aH\text{-}2^a$	0/12	0
MSWG	$A \times ASW\ F_1$	$H\text{-}2^aH\text{-}2^s$	$\sim 5 \times 10^7$	—	—	—	—	$A \times ASW\ F_1$	$H\text{-}2^aH\text{-}2^s$	8/8	100
—	—	—	—	*S6A*	A	$H\text{-}2^aH\text{-}2^a$	20	A	$H\text{-}2^aH\text{-}2^a$	2/12	17
MSWG	$A \times ASW\ F_1$	$H\text{-}2^aH\text{-}2^s$	$\sim 5 \times 10^7$	*S6A*	A	$H\text{-}2^aH\text{-}2^a$	20	A	$H\text{-}2^aH\text{-}2^a$	6/11	55
—	—	—	—	*S6A*	A	$H\text{-}2^aH\text{-}2^a$	200	A	$H\text{-}2^aH\text{-}2^a$	14/16	88
MSWG	$A \times ASW\ F_1$	$H\text{-}2^aH\text{-}2^s$	$\sim 5 \times 10^7$	*S6A*	A	$H\text{-}2^aH\text{-}2^a$	200	A	$H\text{-}2^aH\text{-}2^a$	15/15	100

a few generations of transfer. These were excluded from the present experiments.

The 'stable' tumours that grow only in F_1 hybrids of the original genetic composition would lend themselves ideally to mutation studies (compare ref. 3), provided that certain basic conditions can be fulfilled. A tumour arising in an $A \times A.SW\ F_1$ hybrid (genotype: $H\text{-}2^aH\text{-}2^s$) would be unable to grow in the parental A-line (genotype $H\text{-}2^aH\text{-}2^a$), unless a mutation occurred from $H\text{-}2^s$ to $H\text{-}2^a$ in one of the tumour cells. Such a mutant would have an absolute selective advantage when the population is tested for growth in the A-strain, where it would give rise to a progressively growing tumour, while all cells of the original type would be destroyed by the host. It would be still quite unable to grow in the other parental line ($A.SW$, genotype $H\text{-}2^sH\text{-}2^s$). Such a system would have the unique quality of making detectable a single gene mutation occurring in a single cell within a large neoplastic cell population.

It is not *a priori* certain, however, that the mutant would be able to survive under conditions in which the rest of the inoculated population, usually consisting of several million cells, is being destroyed simultaneously by an intensive and efficient host reaction. In spite of its favourable genetic composition, the mutant cell or its derived clone may be damaged by the host reaction or by toxic products of the damaged and killed tumour cells in a non-specific way. If this were the case, rare mutations would scarcely be detectable in such a system. Because of this possibility, it was considered necessary to carry out model experiments in order to investigate the survival of known mixtures of compatible and incompatible tumour cells, differing by a single allele at the H-2 locus, after inoculation into mice of known genotype. The main results are described here.

Sarcomas induced by the subcutaneous injection of methylcholanthrene were used in their early transfer generations (less than 10). Cell suspensions were made by forcing the freshly removed, ice-cooled tumour tissue through stainless steel nets into Krebs–Ringer-phosphate solution, containing 0·25 per cent gelatin and 0·5 per cent glucose. Cells were enumerated in a hæmocytometer and appropriate dilutions were made in the same solution. A known large number of tumour cells that had originated in an $A \times A.SW\ F_1$ hybrid were then mixed with a known small number of similarly suspended cells derived from the parental A-strain. The mixtures were inoculated subcutaneously into A mice. Control A mice were inoculated either with cells of the F_1 tumour alone or with cells of the A tumour alone. The same cell dosages were used in the controls as there were in each of the mixed inocula. Mice of both sexes were used, weighing 20–25 gm. They were all derived from the single-line inbred nucleus of the strain, kept by continuous brother-to-sister mating. The inoculated animals were observed for tumour formation by regular palpations, followed by calliper measurements of the progressively growing neoplasms and by recording the time elapsing until the death of the host from the tumour. Mice without tumours were considered negative after an observation period of four months.

The results of some representative experiments are shown in Table 1. It appears that even in cases where the compatible ($H\text{-}2^aH\text{-}2^a$) fraction of the inoculated cell population was as small as 4×10^{-7}, it survived not only as well as, but even much better than, in the controls, in spite of the simultaneous destruction of the overwhelming majority (genotype: $H\text{-}2^aH\text{-}2^s$) by the intense homograft reaction of the $H\text{-}2^aH\text{-}2^a$ host. Indeed, it seems as if the former cell type would have been stimulated in its growth considerably by some factor involved in the destruction of the latter. This was manifested by an increased percentage of mice killed by progressively growing tumours, and by a more rapid development of the neoplasms and a reduced survival time of the tumour-bearing animals, when mice receiving the mixture of compatible and incompatible cells were compared with animals inoculated with the same number of compatible cells alone. The mechanism of this stimulating effect is not clear. It could be due conceivably to products liberated by the incompatible tumour cells in the course of their destruction or to the homograft reaction itself. A similar stimulating effect has been found by Révész[4] in experiments in which mixtures of living tumour cells and cells of the same tumour line but killed by X-rays were inoculated into compatible hosts. Since his system also involves, besides disintegration of killed cells, an intense inflammatory reaction of the host, it does not distinguish between the possibilities of stimulation by cell products or by the host response.

The stimulating effect does not seem to be specific for the cells of the $H\text{-}2^aH\text{-}2^s$ genotype, or for methylcholanthrene-induced homologous tumours, since it occurred in a similar fashion when a small number of *S4A* tumour cells, indigenous to the A-strain, were mixed with a large proportion of cells derived from a mammary carcinoma of the *DBA* strain, and inoculated into *A*-mice. Preliminary experiments indicate that there is no stimulating (or inhibiting) effect if the compatible and incompatible cells respectively are inoculated at two different sites in the same recipient animal. Further studies on the mechanism of the stimulating effect are in progress.

These findings have three main implications. First, they emphasize the extreme specificity exhibited by the homograft reaction and its ability to 'recognize' a very small number of cells of compatible genotype within a large population of incompatible cells of similar morphological origin and differing from the former only with regard to a single gene locus. Second, they justify the expectation that the present tumour–host system will enable the detection of a single mutation at a single histo-compatibility locus in a single tumour cell. Finally, similarly to the experiments of Révész[4], they indicate that the destruction of a very large proportion of a tumour-cell population does not necessarily lead to the damage of the small surviving fraction, provided that the latter is genetically compatible with the host. The disintegration of the damaged cell fraction and the ensuing inflammatory response do not seem to increase the chances of the host destroying the surviving part of the population and being cured; on the contrary, they stimulate its growth. It seems that the host has no effective way of reacting against tumour cells of compatible genetic constitution, either in a specific or a non-specific way, at least when considering host–tumour systems similar to those used in the present experiments.

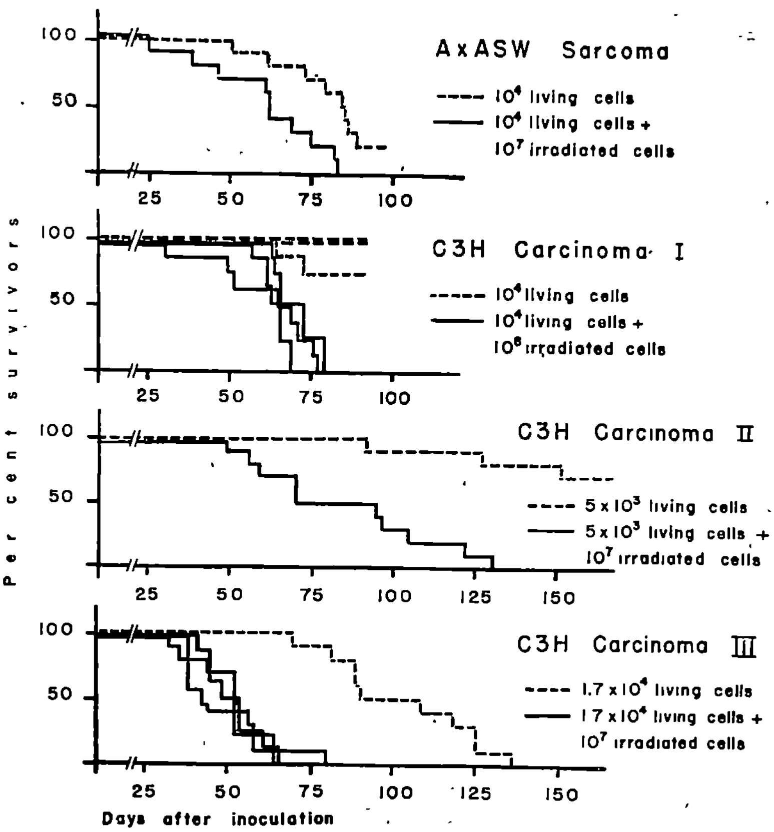

Fig. 1. Effect of cells lethally damaged by X-rays on admixed viable cells. Note higher incidence of progressively growing tumours and a reduction of survival-time in animals inoculated with mixture. Four different tumours were inoculated into mice of the original genotype

This work has been supported by research grants from the Swedish Cancer Society and Lotten Bohmans Fond.

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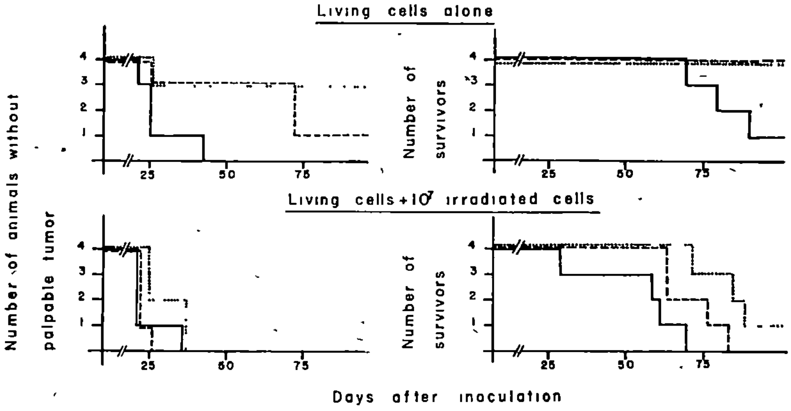
Effect of Tumour Cells killed by X-rays upon the Growth of Admixed Viable Cells

Tumours irradiated with sublethal X-ray doses can be schematically considered as containing two kinds of tumour cells, differing in their prospective reproductive potentialities. One fraction has been damaged irreversibly so as to lose the ability for continued reproduction. These cells may die immediately or after a number of cell divisions[1]. Another part of the cell population is composed of cells undamaged or damaged in a reversible way, and still capable of multiplying serially without restraint. The relative proportion of these two fractions is probably related to the X-ray dose, the inherent sensitivity of the cells and to various environmental conditions during irradiation.

Very little is known about the potential influence that the lethally damaged population may exert on the continued proliferation of the surviving fraction, either directly or through the host organism. It is conceivable that the dying cells may stimulate the growth of the survivors in a variety of ways; but it is equally possible that they inhibit them by toxic products or as a result of the intense local inflammatory reaction they induce in the host.

The problem was approached experimentally by mixing irreversibly damaged and viable mouse tumour cells in various proportions. Two main tumour types were used. The first group includes neoplasms that arose spontaneously or have been induced by carcinogens in mice of highly inbred strains or in F_1 hybrids produced by crossing two inbred strains. These tumours were used after a single generation of transfer into mice of the original genotype. Another category is represented by the Ehrlich ascites tumour that originated in a mouse of



——, 5×10^3 living cells; – – –, 5×10^2 living cells; ......, 5×10 living cells

Fig. 2. Effect of cells lethally damaged by X-rays on the growth of viable cells admixed in various numbers. A spontaneous mammary carcinoma of the *C3H* strain was used. The curves on the left show the appearance of palpable tumours; those on the right denote survival time. Note higher incidence of tumours, reduced latency-period and decrease of survival-time in animals receiving the mixture

unknown genetic composition and has been carried in heterozygous animals for sixty years.

The various solid tumours were brought into suspension by forcing the freshly removed, ice-cold tumour tissue through stainless steel screens into a solution of Krebs–Ringer phosphate, containing 0·25 per cent gelatin and 0·5 per cent glucose. The cells were enumerated in a hæmocytometer and appropriate dilutions were made with the same solution. The Ehrlich ascites tumour was used in its natural suspension form. One aliquot of each suspension was irradiated *in vitro* with 12,000 r. in a nitrogen atmosphere, a dose far above what is necessary for the complete inactivation of all tumours used in the present study. A known number of irradiated cells was mixed in various proportions with an untreated aliquot of the same suspension. Three groups of mice were inoculated. Group *A* (6–10 mice) received only lethally damaged cells. Group *B* (10–30 mice) was inoculated with untreated cells alone. Group *C* (10–30 mice) received mixtures of the two cell types in various proportions. The number of lethally damaged cells was kept constant, and the untreated cells were admixed in the same number as used for the inoculation of group *B*. The latency-period elapsing before the appearance of palpable tumours was determined and the survival-time of the tumour-bearing animals was recorded. Mice surviving without tumours were kept under observation for three to six months. In the case of the Ehrlich ascites tumour, the total number of free tumour cells in the peritoneal cavity was also followed by quantitative growth curves[2].

No growth was obtained in any mouse belonging to group *A*. When comparing groups *B* and *C*, the lethally damaged cells were found to exert an intense stimulating effect on the proliferation of viable tumour cells of the first category (consisting of four different spontaneous mammary carcinomas of the *C3H* strain and a methylcholanthrene-induced sarcoma of the $A \times ASW\ F_1$ hybrid combination). This was most apparent when the number of viable cells was small (10^2–10^3) compared to the number of damaged cells (about 10^7). In such cases, group *C* showed a reduced latency-period and a decreased survival-time of the tumour-bearing animals when compared to group *B* (Figs. 1 and 2).

Different results were obtained with the Ehrlich ascites tumour[2]. When measuring the growth curve of intraperitoneally inoculated tumour cells, an analogous stimulation was found upon mixing 2×10^6 living cells with 20×10^6 lethally damaged cells. If a small viable inoculum was used instead (100 cells) and the number of damaged cells was kept constant, a pronounced inhibition was observed, however. While 100 cells alone led to progressively growing tumours in all mice, the presence of dead cells completely prevented their development. This was found to be due to an active immunization of the host against the immunogenetically foreign Ehrlich tumour by the cells damaged by X-rays, thus preventing the small viable fraction from reaching an irreversible population-level.

These findings indicate that fallacious results may be obtained with so-called non-specific tumours that grow in genetically foreign hosts. A treatment that damages only one part of the cell population may lead to tumour regression after receiving help from the histo-incompatibility reaction of the mouse. This agrees in principle with the findings of Cohen and Cohen[3]. A similar situation does not seem to occur with an immunogenetically compatible tumour–host system, where partial damage of the population appears to stimulate the growth of the survivors in all cases. This occurs in spite of the fact that the host reacts with an intense and histologically very impressive local inflammatory reaction against the presence of damaged and killed tumour cells[4]. This reaction is nevertheless unable to destroy, or substantially damage, compatible and viable tumour cells. In this respect it is similar to the homograft reaction[5].

In our continued studies about the nature of the stimulating effect exerted by dead cells we are trying to distinguish between the following possibilities: (1) specific stimulation by homologous cell products[6]; (2) a 'feeder effect'[7], in which the dead cells release essential nutrients; and (3) stimulation through provoking an inflammatory response and/or vascularization from the side of the host.

I wish to thank Dr. G. Klein for many valuable discussions, and Miss L. Hennings for her assistance in the experimental work. This work was supported by grants to Dr. G. Klein from the Swedish Cancer Society and Konung Gustaf V:s Jubileumsfond.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Incorporation of Radioactive Aspartic Acid into the Proteins and Related Fractions in Mice bearing the Ehrlich Ascites Carcinoma

In Zamecnik's laboratory, Frantz *et al.*[1], using dinitrophenol, found in liver slices a parallelism between the inhibition of phosphorylation and of amino-acid incorporation. Siekevitz[2] demonstrated in a cell-free system a relation between oxidative phosphorylation and amino-acid incorporation in a crude rat-liver homogenate. Hoagland[3] concluded from his experiments that the carboxyl groups of the amino-acids are activated by adenosine triphosphate, and that the activated amino-acyl groups are bound through an adenosine monophosphate bridge to an enzyme acting as an intermediate amino-acyl transfer compound. However, such intermediates have not yet been isolated and identified. In their systems it was not possible to 'exchange out' the carbon-14 labelled amino-acids with large quantities of unlabelled amino-acids; thus the incorporation was different from the exchange process described by Gale and Folkes[4] in fragmented *Staphylococcus aureus*. J. T. Park[5] has isolated uridine-5′-phosphate derivatives containing an amino-sugar and amino-acids from extracts of *Staphylococcus aureus* treated with penicillin. On the basis of these and a great number of other experiments, Borsook[6] proposed a hypothesis for the mechanism of biosynthesis: the carboxyl groups of free amino-acids are first activated by an enzyme system dependent on adenosine triphosphate. They are then transported to a nucleic acid template by an unknown mechanism and are arranged in a specific sequence, the amino-acids being attached to the phosphate of nucleic acid by their carboxyl groups. On this template, the amino-acids are then linked by peptide bonds through the action of another enzyme, and the protein molecule peels off the template.

The following work is an attempt to find and investigate any labelled compounds of relatively low molecular weight which might be formed on administration of a ^{14}C-labelled amino-acid to mice bearing the Ehrlich ascites carcinoma. The tumours were produced by intraperitoneal transfer of approximately 10^7 tumour cells into each mouse from stock mice (C_{57}Black × C_3HF_1). After the tumour has grown for four days, 0·1 ml. of a solution of L-aspartic acid-^{14}C (generally labelled, Radiochemical Centre, Amersham) containing 8·33 μc. (in 0·16 mgm.) was injected intraperitoneally into each of the ten mice.

The mice were killed 15 min. after the injection, the livers pooled and kept at −78° C., and from the ascitic fluid the tumour cells were separated by a short centrifugation at 0°, and were then mixed with an equal volume of 0·66 N perchloric acid at 0°. After homogenizing and standing for 3 hr. at 0°, the precipitate was centrifuged off and the supernatant neutralized with potassium hydroxide at 0°. After the potassium perchlorate was centrifuged off, a clear, neutral solution was obtained, practically free of perchloric acid (1 per cent). This solution will be called the cell extract. In a similar way a liver extract was obtained from the pooled livers.

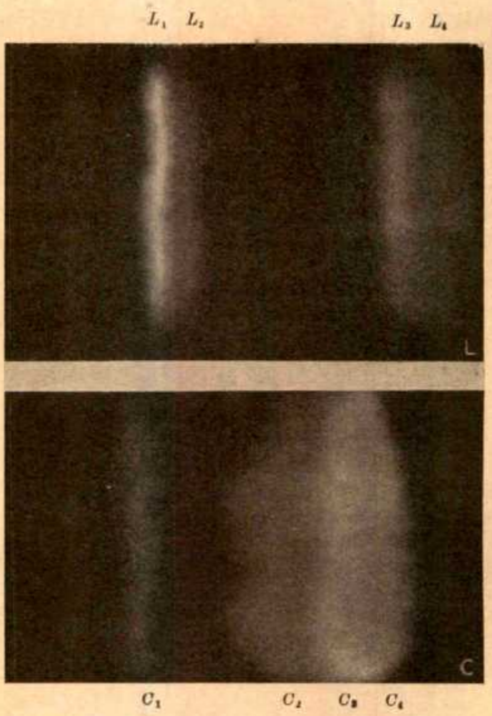

Fig. 1. Autoradiograms of the electrophorograms of the liver extract (L) and the cell extract (C)

These extracts were submitted to paper electrophoresis*(Whatman 3 *MM*, veronal buffer *p*H 8·6, 300 V./12 m.amp. = 10 V./cm., 210 min.). After drying in a current of warm air (40°), autoradiography revealed four labelled zones moving to the positive pole (Fig. 1).

It is interesting to note the differences in the strength and the electrophoretic mobility of the fractions L_2 and C_2; although, at this stage, it is not certain that this difference can be attributed to a particular state of the mechanism of biosynthesis in the tumour cell.

Zone L_4 was eluted and was run in ammonium sulphate–*iso*propanol[7]. The ultra-violet print shows two spots with R_F 0·37 and 0·81 respectively. Autoradiography showed that only the spot with R_F 0·81 contained carbon-14 activity. This spot on hydrolysis with N hydrochloric acid (100°, 1 hr.) gave a substance which ran in *iso*propanol.hydrochloric acid[8] with the same speed as uridylic acid (R_F 0·63) and had the same ultra-violet spectrum in neutral, acid and alkaline solution. It also gave a ninhydrin-positive spot which ran with the same speed (R_F 0·36) as aspartic acid in this same solvent. The carbon-14 activity was contained in the aspartic acid spot, while the uridylic acid spot was inactive. The other spot (R_F 0·37 in ammonium sulphate–*iso*propanol), which did not contain carbon-14 activity, was identified as adenylic acid.

Zone L_3 gave in ammonium sulphate/*iso*propanol two spots with R_F 0·38 and 0·70 respectively. All the carbon-14 activity was contained in the R_F 0·70 spot. It had the same ultra-violet spectrum as uridylic acid. In *tert*-butanol/hydrochloric acid[9] the spot runs with the front, whereas uridylic acid under the same conditions has R_F 0·78.

In conclusion, both zones L_4 and L_3 contain inactive adenylic acid, while the carbon-14 activity is contained in a uridylic acid–aspartic acid compound, which in the substance of zone L_4 has R_F 0·81 and in that of zone L_3 has R_F 0·70 when run under the same conditions.

A proof of the constitution of the uridylic acid–aspartic acid compounds must await the results of further investigations at present in progress. The identification of the other zones obtained by electrophoresis is also proceeding. Fuller details, together with a consideration of possible biochemical implications, will be given in another paper.

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Identity of the Phosphodiesterase and Deoxyribonuclease in Rattle-Snake Venom

As part of a programme on different phosphoesterases, the behaviour of the phosphodiesterase activity in rattle-snake venom has been studied by anion exchange chromatography. The adsorbent was the diethylaminoethyl cellulose of Sober and Peterson[1], and in order to utilize possible displacement effects a one-step-elution technique was used. This procedure has been applied earlier for the detection and separation of two acid phosphomonoesterases from horse radish[2,3]. However, the chromatographic experiments described here differ owing to the fact that we now have been working at a pH near the pK of the ion exchanger[1]. Although the investigation is being continued, this communication may be justified by two unexpected findings: the venom seems to contain two phosphodiesterases and both of them digest deoxyribonucleic acid.

A typical experiment, pointing toward these conclusions, was carried out in the following way. A column (22 cm. × 1·04 cm.) with 19 ml. of diethylaminoethyl cellulose was brought into equilibrium with 0·02 *M* tris(hydroxymethyl)aminomethane – hydrochloric acid buffer[4] ('Sigma 7–9, biochemical buffer', Sigma Chemical Co., St. Louis 18, Mo.) of pH 8·9 (the starting buffer). Of the freeze-dried venom from *Crotalus adamanteus* (Ross Allen's Reptile Institute, Silver Springs, Florida), 40 mgm. was dissolved in 2 ml. of starting buffer. After centrifugation, which removes some less-soluble globulin material, the solution was applied to the column. The chromatogram was then developed with a 0·33 *M* tris(hydroxymethyl)aminomethane – hydrochloric acid buffer of pH 8·9 using a water pressure of 28 cm. The first 2 ml. were discarded and fractions were then collected every 8 min. with volumes of around 0·8 ml. The temperature was 4°.

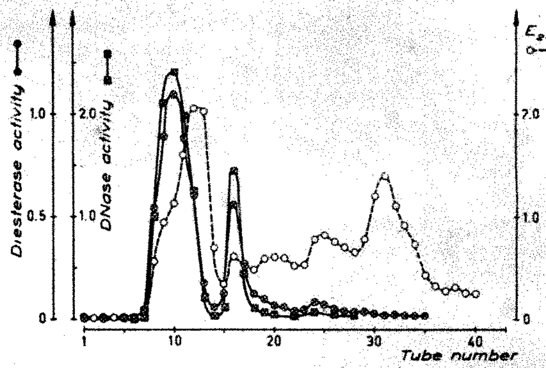

Fig. 1. Chromatography of rattle-snake venom on diethylaminoethyl cellulose. Open circles represent extinction at 280 mμ, crossed circles the activity toward calcium (bis(*p*-nitrophenyl)-phosphate)$_2$ expressed as millimoles of nitrophenol liberated per l. of incubation mixture and crossed squares the deoxyribonuclease activity expressed as liberated extinction at 260 mμ

The effluent was analysed for protein content, measured as extinction at 280 mμ in a Beckman *DU* spectrophotometer, and for phosphodiesterase and deoxyribonuclease activity. Calcium (bis(*p*-nitrophenyl)-phosphate)$_2$ (for preparation, see ref. 5) was used as substrate for the diesterase activity and the procedure was the same as that utilized for the determination of a monoesterase[6].

The deoxyribonuclease activity was estimated as the acid-soluble nucleotide material liberated from a 0·6 per cent solution of deoxyribonucleic acid, prepared according to Kay *et al.*[7], and dialysed against 0·05 *M* tris(hydroxymethyl)aminomethane–hydrochloric acid buffer of pH 8·9. Of this substrate solution, 100 μl. was incubated with 25 μl. from the different fractions for 60 min. at 37°. The reaction was stopped with 1 ml. of 0·01 *M* lanthanum nitrate in 0·1 *M* hydrochloric acid; the precipitated deoxyribonucleic acid was centrifuged down and the extinction at 260 mμ of the supernatant fluid read against a blank was taken as the deoxyribonuclease activity.

The result from this experiment is shown in Fig. 1. As can be seen, both phosphodiesterase and the deoxyribonuclease activities (crossed circles and crossed squares, respectively) show two almost coinciding peaks. The question whether or not these two peaks correspond to two different enzymes will be discussed elsewhere together with additional chromatographic experiments.

The possible identity of the phosphodiesterase and the deoxyribonuclease activities is indicated by the striking coincidence of the curves in Fig. 1, which is even better than the figure shows. This depends on the fact that, while the splitting of calcium (bis(*p*-nitrophenyl)phosphate)$_2$ follows a straight line with increasing amount of enzyme, the corresponding relation for the digestion of deoxyribonucleic acid has a lag part in the beginning.

The coincidence has been confirmed in another chromatographic experiment, in which the conditions were only slightly different from the experiment shown in Fig. 1, but using as substrate deoxyribonucleic acid prepared according to Hammarsten–Sevag[8,9]. Preliminary determinations have also shown the pH optimum for the deoxyribonuclease activity to be around 9, which is similar to the optimum of the diesterase activity.

Table 1. HEAT INACTIVATION OF DEOXYRIBONUCLEASE AND PHOSPHODIESTERASE ACTIVITY (ARBITRARY UNITS)

Time in min.	Temp. 55° C.			Temp. 57° C.		
	Diesterase	Deoxyribonuclease	Ratio of diesterase to deoxyribonuclease	Diesterase	Deoxyribonuclease	Ratio of diesterase to deoxyribonuclease
0	965 987	868 900	1·10	815 824	530 570	1·49
5	960 936	852 766	1·17			
15	872 875	767 780	1·13	750 720	480 520	1·47
30	821 787	744 756	1·07	695 686	440 440	1·57
45	866 821	706 698	1·20			
60	747 809	694 648	1·16	463 460	300 305	1·53
75	764 780	608 666	1·21			
90	750 737	616 622	1·20			

The classical view on the enzymatic degradation of deoxyribonucleic acid[10] has been that an enzyme called deoxyribonuclease acts on the macro molecule, splitting it mainly into oligonucleotides. Another enzyme, named phosphodiesterase, then acts on the oligonucleotides, hydrolysing them nearly completely to mononucleotides.

However, the specificity of different phosphodiesterases has been a subject of discussion. Privat De Garilhe and Laskowski[5] pointed out that their purified phosphodiesterase from rattle-snake venom acts on both calcium(bis(p-nitrophenyl)phosphate)$_2$ and oligonucleotides, but that no action could be observed toward "a highly polymerized DNA". Brawerman and Chargaff[11], when studying barley phosphodiesterase, doubt that the same enzyme is acting on different substrates of low molecular weight, while Schmidt[10] classified the phosphodiesterase from different venoms as "unspecific".

As mentioned earlier[2], the chromatographic procedure used here gives only a preliminary group separation and, therefore, a limited degree of purification. The enzyme studied by Privat De Garilhe and Laskowski[5], which should be identical with ours, is probably purer than our preparation. It might thus be possible that our enzyme preparation contains two different enzymes, one acting on deoxyribonucleic acid and one on calcium(bis(p-nitrophenyl)phosphate)$_2$.

In order to check this hypothesis the heat inactivation of the phosphodiesterase and deoxyribonuclease activities has been followed. Chromatographically purified samples, similar to the one in tube 10, Fig. 1, were kept at temperatures between 50° and 58°, and at different times samples were taken out and incubated with the two substrates. The experiment at 50° showed no measurable inactivation, while at 58° precipitation caused difficulties in obtaining reproducible figures for the activities. The results from two other series are given in Table 1.

The coincident inactivation demonstrated here, together with the striking parallelism between the two activity curves in Fig. 1, thus indicate that the same enzyme is responsible for the action on both calcium(bis(p-nitrophenyl)phosphate)$_2$ and macromolecular deoxyribonucleic acid.

This investigation is financially supported by grants from the Rockefeller Foundation and the Swedish Cancer Society.

We wish to express our thanks to Profs. E. Hammarsten and A. Tiselius for their stimulating interest.

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Sialoadenectomy and Thyroid Response to Thyrotrophic Hormone

PREVIOUS observations[1-3] have been reported which indicated the salivary glands to be capable of modifying thyroid activity such modification being made apparent by a reduced iodine-131 uptake, reduced turnover rate and a reduction in the thyroid-stimulating hormone titre as determined by the method of Barell and Holmgren[4]. Since sialoadenectomy imposed upon hypophysectomized rats did not result in different thyroid activities[2], it was postulated that the salivary glands, that is, substance(s) elaborated therefrom, could act upon the thyroid (1) in conjunction with the hypophysis (synergistic action) or (2) upon the hypophysis directly. In an attempt to learn something of the mode of action of the salivary-gland secretions on thyroid activity, the response of sialoadenectomized, hypophysectomized and intact animals to parenteral thyroid-stimulating hormone was studied. Animal feeding, care, size, strain, pre- and post-operative treatment were as previously described[1-3]. There were not less than eight and no more than twelve rats in any experimental or control group. The radioactivity assays were performed in the same manner as they were in previous studies.

Preliminary experimentation (Table 1) showed that the thyroids of intact rats would take up 16·3 per cent more phosphorus-32 when treated with thyroid-stimulating hormone (50 μgm. per 100 gm. body-weight), whereas the thyroids of sialoadenectomized rats take up 53·7 per cent more phosphorus-32 than do their non-treated controls in response to the same dose. A second experiment was performed, the results of which are indicated in Table 2. Thyrotrophic hormone increased the phosphorus-32 activity in the intact animal thyroids 14·2 per cent over base-line values; in the sialex animals a 132 per cent increase was observed with the 50 μgm. dose, whereas with a 100 μgm. dose,

Table 1. EFFECT OF PARENTERAL THYROTROPHIC HORMONE ON THE PHOSPHORUS-32 UPTAKE OF INTACT AND SIALOADENECTOMIZED RATS

	Counts/min. phosphorus-32 per mgm. thyroid
Intact	164·3 ± 41·7*
Intact + thyroid-stimulating hormone (50 μgm./100 gm. body-weight)	191·2 ± 28·9
Sialoadenectomized	122·7 ± 29·4
Sialoadenectomized + thyroid-stimulating hormone (50 μgm./100 gm. body-weight)	188·7 ± 41·8

* Standard error of the mean

Table 2. TITRE OF THYROID-STIMULATING HORMONE AND THE EFFECT OF PARENTERAL HORMONE MEASURED BY PHOSPHORUS-32 UPTAKE TWO HOURS AFTER INJECTION OF 50 μC. RADIOACTIVE PHOSPHATE

Group	Average counts per min./mgm.
Intact control	162·0 ± 12·9*
Intact control + thyroid-stimulating hormone (50 μgm./100 gm. body-weight 2 hr. before phosphorus-32)	184·9 ± 19·3
Sialoadenectomized	89·7 ± 4·0
Sialoadenectomized + thyroid-stimulating hormone (50 μgm./100 gm. body-weight 2 hr. before phosphorus-32)	232·0 ± 11·2
Sialoadenectomized + thyroid-stimulating hormone (100 μgm./100 gm. body-weight 2 hr. before phosphorus-32)	392·9 ± 42·3
Hypophysectomized	28·3 ± 3·0
Hypophysectomized + thyroid-stimulating hormone (50 μgm./100 gm. body-weight 2 hr. before phosphorus-32)	162·3 ± 10·9
Hypophysectomized + sialoadenectomized	24·8 ± 1·6

* Standard error of the mean

Table 3. COMPARISON OF THE AVERAGE WEIGHT OF RAT THYROIDS

Group	Average thyroid weight (mgm.)	P value compared with controls
Intact controls	14·0 ± 0·7*	—
Sialoadenectomized	12·1 ± 0·3	0·018
Hypophysectomized	11·7 ± 0·5	0·015
Hypox + sialex	11·9 ± 0·6	0·030

* Standard error of the mean

a 341 per cent increase was noted. Hypophysectomized animals responded to thyroid-stimulating hormone in the manner expected, showing a 472 per cent increase in phosphorus-32 activity in the thyroid. The titre of thyroid-stimulating hormone in hypophysectomized–sialoadenectomized rats was found to be essentially the same as that of hypophysectomized rats, an observation in agreement with previous findings[3]. The data presented thus far are indicative of some regulatory function of the secretions of the salivary glands on thyroid activity, probably involving the control of the action of thyroid-stimulating hormone on thyroid tissue or by an effect on the thyroid cells which prepares them for the action of the hormone. The greater response of sialoadenectomized animals to the hormone, we feel, indicates that there is such a controlling mechanism. However, the role of the hypophysis appears to be dominant in the processes involved since its removal greatly reduces the observable effects of sialoadenectomy. It is quite obvious that the secretions of both glands must complement each other in sequential or parallel actions.

Analysis of the average weights of the thyroids from animals of comparable size discloses an interesting and collaborative observation. As indicated in Table 3, a significant difference appears to exist between the sizes of the thyroids of intact, sialoadenectomized, hypophysectomized and hypophysectomized–sialoadenectomized rats. Whether these changes are due to a relationship between the hormones or to metabolic disturbances induced by alterations in hormone patterns is not yet known[5].

This study was sponsored by a grant (C-1881) from the National Institutes of Health, Bethesda.

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Antifibromatogenic Potency of 9α-fluoro Derivatives of Progesterone

THE use of halogenated pregnene derivatives, especially of 9α-fluoro-hydrocortisone, has been undoubtedly the greatest recent advance in the experimental pharmacology of steroids, as evidenced by the outstanding work of Fried and his colleagues[1] on the various potencies of this corticoid. In the present communication we discuss results obtained in guinea pigs, in which we tried to prevent the abdominal fibromatogenic action of œstrogen; other antiœstrogenic potencies also have been studied.

Antifibromatogenic activity and likewise other antiœstrogenic potencies of progesterone are known to diminish when oxidation is performed[2] at C_{21}, C_{11} and C_{17}. Diminution of these potencies is striking with oxidation at C_{11} (11β-hydroxyprogesterone) and, even more pronouncedly, with oxidation at C_{17} (17α-hydroxyprogesterone)[3]. How will the 9α-fluoro-derivatives of these compounds behave?

Pellets containing 20–80 per cent of 9α-fluoro-11β-hydroxyprogesterone mixed with cholesterol were implanted beneath the skin of castrated female guinea pigs. Pellets of œstradiol also were implanted. Complete inhibition of large abdominal fibroids was

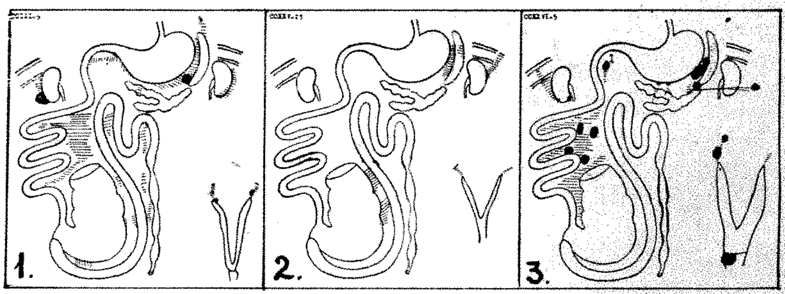

Fig. 1. Maximal fibrous tumoral reaction with œstrogen and 69 μgm. of 11β-hydroxyprogesterone. Large tumours (solid black) behind the kidney and on the spleen, apical tumours of the uterus; fibrous strands (shaded areas) in the mesentery, hilus of the spleen and behind the kidneys. Fibrous tumoral effect, 7 (average, 2·7), ref. 2. Uterine weight 2·3 gm.

Fig. 2. Maximal fibrous tumoral reaction with œstrogen and 3 μgm. of 9α-fluoro-11β-hydroxyprogesterone. Fibrous strands in the mesentery and the hilus of the spleen. Tiny nodule of the latter. Fibrous tumoral effect, 2 (average: 1·3; Table 1). Uterine weight, 1·6 gm.

Fig. 3. Maximal fibrous tumoral reaction with œstrogen and 59 μgm. of 9α-fluoro-11β,17α-dihydroxyprogesterone. Large tumours and fibrous strands. Fibrous tumoral effect, 12 (average: 5·7; Table 1). Uterine weight, 5·1 gm.

Table 1. EXPERIMENTS ON 27 CASTRATED FEMALE GUINEA PIGS RECEIVING DURING THREE MONTHS ŒSTRADIOL AND 9α-FLUORO-11β-HYDROXYPROGESTERONE. EXPERIMENTS ON 7 ANIMALS RECEIVING 11β,17α-DIHYDROXYPROGESTERONE

Group	No. of animals	Œstradiol (μgm./day)	9α-Fluoro-progesterone derivatives (μgm./day)*	Fibrous tumoral effect (ref. 2)	Coeff. Q_{2-3} (ref. 2)	Uterine weight (gm.)	No. of pellets and concentration of 9α-fluoro-hydroxyprogesterone
			11β-hydroxy				
I	2	54–64	0·7	4·0 (3·5–4·5)	1·0	2·0 (2·0–2·0)	1; 20 per cent
II	6	47–73	2·2†	1·3 (0·5–2·0)	0	2·2 (1·6–3·5)	1; 20 ,,
III	7	34–52	8	1·1 (0·5–1·5)	0	1·6 (1·1–2·8)	1; 40 ,,
IV	5	38–54	16	1·0 (0·5–1·0)	0	1·7 (0·8–2·3)	2; 40 ,,
V	7	37–66	65	1·1 (0·5–2·0)	0	1·6 (0·9–2·3)	1; 80 ,,
			11β,17α-dihydroxy				
VI	7	36–61	56	5·7 (1·0–12)	1·9	5·1 (3·0–8·0)	1; 100 ,,

* Absorption per day was calculated from loss of weight of the pellet during the experiment, on the assumption of non-selective absorption, as with the mixture of non-halogenated steroids (ref. 7). Fluorine was determined by the micromethod of Kolthoff and Slamsby (ref. 8). The method was not sufficient to establish any difference or lack of difference between the percentage of fluorine in non-used and used tablets. But the comparative figures of absorption per day in column 4 are not in favour of selective absorption. On the assumption of selective absorption, these figures should be multiplied by 5, with 20 per cent pellets (11 μgm./day); by 2·5, with 40 per cent pellets (20 μgm./day); by 1·25 with 80 per cent pellets (80 μgm./day); a drop from 80 μgm./day with 80 per cent pellets to 20, and 11 μgm./day with 40 per cent and 20 per cent pellets, is not possible with selective absorption (ref. 7).

† Range: 1·8–2·6 μgm./day.

obtained with as little as 2·2 (1·8–2·6) μgm./day of the halogenated compound (Table 1; Fig. 2). An average of 15 μgm. of progesterone was necessary to produce a similar effect[3,4]. Thus, the antifibromatogenic potency of 9α-fluoro-11β-hydroxyprogesterone is about six to seven times that of progesterone. But the increase of activity through halogenation appears to be even more striking when comparing 9α-fluoro-11β-hydroxyprogesterone with 11β-hydroxyprogesterone. With as much as 78 and even 490 μgm./day of the latter, prevention is still less pronounced than with 2·2 μgm. of the 9α-fluoro-compound (Table 2; comp. also Figs. 1 and 2). Halogenation with fluorine increases antifibromatogenic activity about two hundred times. (Should the assumption of non-selective absorption (see Table 1) be erroneous, increase of potency through halogenation with fluorine would be only about fifty times.)

As to the antihysterotrophic potency, the difference between the two compounds is not so striking, but also fully evident: with an average of 8 μgm./day of 9α-fluoro-11β-hydroxyprogesterone, the same antihysterotrophic effect is obtained as with 78 μgm./day of the non-halogenated compound[2]. It was the same with the antiluteinizing action (unpublished work). An increase of the antihysterotrophic activity of 11β-hydroxyprogesterone through halogenation had already been demonstrated in the extensive work of Huggins and Jensen[5] with the uterus of hypophysectomized rats. A considerably greater effect was obtained by these authorities with the injection of 250 μgm./day of the fluoro-compound than with the injection of 1,000 μgm./day of the non-halogenated compound.

Experiments were performed also with 9α-fluoro-11β,17α-dihydroxyprogesterone. As seen from Table 1, the antifibromatogenic and antihysterotrophic potencies of this compound are greatly inferior to those of 9α-fluoro-11β-hydroxyprogesterone. No prevention of the fibromatogenic or hysterotrophic action of œstrogen was obtained with as much as 56 μgm./day, that is, with an amount twenty to thirty times greater than the already highly active dose of 9α-fluoro-11β-hydroxyprogesterone (1·8–2·6 μgm./day). This finding gives new evidence of the deleterious influence of oxidation at C_{17} in the α-position on the antiœstrogenic potencies of progesterone derivatives (comp. Figs. 2 and 3), an influence which was already so evident with 17α-hydroxyprogesterone[3]. Indeed, an antihysterotrophic activity has been obtained in the rat with large quantities of 9α-fluoro-hydrocortisone[5,6], that is, notwithstanding the presence of OH in C_{17}-α.

Table 2. COMPARATIVE ANTIFIBROMATOGENIC POTENCY OF THREE STEROIDS IN GUINEA PIGS

	Antifibromatogenic steroid	μgm. per day	Fibrous tumoral effect	Coeff. Q_{2-3}	Antifibromatogenic potency
A	Progesterone (ref. 4)	9 15	3·6 1·5	1 0	1·00
B	9α-fluoro-11β-hydroxyprogesterone	2·2	1·3	0	6·00–7·00
C	11β-hydroxyprogesterone (ref. 2)	78 490	2·7 2·2	0·7 0·2	<0·03

The enormous increase of the antifibromatogenic activity due to halogenation with fluorine justifies the question whether use of this procedure could be used in trials with the antifibromatogenic and antitumorigenic action of steroids in those cases in which hitherto progesterone has been used. Similar clinical trials would be apparently handicapped by the fact that 9α-fluoro-11β-hydroxyprogesterone has also cortical activities[1].

Thanks are due to Dr. Josef Fried, of the Squibb Institute for Medical Research, New Brunswick, N.J., for a generous supply of halogenated pregnene derivatives.

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Demonstration of Acetylcholinesterase on Motor End-plates after embedding in Polyethylene Glycol

Polyethylene glycol seems to be particularly suitable as an embedding medium for demonstrating several enzymes. Certain polyethylene glycols and their monostearates (polyethylene glycol 1,000 and 'Nonex 63', both obtainable from Gemec Chemicals Co., 120 Moorgate, London, E.C.2 ; 'Polywachs 1,000' and 'Produkt V 2,275'. both manufactured by C. W. H. Marl, Kreis Recklinghausen, Germany) are available as wax-like compounds, which in consistency strongly resemble paraffin, but have a lower melting point and are soluble in water, are very suitable for demonstrating non- or slightly diffusible enzymes. The polyethylene glycol embedding has the great advantage over paraffin embedding that the procedure takes only a short period of time (4–5 hr.) and the enzyme is exposed for 2–3 hr. at 42° C. In addition, substances such as ethanol which may inactivate the enzymes can be avoided.

The histochemical localization of acetylcholinesterase was studied on the motor end-plates of the guinea pig's intercostal muscle. Polyethylene glycol embedding was performed by the method of Miles and Linder[1], and the Koelle acetylthiocholine iodide method modified by Gerebtzoff[2] was used to demonstrate acetylcholinesterase. The intensity of the reaction seems to be quite satisfactory, structural details are well distinguished, and diffusion artefacts are negligible even after incubation for 40 min., as can be seen in Fig. 1*a* and *b*.

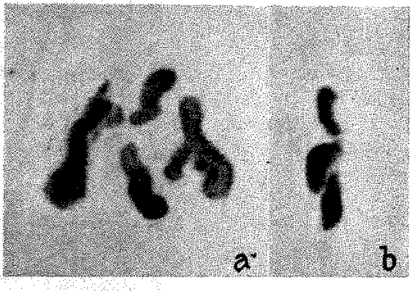

Fig. 1. Motor end-plate of the guinea pig's intercostal muscle: (*a*) in the plane of the section; (*b*) lateral view

An advantage of our method over frozen sections is that it allows sections to be cut as thin as $4-5\mu$ and to be handled on slides during the histochemical procedure; the reaction can be carried out even several days after embedding. Further, it permits the preparation of serial sections, some of which may then serve for other histochemical reactions or stainings. An inconvenience in using polyethylene-glycol as an embedding medium is the hygroscopic nature of the wax, which in the relative high vapour content and temperature of the surrounding air makes sectioning difficult. With time, the acetylcholinesterase activity gradually diminishes in the block. Several days after embedding it is still significant, and to obtain good results the incubation time should be increased by one-third to one-half. One month after embedding, the enzyme is difficult to demonstrate.

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Changes in the Amount of Nucleic Acids and Free Nucleotides during Early Embryonic Development of Sea Urchins

During the early embryonic period, the embryo of the sea urchin[1,2], and also those of the frog[3] and the chicken[4], live upon deoxypentose nucleic acid, stored within the cytoplasm of the embryo; this reserve is used for the nuclei as they increase in number. Only after a certain period of development does the embryo start synthesizing deoxypentose nucleic acid itself. The time of appearance of this new synthesis is naturally different in animals belonging to different orders; but even within the same group of animals, closely related species start this synthesis at varied developmental stages. We have found this to be true for some species of sea urchins, *Paracentrotus lividus* from Roscoff, France, *Psammechinus miliaris* from Roscoff and from Kristineberg, Sweden, and *Echinus esculentus* from Kristineberg. The embryos of *Paracentrotus* and *Psammechinus* were reared at + 18° C. and those of *Echinus* at + 12° C. When cultivated at 12° C., *Paracentrotus* and *Psammechinus* showed almost the same rate of development as *Echinus*.

For the estimation of the nucleic acids as well as for the free nucleotides a method was used[5] by which the homogenate is extracted with 10 per cent sodium chloride at + 85° C. Ribonucleic acid and deoxypentose nucleic acid were precipitated by ethanol. The nucleotides in the supernatant were precipitated by lanthanum acetate. Ribonucleic acid was separated from the deoxypentose nucleic acid by alkaline hydrolysis for 5 hr. The fractions were estimated spectrophotometrically in ultra-violet light. We have also compared this method to that of Ogur and Rosen[6] and found good agreement.

Fig. 1 represents typical series of measurements. On the average, five further series of determinations were carried out for each species, which all gave curves of identical shape. From the figure it is obvious that the three species investigated start the synthesis of deoxypentose nucleic acid at different stages: *Paracentrotus* at the 32-cell stage, *Psammechinus* at about a 100-cell stage and *Echinus* at about a 500-cell stage. The absolute amount of deoxypentose nucleic acid stored in the unfertilized egg may vary greatly within the same species. Thus we have found, for both *Paracentrotus* and *Psammechinus*, samples of eggs which contained only about one-tenth of the amount of stored deoxypentose nucleic acid indicated in Fig. 1, and in spite of this fact synthesis of the acid started always at the same stage and development led to normal plutei.

It seems as if during the earlier part of the breeding time the eggs contain more deoxypentose nucleic acid than in the later stages. Thus it is not the actual amount of stored deoxypentose nucleic acid in the single embryo which determines the moment at which the synthesis begins. However, on the average, the embryos of *Paracentrotus* contain the smallest amounts of stored deoxypentose nucleic acid and those of *Echinus* the highest. For *Paracentrotus* it has been shown earlier[7] that the synchronous cellular division which initiates embryonic development stops at exactly the same stage as the synthesis of new deoxypentose nucleic acid starts. This has now been demonstrated to be valid also for the two other species mentioned.

Testosterone propionate has been found to inhibit the formation of nuclear deoxypentose nucleic acid

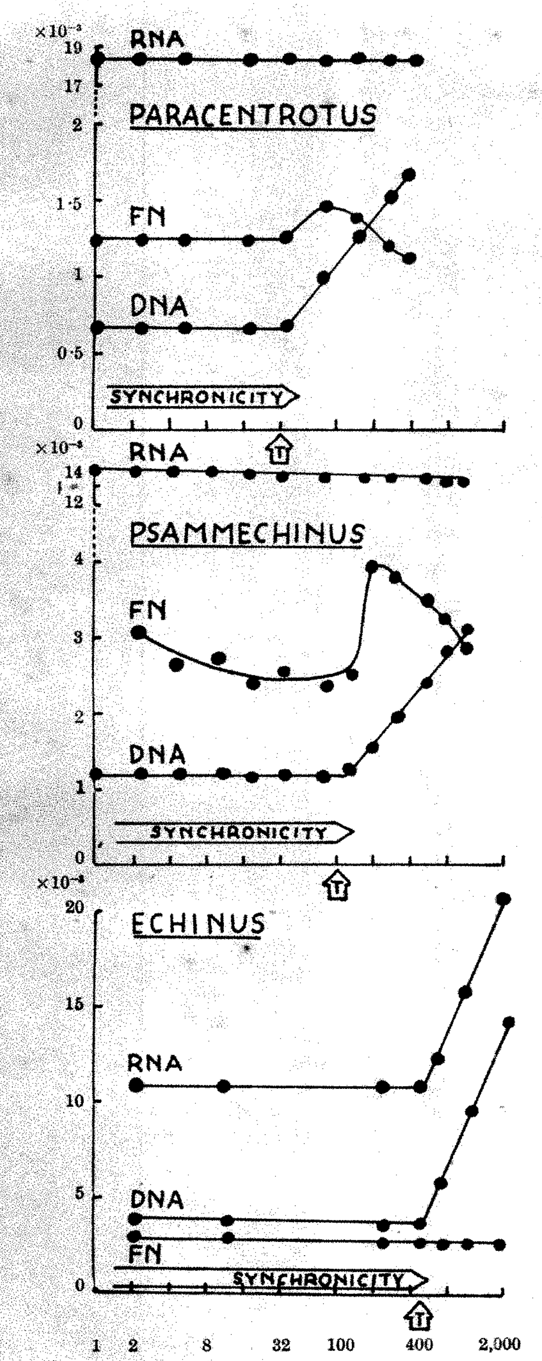

Fig. 1. Change in amount of deoxypentose ribonucleic acid (*DNA*), ribonucleic acid (*RNA*) and free nucleotides (*FN*) during the early embryonic development of three species of sea urchins. The period for the synchronous cellular division is indicated. The arrows marked *T* represent the moment when testosterone propionate added at the 2-cell stage inhibits cellular division and deoxypentose nucleic acid synthesis. Vertical axis: Amount of acid (γ) per embryo. Horizontal axis: embryonic stage expressed as the number of cells of the embryo

when its synthesis in *Psammechinus* begins[2] and correspondingly to block the cellular cleavage exactly when synthesis of the acid should start. Testosterone propionate has just the same action in the two other species. By the action of testosterone very broad chromosome bridges form at anaphase at the 16–32-cell stage in *Paracentrotus*. In *Psammechinus* these anaphase bridges form at the 128-cell stage and are long and slender. In *Echinus* the cells are just able to carry through the division at the 500-cell stage but die afterwards. Furthermore, it has been found that there is also a relation between the time when synthesis of deoxypentose nucleic acid starts and the time of hatching. The embryos of *Paracentrotus*, which start their synthesis of deoxypentose nucleic acid first, hatch as early as at about an 800-cell stage, *Psammechinus* at about a 1,000-cell stage and *Echinus* only after having divided to about 1,500 cells.

As regards the content of ribonucleic acid within the embryos, it is observed from the curves that during the embryonic development the ribonucleic acid remains constant for a long period. Only in *Echinus* is there a sudden new synthesis of ribonucleic acid, which occurs for some reason at the same time as the synthesis of deoxypentose nucleic acid. For the other two species the ribonucleic acid content has been followed beyond hatching without any sign of synthesis of new ribonucleic acid. It may be observed that for these two species the ratio of deoxypentose to ribonucleic acid is much higher than in *Echinus*. However, the course of the ribo- and deoxypentose nucleic acid curves for each species gives no support to any assumption of an inter-conversion of the two nucleic acids.

The amount of the free nucleotides is constant during the whole period investigated for *Echinus*, but shows a temporary increase around the time for deoxypentose nucleic acid synthesis in the other species. By paper chromatograms it has been found that new nucleotides form at this time, and we presume the visible change in the amount of the free nucleotides to reflect the turn-over rate of synthesis of deoxypentose nucleic acid. Thus, this synthesis may start with a synthesis of nucleotides, and not represent simply a process of polymerization.

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Specificity of Gold Thioglucose for Ventromedial Hypothalamic Lesions and Hyperphagia

IN a recent publication[1] it was shown that gold thioglucose produces lesions in the ventromedial hypothalamic area of injected mice. It had previously been shown[2] that gold thiomalate, although similar to gold thioglucose with respect to toxicity, gold content and molecular weight, does not cause obesity; its injection does not lead to hypothalamic lesions[1]. To study further the specificity of gold thioglucose in causing ventromedial hypothalamic lesions and hyperphagia the action of other gold thio compounds was examined, in particular a compound where the gold thio moiety is linked to a radical very similar to glucose, namely, gold thiosorbitol (supplied through the kindness of Abbott and Co.), and compounds where the gold thio moiety is linked to metabolites other than glucose: besides gold thiomalate, gold thiocaproic acid and gold thioglycerol were available (also supplied by Abbott and Co.). The effects of gold thioglycoanilide and gold sodium thiosulphate were also examined. The main dose of each compound used in these experiments was calculated to provide as much gold as is contained in the dose of gold thioglucose found most effective to yield obese mice. (In a series of 800 Swiss mice treated with gold thioglucose 1 mgm./gm. body-weight was found to induce obesity in 60 per cent of surviving mice and varying degrees of ventromedial hypothalamic damage in all animals examined.) For each compound in addition to the main dose a number of multiples and fractions of this standard dose were used.

Nearly a thousand mice were used. None of the gold thio compounds other than gold thioglucose proved effective in inducing obesity, although the general toxicity of several of the doses used was of the same order as that of the effective dose of gold thioglucose. Finally, to test the generality of the action of gold thioglucose, the effect of its administration on the central nervous system of rats was examined. In the rat, gold thioglucose administration does not lead to obesity. However, rats appear to be more susceptible to the toxicity of gold compounds in general; the lethal effect of a dose of gold thioglucose effective in causing hypothalamic lesions might mask this latter effect. Accordingly, rats were injected with 1 mgm./gm. of gold thioglucose; control animals were injected with an equal dose of gold thiomalate. The animals were killed after 24–72 hr. Hypothalami of animals injected with gold thioglucose showed lesions consisting of diffuse hæmorrhagic areas and pyknosis and degeneration of nerve cells throughout areas of œdema and hæmorrhage. In all cases the ventromedial area was the area involved, with the ventromedial nuclei, arcuate nuclei and in some cases the supraoptic nuclei partly or wholly obliterated. The picture obtained was very similar to that previously described in detail for mice[1]. Gold thiomalate administration did not induce any visible hypothalamic damage.

The results presented herewith are consistent with the view[1] that the presence of the glucose component in the molecule makes the ventromedial hypothalamic barrier much more permeable to this compound than to compounds not containing glucose. This area has been shown through behavioural methods[3] to be a 'satiety' area inhibiting periodically a constantly activated feeding mechanism. The present findings support the idea that the ventromedial area exerts its influence on food intake behaviour because of its property as a 'glucoreceptive' centre in the sense postulated in the glucostatic theory of the regulation of food intake[4].

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Metabolism of Lysergic Acid Diethylamide

IN a communication on lysergic acid diethylamide, Axelrod, Brady, Witkop and Evarts[1] state: "Although the hallucinogenic agent, lysergic acid diethylamide, has been the subject of numerous investigations, little is known about its biological fate". However, a number of facts, not mentioned in this communication, about the destruction, distribution and excretion of this compound have recently been published which show that we are not quite as ignorant about the biological fate of this compound as one might infer from this statement.

Lysergic acid diethylamide is neither bound nor destroyed in blood, because, when incubated with blood (rat) at 38° C. for 6 hr. and then assayed for its activity a 100 per cent recovery is obtained. The result is different when this diethylamide is added to homogenates of rat organs. In these, the activity of lysergic acid diethylamide decreases within a few minutes, but there is no, or only a little, further decrease in activity during the following hours and the same results are obtained whether incubation is at 38° C. or at 3° C. The activity of this diethylamide in the incubates has been assayed on the rat uterus by its inhibiting effect on the 5-hydroxytryptamine contraction. With liver and muscle homogenate the activity of the diethylamide became reduced within a few minutes to nearly 50 per cent; but scarcely any further reduction occurred during the next 17 hr. The lysergic acid diethylamide activity of brain homogenates was reduced to 42 per cent after 10 min., and to 21 per cent after 17 hr. These experiments do not differentiate between loss of activity due to binding of this diethylamide to some tissue constituent, and transformation into an inactive compound. The finding of identical results at 3° C. and 38° C., however, speaks against a metabolic transformation of lysergic acid diethylamide in the homogenates[2].

The distribution of lysergic acid diethylamide in blood and tissue at various times after its intravenous injection into mice or rats has been studied by either estimating the diethylamide biologically[2], or by injecting the diethylamide labelled with carbon-14 and determining it chemico-physically[3,4]. There was good general agreement between the results obtained with the two methods. The half-time value reached in blood was 7 min. in the experiments with the labelled diethylamide and 37 min. in those in which diethylamide was assayed biologically. Most of the organs reached the highest level of lysergic acid diethylamide after 10–15 min. and then lost it gradually in the course of the next few hours. The highest concentration was found in the liver after 30 min., when it was about six times greater than in the blood. The order of decreasing concentration of lysergic acid diethylamide in other organs was: kidney, adrenals, lung, spleen, pancreas, large intestine, heart, skeletal muscle, skin, brain. The concentration in the brain was at all times lower than in the blood.

In the experiments of Boyd *et al*[3] with labelled diethylamide, 7–8 per cent of the total activity was excreted within 12 hr., about half of this in the expired air, the rest in the urine and fæces, but 70 per cent was found in the intestinal contents. Stoll *et al.*[4] found 50 per cent of the injected dose in the intestinal contents within two hours after the injection.

There is no doubt that lysergic acid diethylamide or its metabolites are excreted in the bile. In experiments in which labelled diethylamide was injected into rats with bile fistulæ, Stoll *et al.* found that the bile contained within 2 hr. 70 per cent of the total radioactivity. The greater part of lysergic acid diethylamide undergoes chemical alteration because the excreted compounds or metabolites, in contrast to the diethylamide, were water-soluble. Paper chromatography revealed that the bile contained three radioactive compounds with the respective R_F values of 0, 0·13, 0·18. These compounds have not yet been identified chemically or biologically. The last two compounds give the Van Urk colour reaction and the blue fluorescence, characteristic for derivatives of lysergic acid, but neither of them is the 2-oxy-lysergic acid diethylamide, a compound obtained by Axelrod *et al.*, with *in vitro* "enzyme systems present in mammalian liver microsomes when supplemented with oxygen and a reduced triphosphopyridine nucleotide generating system". The problem of whether the third metabolite found in bile, which no longer gives the Van Urk colour reaction, is identical with 2-oxy-lysergic acid diethylamide has still to be examined.

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Inhibition of Phosphoglucose Isomerase

The key carbohydrate intermediate, glucose 6-phosphate, which may follow several alternative metabolic pathways including the 6-phosphogluconate oxidative cycle and the glycolytic sequence, enters the latter route by the phosphoglucose isomerase reaction. This reaction, in which glucose 6-phosphate is reversibly converted into fructose 6-phosphate, could conceivably play a part in the regulation of carbohydrate metabolism, although it has seldom been considered from this point of view, doubtless because of the extremely high activity of the enzyme in most tissues and because the reaction has so far appeared to be very little affected by extraneous influences. The present evidence suggesting that the enzyme is strongly inhibited by 6-phosphogluconic acid, an intermediate in the direct oxidative pathway, may therefore be of interest in connexion with studies on the mechanism responsible for the partitioning of carbohydrate between the direct oxidative pathway and the glycolytic route.

The enzyme reactions were carried out by a technique similar to that described by Bodansky[1]. Crude phosphoglucose isomerase extracts from mammalian blood, liver and muscle were employed. Various preparations of 6-phosphogluconic acid made by the bromine oxidation of glucose 6-phosphate[2] were used. With glucose 6-phosphate at a concentration of 0·002 *M* as the substrate, inhibitions of the order of 95 per cent were observed in the presence of equimolecular concentrations of 6-phosphogluconic acid, and inhibitions of about 75 per cent were obtained using 0·001 *M* 6-phosphogluconate. A similar inhibitory effect was demonstrated using fructose 6-phosphate as substrate.

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Separation of Neovitamin A_1 from All-Trans Vitamin A_1 by Chromatography on Alumina

In fish liver oils and synthetic preparations of vitamin A_1 it is possible to estimate the contents of the two isomers, neovitamin A_1 and all-trans vitamin A_1, by spectrophotometry following separation by chromatography on activated secondary calcium phosphate (dicalcium phosphate), length of column 300–600 mm. [1].

Even when the dicalcium phosphate has been subjected to the activation process previously described[1], the separation of the two vitamin A_1 isomers obtained is not equally satisfactory on all commercially available dicalcium phosphate preparations.

Earlier investigations have shown that a poor separation of the two vitamin A isomers is obtained by chromatography on columns consisting of the comparatively coarse-grained alumina which is usually marketed as suitable for chromatographic purposes. It has now been observed that good separation is obtained by chromatography on alumina prepared from fine-grained aluminium hydroxide.

The fractionation curve shown in Fig. 1 represents the results obtained by chromatographing 1·5 mgm. of a mixture of the alcohols of synthetic neovitamin A_1 and all-trans vitamin A_1. Chromatography was performed on a 75 cm. × 0·9 cm. column of aluminium oxide prepared as follows. Mixtures of diethyl ether and light petroleum with increasing contents of diethyl ether (2–25 per cent v/v) were used for the elution. Eluate was collected in 4-ml. fractions. On the basis of measurements of E_{325} for the individual fractions the ratio of the two vitamin A_1 isomers could be calculated. The result was: neovitamin : all-trans vitamin = 30 : 70.

The alumina used for the chromatography was prepared from aluminium hydroxide, analytical

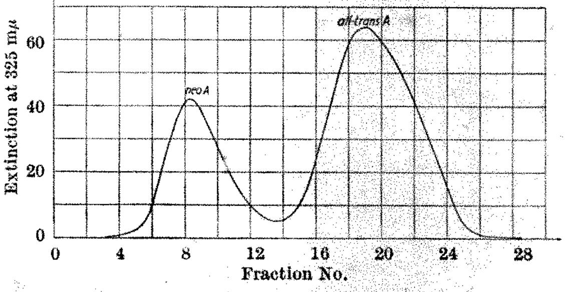

Fig. 1. Fractionation curve for synthetic neo- + all-trans-vitamin A_1 chromatographed on a 75 cm. × 0·9 cm. column of fine-grained alumina

grade ('Baker's analysed'), with a grain-size distribution characterized in that 100 per cent passes sieve *DIN* 80, while 97 per cent passes sieve *DIN* 100 and 70 per cent passes sieve *DIN* 150 *E*. A suspension of 10 gm. aluminium hydroxide in 40 ml. water has a *p*H of 9·6.

Aluminium hydroxide of this type is heated to 800° C. for seven hours[2] and cooled in an exhausted desiccator (a suspension of 10 gm. of this alumina in 40 ml. water has a *p*H of 10·2). Now 6·5 gm. distilled water is added to 100 gm. of alumina which has been transferred to a bottle with a close-fitting stopper. The bottle is shaken vigorously, and, when it has been allowed to stand for a couple of hours, the adsorbent is ready for use.

The rate of percolation through a 75 cm. × 0·9 cm. column of the prepared alumina was about 1·3 ml. per minute when applying a pressure of 0·4–0·5 atmosphere.

The losses involved in fractional chromatography were ascertained by comparison with the result of simple chromatography of 0·3 mgm. of the vitamin A_1 mixture used on a 10 cm. × 1·2 cm. column of dicalcium phosphate and simultaneous collection of the two vitamin A_2 isomers. The loss in this simple chromatography is 0·5–2 per cent[3]. The loss occurring in the fractional chromatography was about 10 per cent. In a similar fractional chromatography of 3 mgm. of vitamin A_1 on a 68 cm. × 0·9 cm. column of alumina the loss of vitamin A_1 was about 8 per cent.

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Preparation and Properties of Dinitrophenyl-NH(ε)-Insulin

THE reaction of 2,4-dinitrobenzene sulphonate[1] with insulin has yielded a water-soluble and biologically active product. The only reactive group, which is shown to be substituted, is the ε-NH_2 of lysine in the hormone molecule.

30 mgm. of crystalline insulin (Eli Lilly) and 75 mgm. dinitrobenzene sulphonate were dissolved in 5 ml. 0·1 *M* sodium carbonate and was allowed to stand at 3° C. for 216 hr. The solution was then diluted to 25 ml. with distilled water, dialysed thoroughly in a cold room and lyophilized. The yellowish product weighed 30·5 mgm. The derivative (5 mgm.) was hydrolysed for 24 hr. at 110° C. with 0·5 ml. of constant-boiling point hydrochloric acid in a sealed evacuated tube. The whole hydrolysate was submitted to two-dimensional paper chromatography[2] to estimate quantitatively the amount of dinitrophenyl amino-acids. Only ε-dinitrophenyl-lysine in an amount of one mole per mole (6,000) of insulin was found to be present. The fact that the N-terminal glycine and phenylalanine in the hormone molecule are not substituted was further confirmed by the reaction of fluorodinitrobenzene[3] with the derivative. (Reactions of dinitrobenzene sulphonate with prolactin and ribonuclease also showed that terminal amino-groups are not dinitrophenylated.) Moreover, spectrophotometric analysis[4] of the derivative indicated that the tyrosine residue did not react with dinitrobenzene sulphonate under the experimental conditions. Since insulin contains only one lysine residue[5], the acid hydrolysate of the derivative gave no evidence for the presence of free lysine as analysed by two-dimensional paper chromatography in the solvent system previously described[6]. Thus, the derivative is dinitrophenyl-NH(ε)-insulin.

Preliminary studies showed that the solubility behaviour of dinitrophenyl-NH(ε)-insulin is similar to that of the native hormone. Unlike the dinitrophenylated insulin obtained by the fluorodinitrobenzene procedure[3], dinitrophenyl-NH(ε)-insulin is highly soluble in neutral solutions. In *p*H 7·2 trihydroxymethylaminomethane buffer of 0·10 ionic strength at 1° C., the derivative migrated as a single peak in a Spinco electrophoresis-diffusion apparatus with an electrophoretic mobility of $-7{\cdot}5 \times 10^{-5}$ cm.^{2} per volt per sec. which, as is to be expected, is lower than the value ($-6{\cdot}4 \times 10^{-5}$) obtained with native insulin. Additional physicochemical and biological characterizations of dinitrophenyl-NH(ε)-insulin will be presented at a later date.

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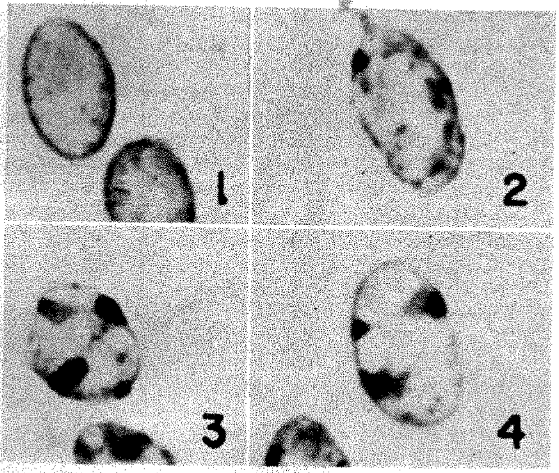
Possibility of Prenatal Diagnosis of Sex in Cattle and Sheep

WE have previously shown[1] that a correct prenatal diagnosis of sex can be made in humans by an analysis of cells from the amniotic fluid. This method of diagnosis, which has also recently been used in other laboratories[2], is based on a determination of the percentage of amniotic fluid cells with a chromocentre, especially a chromocentre at the nuclear membrane, a criterion that has also invariably given correct results when applied to human cells from other sources[3]. Since this method is so accurate in humans, we have examined the possibility of its application to cattle and sheep.

Our study in cattle has been based on epithelial tissues taken from young and old males and females after birth; from a 6-week, an 8-week and a 16-week-old male fœtus; and from a 12-week-old female fœtus. It was found that the cells in these tissues, most of which have several chromocentres, do not have the clear sex differences found in humans (Figs. 1–4). In a previous study on cattle a sex difference has been reported for nerve cells[4]; but such cells would not be found in the amniotic fluid.

An examination of epithelial cells from young and old male and female sheep after birth has shown that most cells have several chromocentres, and that also in this species there is not the clear sex difference found in humans.

Since no clear sex difference has been found in the nuclei of epithelial cells in cattle and sheep, a



Photomicrographs of cells from sections of skin. Feulgen and fast green staining. 1, human male, nucleus without a chromocentre; 2, human female, nucleus with a chromocentre at the nuclear membrane; 3, bull, nucleus with several chromocentres; 4, cow, nucleus with several chromocentres

prenatal diagnosis of sex based on the determination of the percentage of amniotic fluid cells with a chromocentre at the nuclear membrane cannot be made in these domestic animals.

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γ-Amino-butyric Acid and Other Free Amino-acids in the Coconut

γ-AMINO-BUTYRIC acid has been described as present in the aqueous and alcoholic extracts of a number of plant and animal tissues[1-7]. In the course of studies on the nitrogenous constituents of coconut (*Cocos nucifera*) endosperm using paper chromatography, I have found this amino-acid to be present in amounts apparently larger than any other amino-acid except alanine in the watery liquid inside the mature fruit. Further investigations at three consecutive stages of development, namely, 4–5 months, 5–6 months and 6–7 months after setting of the fruit revealed that γ-amino-butyric acid is not present in the liquid endosperm at 4–5 months after setting of the fruit, but makes its appearance in the liquid when the solid endosperm has been deposited as a thin gelatinous layer on the nucellus in the fifth to sixth month after setting.

At this stage, γ-amino-butyric acid is barely detectable in two-dimensional chromatograms of concentrates of the fluid endosperm but is detectable in chromatograms of aqueous extracts of the solid endosperm. In the sixth to seventh month after setting when the solid endosperm has attained a thickness of about $\frac{1}{10}$ in., γ-amino-butyric acid can be clearly seen in both one- and two-dimensional chromatograms of concentrates of the liquid endosperm as well as in extracts of the solid endosperm. γ-Amino-butyric acid is not present among the products of hydrolysis of coconut globulin.

The γ-amino-butyric acid was identified in one-dimensional chromatograms by running an authentic sample of this amino-acid side by side with the solution being chromatographed; and in two-dimensional chromatograms both with and without addition of an authentic sample of γ-amino-butyric acid to the solution being chromatographed, as well as by the copper carbonate method of Crumpler and Dent[8].

The solutions used for chromatography were prepared by evaporating equal volumes of the endosperm liquid of fruits of different ages to small volume under reduced pressure and making up to equal volumes, the final concentration being 14–15 times. 2-ml. aliquots of these concentrates were passed through a 'Dowex 50' (15 cm. × 1 cm.) column, and after washing out the sugars with distilled water, the amino-acids were eluted with ammonia. The eluates were evaporated to dryness and the residues taken up in equal volumes of water. (Further elution of the columns with soda yielded only traces of ninhydrin-reacting substance.)

3–6-μl. aliquots of these solutions were used for one-dimensional chromatography and 6–12-μl. aliquots for two-dimensional chromatography. Phenol–water in the presence of 0·1 per cent ammonia and butanol/acetic acid/water (4 : 1 : 5) were used as solvents in the one-dimensional chromatograms which were run alongside a range of amino-acids, singly and in mixtures, on No. 1 Whatman filter paper; buffered (*p*H 9·3) *m*-cresol–phenol (1 : 1)[9] followed by butanol/acetic acid/water (4 : 1 : 5) using No. 3 *MM* paper gave the best results in two-dimensional chromatograms. After drying the papers in a current of air, they were sprayed with a 0·1 per cent solution of ninhydrin in butanol and heated for five minutes in an oven at 100° C. to develop the spots.

The following amino-acids were found at all stages of development studied: aspartic and glutamic acid, serine, alanine, valine, leucine and *iso*leucine. Threonine and glycine were present in much smaller amounts. Tyrosine, phenylalanine, tryptophan, α-amino-butyric acid and methionine could not be detected. In the case of the 6–7-month old fruit and the mature fruit, asparagine, glutamine, cystine, the basic amino-acids and β-alanine were found when larger aliquots of the liquid endosperm concentrates were used in two-dimensional chromatograms. Proline, in contrast to γ-amino-butyric acid, was present in largest concentration in the liquid endosperm of the immature fruit and decreased in amount with increasing maturity of the fruit until only a trace was present in the liquid endosperm of the fully mature fruit. Aspartic and glutamic acids increased somewhat and alanine and γ-amino-butyric acid increased markedly with increasing age of the fruit, while the others showed less marked variations. Concentrated aqueous extracts of the solid endosperm at 5–6 months and 6–7 months after setting and at maturity showed a distribution of amino-acids similar to that of the liquid endosperm at the 6–7 month stage. In addition, faint spots at positions corresponding to tryptophan, α-amino-butyric acid, tyrosine and phenylalanine were seen.

The appearance of γ-amino-butyric acid at the stage corresponding to deposition of the solid endosperm and its apparently increasing concentration in the liquid endosperm with increasing maturity of the nut suggest that this amino-acid arises as a result of some reaction connected with protein synthesis. A full account of this work will be published elsewhere.

I thank Dr. R. L. M. Synge and Prof. F. C. Steward for authentic samples of γ-amino-butyric acid; and Mr. B. P. M. Perera for technical assistance.

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Selective Destruction of Mesenchyme in Tissue Culture by the α-Toxin of *Clostridium welchii* Type *A*

The α-toxin of the gas-gangrene organism *Clostridium welchii* type *A* is one of the few lethal toxins of known enzymic action; it is a lecithinase *C*, which splits lecithin into phosphoryl choline and a diglyceride[1]. It affects the enzymic activity of isolated mitochondria and lyses red blood cells[3]. Unfractionated *welchii* toxin caused histological changes in fragments of tissues and organs, including the release of fat globules, lysis of nuclei, and general break-up, that agreed more or less with the clinical picture[4], and destroyed guinea pig spleen in culture[5].

In the present experiments, explants, about 1 mm. across, of the organs of chick embryos (6–13 day) were exposed to various dilutions of the toxin for 30 min. at 38° C., washed, and grown in a clot of plasma and embryo extract as 'hanging-drop' cultures.

Untreated explants from most organs produced an outgrowth of fibroblasts and wandering cells. If the organ contained epithelium, whether and how soon the latter grew out depended partly on its relations to the surface of the explant; if any epithelium appeared in the zone of growth, it was usually overgrown in subculture by fibroblasts. It was found that in some concentrations the toxin would eliminate the fibroblasts and wandering cells from the outgrowth of many organs, including lung, mesonephros, metanephros, thyroid, pancreas, and gut, and leave the epithelium flourishing. Stained sections of rather larger explants that had been grown by the watch-glass method showed that the internal mesenchyme had been killed. The results with lung were especially striking, for after the connective-tissue stroma had been destroyed, the unfettered bronchial system was able to unfold. In the absence of connective tissue, the epithelial cells became disarranged, and after two days the tubules had given place to sheets, strands, and small vesicles. Cell division was very common, and subculture yielded pure epithelium.

The range of concentration over which the mesenchyme and the epithelium were killed varied from organ to organ. Thus, some of the mesenchyme of the metanephros was able to withstand exposure to 100 *LD*50 (mouse)/ml. (1 I.U. α-antitoxin neutralized about 25 *LD*50), whereas that of lung was completely destroyed at 10 *LD*50/ml. Much of the epithelium of the lung survived after the standard 30-min. treatment with 1,000 *LD*50/ml.; and that of the metanephros was still more resistant, some of it not being killed when grown in a medium that initially contained this concentration. In contrast, 10 *LD*50/ml. was lethal to both components of skin, though 1 *LD*50/ml. left them healthy.

Differential sensitivity was shown also by fœtal rat lung (17-day); a few fibroblasts grew out after exposure to 100 *LD*50/ml., but pure epithelial cultures were obtained after 1,000 *LD*50/ml.

The differential effect was still produced by the lecithinase after the traces of other toxins present had been inactivated by specific antisera.

This lecithinase may prove a useful tool for obtaining pure cultures of epithelium. The methods so far available for this purpose have depended on the selective inhibition of mesenchymal growth, except in those organs in which the two components are readily separable; whereas the lecithinase actually kills the mesenchyme selectively. For preparative work, a comparatively crude toxin would be adequate.

It is not yet clear how these results are related to those of Davidson and Waymouth[7], who found that the lecithinase *A* of snake venom changed the appearance of the cells in explant chick heart from elongated to polyhedral.

I should like to thank Dr. H. B. Fell and Dr. W. Jacobson for their most helpful interest in this work, Dr. M. G. Macfarlane for providing purified toxin, Miss M. Barr of the Wellcome Laboratories for antisera and a further supply of toxin, and Mr. A. J. May and Mr. W. J. Randles for their assistance.

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Preservation of Corneal Endothelium by Freezing

The report[1] that spermatozoa from several species could be protected from the harmful effects of freezing by the addition of glycerol to the medium opened the way to the preservation for indefinite periods of a wide variety of mammalian tissues. An attempt to include the human cornea in this list[2] was only partially successful. It was suggested that the lack of complete success was due to the failure of the glycerol–saline technique to protect the corneal endothelium. It was therefore decided to investigate directly the effect of this treatment on the corneal endothelium of the rabbit.

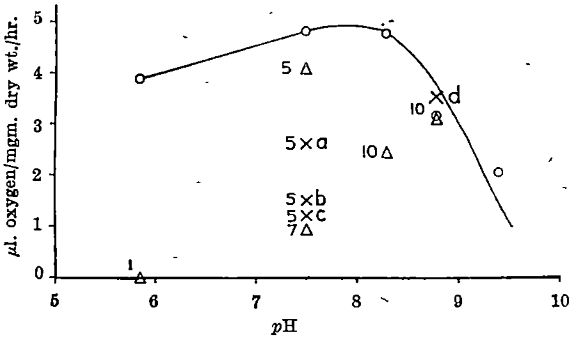

Fig. 1. The effect of pH, glycerol and freezing on the oxygen uptake of the corneal endothelium. ○, untreated corneæ; Δ, glycerol-treated corneæ; ×, glycerol-treated and frozen corneæ. The figure on the left of the symbol indicates the concentration of glycerol; the letter on the right the thawing procedure: *a*, thawed by immersion in water bath at 37° C. and maintained at that temperature for 60 min. before removal of endothelium; *b*, thawed at room temperature and allowed to stand 40 min. at room temperature before removal of endothelium; *c*, thawed by immersion in water bath at 37° C. (three minutes) followed by 20 min. at room temperature; *d*, thawed by immersion at 37° C. and maintained at that temperature for 20 min.

The criterion of viability employed was the oxygen uptake of the endothelium, and this was measured in a semi-microrespirometer designed specifically to respond to the small uptakes anticipated for a single endothelium. The whole, excised cornea was pretreated with the experimental solution and the endothelium, a monocellular layer, was removed along with Descemet's membrane; the tissue weighed about 1·3 mgm. when dry.

Eastcott *et al.* treated their material with 15 per cent glycerol in saline for one hour before freezing. In a preliminary series of experiments it was shown that such a long period was unnecessary, possibly harmful, and that 30 min. was sufficient to allow the cornea to come to equilibrium with the solution bathing it.

The results of the main series of experiments are summarized in Fig. 1. In physiological saline (pH 5·85) it is seen that even 1 per cent glycerol is toxic but that the resistance to the toxicity of glycerol increases with pH. It is also seen that at pH 7·5 and a glycerol concentration of 5 per cent, up to about 50 per cent of the cells can be made to survive freezing at −79° C. At pH 8·8 the endothelium is completely resistant to the toxic action of 10 per cent glycerol and at this glycerol concentration and pH the endothelium is completely protected against the harmful effects of freezing and thawing.

With the exception of the physiological saline all solutions were buffered and contained sodium chloride, potassium chloride, magnesium sulphate, and glucose.

Corneal grafting experiments in rabbits are in progress employing tissue frozen at −79° C. after treatment with 10 per cent glycerol at pH 8·8. Full details of all this work will be published in due course.

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Effect of Testosterone and Androstene 3β-17α-Diol on the Activity of the Reticulo-endothelial System

It is now well recognized that the reticulo-endothelial system plays an important part in the defence of the body against infection. The cells act as scavengers in the later stages of acute infection, they function prominently in chronic infection and there is much circumstantial evidence to show that they play an important part in the production of antibodies. Nicol, Helmy and Abou-Zikry[1] found that the phagocytic activity of the reticulo-endothelial system could be increased by the administration of œstrogens. Unfortunately these substances have many unpleasant side-effects which restrict their use clinically. The influence of other steroids on the reticulo-endothelial system is therefore being investigated; the effects of cortisone[2] and deoxycorticosterone[3] have previously been reported.

The present communication deals with the effects of testosterone and androstene 3β-17α-diol. Forty-nine male guinea pigs were used. The reticulo-endothelial macrophages were studied by giving all the animals one daily injection of trypan blue subcutaneously for the last six days prior to being killed by chloroform. The dosage of the dye was calculated on the basis of 0·8 ml. of a 1 per cent solution in distilled water per 100 gm. body-weight. Seven of the animals were given dye only and were used as controls. The hormone treatment given to the remaining forty-two animals is shown in Table 1. Specimens were taken from the spleen, liver and lymph nodes and fixed in Heidenhain's 'Susa' fluid. Sections were cut at 10μ thick and stained with weak eosin, dilute carbol fuchsin or alum carmine. The activity of the reticulo-endothelial system in the organs studied was assessed by the number of dye-bearing cells and the intensity of the vital staining.

Table 1. HORMONE TREATMENT GIVEN TO FORTY-TWO ANIMALS

Number of animals	Hormone used	Daily dose intramuscularly	Duration of treatment
6	Testosterone propionate (Organon)	1 mgm.	1 week
6	,,	5 ,,	1 ,,
3	,,	5 ,,	2 weeks
9	,,	5 ,,	3 ,,
6	,,	5 ,,	4 ,,
6	Androstene 3β-17α-diol (Organon) dissolved in olive oil	1 ,,	1 week
6	,, ,,	1 ,,	3 weeks

The results were as follows:

Testosterone. In the group of animals which received 1 mgm. of testosterone daily for one week the intensity of the vital staining was slightly reduced in the macrophages of the spleen, but the appearances in the liver and lymph nodes remained similar to those of the controls. In those which received 5 mgm. daily for one and two weeks the intensity of the vital staining in the macrophages was slightly reduced after one week of treatment and markedly reduced after two weeks, the greatest reduction being seen in the macrophages of the spleen and liver. In the animals which received 5 mgm. daily for three or four weeks the phagocytic activity of the macrophages gradually returned to normal, and in those which received the hormone for four weeks the vital staining appearances were similar to those of the controls.

Androstene 3β-17α-*diol*. The animals which received 1 mgm. of androstene 3β-17α-diol once daily for one week showed vital staining appearances similar to those of the controls. In those which received 1 mgm. daily for three weeks there was marked reduction in the number of vitally stained macrophages and also in the intensity of the vital staining in the spleen, liver and lymph nodes.

The above results indicate that in the male guinea pig testosterone propionate depresses the phagocytic activity of the reticulo-endothelial system during the first two weeks of treatment; but if the injections are continued the system gradually recovers during the third and fourth weeks. The effect of testosterone is, therefore, similar to that of cortisone. Androstene 3β-17α-diol is also shown to have a depressant action on the activity of the reticulo-endothelial system.

For this research we gratefully acknowledge the gift of androstene 3β-17α-diol from Dr. Tindall, of Organon Laboratories, Ltd.

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Agar Clarification

THE clarification of agar has always presented technical difficulties. The problem has become even more acute with the application of agar gels as a supporting medium for the interaction of antigen–antibody systems. A clear, transparent gel is essential for reading and photographing the lines, often fine and faint, formed by the antigen–antibody precipitates. That the classical microbiological methods of clarification, for example, filtration through sand and paper pulp, egg albumin coagulation, are insufficient is obvious from the elaborate, laborious methods devised in attempts to produce clear agar[1,2].

A very simple procedure for satisfactory agar clarification is here described. It is an adaptation of a step used by Viswanatha and Liener in the purification of a proteinase[3].

1 per cent w/v New Zealand agar is suspended in distilled water and dissolved by heating in a boiling water-bath. The solution is twice filtered rapidly through well-rinsed glass wool in a Buchner funnel to remove grossly insoluble particles. At this stage in our laboratory we add 1 per cent w/v sodium azide as a preservative, but this step is optional.

To the glass wool-filtered agar is added 1 or 2 per cent w/v of a mixture of equal parts of powdered bentonite and 'Hyflo Super-Cel' (Johns-Manville Co., Ltd.) and the whole shaken vigorously by hand to disperse the clarifying agents. The suspension is stored at 56° C. for several days, the clarifying agents being resuspended daily by gentle inversion of the bottles. When the cloudy flocculum is completely carried down from the supernatant by the bentonite–'Super-Cel' mixture the clarified agar is carefully decanted. Clarification is more quickly accomplished with 2 per cent of the mixture, but the recovery of agar is smaller.

The clarified agar is filtered through a fluted Whatman No. 5 paper in a heated funnel into a bottle standing in hot water. The first 25 ml. or so are returned to the funnel for re-filtering. The filtered agar in the molten state has the colourless clarity of water, and only a faint, clean, unclouded opalescence when set in plates.

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Validity of Miley's Electrometric Method for the Qualitative Analysis of Oxidation Layers formed on Copper

IN a preliminary paper, published in 1951, L. de Brouckère, F. Bouillon and Y. Bouillon-Nyssen[1] showed that films formed on copper by anodic oxidation in molar solutions of sodium hydroxide contained, among other things, cupric hydroxide. This compound could be reduced electrochemically in $0 \cdot 2\,M$ solutions of ammonium chloride. The reduction potential was different from those of cuprous and cupric oxides, so that Miley's electrochemical method could, in principle, be applied to the qualitative analysis of mixed films. The various end-points were quite easy to localize.

The quantitative character of the electrochemical reduction of copper compounds in ammonium chloride solutions has been questioned by Campbell and Thomas[2], who suggested replacing it by potassium chloride, in which the copper oxides are completely insoluble. However, in this medium the potential-time curves are somewhat smoothed out, so that it is rather difficult to separate the various reactions occurring at the electrodes.

Ammonium chloride thus appeared to be the best electrolyte to use for qualitative analysis, potassium chloride being better suited for quantitative work.

Unfortunately, it has now been found that cupric hydroxide cannot be reduced in potassium chloride solutions, hydrogen being evolved from the very beginning of the electrolysis. A systematic study of these phenomena, which will be published shortly in the *Bulletin des Sociétés chimiques de Belgique*, has shown that copper hydroxide can only be reduced in such media as are able to dissolve it. Quantitative results can obviously only be obtained if the speed of reduction of the dissolved ions is greater than, or eventually equal to, the speed of dissolution.

We have been particularly interested in the reduction of copper compounds in solutions of sodium hydroxide as these have recently been used by several authors for analysing the films formed on copper by anodic oxidation[3]. Potential-time curves published in the literature generally have more than one horizontal part, and this has been interpreted as proving the complex nature of the films, which are supposed to consist of a mixture of cuprous and cupric oxides with some cupric hydroxide. We believe that this interpretation is not completely justified, especially

Table 1

Nature of the electrolyte used	General characteristics of potential-time curves		
	Films of 'pure' $Cu(OH)_2$	Films of 'pure' CuO	Films of dehydrated $Cu(OH)_2$
0·2 *M* KCl	No reduction	One long horizontal part (CuO) and one inflexion (Cu_2O)	One long horizontal part (CuO) and one inflexion (Cu_2O)
0·2 *M* NaOH	One long horizontal part and one inflexion	One long horizontal part and one inflexion	One long horizontal part and one inflexion
M NaOH	Three horizontal parts	One long horizontal part and one inflexion	One long horizontal part and one inflexion
4 *M* NaOH	Three horizontal parts	Three horizontal parts	Three horizontal parts

when strong sodium hydroxide solutions ($c \gg M$) are used.

The qualitative results presented here concern films made up of practically pure cupric oxide or hydroxide. Actually, as the primary product of anodic oxidation is always cuprous oxide, a small amount of this compound is probably present in every film; but it must be in very small quantity as it could not be detected in our X-ray patterns. Some of our results are summarized in Table 1.

Clearly, the number of kinks in the potential-time curve depends as much on the nature of the electrolyte used as on the composition of the layer analysed. In particular, complex curves can be obtained with films containing only one compound. Great care must therefore be taken in using Miley's method for qualitative purposes.

In a paper to be published later these results will be interpreted, and it will be shown that the total quantity of electricity used for reducing the film is proportional to the number of copper ions it contains. The method may therefore be used for quantitative measurements even when it fails for qualitative purposes.

This work was carried out under the direction of Prof. L. de Brouckère; we wish to thank her for help and criticism. We also thank the Union Minière du Haut Katanga for financial help.

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Polarographic Determination of Rate of Periodate Oxidation of Epimeric Open-Chain 1,2-Glycols

The use of glycol-splitting reagents for the study of structural features in alicyclic glycols and sugars is firmly established[1], but only isolated instances of the application of this method to the study of epimeric pairs of open-chain vicinal diols are known[2].

A new and very advantageous method for following the glycol fission by periodic acid has now been developed, based on the polarographic determination of the reagent. This procedure, which is widely applicable, has several advantages over current methods. It is accurate, rapid, measurement is semi-automatic and the kinetic data are obtained in a single run without sampling; this is particularly striking in fast runs, where a recording of the complete kinetic curve is obtained (Fig. 1). Only milligram amounts of material are required for complete kinetic measurements, which, moreover, may be carried out at greater dilution (10^{-3}–10^{-5} *M*) than has hitherto been possible, and over a considerable range of *p*H. The accumulation and disappearance of the reaction product (aldehydes) may be followed in some instances, and any possible over-oxidation[3] (disappearance of iodic acid) is readily detected.

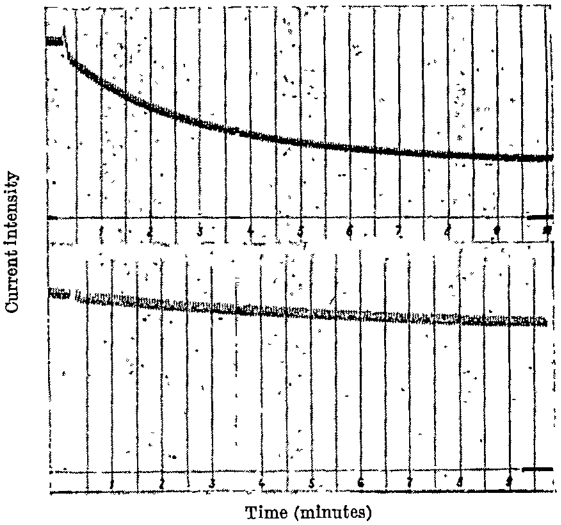

Fig. 1. Rate of oxidation of the threo- (upper curve) and erythro-1-phenyl-propane-1,2-diols in a 0·2 molar acetate-buffer of *p*H 4·7 with 1 molar sodium nitrate at 25° C., 6×10^{-5} molar glycol, $6 \times 10^{-5}M$ periodic acid. The change of the current registered with time at 0 V. (S.C.E.). The distance between abscissæ corresponds to 0·5 min., first abscissa in $t = 0·5$ min. Galvanometer sensitivity 2·2 $\times 10^{-9}$ amp./cm.

The method has already found very useful applications in the elucidation of the structure of natural compounds available only in semi-micro amounts; for example, in determining the structure of laserpitine[4] and in a study of steric problems in steroid 16,17-diols (Fajkoš, J., and Krupička, J., unpublished results).

Our principal aim in developing the method, however, has been the study of the oxidation of a series of stereoisomeric pairs of open-chain disecondary glycols. It was hoped that the rate data might yield useful information regarding the mechanism of this reaction on one hand and the effect of the steric bulk of the substituents on the other.

The applicability of the method was first verified by observing the reaction of ethylene glycol with periodic acid. The results were in satisfactory agreement with those recently obtained by Buist and Bunton[5], who regard the decomposition of a relatively stable intermediate as the rate-determining step.

In contrast to this, the oxidation of disecondary glycols has been found to follow simple second-order kinetics. The reaction is generally acid-base catalysed; general acid-base catalysis has been reported previously for the periodate oxidation of pinacol[6]. Rate constants of the acid- and base-catalysed reactions and of the uncatalysed reaction were determined

Table 1. Specific Second-order Rate-constants (l mol.$^{-1}$s.$^{-1}$ at 25° C.) for the Reaction of Open-chain 1,2-Glycols catalysed by Different Acids and Bases

$6 \times 10^{-5} M$ glycol, $6 \times 10^{-5} M$ potassium iodate

	Water	H_3O^+	CH_3COOH	CH_3COO^-	$H_2PO_4^-$	HPO_4^{2-}
1-Phenyl propane-1,2-diol: threo	9·2	1,360	Small	1,150	100	12,000
erythro	3·7	665	30	120	75	1,100
Butane-2,3-diol: threo	8 0	3,000	50	500	850	6,000
erythro	4 3	340	10	37·5	—	—

The values of k_{H_2O} and $k_{H_3O^+}$ have been determined in solutions containing nitric acid (pH 2–3) and 1 M sodium nitrate. To 0 2 M acetate and 0·07 M phosphate buffers, 1 M sodium nitrate was added

(Table 1). The base-catalysed reaction follows the Brønsted law. The value of the latter constant was found to be very close to the experimental values at pH 3, which are given in Table 2. From these findings it follows that the mechanism operative in the reactions studied differs from that found by Buist and Bunton[5] for ethylene glycol.

Consideration of the results presented in Tables 1 and 2 shows that the threo-epimers are in all instances oxidized faster than the erythro-isomers, the difference within the epimeric pair being more pronounced for the catalysed reaction than for the reaction in pure solvent. The difference in rates is sufficient to permit the analysis of mixtures of threo- and erythro-isomers and has, in fact, been successfully used for this purpose (Sicher, J., Šipoš, F., and Šorm, F., unpublished results. Šipoš, F., thesis, Institute of Chemistry, Prague). Furthermore, the reaction provides a simple and reliable method for determining the configuration of disecondary 1,2-glycols, provided both isomers are available. (The rate of reaction with glycol-splitting reagents has, of course, been frequently used for this purpose in the cyclohexane series. Recently, however, several instances have been reported in which the *trans*-isomer was oxidized faster than the *cis*[7].) On the other hand, the results show that the rate is not a simple function of the steric bulk of the substituents. Comparison of threo-isomers I, IX and IV, V points to an unexpected but marked accelerating effect due to the phenyl group; it should be noted that this effect does not occur with the corresponding erythro-isomer. The accelerating effect is apparently due to polar factors; it is, however, not enhanced by introducing the p-methoxy-group (VI). In the three purely aliphatic symmetrical glycols, k'_{threo} decreases with increasing size of $R = R'$, but again there is little variation in the corresponding value of k'_{erythro}. It should be noted that if the rate-determining step were the formation of a 'cyclic ester' or any geometrically equivalent species, it is the rate for the erythro-isomers which would be expected to vary with changes in R and R', rather than the rate for the threo-isomers.

Table 2. Second-order Rate-constants (l.mol.$^{-1}$s.$^{-1}$ at 25° C.) for the Reaction of Glycols with Periodic Acid

Values measured in 0·001 M nitric acid, 1 M sodium nitrate, $6 \times 10^{-5} M$ glycol, $6 \times 10^{-5} M$ potassium iodate (pH of the final solution adjusted to 3)

	R.CH(OH).CH(OH).R' R	R'	k'threo	k'erythro
I	Methyl	Methyl	9·9±0·1	4 8±0 2
II	Ethyl	Ethyl	8 8±0·1	4·4±0·2
III	Propyl	Propyl	5·5±0·1	4 9±0·1
IV	Cyclohexyl	Methyl	5·6±0·1	4 5±0·1
V	Phenyl	Methyl	10·1±0 4	4·6±0·1
VI	p-Methoxyphenyl	Methyl	9·8±0·4	5·2±0 1
VII	Phenyl	Ethyl	6 2±0 2	4·3±0 1
VIII	Phenyl	Isopropyl	11 5±0 2	3·7±0 2
IX	Phenyl	Phenyl	14·2±0 4	3 3±0·1

This investigation is being continued and will be published in detail elsewhere.

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Structural Characterization of Cæsium Antimonide: Temperature Factors in Cubic Crystals

We have completed an X-ray investigation of cæsium–antimony alloys which shows that the photoelectric surface material cæsium antimonide is a 'normal valency' intermetallic compound with a small range of homogeneity probably from Cs_3Sb to $Cs_{3+x}Sb_{1-x}$, where x, estimated from the observed variation of unit-cell dimensions, is of the order of 0·05. The atomic arrangement is pseudo body-centred cubic with a structure based upon the $B32$ sodium thallide type (NaTl). The cubic unit cell (a = 9·14–9·19 A.) contains sixteen atoms at special positions of space group $Fd3m$—O_h^7. Eight equivalent sites at $(0,0,0;\ 0,\frac{1}{2},\frac{1}{2};\ \frac{1}{2},0,\frac{1}{2};\ \frac{1}{2},\frac{1}{2},0) + 0,0,0;\ \frac{1}{4},\frac{1}{4},\frac{1}{4}$ are occupied solely by cæsium atoms and eight other sites, at $(0,0,0;\ 0,\frac{1}{2},\frac{1}{2};\ \frac{1}{2},0,\frac{1}{2};\ \frac{1}{2},\frac{1}{2},0) + \frac{1}{2},\frac{1}{2},\frac{1}{2};\ \frac{3}{4},\frac{3}{4},\frac{3}{4}$, are occupied randomly by four cæsium and four antimony atoms. The structure may be described as consisting of two interpenetrating diamond-type lattices, one of cæsium atoms and the other of equal numbers of cæsium and antimony atoms. The semi-conducting properties of the material are explained by a filled Brillouin zone containing two electrons per atom. A full report of the investigation, together with a discussion of the cæsium antimonide structure and its correlation with other properties of the material, will be made elsewhere[1].

The observed X-ray diffraction effects from Cs_3Sb are accounted for only if the amplitudes of thermal vibrations are very much greater for cæsium atoms than for antimony atoms. In cæsium antimonide the root-mean-square displacements of the different atoms from their mean lattice positions (0·52 A. for cæsium and 0·25 A. for antimony at 291° K.) are approximately the same as the corresponding displacements in metallic cæsium and metallic antimony. This unexpectedly large difference between the Debye temperature factors of the different atoms (f_{Cs} = 55, f_{Sb} = 51 at $\theta = 0°$ for the electron distributions of the atoms at rest) causes the appearance of a complete series of X-ray superlattice reflexions, with *h*, *k* and *l* all odd, which were at first erroneously thought to be due to specific shifts of some or all of the atoms from the special positions. Although the assignment of separate temperature factors to different atoms is well known[2], the need for this has been recently emphasized by Lonsdale and Grenville-Wells[3]. In discussing the different Debye factors observed for different reflexions of α-brass[4], Lonsdale and Grenville-Wells point out that the Debye factor for reflexions from a cubic crystal is independent of crystallographic direction only if all the atoms have similar thermal motions. They demonstrate that unless the exponential constant B is the same for all atoms, then the ratio F^R/F^T (R = rest, T = given temperature) will vary from one reflexion to another. They state that "the ratio may sometimes be less than 1; that is, the structure factor may be greater at high temperature than at a low one and may change sign".

The diffraction effects which we have observed from cæsium antimonide illustrate the validity of this statement in a striking way. For example, the values of the ratio F^R/F^{291} for a number of Cs_3Sb reflexions are listed in Table 1.

Table 1. VALUES OF THE RATIO F^R/F^T (T=291° K.) FOR SOME Cs_3Sb X-RAY REFLEXIONS

θ	*hkl*	F^R/F^T
8·4	111	+2·75
13·8	220	+1·56
16·2	311	−1·02
19·7	400	+1·43
21·6	331	−0·49
42·4	800	+2·96
43·7	733	−0·21
72·5	880	+6·28
74·7	971	−0·24

At low Bragg angles the ratios for reflexions with *h*, *k* and *l* all odd are greater than 1 and may be positive or negative; at higher angles the ratios are negative and much less than 1. For reflexions with *h*, *k* and *l* all even the ratios are positive and greater than 1 but they show a wide range of values.

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Use of Radioisotopes in the Study of Wool Growth and Fibre Composition

Bern *et al.*[1], and Ryder[2], carried out hair-growth experiments involving the injection of mice with cystine labelled with sulphur-35 followed by the detection of radioactivity in the hair follicle using the autoradiographic technique of Pelc[3]. The preliminary results of similar experiments carried out with mice and lambs are presented here.

The shortest time after injection at which Bern took samples was 1 hr. In the present study moderate activity was detected in the vibrissal follicles of a mouse killed 6 min. after an intraperitoneal injection of about 40 microcuries of labelled cystine. Accumulation in the follicle of sufficient activity to produce an autoradiograph would be expected to take a little time. But the radioactive compound can be regarded as entering the follicle almost immediately after injection, because there was already slight activity in the follicles of a mouse killed only 2 min. afterwards.

Although there has always been activity in the bulb, it has never given a dense autoradiograph; even 6 min. after injection the densest autoradiograph was at a level higher up the follicle than the bulb. This stretched from the neck of the bulb into the fibrillary zone of the fibre, that is, the zone which gives the strongest reaction for sulphydryl groups and immediately precedes the pre-keratinization zone in which the sulphydryl reaction is less[2]. In the present study no activity was detected in the pre-keratinization (keratogenous) zone until two hours after injection when radioactive sulphur seemed to be just beginning to extend into that zone.

The immediate appearance of activity at a level higher than the bulb is in accordance with the findings of Bern[1], and seems to support his suggestion that compounds containing sulphur enter the follicle above the bulb. It also seems to support the suggestion of Ryder[2,4] that substances needed in keratinization could enter from the blood-vessel network surrounding the follicle. In addition, the greater grain density at levels higher than the bulb might suggest that in fact more sulphur enters from the surrounding net than the papilla.

In the lamb (skin sample taken ½ hr. after injection) the difference between the density of the autoradiograph of the bulb and of the regions immediately above it was less marked than in the mouse. The autoradiographic preparations were stained with Bennett's[5] sulphydryl reagent before the application of film, and the increase in grain density at levels of the follicle higher than the bulb is associated with increase in the reaction for sulphydryl groups. This suggests that the sulphur enters the follicle in a compound (probably cysteine) containing sulphydryl groups. But it may be that sulphur enters only through the papilla and that the autoradiograph is merely indicating the region with most sulphur. In fact, the sulphur arrives there so quickly that the entry route is uncertain. The possibility of growth up to that level is ruled out, and the short distance to the region with the strongest autoradiograph from the surrounding vessel net makes it tempting to suggest diffusion through the follicle wall, although the fluid content of the lower cells of the fibre would help diffusion up the fibre from the papilla. So far only sulphur fixed in the tissue has been detected; possibly frozen-dried preparations would show the route of sulphur into the follicle.

In the lamb perhaps the most striking finding was the uniformity in the density of the autoradiograph of the orthocortex and paracortex, that is, the dye-accessible and non-dye-accessible halves of the cortex of the fully formed fibre[6]. Mercer *et al.*[7] gave figures which suggested that the paracortex contained as much as two-thirds of the total cystine of the fibre. If this were so, one would expect the grain density of the autoradiograph of the paracortex to be twice that of the orthocortex. Autoradiographic preparations of fibres cut at about the level of the skin surface have been stained to show the orthocortex, and grain counts have been made of the density of the autoradiograph over each half of the fibre. The grains in three squares over each half of the fibre were counted at a magnification of × 1,080, using a ½-mm. eyepiece graticule. A series of results is

Table 1. Autoradiographic Grain Density Counts

	Orthocortex (D.A.)	Paracortex (non-D A.)
Fibres in skin sample taken 48 hr. after injection	28	41
	22	26
	23	18
Fibres in skin sample taken 5 days after injection	44	42
	47	34
	51	53
	56	51
	52	47
	59	65

shown in Table 1; no significant difference was found between the grain densities of the two halves.

The results obtained using this method therefore suggest that the orthocortex and paracortex each contain similar amounts of cystine.

I am indebted to Dr. A. Robson and Dr. M. C. Corfield for many helpful discussions on the procedure used; and for preparing the solutions used in the experiments. I wish to thank Mr. G. R. Standley for technical assistance.

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Intracrystalline Free Volumes in some Host Lattices

Various instances are known of continuous crystalline 'host' lattices within which 'guest' molecules may be trapped[1,2]. Organic lattices of this kind include the networks formed by hydrogen-bonded quinol molecules in the quinol clathrates; hydrogen-bonded urea and thio-urea networks in the urea and thio-urea adducts. Among inorganic lattices the best known are the crystalline zeolites, the most open of which, faujasite, easily occludes molecules as large as *iso*-octane; and two different kinds of hydrogen-bonded watter lattice, each with cavities able to encage diverse molecular species. It is of interest to compare aspects of the geometry of the free volumes of these host lattices, and to contract the free volumes of the organic and the inorganic lattices. It is also interesting to know the upper limit to the free volume in such continuous networks. Accordingly, the spatial properties of some cage and channel systems are summarized in Table 1. The term 'free', used above and in Table 1 in relation to channel and cage dimensions, means not occupied even by the periphery of any of the atoms forming the continuous network.

Quinol clathrates and water clathrates have free volumes in the form of separated cavities, the windows or apertures leading from one cage to another having very small free diameters. Urea and thio-urea adducts have free volumes in the form of continuous uniform capillaries, non-intersecting and all parallel to the hexagonal c-axis. The zeolites have free volumes in the form of cages joined by quite wide windows to each of several other cages, so that a continuous system of intersecting channels results[12], with free diameters varying periodically along their lengths. The zeolites of Table 1 differ from the other host lattices in being quite stable in absence of guest molecules, and in permitting migration of suitable small guest molecules from one cavity to another throughout the crystal.

Van der Waals[4] has pointed out that the atoms surrounding the cavity in the β-quinol-argon clathrate are located near the surface of a sphere of 7·9 A. diameter. On subtracting the equilibrium diameter 3·7 A. of an aromatic carbon atom one obtains a free diameter of 4·2 A. Subtracting the collision diameter of such an atom, 3·3 A., gives a diameter of 4·6 A. However, the β-quinol network is capable of some alteration according to the size of the included molecule. For the quinol-sulphur dioxide clathrate[3], the free diameter and volume may be found from the volume of sulphur dioxide, estimated as liquid, which is occluded per cm.^{3} of crystal (Table 1). In this network the free volume is comparatively small. The corresponding data for the urea-adducts have been calculated from the crystal structure given by Smith[5], and for thio-urea adducts from the corresponding work of Lenné[6]. By treating the channels in the host lattice as cylinders, and allowing 3·0 A. as the van der Waals diameter of nitrogen[13], one obtains the results given in Table 1. This time the free volumes are very substantial indeed.

The cage diameters of water clathrates of types 1 and 2 are taken from a paper by v. Stackelberg and Muller[7]. They are derived from the co-ordinates of the water molecules forming the wall of each cage, and the diameters of the water molecules. The latter were assumed equal to the distances between the centres of oxygen atoms of adjacent water molecules. Cage 1 is a pentagonal dodecahedron, cage 2 is a polyhedron with 14 pentagonal faces, and cage 3 a polyhedron with 16 pentagonal faces. The free volumes of Table 1 have been obtained taking the cubic unit cell edge of 12·0 A. for the type 1 and 17·3 A. for the type 2 water clathrate. In both these structures a large free volume exists, though

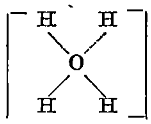
Table 1. Spatial Properties of Some Cage Systems

System	Free diameter of cage (A.)	Free diameter of apertures joining cages (A.)	Free volume enclosed by framework of host lattice (cm.^{3}/cm.^{3})
Quinol-SO$_2$ clathrate (ref. 3)	5·2	Small	0·09
Quinol-*A* clathrate (ref. 4)	4·2	,,	0·05
Urea-*n*-paraffin adducts (ref. 5)	5·2	5·2	0·37
Thiourea-hydrocarbon adducts (ref. 6)	$6{\cdot}1_3$	$6{\cdot}1_3$	0·41
Type 1 water clathrate (ref. 7)	Cage 1 5·2	Small	0·46
	,, 2 5·9	,,	
Type 2 water clathrate (ref. 7)	,, 1 4·8	,,	0·46
	,, 2 6·9	,,	
Chabazite (refs. 1, 8)	7·3	3·2 [4·9]	0·46
Zeolite 4*A* (refs. 1, 9)	Cage 1 ~7	~3·2 —	0·46
	,, 2 ~11·8	~4·4 —	
Faujasite (refs. 1, 9, 10)	,, 1 ~7	~3·2 —	0·53
	,, 2 ~12	~9 —	
Gmelinite (ref. 11)	~7·3	~3·2 [4·9]	0·46
Erionite	—	— —	0·44
Levynite	—	— [3·8]	0·40
Harmotome	—	— —	0·35
Mordenite	—	— [4·0]	0·33
Analcite	—	— —	0·20

both lattices are metastable with respect to ice or liquid water unless a substantial fraction of the cavities is filled by guest molecules.

For the zeolites chabazite, '4*A*', and faujasite, structural details essential from the present point of view have been presented elsewhere[1]. Chabazite, for example, is built by stacking slightly distorted cubo-octahedral cages in 8-fold co-ordination[8], and gmelinite also seems to be based upon the same framework[11]. The free diameter of the cages and the free volume within the crystals have been derived from unit cell dimensions and from the volume of zeolitic water which may be displaced from them. Molecules somewhat larger than the free diameters of the windows connecting adjacent cages can diffuse through these windows by an activated diffusion process, and I[2] have therefore also given in connexion with the molecular sieve property the larger dimensions in the square brackets of Table 1, column 3, based upon diffusion experiments. These, however, are not free diameters. Table 1 shows free volumes for some zeolites as large or larger than those found for the water clathrates. For six of the host lattices of Table 1 the free volume is 0·46 cm.^{3} per cm.^{3} or above, and the maximum figure is 0·53 cm.^{3} per cm.^{3}. It is possible, but not proved, that this latter figure is about as large as the free volume of a stable host lattice could be. However, this is not necessarily true of networks filled with guest molecules, but unstable in their absence.

The arrangement of 'bonds' around the oxygen atoms of water in the water clathrates is a slightly distorted tetrahedron,



so that these structures are in this respect analogous to the alumino-silicates (zeolites). It is these networks, based upon the tetrahedron, which so often show large free volumes. It may be inferred that tetrahedron-based network phosphates and borosilicates with large free volumes may be possible. Gallo-silicates, gallo-germanates and alumino-germanates showing this property have recently been synthesized in this laboratory[14]. The possibility of open-cage structures based on other ultimate building units, such as the octahedron, must, however, also be envisaged.

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The Hydrogen-Bond Strength of Ice

Pauling[1] estimated the strength of the hydrogen bond in water by taking the heat of sublimation of ice and allowing a reasonably guessed value for the dispersion contribution to the bond, and arrived at a value of 4·5 kcal./N bonds, where N is Avogadro's number. Later, Grunberg and Nissan[2] calculated the dispersion contribution from surface tension data by assuming that the dispersion energy equalled the work of cohesion as defined by Harkins[3]. By taking the internal latent heat of vaporization of water plus the heat of fusion as equal to the internal heat of sublimation of ice and subtracting the work of cohesion, a value of 3·71 kcal./N was obtained. They also made a calculation from the dipole moment (taking certain evidence from viscosity data into account) and found a value of 3·23 kcal./N. Recently, I[4] formulated a relationship between the elastic constants of cellulose sheets and the strength of the hydrogen bond. The same relationship should apply to ice and therefore it should be possible to calculate the bond energy from the modulus of elasticity.

Consider a cube of ice in which the crystallites are randomly oriented and let a uniaxial tensile stress f act on two faces producing a small strain $\delta\sigma$. The energy per unit volume stored in the cube δU is the product $f\delta\sigma$, or taking infinitesimal quantities

$$f = \frac{\mathrm{d}U}{\mathrm{d}\sigma} \tag{1}$$

If the orientation of the crystallites, or hydrogen bond direction, is assumed random, then, to a first approximation, we can take $\frac{1}{3}$ of the total bonds available to be in the direction of strain. Thus the volume which a strained hydrogen bond occupies will be v_m, where

$$v_m = 3 \times 18/N\rho \sim 100\ \text{A.}^3 \tag{2}$$

where N is Avogadro's number and ρ the density of ice. While it is permissible to think of $\mathrm{d}U$ on a macroscopic scale as distributed uniformly in the volume of ice, on the molecular scale we imagine it localized in the O—H and O..H bonds. If r_1 and r_2 are the bond-lengths of the O—H and O..H links, and if the bond-strengths are k_1 and k_2 respectively, then a macroscopic strain of $\mathrm{d}\sigma$ will distribute itself among the two links according to

$$\mathrm{d}\sigma = \mathrm{d}\sigma_2\,(r_2/v_m{}^{1/3})\,[1 + (k_2/k_1)] \tag{3}$$

Therefore, $f = (\mathrm{d}U/\mathrm{d}\sigma)$

$$= (\mathrm{d}U/\mathrm{d}\sigma_2)/\{(r_2/v_m{}^{1/3})\,[1 + (k_2/k_1)]\} \tag{4}$$

Taking the Morse function for $U(\sigma_2)$ as was done for cellulose sheets, we obtain

$$f = 2(a_2)^2\left[\frac{v_m{}^{1/3}}{r_2(1 + (k_2/k_1))}\right]^2 U_0\sigma - \text{terms in higher powers of } \sigma \tag{5}$$

$$\text{So } E = \lim_{\sigma\to 0}\,(f/\sigma) = 2(a_2)^2\left[\frac{v_m{}^{1/3}}{r_2[1 + (k_2/k_1)]}\right]^2 U_0 \tag{6}$$

where a_2 is Morse constant, of order 2; U_0 is energy of dissociation of the hydrogen bond per unit volume of material $= J\Delta H/2{,}000\,v_m N$; and J is mechanical equivalent of heat.

It follows, then, that ΔH in kcal./N bonds is given by

$$\Delta H = Er_2^2\,[1 + (k_2/k_1)]^2\,v_m{}^{1/3}\,N/2{,}000\,a_2^2 J \tag{7}$$

Values for E reported in the literature for ice[5] are grouped around $1·05 \times 10^{11}$ within $\pm\,0·05 \times 10^{11}$. Substituting the values for the other parameters (that is, $r_2 = (2\cdot76 - 1\cdot07) \times 10^{-8}$; $k_2 : k_1 \sim 1 : 8$; $v_m = 10^{-22}$) gives $\Delta H = 3\cdot2$ kcal./N bonds against 3·2 from the dipole moment and 3·7 from thermodynamical data. It appears that a figure of 3·4 ± 0·2 kcal./N bonds is the most probable value of the hydrogen bond energy for ice and water.

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Oct. 2.

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A Solar Magnetograph

THE first test observations for the detection and measurement of both small magnetic fields and small Doppler effects on the Sun's surface have been carried out during recent months at the Cambridge Observatories with a photoelectric magnetometer newly built under a grant from the Department of Scientific and Industrial Research. This instrument is a modified version of one constructed by H. W. Babcock some time ago at the Mount Wilson and Palomar Observatories[1]. It is used in conjunction with the Cambridge solar spectrograph which has a large diffraction grating of excellent quality, ruled by H. W. Babcock[2] and working in the 5th order, where it reaches a measured resolving power of 600,000. The Zeeman effect in a suitable Fraunhofer line is analysed with the aid of an electro-optical retardation plate of ammonium di-hydrogen phosphate and a fixed 'Polaroid'. The retardation of the plate oscillates in sign at 400 c./s. due to the applied potential of 3·5 kV. r.m.s. A selected portion of each wing of the Fraunhofer line is imaged on the cathode of a corresponding photomultiplier (*E.M.I.* type 6094). The outputs from the two photomultipliers are fed into a difference amplifier, and the resulting signal after amplification by a selective frequency amplifier is applied to a phase-sensitive rectifier. Time constants up to 10 sec. are provided. The difference amplifier rejects elliptical polarization from the cœlostat mirrors, and, provided the examining slits are correctly placed, small Doppler shifts of the line are relatively unimportant.

Directly the instrument was brought into operation it revealed a wealth of magnetic structure on the Sun's surface, as was expected from observations already made in Pasadena[3]. One of the most striking phenomena is the presence of comparatively large fields not located on any surface feature visible in ordinary integrated light. These frequently occur at some distance from an apparently single sunspot, near where one would expect to find the following spot of an ordinary pair, and with the appropriate polarity with respect to the leading spot. The existence of such fields appeared probable in rare cases from work carried out long ago by G. E. Hale[4], but they are rather difficult to detect by purely photographic methods, as were, for example, tried by one of us[5] using a kind of blink method. With the present instrument they are detected with ease.

If the slit-length of the spectrograph is reduced to about 4 sec. of arc on the disk, very small areas with rather strong fields, up to about 100 gauss, can, under the present conditions of high solar activity, be found in large numbers along the main sunspot belts, even when in white light nothing but undisturbed photosphere can be seen on the surface. Some of these fields may occur over very tiny spots or over the well-known pores which appear among the photospheric granules. Small optically visible spots have developed in some of these patches one or two days after their discovery, suggesting, as has already been anticipated from theory, that a magnetic field is probably the precursor of a sunspot. The long-standing problem as to where the lines of force leaving the Sun's surface in a spotted area eventually return to the surface may be brought nearer solution by observations of this kind.

The fact that very small areas, apparently only a few square seconds of arc in extent, sometimes reveal relatively strong magnetic fields suggests that the magnetic structure of the Sun's surface may be appreciably finer than can be resolved by the instrument in its present form. It may well be that the dimensions of this fine structure will in future be found comparable in character with the Doppler fine structure recently discovered in Fraunhofer lines both here and elsewhere[6,7] by the use of large diffraction gratings of exceptionally high quality.

The sensitivity of the present instrument is sufficient to detect fields of the order of one gauss, but only with a relatively long slit, which results in highly localized and rather strong fields being smeared out into apparently larger and rather weak fields.

The instrument can be adapted to measure very small shifts of Fraunhofer lines down to quantities of the order of 1μ, equivalent to Doppler shifts of a small fraction of 1 km./sec. The limit so far has been set by the general rigidity of the spectrograph building and by the seeing conditions.

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Photoelectric Polarimeter using the Faraday Effect

THE sugar industry is becoming increasingly interested in the possibility of replacing polarimeters of the visual type with photoelectric instruments. Of the various designs which have been suggested, a promising one is that in which the plane of polarization of the light emerging from the polarizer is made to oscillate through a suitable angle. When the analyser is perpendicular to the mean direction of the plane of polarization, the emergent light intensity, though it may be modulated at twice the frequency of oscillation, has a zero alternating component at the fundamental frequency. This condition is detected by means of a photocell and amplifier, the system thus combining the advantages of a.c. amplification and of the half-shadow principle used in visual polarimetry.

The various mechanical methods which have been suggested for producing the desired oscillation of the plane of polarization are not very suitable for a commercial instrument, and it is therefore rather surprising that the potentialities, in this connexion, of the magneto-optic or Faraday effect have been overlooked. The amplitude of oscillation which can be so obtained is rather small, but this is not necessarily a disadvantage, as the following argument shows.

If θ is the total angle through which the plane of polarization swings, then the sensitivity, that is, the rate of change of photocell output with angle of analyser, varies as $\sin \theta$ and is therefore greatest for $\theta = 90°$. The precision, however, when it is limited solely by shot noise in the photocurrent, is greatest for $\theta = 0$, since the root-mean-square shot noise varies as the square root of the mean photocell illumination, that is, as $\sin \theta/2$. Moreover, the accuracy, as distinct from the precision, is likely to be limited mainly by disturbances of the kind which appear as a modulation of the light intensity. In terms of angle, therefore, the resulting errors may be expected to vary as (mean light intensity) ÷ (sensitivity), that is, as $\tan \theta/2$. It follows that both precision and accuracy will improve progressively with decreasing θ until θ reaches a limiting value where the sensitivity is so small that extraneous disturbances (for example, dark-current or amplifier noise) begin to take effect.

Experiments indicate that, if a photomultiplier is used as the detector, this limiting value of θ is well within the capabilities of a Faraday cell of practical design. The following details of the construction and performance of an experimental instrument may serve to illustrate this conclusion.

The Faraday cell employed a lead–zinc borate glass (Chance *DEDF* No. 030,181, Verdet constant about 0·14 min./gilbert) in the form of a cylindrical rod 10 cm. long and 1 cm. diameter. The coil surrounding this was wound with 18 *SWG* enamelled copper wire on a Keramot former to these dimensions: int. diam. 1·4 cm.; ext. diam. 3·6 cm.; length 11·5 cm. The coil was supplied with 1 amp. of alternating current at 50 c./s. (sinusoidal waveform), which sufficed to swing the plane of polarization through an angle θ of 6° with a power dissipation of only 1 watt. The detection system comprised an 11-stage photomultiplier, a.c. amplifier, phase-sensitive rectifier and output meter.

The 'light-gathering power' of the optics, as determined by the size and separation of the stops, was if anything rather less than that of a typical visual polarimeter. The instrument was illuminated with 5461 A. light from a mercury lamp and monochromator; the effective light flux may be judged from the fact that, with analyser and polarizer *parallel*, the primary photocurrent was about 2×10^{-9} amp.

In these circumstances, the root-mean-square fluctuation in meter reading, for a bandwidth, as set by the overall response time, of 0·1 c./s., was equivalent to about 1 second of arc in the angular setting of the analyser, a value quite close to the shot-noise limit. The stability over a period of several minutes was of the same order. These results indicate a performance much superior to that of a visual polarimeter, and have encouraged us to proceed with the design of a similar instrument suitable for industrial use.

The work described above has been carried out as part of the research programme of the National Physical Laboratory, and this communication is published by permission of the Director of the Laboratory. Acknowledgments are due to Mr. S. P. Middleton for the design of the Faraday cell and assistance in the experimental work.

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Population Growth

Dr. C. B. Goodhart's article, "World Population Growth and its Regulation by Natural Means"[1], performs a useful service in emphasizing that 'family size' may be a very poor indicator of the extent to which the descendants of a family will increase or decrease in number over a period of generations. This latter property might be termed 'net reproductive capacity'. As he points out, family size and net reproductive capacity might be positively correlated in some circumstances and negatively correlated in others.

However, if as Dr. Goodhart suggests the 'families of low fertility' may be replacing the more fertile lines during the present period of rapid population increase (because of a greater net reproductive capacity when disease is controlled, etc.), there is still a difficulty in accepting that as a result " . . . the mean fertility should fall and the population should taper off to a new position of equilibrium at a much higher level of numbers . . . ". This surely could only happen if there were some sharp curtailment of the superior net reproductive capacities of the 'less fertile' after they had succeeded in displacing the 'more fertile lines'. In other words, after the tortoise has beaten the hare, what reason have we to believe that he will stop running ?

More important, however, is a second point, which Dr. Goodhart has touched upon only briefly. We know almost nothing about the differentials in net reproductive capacity which may exist within a population. In spite of this, there is continued speculation concerning the possible effects of such differentials on the size and quality of future human populations. The time would seem to be ripe for a shift in emphasis from speculation to a serious consideration of the feasibility of observing the differentials themselves.

Limited surveys are probably inadequate for such a purpose, but there is an alternative approach. Essentially complete information of the kind required exists, although unfortunately not in a readily available form, in the routine registrations of marriages, births and deaths. These are sufficiently specific in their information content to identify parents and offspring unambiguously. Thus individual lines of descent could conceivably be followed over an indefinite number of generations. Of course, to reconstruct even a single family tree from such back records by a process of searching would be excessively laborious.

At first sight it is difficult to imagine any simple procedure for making use of this kind of record to derive the net reproductive capacities for lines of descent differing with respect to family size, or some other important attribute. However, it is altogether possible that current procedures for obtaining vital statistics from these registrations could be modified to permit the future extraction of appropriate family data for whole populations, and spanning an indefinite number of generations.

There is reason for believing that such modified handling procedures might perhaps prove quite simple in operation. Until recently, no serious thought had been directed to this end; but preliminary discussions in Canada, initiated for a rather different reason, suggest that some form of population accounting which takes cognizance of the family relationships from generation to generation may in fact be feasible. Without going into details, the essential feature lies in bringing together by means of a coding system (such as might be used with a punch-card medium) those records relating to the births, marriages and deaths of the offspring from a single pair of parents. There are a number of ways in which this can be accomplished. The product is in essence a family tree of the population, complete with the dates of all events, family sizes, causes of death, and, eventually, degree of consanguinity of the parents.

Most of the speculations regarding future populations imply that the problem is of practical importance. If so, is it not time that we started recording and handling our vital statistics to permit appropriate observations to be made on the differentials of reproduction, so that we shall not always be forced to draw conclusions about future populations from such meagre data? The possible negative correlation between family size and number of descendants which Dr. Goodhart postulates represents only one of the possible relevant kinds of observation.

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[1] Goodhart, C. B., *Nature*, **178**, 561 (1956).

There is perhaps one way in which the tortoise might be expected to continue to slow down after he has beaten the hare.

The suggestion was that families (in the sense of 'lines of descent') of low average fertility might come to predominate in the population as a result of selection for success in life when indiscriminate mortality was low. This low average fertility is seen as being due to their having a high proportion of individuals who are subfecund, whether as a result of physiological sterility or because they are 'psychologically infecund' and disinclined to marry or have children. Such infecundity, whether physiological or psychological, is congenital and likely to be at least partly conditioned by inherited genetical factors, so that its already surprisingly high incidence in some communities must be the result of natural selection. It was suggested that this selection for relative infecundity (correlated with other inherited characteristics of high survival value) was likely to be extended in the future. If that does indeed happen, and the incidence of subfecundity is seriously increased, then the rate of population growth should continue to slow down for so long as the selection pressure is maintained; and that is not directly dependent upon the total numbers of the population, nor upon its average fertility.

C. B. Goodhart

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Splitting of Genera

The recent passion for the progressive splitting up of genera has spread through most branches of zoology and latterly to botany as well. In fact, the present phase in taxonomy is to lump species and split genera, thus making genera on the whole as small as possible. In some groups (for example, Heteroptera, Cypraeidae, birds of paradise) this practice has reached absurd limits. The steady march of this practice goes almost unnoticed until large general or popular books are compiled where all recent work is uncritically assimilated regardless of quality. Two such Australian works on shells[1,2] and a recent book on birds[3] are illustrations. They admirably serve their purpose of presenting to the public excellent well-illustrated identification handbooks; but the nomenclature used is highly unstable, which is particularly undesirable in a book of wide public appeal.

The solution for this problem lies with the two International Commissions for Nomenclature. It is not, of course, denied that a very large number of genera remain to be described; but the burden of proving their complete distinctness rests with the describer. At present, names are very often proposed on flimsy grounds and the work of proving their validity or otherwise is handed down to future workers. For example, Steadman and Cotton[4] have summarized the 'accepted' classification of the Cypraeidae, and the genera and even subfamilies are separated on characters which are no higher than specific. New genera are established using merely the specific characters of the unique species included without any additional evidence. The result is that two species such as *Cypraea tigris* L. and *C. pantherina* Sol. are placed in different genera, whereas they are only just distinct species which actually hybridize.

Such absurdities should have no standing in nomenclature. I would propose that taxonomists consider a clause to be added to the international rules laying down that no generic name proposed after a certain date (possibly placed in the past) has any standing unless full reasons are given for its separation, not merely that it must be accompanied by a description. The interpretation of the term 'full reasons' is, of course, of paramount importance and varies from group to group. For example, no mollusc genus should be proposed without a comparison of its anatomy with allied genera. Each group has its accepted characters used for differentiation purposes and these should be used. If in a group the main classification depends on one character, then the description of a new genus should include full details of that character. I believe some such clause is needed to prevent certain branches of taxonomy developing into a farce. The mere extra labour involved in describing more than the macromorphology will prevent many of the offenders from too lightly proposing names.

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Sept. 21.

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[1] Allan, J., "Australian Shells" (Melbourne, 1950).

[2] Allan, J., "Cowry Shells of World Seas" (Melbourne, 1955).

[3] Roberts, A., "The Birds of South Africa" (London and Johannesburg, 1940).

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FORTHCOMING EVENTS

Thursday, December 27

Royal Institution (at 21 Albemarle Street, London, W.1), at 3 p.m.—Dr. H. Baines: "Photography". (First of a course of six lectures adapted to a juvenile auditory. Further lectures on December 29, January 1, 3, 5 and 8.)

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant, Grade A, for General Chemistry, at Birkenhead Technical College—The Director of Education, Birkenhead Education Committee, 63 Hamilton Square, Birkenhead (December 28).

Head (honours graduate in chemistry, physics or metallurgy, with teaching, industrial and/or research experience, Corporate Member of a Professional Institution, and preferably experience of administration in a Senior Technical College) of the Department of Pure and Applied Science (Grade II), at Enfield Technical College, Queensway, Enfield, Middlesex—The Secretary to the Education Committee, Middlesex County Council, 10 Great George Street, Westminster, London, S.W.1, quoting Ref. F/CW/2 (December 29).

Physics Graduate in the Department of Radiotherapy, for duties which include physical investigations concerned with the clinical use of rotation therapy, multicurie cobalt units, low voltage X-rays and radioactive isotopes, and also some teaching of radiographer students—The Assistant Administrator, The Churchill Hospital, Headington, Oxford (December 29).

Assistant Lecturer or Lecturer (preferably with special qualifications and interests in mineralogy and petrology) in Geology—The Registrar, University College of North Staffordshire, Keele, Staffs (December 31).

Research Fellow (male graduate in some branch of physical science, with experience of observing, and preferably also of photographic work) to assist the Superintendent at the Norman Lockyer Observatory, near Sidmouth—The Secretary, The University, Exeter (December 31).

Lecturer or Assistant Lecturer in Mathematical Statistics—The Registrar, The University, Manchester 13 (January 1).

Chemist (with a degree of a British university and/or Associate Member of the Royal Institute of Chemists) with the Basildon Development Corporation, Sewage Treatment Works, to make chemical analyses of sewage effluent, trade wastes, etc.—The General Manager, Basildon Development Corporation, Gifford House, Basildon, Essex (January 4).

Hospital Biochemist, Senior grade (with a university degree in science or equivalent qualification) in the routine Biochemical Section of the Department of Clinical Biochemistry—The Administrator, Radcliffe Infirmary, Oxford (January 4).

Research Fellow or Senior Research Fellow in Poultry Science in the Faculty of Rural Science—The Registrar, University of New England, Armidale, New South Wales, Australia (January 7).

Head (with an engineering degree, Corporate Member of a Professional Engineering Institution, experience in industry and preferably as head of a department or senior lecturer in a technical college) of the Department of Engineering, Singapore Polytechnic—The Secretary, Advisory Committee on Colonial Colleges, 1 Woburn Square, London, W.C.1 (January 15).

Lecturer (with a good honours degree, diploma in education, and suitable teaching experience) in Geography, in the Department of Teacher Training, Kumasi College of Technology, Gold Coast—The Secretary, Advisory Committee on Colonial Colleges, 1 Woburn Square, London, W.C 1 (January 15).

Pharmacologist (with a university honours degree with physiology and biochemistry as major subjects, and research experience in pharmacology) at the Laboratories of the Division of Animal Health and Production, Commonwealth Scientific and Industrial Research Organization, Parkville, Victoria, Australia, to undertake and expand investigations on the pharmacological and toxicological properties of substances extracted from Australian plants, with special reference to alkaloids—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting Appointment No. 201/105 (January 19).

Drummond Fellows for Research in Nutrition—The Honorary Secretary, Drummond Trust, University College, Gower Street, London, W.C.1 (January 31).

Lecturer in Psychology at the University of Natal, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, January 31).

Assistants in Chemistry—The Secretary of University Court, The University, Glasgow (February 1).

Postgraduate Research Scholars for research in Chemistry, Household Science, Nutrition or Physics—The Secretary, Queen Elizabeth College (University of London), Campden Hill Road, London, W.8 (March 1).

Assistant or Associate Professor (with graduate training in physics, and research and practical experience in the field) of Geophysics—Head, Department of Physics, University of British Columbia, Vancouver 8, B.C, Canada.

Isotope Assistant (with a first- or second-class honours degree in physics or physiology)—The House Governor, King's College Hospital, Denmark Hill, London, S.E.5.

Laboratory Technician (with G.C.E. science and mathematics, preferably at advanced level, or laboratory qualifications) in the Physiology Department to assist with research—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2.

Laboratory Technologist (preferably A I.M.L.T., and at least two years experience in a medical or veterinary biochemistry laboratory) in the Nigerian Federal Government Department of Veterinary Research, to assist the Biochemist in investigation of normal and abnormal conditions in livestock—The Crown Agents, 4 Millbank, London, S.W.1, quoting M.3/43811/NF.

Lecturer (with a good degree and preferably industrial experience) in Metallurgy—The Secretary, Royal College of Science and Technology, Glasgow.

Parapsychologists (preferably married couple under 30, with degrees in psychology or allied subjects), to assist with the work of the Institute—The Director, Institute for the Study of Mental Images, Church Crookham, Hants.

Physicists, Principal Scientific Officers to fill responsible positions in a group developing prototype military reactors, and Senior Scientific Officers/Scientific Officers to assist them—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting Ref A.1255/34.

Research Officer (with at least a Bachelor's degree in physics or engineering physics, plus several years experience in the theory of wave propagation, seismology and acoustics) in the Division of Building Research, National Research Council of Canada, Ottawa, for duties which will include basic research in ground vibrations, their propagation and their effect on building structures; dealing with construction problems relating to ground vibrations; studying effects on building structures of earthquakes, blasting, pile-driving, etc., and developing suitable instruments for the above studies—The Employment Officer, National Research Council, Sussex Drive, Ottawa 2, Canada, quoting Br.169.

Scientific Officers (Chemists) in the Metropolitan Police Laboratory—The Secretary, Room 165(S), New Scotland Yard, London, S.W.1.

Senior Technician in the Zoology Department—The Secretary, Royal Holloway College, Englefield Green, Surrey.

Statistician (with a degree in statistics or mathematics, and preferably experience in industry), to act as chief assistant to the Head of the Statistics Department, which deals with a wide range of problems in fundamental and industrial research, calling for the use of varied statistical and mathematical techniques—The Secretary, The Hosiery and Allied Trades Research Association, 4 First Avenue, Sherwood Rise, Nottingham.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Report of Her Majesty's Civil Service Commissioners for the period 1st April, 1955, to 31st March, 1956. Pp. 39. (London: H.M. Stationery Office, 1956.) 2s. 3d. net. [1710

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Responses of Vegetation to Fire: a Study of the Herbaceous Vegetation following Chaparral Fires. By James R. Sweeney. (University of California publications in Botany, Vol. 28, No. 4.) Pp. 143–250+plates 12–27. (Berkeley and Los Angeles: University of California Press; London: Cambridge University Press, 1956.) 2 dollars. [1710

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FREEDOM IN THE UNIVERSITIES

LIKE other forms of freedom, academic freedom in British universities is sometimes misunderstood and too often taken for granted. It is heartening, therefore, to see that such a widely experienced vice-chancellor as Sir Eric Ashby has devoted considerable thought to define the internal conditions under which universities in the British Commonwealth of Nations are able to determine their own policies and to manage their own affairs. His concern was to examine how university constitutions may be worked in order to allow academic men to exercise their many conceptions of academic freedom*.

No university constitution can guarantee academic freedom, and, as Sir Eric clearly shows, almost any constitution can be made to work so that freedom is preserved. Oxford and Cambridge are autonomous societies, governed by academic men and without lay control. Since 1889 the Scottish universities have been governed by Courts on which there is some lay representation, although responsibility for academic matters is delegated to the Senatus, which is composed predominantly of professors. The modern, or civic, universities are governed by Councils composed predominantly of laymen, with some academic representation, though certain powers are delegated to the board of professors, which is usually called the Senate. The universities and university colleges of the Commonwealth have constitutions which resemble those of the British civic universities.

This summary overlooks the substantial variations among constitutions of modern universities. Until 1942, for example, the chief academic board of the University of Sydney (the Professorial Board) could deal officially only with certain delegated responsibilities and with matters referred to it by the lay governing body (the Senate): it was on occasion prevented from expressing its views outside these limits. By contrast, the academic bodies of the Universities of Manchester, Bristol and Nottingham (among others) have, since their foundation, been empowered "to discuss and declare an opinion on any matter whatsoever relating to the University". Even in procedures relevant to the maintenance of academic freedom, no two universities in the British Commonwealth operate in the same way.

A catalogue of university constitutions does not of itself throw much light on the conditions for maintaining self-government. In all constitutions, except those of Oxford and Cambridge, ultimate sovereignty resides in a governing body of which the academic staff does not form a majority; and beneath the governing body there is a hierarchy of finance committees, senates, faculties and boards of studies. Yet in very few universities and colleges in the Commonwealth does the governing body deprive members of the academic staff of the privilege of determining their own policies and managing their own affairs. When their constitutions are worked wisely, universities of the Commonwealth are able to ensure that every permanent member of the academic staff has an opportunity to take part in the formulation of policy, fully as effective as the part taken by the academic body at Oxford or Cambridge. This is surely the freedom which should be most jealously guarded.

Despite their unpromising framework of government, modern universities are able to function virtually as self-governing societies because, in general, the constitutions function, in Sir Eric's words, as "inverted hierarchies". No matter whence they emanate, ideas are fed into the administrative machine at the level of a department or faculty board and seep gradually upward until they are eventually submitted to the predominantly lay Council for approval. By and large, the main direction of flow of new ideas and proposals is from below upwards, and not in the reverse direction.

If there is to be academic freedom, the academic staff in a university should have *de facto* control of the following functions: (1) the admission and examination of students; (2) the curricula for courses of study; (3) the appointment and tenure of office of academic staff; and (4) the allocation of income among the different categories of expenditure. In healthy universities it is found that the governing body delegates these functions—sometimes by tradition and sometimes by legislation—to the academic body; and in healthy universities the academic body ensures that this delegation is not merely to an oligarchy of professors but is well dispersed among the whole teaching staff. Where, for one reason or another, *de facto* control of these functions is withheld from the academic body, academic freedom is insecure.

If lay governing bodies were to intervene in the admission of students, for example, there would be justifiable resentment from the academic staff. It is rare in the British Commonwealth of Nations for a qualified student to be excluded from a university on grounds of race or colour or religious or political belief; for this reason developments in South Africa are regrettable and disturbing.

A more common weakness is for the university to lose its control over standards of admission by accepting automatically any student who has passed, at some prescribed level, examinations controlled by an outside body. Indirectly, too, the university loses some control over its own standards of admission when recalcitrant local education authorities like the West Riding of Yorkshire refuse to finance students who, despite their having been accepted by a university, do not possess qualifications which are satisfactory to the local education authority.

In any university which claims to manage its own affairs, members of the academic staff must have *de facto* control of academic appointments. This is recognized in most university constitutions, which give the governing body authority to appoint academic staff only "after considering a report from the Senate". The effect of the general practice is to put the real responsibility for filling academic posts on the shoulders of the academic staff.

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* *Bulletin of the Committee on Science and Freedom*, No. 7 (G. Polanyi, Wilmslow Road, Manchester; December 1956).

The procedure is not without its dangers. The Councils of a few universities still require two or more nominations from the academic body, and reserve the right to select the successful candidate on their own initiative from among these two or three names; in making their selection, Councils have been known to show preference for candidates with local or regional connexions. This is detrimental to the well-being of any university, and should be strenuously resisted.

Security of tenure in academic posts is guaranteed because most universities do not give themselves the power to discharge academic men except for moral turpitude or incapacity to fulfil their contracts; even then it is a power very rarely exercised. On those rare occasions when disciplinary action is taken against an academic man, the wise vice-chancellor ensures that the investigation, the report and recommendation are made by a group of the man's academic colleagues, and not by the lay governing body. There is an admirable tradition in the British Commonwealth which permits academic men to hold political and religious opinions with impunity, however repugnant these opinions may be to the governing body, and (on occasion) however irresponsible and indiscreet some academic men may be in promulgating their views.

This, and much other evidence besides, leaves no doubt that self-government is as widespread and as effective and secure in modern British and Commonwealth universities as in our two ancient self-governing universities. The constitutional differences between the two kinds of universities and the fact that there is *de jure* lay control in one kind and not in the other do not greatly influence the ways in which universities manage their affairs. In all of them policy is in the hands of the academic staff; where this is not guaranteed by statute it is ensured by tradition.

Whatever else flows upwards in universities, however, money flows downwards. Considerably more than half the income of all British universities comes from the public purse. No degree of self-government within universities could avail to protect them against intervention from their paymasters if they cared to intervene. In fact, in the United Kingdom, the paymasters have never intervened and show no sign that they are likely to do so.

Here is the potential danger to academic freedom in universities. The academic staff may control admissions, examinations, courses of study, and appointments; yet a lay finance committee, under a lay honorary treasurer, might so recommend the allocation of funds as to encourage one faculty more than another, or one department more than another, without regard to the wishes of the academic body. The constitutions of modern universities provide no safeguard against this, and here a heavy responsibility falls on the vice-chancellor.

The long and noble heritage of academic freedom in Europe has been preserved by a technique for working almost any form of constitution. The technique is to secure government by consent and, after consultation, by ensuring that there is an upward and not a downward flow of business and policy-making. There is an important condition for its survival, namely, that the principle of upward flow shall apply throughout the whole hierarchy and not merely between the Council and Senate. Yet, as Sir Eric shows, "not all professors consult their lecturers as scrupulously as they themselves expect to be consulted by the lay governors before decisions are made. As faculty boards become larger, there is a temptation for an oligarchy of senior professors to take over the responsibilities of government on behalf of their more junior colleagues. That way danger lies, for any weakening of the principle of self-government within the academic body makes it harder to preserve self-government within the university as a whole, and correspondingly harder to maintain the autonomy of the university in the modern democratic State". Who wishes to be consulted must consult.

RAMSAY

A Life of Sir William Ramsay, K.C.B., F.R.S.

By Prof. Morris W. Travers, F.R.S. Pp. viii+308+9 plates. (London: Edward Arnold (Publishers), Ltd., 1956.) 50*s*. net.

THIS is a book which one cannot put down: it is even dangerous to pick it up of an evening, unless the next day is to be an 'off' day. As scientific drama it is enthralling; as scene and portrait painting, vivid; and yet as history, which is fully and cogently documented, it is thorough; while the scientific descriptions, as one would expect, are technically precise. In this volume, written by Prof. M. W. Travers between his eighty-first and eighty-third birthdays, with all the strength of style of a man in his prime, we find a remarkable combination of high literary merit, good history, and good science.

In his preface, the author mentions his source-material. In 1913, Ramsay himself, at Ostwald's request, wrote a short autobiographical sketch, which is chiefly interesting for Ramsay's views on the influence of his ancestry, parentage, education and early contacts on his life and work. In 1916, Ramsay died. In 1918, Tilden published his "Memoir" of Ramsay, in which he records much of what is known of Ramsay's childhood and youth. But his account of Ramsay's scientific work is uneven, and, as to his most important work, arid. The reason is that Tilden had no contemporary contact with it: he was never one of the "band of brothers", which Soddy found in London at University College, as he has described, when he came from Montreal to join Ramsay. Travers was one of that band: he and Ramsay together had discovered and isolated three of the five permanent rare gases. So Travers knew it all from the inside. In 1928 he had, with the aid of Ramsay's laboratory note-books, lent to him by Lady Ramsay, made a study of it in his "Discovery of the Rare Gases". Then, when Lady Ramsay died in 1937, she left a large collection of Ramsay's letters and other papers, which her daughter, Lady Tidy, presented as working material to Prof. Travers. These letters contained a wealth of illuminating information, some of it of first importance in relation to historical matters which had remained obscure or had actually become garbled for lack of precise information. Here was ample material for a new and authoritative biography. Prof. Travers spent the years 1937–39 and 1948–52 ordering this material, in combination with material which he had himself collected. The whole of this annotated source material, bound in twenty-four volumes, has since been presented by Lady Tidy and Prof. Travers to University College, and is now preserved in the library of the College. In 1952, Prof. Travers began writing the present book.

The book is fundamentally a critical as well as an informative contribution to scientific history. But Ramsay left so much on paper, as well as in survivors' memories, that revealed his personality, that the book is also a vividly graphic human biography. We see Ramsay making music, swimming and diving, sailing small boats, learning to paint, learning languages, making numerous friends, making journeys especially to see them, conversing with them, and writing them long and entertaining letters, his letters, like his conversation, full of wit, humour and generous feeling. We see him as a public figure, working unselfishly, often at tremendous pressure, for the organization of university education or of science; and we see him as "a fellow sticking in with tooth and nail to his work" in the laboratory—to quote a description he once gave of himself.

A reviewer must not spoil the story, but the reader of this book will discover how this man of many parts kept the University College of Bristol's head above water when it was almost drowning financially; how he took an initiative which led to the original establishment of government grants for British universities and university colleges; how he organized the first considerable importation of radium into Britain, at first for purely scientific purposes; how he then, with medical colleagues, founded radiotherapy; and how, with other colleagues, after sustained effort, he got it recognized in the University of London that the most fundamental university activity is research, and that teaching is barren without it. To this day, the University of London will dignify no one with the name of 'Teacher' who cannot show a considerable record of research publications.

So little support had research in universities in Ramsay's most productive period that he had to do consulting work, in order to earn the money to buy the materials to do it. These were the conditions in which he elucidated laws of liquid-vapour equilibria, partly with Sydney Young, discovered and isolated argon with Rayleigh, discovered and isolated terrestrial helium, discovered and isolated neon, krypton, and xenon with Travers, proved with Soddy the α-rays of radium to be charged helium, and measured the atomic weight of radon with Whytlaw-Gray, laying bare in this last work the pattern of radioactive change. Ramsay and Soddy bought their own radium with their savings or pocket-money. Travers got his compressor by reversing the valves of an old vacuum pump, and generated the hydrogen that he had to liquefy to attain the low temperature needed, from zinc and sulphuric acid in a beer barrel. Whytlaw-Gray's first 'research work' (he has told me this—it is not in the book) was to paint an old and rusty gasometer in an effort to make it gas-tight.

I personally would have liked the book to include some account of Ramsay's early views on the electronic theory of chemistry, which were ahead of their time; and I would have enjoyed a somewhat fuller account of the work with Whytlaw-Gray on radon, one of the finest examples of chemical manipulation of all time. However, Prof. Travers does go very fully and frankly into the one error by Ramsay, which has brought so much comfort to his detractors. In this again Ramsay was, in thought, far ahead of his time: he believed in the possibility of artificial transmutation—of 'atom splitting'—when no one else did, when to do so was heretical. He searched for it, and thought that he had found instances of its realization, in spectrum-analytical amounts; but actually impurities, in those amounts, had found their way, during his manipulations, into his apparatus. Ten years later, Rutherford really observed it, but only in one atom at a time. Three decades were to pass before it was effected on any analytical scale.

The book is illustrated, not only in the conventional manner of a scientific biography, with portraits, photographs of apparatus, and the like, but also with many photographic reproductions from hand-written letters by Ramsay, and to Ramsay, and from his laboratory note-books. Of course, the extracts thus reproduced are selected for their historical importance: they add greatly to the value of the book as history. But this sort of history is not dry or heavy with detail: days of joy are in store for all who read this permanently important contribution to chemical history.

C. K. INGOLD

SOCIAL CHANGE IN NEW GUINEA

New Lives for Old

Cultural Transformation—Manus, 1928–1953. By Margaret Mead. Pp. xxii + 548 + 16 plates. (London: Victor Gollancz, Ltd., 1956.) 25*s*. net.

DR. MARGARET MEAD returned in 1953, after an absence of twenty-five years, to Manus in the Admiralty Islands, the scene of her "Growing up in New Guinea". In the interval, the Manus had been occupied by the Japanese and liberated by the Americans, and had adopted, first a millenary cult which promised that a magical cargo of all kinds of trade goods would arrive if they threw all their old possessions into the sea, and then a rational modernization movement known as the 'New Way of Thinking'. This involved the union of thirty-three villages under a single elected council, the teaching of all boys to read, the establishment of a communal treasury from which, among other aims, alienated land would be brought back, the re-siting and re-building of villages and other public works by the labour of the whole population under the instructions of the elected leaders. Many of these activities were in line with the reconstruction policy of the Australian administration. The Manus were also bidden by their leaders to cease from the quarrelling which Dr. Mead had found so prevalent twenty-five years before, and not to support their kinsmen if quarrels did arise. She refers often to the 'code' of the New Way, and once to an offence under it, but she does not record it. Of the leader, Paliau, she says that his ideas as to method were vague, though he was certain that "the old bad culture was to be completely abandoned for a new culture which would bring the natives into world culture".

The lesson of Manus, in Dr. Mead's view, is that we need not be as apprehensive as some anthropologists have been of the disturbances that may be caused by radical social change. We should realize that the worst difficulties arise from the incomplete adjustments which Europeans force on subject peoples by 'selective giving'; both the phrase and the idea come from Malinowski, though the source is not acknowledged. Dr. Mead does, however, state the grounds for these apprehensions, and she makes quite clear the difference between the reasonable views which anthropologists have held and the absurd ones with which they have been credited. There cannot be many anthropologists now outside South Africa who believe that non-European peoples should be discouraged from adopting Western techniques and the social organization that goes with them. But Dr. Mead's own account suggests that the mere desire for change, even for total change, is not enough—that even if we no longer hesitate to promote change for fear of the problems that it will create, we must still realize that there will be problems. Some of us believe that the most useful application of the anthropologist's knowledge consists in pointing out these problems.

Not many British anthropologists would interpret the process of change as Dr. Mead does. For her, it occurs if a people's education has moulded their personality in such a way that they are capable of change, and if an example is offered to them which they consider worthy of imitation.

The entity which changes is a 'culture', a collection of ways of acting, feeling and thinking, and the change is a process of imitating the ways of others. In the case of the Manus, the example was the democratic way of life as embodied in the 'G.I.', who is friendly with his fellows instead of being surly and suspicious as adult Manus used to be. In Britain we do not see 'cultures' in confrontation, one 'accepting' or 'taking' items from the other as though they were displayed for sale, nor do we consider that society cannot change without changes in personality. To us a society is a body of people united by a system of recognized relationships within which they compete for such advantages as the system offers, including, of course, public esteem. The new situations that arise when a small-scale society is incorporated into a much wider economic and political system offer new opportunities, which again individuals exploit in so far as they expect to derive advantage from them. The difficulties of adjustment are difficulties of choice between alternative courses of action; the new activities may involve loss of esteem, the neglect of obligations, or conflict with vested interests; or the advantages of a change which is offered as an improvement may not be clear. A formidable difficulty in Dr. Mead's argument is that she tries at one and the same time to treat the events in Manus as the product of a unique combination of favourable circumstances and as a basis for generalization. Actually many simple societies have willingly accepted changes as radical as have the Manus, after an early period of conservatism such as the Manus also went through, but without their cataclysmic recent history. Not many of these, so far, have been in New Guinea. But the fact, which Dr. Mead insists upon so often, that New Guinea techniques are those of the Stone Age is not really very significant. The possession of iron tools does not imply a social organization so much nearer to that of the West as to make New Guinea unique.

Dr. Mead's writing is, in the main, refreshingly untechnical, though it is at the same time so sentimental that the straightforward physiological terms which she uses here and there produce a shock of incongruity. She seems to be cajoling an audience whose attention would not be held by a more matter-of-fact presentation, and this may cost her the interest of a harder-headed public. L. P. MAIR

MODERN PHYSICS FOR ENGINEERS

Modern Physics

A Textbook for Engineers. By Prof. Robert L. Sproull. Pp. xii+491. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1956.) 62s. net.

THE engineer who has a sound knowledge of wave propagation and communications theory, and is master of the associated mathematics, approaches modern quantum mechanics equipped with the basic concepts and vocabulary and much of the necessary technique. Prof. R. L. Sproull's excellent book is written for this type of reader, to supply a theoretical background leading to a proper understanding of physical processes of engineering importance. Electrical analogies for problems in other fields, such as optics and acoustics, arise naturally, of course; and, indeed, extracting the fullest significance from a differential equation by applying it generally ought probably not to be called analogy, unless we extend the term as far as wave mechanics itself. But the feature which makes the book so clear and interesting to read is the author's regular appeal to some macroscopic wave property of electromagnetic waves that is comparable with the behaviour of a wave-function; the theoretical physicist is shown, in fact, to be using the same methods as the practical man, though applying them to quite different problems.

Fundamental experiments on the particle and wave properties of the electron, proton and neutron are described in the earlier chapters and lead up to the idea of a particle guided by a wave-packet. The indeterminacy principle is shown to arise if we attempt to discern two co-ordinates of a wave-packet regarded as a modulated continuous wave, and the principle is discussed more fully with reference to pulse spectra in an appendix. Next, the Schrödinger wave equation is stated, and the meaning of the wave-function Ψ explained. The first step is to show that the equation does lead to some results when applied to simple problems: the case of a free electron in a square potential well, and then a bound electron. The rigorous analytical treatment is accompanied by a transmission-line analogy. Having, so to speak, established confidence in the method, the author applies it next to the Coulomb-field potential of the hydrogen atom, and shows that quantum numbers arise inevitably in the theory. 'Allowed' transitions with unsymmetrical integrals are likened to the radiating property of an antenna driven out of phase, and the transitions that are 'forbidden' because of symmetry to the non-radiating in-phase driven antenna. The exclusion principle, illustrated by the electronic structure of light atoms, is explained in more general form to prepare the reader for its use in solid-state theory.

A detailed quantitative discussion of ionic and covalent binding precedes the chapter on crystals and the metallic state. Lithium is taken as a typical metal, and the reason for its metallic properties deduced from its 2*s* wave-function. Next, a one-dimensional square-well model of a metal is considered, and compared with a wave-filter for which V is the analogue of Ψ. It is pointed out that matters are much more complicated with actual potential distributions in three dimensions (Brillouin zones are mentioned but not discussed) but that the general principles are the same. Three chapters on the mechanical, thermal and electrical properties of solids follow ; and these properties are explained in terms of quantum mechanics. Semiconductors and their many applications are treated fully, and the final chapters deal with thermionic emission, electron optics, radioactivity, and nuclear reactions.

The book is satisfying because the author does not attempt to oversimplify a difficult argument, but instead precedes it by taking simpler cases which allow of a naturally straightforward treatment and analysing them thoroughly. The mathematics is kept to a level that does not require the specialist techniques of the mathematical physicist. For example, the Fermi distribution is introduced with the statement that a Maxwell distribution for conduction electrons could not satisfy the exclusion principle, and this one does ; the formula for the Fermi distribution is stated without proof, but its meaning and some of its consequences are explained and worked out quantitatively in the fullest detail.

Many numerical exercises are included, and at the end of each chapter there are references to standard treatises ; the reader who has worked through this book should certainly be well equipped to consult such more specialized works with understanding.

G. R. NOAKES

DISEASES OF TOBACCO IN AFRICA

Tobacco Diseases, with special reference to Africa

By Dr. J. C. F. Hopkins. Pp. xvi+178+4 plates. (Kew : Commonwealth Mycological Institute, 1956.) 35*s*.

THIS book is one of a series published by the Commonwealth Agricultural Bureaux on diseases of tropical and subtropical plants. Dr. S. P. Wiltshire says in his foreword that it is designed for plant pathologists, extension officers and tobacco farmers.

The first part of the book is devoted to a detailed consideration of the problems involved in the production of disease-free tobacco seedlings and the maintenance of healthy plants from transplanting to reaping. The subjects discussed include the preparation of seed-beds, cleaning and disinfecting seed, spraying both in the seed-beds and in the field, and the effects of some cultural practices on disease control. The main points of all these operations are dealt with fairly comprehensively, though some of the recommendations will be questioned by the more progressive growers and by many of those engaged in tobacco research in Rhodesia to-day. Some examples of these might include the use of bricks and cheese cloth in seed-beds, the advice to remove and burn or compost all tobacco stalks in preference to ploughing them in, and priming (removal of lower leaves) as a method of disease control.

The second part of the book contains detailed descriptions of symptoms of diseases and disorders which may be encountered by tobacco growers. Following the pattern of his earlier handbook, "Diseases of Tobacco in Southern Rhodesia", the author introduces each description with a few notes on the causal organism. There are many excellent photographs and coloured plates showing symptoms of the diseases which are described in the text, and these should prove useful to students of tobacco culture, extension officers and farmers. The descriptions include some bacterial, fungal and virus diseases which are comparatively rare, as well as those which are more common. There are also sections dealing with physiological, deficiency and miscellaneous diseases and those peculiar to the curing barn.

Some of the control measures advocated do not find support in the data and recommendations published by the Tobacco Research Board of Rhodesia and Nyasaland in recent years. To that extent this book will tend to confuse rather than to clarify the thoughts of farmers on the control of diseases in tobacco. Nevertheless, this book brings together the author's experiences and personal observations of tobacco disease problems in the course of a long career in Africa, and will therefore be read with great interest by those working with this crop.

I. NEAS

BIOLOGY OF SENESCENCE

The Biology of Senescence

By Dr. Alex Comfort. Pp. xiii+257. (London : Routledge and Kegan Paul, Ltd., 1956.) 25*s*. net.

DR. COMFORT has made sure that there are no misconceptions about the subject of his book by calling it the "Biology of Senescence" rather than "The Biology of Ageing". He goes still further in precision by defining what he means by senescence. It is, he says, an increasing likelihood of death with increasing age, or "a decrease in viability and an increase in vulnerability". This precision has much to support it, and in fact one might say that the advance of gerontological studies is to some extent dependent upon the use of a scientifically accurate nomenclature. The word 'ageing', which is often used synonymously with 'senescence', has a very much wider connotation and could include all the changes in the individual following conception and until death.

In his book Dr. Comfort first provides an introduction and historical discussion. In this he devotes some space to that remarkable sponsor of the term 'biological time', Lecomte du Noüy, who in 1936 devoted a good deal of thought to a discussion of the significance of physiological and physical time : "Everything, therefore, occurs as if sidereal time flowed four times faster for a man of fifty than for a child of ten" and "a year . . . seems longer to a child" . . . . "Thus we find that when we take physiological time as a unit of comparison physical time no longer flows uniformly". Dr. Comfort takes a cue from these metaphysical circumlocutions and adds to this system "alcoholic time", which he defines as the apparent progress of a bottle towards emptiness as it appears to the alcoholic who drinks it. The author's final conclusion about Du Noüy's discussion of time is that he "has gone down clutching a platitude and come up embracing a metaphysical system". In other words, just as physiology suffered for hundreds or even thousands of years from the attempts by Pythagoras to apply the lore of number to it, so the study of senescence has long been bedevilled even to the point of "intellectual disaster" by this type of attempt to describe it in mathematical terms.

But it must not be thought that Dr. Comfort's book is all metaphysical discussion; far from it—there is (if one may be pardoned such a metaphor at this point) plenty of meat in it. There are sections on the nature and criteria of senescence, maximum longevities among various animals, the maximum life-span in man, the distribution of senescence among vertebrates and invertebrates, senescence in Protozoa, the influence of genetic constitution on senescence and longevity, growth and senescence and the mechanisms of senescence.

Dr. Comfort's book is the most comprehensive review on the subject of senescence that has appeared since 1920. The publishers' notice on the cover claims that it has been written to marshal information and suggest lines of investigation for the experimental attacks on old age. In my opinion it fulfils this aim, and it thus becomes an essential part of the bookshelf of anyone interested or working in the field of senescence—or even of 'ageing'. G. H. BOURNE

ENTROPIC ASPECTS OF INFORMATION THEORY

Science and Information Theory

By Prof. Leon Brillouin. Pp. xvii+320. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1956.) 6.80 dollars.

THE theory of information has not been long in gathering a motley crowd of associates. Too often, in consequence, it has found itself vaguely identified with a wide variety of studies, for which in fact it serves merely as a new and useful tool. "Science and Information Theory", by Prof. L. Brillouin, is a book calculated severely to redress the balance. For Brillouin, information theory means simply what might be called the statistical theory of 'unexpectedness', developed chiefly by Wiener and Shannon for the purposes of communication engineering.

The mathematical 'unexpectedness' or improbability of a signal, measured logarithmically, (log $1/p$), is directly related to the size of the most economical code-symbol to represent it. The average unexpectedness ($\Sigma p_i \log(1/p_i)$), over a long sequence of signals, indicates the minimum average number of code-symbols necessary for each signal-transmission. Extremely important and illuminating coding theorems follow from this quantification of 'unexpectedness' as the additive measure which has operational significance for the code-designer, and it is not surprising that it is termed the 'amount-of-information' in the signal.

Unfortunately, as Shannon has been quick to point out, the improbability of a message need have no direct connexion with its logical content—with the number and complexity of the statements it makes. His measure is not, therefore, as Brillouin (p. 1) would have it, a definition of *information*, but merely of the *unexpectedness* of information. As a mathematical index of unexpectedness it can be applied, of course, to other things than messages—to states of thermodynamic systems, for example, in which context the same average measure has long been known under the name of entropy. The entropy of an under-specified system is numerically proportional to the 'unexpectedness' of the information which a complete specification would provide.

It is this equivalence of entropy and 'amount of information' (in Shannon's sense) which Prof. Brillouin is chiefly concerned to trace in a wide variety of physical situations, including the mythical case of Maxwell's 'demon'. The treatment is lucid, rigorous and illuminating at many points; but the persistent confusion of the concept of information with the unexpectedness of information leads to unnecessary mystification at a number of points. A particularly unconvincing example is the discussion (p. 155) of "free information", as something held "in the mind" and so "not directly connected with any physical system". Metaphysics has its proper place; but this is metaphysics misplaced. The 'unexpectedness' which Shannon defined by $\Sigma p_i \log(1/p_i)$ is not (*contra* p. 10) an absolute quantity, but a function, defined only in relation to a chosen distribution of prior probabilities or 'ensemble' of events. In physics the distribution may be fixed by the temperature of the system; but in other contexts the probabilities may be determined quite otherwise, and the direct relation of Shannon's measure to physical entropy disappears. Much of the mystery can be removed if the reader will substitute 'unexpectedness' for 'information' wherever the Shannon measure is discussed, and define the relevant ensemble; but one is left with the feeling that many questions would have been differently expressed had the author done the same.

Having equated "Information Theory" with Shannon's theory of unexpectedness, Prof. Brillouin has to disclaim for it any interest in questions of the meaning and value of information. In point of fact, as the proceedings of three London symposia on this subject can illustrate, the general theory of information has a well-defined place for measures of *descriptive* information-content as well as of unexpectedness. The author does not appear to realize, for example, that the measure developed by Gabor, which he describes on p. 100, is precisely one of the measures of "structural information-content" (termed "logon-content" by Gabor) for which later (p. 291) he finds no place. To talk of "inconsistencies" (p. 291) between these complementary measures is simply to reveal misunderstanding of their nature.

As one might expect, the incidental expositions of fundamental physics throughout the book are masterly. It is gratifying, too, to find lucid accounts of work such as Mandelbrot's on word-statistics, and recent developments in the design of error-correcting codes, included among the more conventional topics. Schouten's name, on the other hand, is not mentioned, despite the similarities between some of his ideas and Brillouin's.

This is a stimulating work—sometimes to insight, occasionally to exasperation. A novice seeking to learn the gist and drift of information theory may find easier introductions elsewhere; but for the student who wants to broaden and deepen his thinking in Prof. Brillouin's chosen portions of the subject the book is to be recommended. D. M. MACKAY

The Draining of the Fens

By Prof. H. C. Darby. Second edition. (Cambridge Studies in Economic History.) Pp. xx+314+31 plates. (Cambridge: At the University Press, 1956.) 35s. net.

THE second edition of this well-known work follows sixteen years after the first. During that time much has happened in the Fens. The floods of 1947 and the threat of severe floods in them during the tidal surge of 1953 are in the memory of most of us. Prof. H. C. Darby does not, of course, write at great length on these matters, since they are but recent, even if particularly severe, episodes in a long line of floods and threats of floods in the past; but in his final chapter he brings his discussion of the draining up to date.

In other respects there are few alterations: minor errors are corrected, and the bibliography has been lengthened. It remains, as was recognized in 1940, a first-class account of one of the most interesting areas in Britain. Prof. Darby writes perhaps primarily from the point of view of the historical geographer, and the briefest glance at the book will show how very familiar he is with his authorities; but he has also made himself fully acquainted with the engineering problems which are so complex. I would have welcomed a rather more detailed discussion of his own views and those of Dr. H. Godwin on the lowering of the surface of the Fens, although there has been considerable modification made on pages 107–110 in the new edition.

The request to review this new edition was welcome in that it gave an added reason to re-read the book. It is, and will long remain, the standard work on the subject; and those who read it for the first time will not fail to be impressed by the extremely clear and scholarly way in which a highly complex subject is presented. It is a companion volume to the author's "The Medieval Fenland". J. A. STEERS

Structural Geology for Petroleum Geologists

By Prof. William L. Russell. Pp. x+427. (London: McGraw-Hill Publishing Company, Ltd., 1955.) 56s. 6d.

THIS book is exactly what its title indicates. It is designed to guide the student and to refresh the memory of the established petroleum geologist. These are busy men absorbed in their business and have little time or inclination to read anything unessential. Structural geology, however, is essential to the finding and winning of oil, and Prof. W. L. Russell has succeeded in providing a useful and readable book. General theoretical discussion is limited, but many well-chosen examples of structure are provided as illustrations. The author remarks that "petroleum geologists at the present time rarely get training in surface field mapping after being employed", and this tendency to do more work inside and less outside seems to be true in much American experience. It means that what used to be common daily observation when petroleum geologists were field men is no longer so, and reading a book like this occasionally will serve to keep a trusty weapon sharp and bright.

A few bibliographical omissions have been noted. Hans Cloos is not mentioned in the account of structure models. J. W. Gregory does not appear in the historical reference to rifts. W. Q. Kennedy is left out of the list of literature on faults, although S. J. Shand's adverse comment on his work is quoted. M. I. Goldman's *magnum opus* on Cap Rock (*Geol. Soc. Amer., Mem.* 50) is absent, although some of his lesser earlier papers are mentioned. Fig. 5–21, p. 134, is a puzzle; but if it depicts a map of anything it is a horst and an anticline, not a graben and syncline. J. V. HARRISON

Mass-Transfer Operations

By Prof. Robert E. Treybal. (McGraw-Hill Series in Chemical Engineering.) Pp. ix+666. (London: McGraw-Hill Publishing Company, Ltd., 1955.) 71s. 6d.

IN this book Prof. R. E. Treybal has summarized a vast amount of up-to-date and valuable information on the basic principles of diffusion and mass transfer, the operations depending on them, and their application to the design of plant. He divides these operations into gas–liquid, liquid–liquid, solid–fluid, and those with immiscible phases, and sub-divides them into humidification, gas absorption, distillation, liquid extraction, adsorption and ion exchange, drying, leaching, and "less conventional" operations such as dialysis and thermal diffusion.

The chapters on liquid extraction, adsorption and leaching are in many respects novel and deserve special commendation. Although the treatment is primarily theoretical the author has recognized the danger of a succession of formulæ becoming tedious (there are 144 under "distillation") and has broken up the text by introducing large numbers of excellent graphs and numerous "illustrations", that is, worked-out problems. There are also many clearly drawn diagrams showing the nature of the plant in which the operations under discussion are conducted. The whole makes a most informative and readable book.

One difficulty remains unsolved—the large number of symbols, still far from being standardized, necessary for the calculations. The author, in an endeavour to find a solution, has listed the notation for each chapter separately, but even this involves much turning over of pages during reading. With a new edition, which seems likely to be called for soon, the issue of a separate card with tables of symbols might well be considered. H. E. WATSON

Scientific and Learned Societies of Great Britain

A Handbook compiled from Official Sources. 58th edition. Pp. 211. (London: George Allen and Unwin, Ltd., 1956.) 35s. net.

THE second post-war edition of this compendious handbook, for which the British Council is now responsible, is on similar lines to the previous issues. Part 1 gives the names and addresses of research organizations administered by the Department of Scientific and Industrial Research, Medical Research Council, Agricultural Research Council and the industrial research associations, with a select bibliography on the organization of scientific research. It also lists the principal scientific and learned societies and institutes in Great Britain under sixteen headings according to their fields of activity, with details of their objects, membership, meetings and publications. Names of officials of these societies are given in some, but not in all, instances. The title pages of the various sections are not numbered, a practice which can be confusing in using a reference book.

An index of subjects and societies completes the volume, which forms a most valuable reference source of British scholarship.

THE KING PENGUIN OF SOUTH GEORGIA

By BERNARD STONEHOUSE

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BREEDING behaviour in king penguins (*Aptenodytes patagonica*) has previously been described only from casual field observations (summarized by Murphy[1] and others) and from records of captive birds[2]. Recent work on a subantarctic colony has shown that neither provides an accurate picture of the remarkable, possibly unique, breeding cycle followed by this species in natural conditions. From October 1953 until December 1954 a colony of five thousand breeding birds was studied in Ample Bay, Bay of Isles, on the north-east coast of South Georgia. Adults, juveniles[3] and chicks were banded for identification and daily observations were maintained throughout a complete breeding season.

Fig. 1 (*A–B*) shows the composition of a 'typical' king penguin cycle generalized from more than a hundred case-histories.

After a period of fattening at sea, usually lasting one or two weeks, the birds spend between four and five weeks ashore undergoing a pre-nuptial moult. They fast during the moulting period, with a fall in weight from 20 kgm. to about 10 kgm.

The moult is followed by a second fattening period at sea, which may take more than three weeks in early spring or less than two weeks later in summer when food is more plentiful. On their return the birds assemble in the breeding colony to begin courtship. At this stage males, weighing 15–17 kgm., are slightly larger and heavier than females; the sexes can usually be distinguished on sight.

Courtship normally occupies about three weeks, but may extend to five or six weeks. A site is selected in the colony (often near the site occupied by one or other partner in the previous season) and is defended against encroachment throughout the late courtship and incubation periods. A single large egg is laid and held between abdomen and feet; no nest is built.

The incubation period is constant at 54–55 days. The first watch of 12–15 days is taken by the male; later the parents incubate alternately in spells which decrease from 12 to 4 or 5 days as full term approaches.

Chicks are fed by their parents through the winter and well into the following spring, usually for a total of 10–13 months after hatching. Well-fed chicks tended by diligent parents are ready for the sea before poorly fed chicks; those which lose a parent during the year take longest to mature but succeed if their remaining parent feeds them competently. Normally, the chicks are abandoned by both parents at some time during the down moult. Within three weeks of delivering their last feed the parents themselves re-appear in pre-moult condition.

The breeding cycle of this species cannot therefore be completed within a year; it usually occupies 14–16 months and may extend over a year and a half. By comparison, the emperor penguin (*A. forsteri*) rears a single chick in 8–9 months, while gentoos (*Pygoscelis papua*) and adelies (*P. adeliae*), like most other species of penguin, rear two young in less than six months.

The king penguin may lay its eggs at any time from late November to mid-April, over a period of 5½ months of the year. A corresponding figure for the gentoo penguin in South Georgia is two months, for the antarctic species emperor and adelie less than a month. Fig. 2 shows the annual duration of activities associated with breeding as seen in the South Georgia colony. The table was compiled and extrapolated from a single year's records; although other observations from South Georgia fit well into the framework, none is sufficiently critical to show whether or not a typical year is represented.

Breeding begins annually in November; and two breeding categories may be distinguished.

Early breeders are those birds which did not breed at all, or bred but failed to rear a chick, in the previous season. Most stay away from the colony throughout winter, although some appear at intervals of 3–4 weeks and associate with successful breeders in the colony. Early breeders undergo their pre-nuptial moult in September and October (Fig. 1, *A*), re-appearing from November onward ready for courtship. In 1953 and 1954 the first eggs were laid on the same date, November 25; by contrast, neighbouring gentoo penguins began laying three weeks later in the second season than in the first. Early breeders reach their peak of laying by mid-December; most have begun incubating by the end of the year.

Late breeders are birds which bred successfully in the previous season. Having fed their chicks through winter and early spring, they moult from late November onward (Fig. 1, *B*) and the first begin courtship early in January. Late breeders reach their peak of laying by mid-February. Although large numbers of courting and incubating birds are present in the colony from November onward, the January influx of late breeders is clearly distinguishable. In 1954 late breeders were estimated to outnumber early breeders approximately in a 3 : 2 ratio. Birds breeding for the first time are believed to form an intermediate group, laying early in January; many pairs

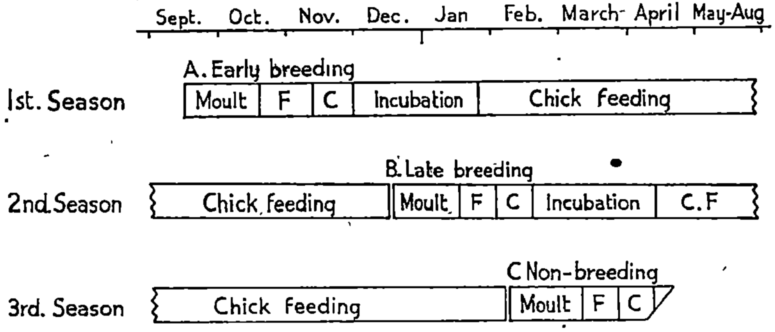

Fig. 1. A typical breeding history, showing the relation of breeding cycles to seasons

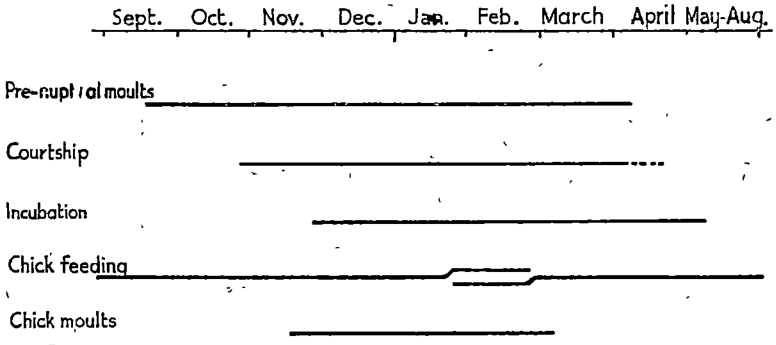

Fig. 2. Duration of breeding activities in all pairs

forming at this time showed indeterminate courtship patterns and inadequate care of their eggs.

Early breeders deprived of their egg lay again with the late breeders; of marked birds in this category more males than females were successful in rearing their chick after the removal or loss of a first egg. The last of the late breeders begin courtship in early April (Fig. 1, *C*); their courtship is desultory and incomplete, seldom resulting in a well-established bond. In May, when the first snow-drifts of the year begin to form, all the remaining eggs are abandoned. At the same time, all the chicks still held by parents are left to join crèches irrespective of their size; those less than a month old are not strong enough to fend for themselves and may die within a week. Only those approaching full size at this stage are likely to survive the winter. Thus, although late breeders may lay their eggs as late as mid-April, observations suggest that only those laying before the end of February succeed in raising chicks.

Fig. 3 shows the growth curve (weight/time) of a typical chick reared by an early breeder. Chicks are hatched with a covering of sparse down and are held closely on the parents' feet for the first week. They are fed every three or four hours by the nursing parent; parents change watch at intervals of 4–7 days. For the first 16–18 days the chicks increase in weight exponentially; later, their weights fluctuate more as large feeds are given less frequently. Chicks stay close to their parents for more than a month; at 5–6 weeks they wander and congregate in crèches which persist through the year from late February onward. The chicks at this stage are left by both parents, which return independently at intervals of about a week to feed them. Studies with banded birds showed that parents feed their own chicks exclusively, recognizing them primarily by sound and calling them out of the crèche with distinctive 'call-signs', to which only their own chick responds.

By late April chicks of early breeders are almost as big as their parents and weigh 11–13 kgm. Those hatched later may reach similar weights in May, but usually remain slightly lighter. Much of the weight is due to visceral and subcutaneous reserves of fat, which are gradually lost during the winter. From May onward feeding becomes irregular, presumably as a result of food shortage at sea, and well-attended chicks may be fed only at intervals of 5–6 weeks. About 2 kgm. of food (triturated cephalopod of unidentified species) are delivered in two or three successive morning feeds; for the next week the parent continues to feed the chicks on a small quantity of mucus (less than 100 gm. daily) secreted in the crop. After staying ashore for 10–15 days the parents return to sea, re-appearing only to bring the next meal. The chicks are by this time covered with down 4–6 cm. thick, and are generally well able to withstand the prevailing cold weather. Growth, as measured by linear increases of beak, foot and flipper, is retarded or stopped; the chicks lose weight at an average rate of 45 gm. daily between feeds, and from April until October there is an overall loss of about 5 kgm. per chick. Only those which reached an initial weight of at least 8 kgm. before May are likely to survive the winter.

In October the parents begin to visit more frequently, and by November are again feeding their chicks at least once weekly. The chicks increase rapidly in weight; by December those with both parents surviving have re-attained or exceeded their autumn weights. The second fattening period is associated with renewed growth and increasing calcification in the bones; the chicks are brought almost to full adult size, although growth is maintained throughout the juvenile (second) year. Juvenile plumage[4] appears under, and gradually replaces, the down. The first chicks enter the sea in December; moults continue through January and early February, but chicks still in down after mid-February are abandoned by their parents and probably are already dying of starvation. Healthy chicks whose parents are lost early in spring may moult successfully after starving for two or three months, and may enter the sea weighing 4–5 kgm., about half the normal weight for a well-fed chick at the end of its moult.

The parents abandon their chicks independently, usually within three weeks of each other, and undergo a prenuptial moult. In two recorded cases, one parent continued to feed the chick while the second completed its moult and paired with a new partner. Asynchrony in moulting, and consequently in courtship, generally ensures that successful parents of one season do not again mate with each other in the following season.

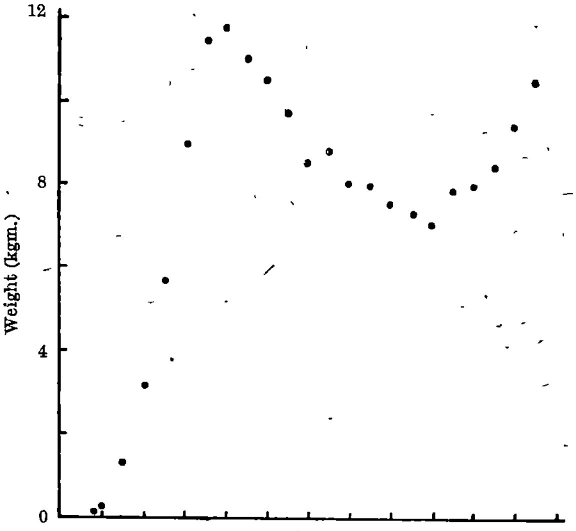

Fig. 3. Bi-monthly weights of a chick from hatching to onset of moult

The problem of fitting a long breeding cycle into a year divided by marked seasonal changes is faced by all large birds of high southern latitudes. The royal albatross (*Diomedea epomophera*)[5,6], possibly also the wandering albatross (*D. exulans*), takes a full year to complete its cycle and breeds only in alternate years. Emperor penguins breed annually but are unique in laying their eggs immediately before mid-winter; the chicks lose their down precociously and are ready for the sea when the fast ice breaks in January and February[7]. The period in which their eggs may be laid is apparently restricted to about a month in all three species. King penguins, which can lay during November–February with every chance of rearing their young successfully, achieve a compromise in being able to raise two chicks in three years. Early breeders of one season, particularly those efficient parents which dispose of their chicks rapidly in spring, may become the successful late breeders of the second season. In the third season they fail to breed, but start again as early breeders at the beginning of the fourth.

Several lines of evidence suggest that king penguins are once again increasing in South Georgia, and are re-colonizing other breeding areas from which they were exterminated during the nineteenth century. These investigations were made on behalf of the Falkland Islands Government, and a full account will be published later in the series of Falkland Islands Dependencies Scientific Reports.

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NIKOLA TESLA (1856–1943)

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TO-DAY, with scientific research conducted by teams rather than individual workers, the lone research worker who in flashes of genius ventured into the uncharted regions of science belongs to the past. One of the most remarkable, if not the most audacious, of these men was Nikola Tesla, many of whose ideas are now commonplace.

Tesla was born a century ago at Smitjan, Lika, in Yugoslavia. He received his earlier education there, at the neighbouring town of Gospic and at Karlovac in Croatia, and it is said of him that even at this time he displayed unusual abilities in mathematics and science. In 1875 he entered the Polytechnic at Graz, graduating in 1878 and proceeding to the University of Prague for graduate work, which he completed a year later.

At this time Tesla's attention was attracted by the invention of the telephone by Bell a few years earlier, and hearing of an exchange being built at Budapest, he proceeded to that city, and when the exchange was completed he was placed in charge of it and had soon patented a telephone repeater for use there. From Budapest, Tesla went to Paris and thence he emigrated to the United States—a step that was to lead to his greatest single achievement. For a time he worked with Thomas A. Edison in the latter's New York laboratory, designing electric machinery; but as Edison favoured direct current for all electrical applications and Tesla favoured his new theory of alternating current, the differences created forced Tesla to leave and proceed to Pittsburgh, where he received an offer from George Westinghouse, who as a rival of Edison was interested in the possibility of alternating current.

It was here that Tesla's theory of alternating current became reality. The principle of alternating current had been known for some time, but the problems of vibration and stalling of motors had baffled all. Tesla neatly solved the problem by replacing the single circuit hitherto used by several circuits carrying the same frequency but out of step with each other; in this way smooth running was achieved as in a multi-cylinder engine. With improvements in the motor came the development of the alternating current generator and transformers.

Legal troubles over patents in this field forced Tesla to leave Pittsburgh and return to New York, where he opened a private laboratory in which he carried out research in a variety of aspects of electrical fields, including generation of high-frequency currents, transmission of energy over single wires without return, methods of conversion, oscillatory charges and mechanical vibration. He described an electronic valve, but there the matter rested; it remained for Fleming and others to bring this to fruition. At one time he publicly demonstrated the control of a ship by wireless, and visualized (more prophetically than he may have then realized) future wars being fought by robots; although he saw his ideas as a benefit to mankind rather than for its destruction. At one stage he conducted a series of experiments in Colorado to prove the Earth a conductor, and about 1901 opened a laboratory on Long Island, where he conducted experiments into such phenomena as high-frequency oscillations and radio waves and discovered what are now regarded as the fundamental laws of broadcasting, although he did not actively enter the field. The Long Island laboratory, however, closed in 1916 because of financial troubles.

The only field outside electrical research in which Tesla actively engaged was in his development of a steam turbine; but as the ideas of Curtis, de Laval and Parsons were by now firmly established, his idea never progressed beyond the prototype stage. However, like Parsons, Tesla visualized the gas turbine.

Tesla's final years were largely given up to theoretical research, much of which was never committed to paper. Financial difficulties forced him into retirement, and there can be little doubt that many secrets went with him to his grave when he died in New York, early in 1943.

In retrospect, Tesla presents an enigmatic figure, who made a sudden appearance on the scientific scene with one outstanding contribution to electrical engineering and then to put forth many ideas which seemed to lead nowhere. Undoubtedly his greatest contribution was his development of alternating current, with all its ramifications, as witnessed by the pioneer station at Niagara Falls in 1896 (although he played no part in it), and above all the availability of electricity generated economically. It was a crowning achievement in the astonishing development of electric power from its discovery by Faraday. But it is, after all, in his research in the realms of high-frequency current that his contribution remains baffling, for while he made what were later regarded as fundamental discoveries, he seldom brought any of them to reality and in some cases published nothing on them. The failure to do this can possibly be attributed to the non-existence of the research laboratory as we know it, and to the fact that the then infant electrical industry preferred to consolidate its gains in the light of tried ideas rather than embark on anything new. Then the sensational discoveries of Röntgen and of the Curies may have turned attention away from Tesla and his work. Finally, Tesla's habit of almost always working alone may have had not a little influence on his work going unnoticed, for he was no teacher and so never was attached to a university, where he would have gathered around him a circle of brilliant young men who could have carried on his ideas and brought many of them to fruition.

International acclaim came to Tesla, particularly as a result of his work on alternating current, and he was invited to address learned societies both in the United States and Europe, among these being the Institution of Electrical Engineers in 1892. In 1893 he received the Elliott G. Cresson Gold Medal of the Franklin Institute for original work presented before the Institute.

Although he left many of his ideas unpublished, Tesla was a prolific writer and a holder of many patents. Two of his books on high-frequency currents and on his other researches reveal his stature as a scientist, for here he describes complex phenomena that have only recently become to be understood. But if Tesla aspired higher than his era was prepared to accept, it must be stated that he aspired in the finest sense, for as he said in London at the Institution of Electrical Engineers in 1892, his aim was "to advance ideas which I am hopeful will serve as starting points for new departures". In this he was successful.

Nikola Tesla may be likened to an explorer who reaches the summit of an unconquered peak and then waits for a support party to consolidate his newly found gains. That done, he proceeds to survey the unmapped untrodden territory beyond and to report on it; but those who follow must often spend much time wandering, often aimlessly, in these realms ere they rediscover their secrets, often without recognition of the first discoverer. Perhaps these are the misfortunes of the idealist; yet the apparent idealist is he who often points the way for others, and therein is the secret of the noble aspirations and greatness of Tesla.

GENERALIZATIONS ON THE APICAL MERISTEM

By Prof. C. W. WARDLAW

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ALTHOUGH the vegetative shoot apical meristems of vascular plants show very evident differences in histological organization, they all give rise to a vascularized leafy axis. That such apices have some organogenic property in common thus presents itself as an inescapable fact[1]. There is therefore a need for concepts that will have a general application to apices, irrespective of their histological patterns.

During recent years a group of French botanists, under the leadership of Plantefol[2] and Buvat[3,4], have been active in histological investigations of vegetative (and floral) meristems of vascular plants, this work having been stimulated by a new theory of phyllotaxis by Plantefol. Among their main conclusions, the following are of special interest: (1) Leaf primordia originate in a superficial ring of actively meristematic tissue, described as the *anneau initial* (initial or initiating ring), which is situated around the base of the inert, or relatively inert, distal apical zone. This *meristematic ring* is regarded as a self-perpetuating embryonic tissue. It is held to be the true vegetative meristem, which would, therefore, be sub-terminal and lateral, and not distal as has so long been thought. The most distal zone of the apex is thus considered to be unimportant in histogenesis and to have no effective part in organogenesis during the vegetative phase. (2) The inception of leaf primordia in the meristematic ring is part of the theory of phyllotaxis proposed by Plantefol[2]. This states that the phyllotaxis of most plants can be referred to a small number of foliar helices. At the extremity of each of these, in the meristematic ring, there is a generative centre which gives rise to all the leaf primordia on that helix. The activities of the several generative centres are harmonized by an organizer which is present in the apex. A generative centre is held to be a physiological, rather than a recognizable, morphological unit. While some investigators[5,6] claim that the theory has been verified by experimental treatments of the apex, others[7-9] have expressed or implied disagreement with it.

In a contemporary monograph from the French school, Camefort[10] has taken up my point about the need for general concepts relating to the shoot apex[1], and has suggested that a meristematic ring (*anneau initial*) may perhaps be present in the apices of all vascular plants. He has, moreover, suggested that, within this concept, it may be possible to interpret the structural differences in the apices of Spermatophyta. He points out that the difference in activity between the allegedly inert apical zone and the meristematic ring may vary according to the species. Where this difference is profound, as in some gymnosperms, for example, in *Picea*, the distal region tends to be homogeneous and a tunica is absent; where it is less pronounced, as in the angiosperms, a tunica is present. In his view, the absence or presence of a tunica is thus associated with a more or less pronounced difference in activity between the apical region and the meristematic ring. Where the summit of the apex is histologically heterogeneous, as in *Taxus*, *Ginkgo*, and *Cedrus*, the superficial cells are cytologically less inert than the underlying 'central' cells. The histological patterns in such apices could be regarded as being intermediate in character between angiosperms (with a tunica), and those gymnosperms which have a homogeneous distal region. In all this diversity of apical construction, says Camefort, the presence of a meristematic ring is the permanent, fundamental fact: the homogeneous meristem, the heterogeneous meristem and the stratified meristem are indicative of successively smaller differences respectively between the activity of the meristematic ring and the apical zone.

Camefort has undoubtedly put forward an interesting generalization which deserves to be more fully investigated. In 1953, I[11] had already indicated that, in attempting to understand the characteristic histological organization of any apex, the size and metabolic properties of the embryonic cells, and the distribution of growth in the apex as a whole, must be considered. Also, although the French workers have stressed the activity of the meristematic ring and its importance as the site of leaf inception, this idea is not in itself new. Already, in 1936, Schoute[12] had advanced the idea that the apex consists of several physiological zones, or levels, which in my[13] terminology and conception would include, in basipetal sequence: (1) the most distal region, which, in ferns, would include the apical-cell group; (2) the sub-distal region in which the patternized distribution of metabolites associated with the inception of growth-centres takes place; (3) the organogenic region in which the formation of primordia from the growth-centres can be observed; (4) the sub-apical region in which conspicuous enlargement takes place; (5) the region of maturation. The meristematic ring of the French school would comprise regions (2) and (3). The inertness attributed to the most distal region is, it need scarcely be said, a very controversial matter and has already been the subject of criticism[14–16].

The morphological phenomenon of greatest generality is that the shoot apices of almost all vascular plants give rise to regularly spaced leaf primordia. This, of course, has long been recognized. The observation, however, acquires a new importance if it is restated with reference to the antecedent and underlying physiological processes, namely, that in the peripheral tissue of the sub-distal region of all apices, in which the embryonic cells are seemingly homogeneous, a patternized distribution of metabolites apparently takes place. This results in the accumulation, concentration, or formation, in more or less well-defined and characteristically spaced loci—often described as growth-centres—of substances actively involved in growth and cell division. Turing[17] advanced a physicochemical theory to explain how a pattern of metabolites might be brought about in an embryonic tissue in which the substances were initially more or less homogeneously distributed, and I[13,18,19] have suggested how this, or some similar physicochemical theory, might apply to very diverse organogenic and histogenic developments in plants. Turing, moreover, postulated that quite differently constituted reaction systems may nevertheless give rise to closely comparable morphogenetic patterns. If this concept can be shown to be valid, it will evidently go a long way towards explaining the many parallelisms of development (or homologies of organization) to be observed in plants. In particular, it will have an important application to the general phenomenon of apical activity now under consideration. The growth-centres, however we may explain their origin, usually grow out as localized mounds on the surface of the apex and develop as dorsiventral leaf primordia. It is a very remarkable fact, and again one of very wide generality, that, in microphyllous and megaphyllous species alike, the primordium at its inception is multicellular and comprises both surface and sub-surface cells. Even the very small, non-vascularized, scale-like microphylls of *Psilotum* are covered by this general statement. In the angiosperms also, the different organs of the flower all have their inception in similar multicellular growth centres.

It is relevant to inquire to what extent the generalization that all shoot apices have the inherent property of giving rise to foliar primordia is borne out by the fossil evidence. Here we come upon a very remarkable state of affairs, remarkable not because the evidence has been neglected by botanists, but rather because concentration on, and perhaps over-emphasis of, the inferences that can be drawn from it from one point of view, seem to have obscured other not less valid inferences. Thus, the ancient Psilophytales, in particular such organisms as the leafless species of *Rhynia*, have been accepted by many botanists both as affording an evident basis for the phylogenetic treatment of the vascular plants, and as providing essential evidence relating to the evolution of the leafy shoot. The discovery of Palæozoic plants, with a bifurcating, leafless and rootless axis, such as *Rhynia*, has enabled morphologists to envisage a 'prototype' or 'archetype' from which the more advanced classes of vascular plants, all characterized by leafy shoots, might have originated. But, on the evidence, *entirely leafless* vascular plants, whether on the 'evolutionary upgrade', or as the result of 'reduction' from some leaf-bearing ancestor, appear to be very rare. The only completely leafless vascular plants known to us belong to the Psilophytales, for example, species of *Rhynia*, *Horneophyton*, *Zosterophyllum*, etc. Other species considered to be of this affinity, however, had an axis covered with evident microphylls, for example, *Asteroxylon mackiei* and others had small scale-like lateral organs. The very ancient fossil, *Baragwanathia longifolia*, of Silurian age, had an axis with abundant microphylls. Many vascular plants, contemporary with the Psilophytales, but belonging to other classes, are known, and these all had leaves. It is therefore an open question whether the entirely leafless genera of Psilophytales were not exceptional in their organization, rather than archetypic of all other classes of vascular plants as has so often been assumed or implied. Indeed, the possibility that they may have been reduced forms in relation to special environmental conditions cannot be excluded[20,21]. The existence of other classes of vascular plants of at least the same antiquity as the Psilophytales, all characterized by foliar development, widens the scope of the generalization under consideration. Lastly, without entering into details, it may also be noted that in the gametophytes of mosses, and in some of the larger brown algae, organized apical meristems are present which give rise to regularly spaced lateral organs.

As we have seen, the importance attributed to the meristematic ring in organogenesis derives from

Plantefol's phyllotaxis theory of multiple helices. According to the theory, each leaf-generating centre moves acropetally (by some mechanism not explicitly specified) along a helical path in the apex. Its actual location is in the meristematic ring where, from time to time during the growth of the apex, it gives rise to leaf primordia[22]. The majority of dicotyledons are considered to have two foliar helices, these having their beginning at the inception of the two cotyledons; and if there are three cotyledons, then there are three helix-generating centres. As an apex enlarges during the ontogenetic development, the number of helices may increase, this being attributed by the French workers either to the formation of two centres from an orginal centre or to the intercalation of a new centre between two existing ones.

Thus, as I understand the theory, in order to account for *the inception of the several helices*, it is necessary to assume that a pattern of growth-centres can originate spontaneously in the apex, beginning with that of the embryo. As I have attempted to show, and have indeed emphasized, this property, or functional activity, of apices is a phenomenon of the widest generality in plants. It is particularly evident in the embryos of species of *Pinus*, for example, *P. ponderosa*, where, in direct relation to the size of the apical meristem, 6–16 evenly spaced cotyledon primordia originate simultaneously in a ring around the meristem, there being no pre-existing lateral organs to exercise regulative effects of any kind. Again, in Rubiaceae such as *Galium aparine*, and in species of *Equisetum*, etc., the ontogenetic development is characterized by an increase in the number of foliar members at successively higher nodes. These and many other instances afford evidence that characteristically spaced growth-centres are determined by factors inherent in the apex, this, in my view, being one of the basic and essential features of the organogenic development of the leafy shoot. Where leaf primordia are already present, the morphogenetic situation in the apex is much more complex. Observation and experiment indicate that the positions of growth-centres (and of the primordia to which they give rise) are affected by the young primordia which surround the apical meristem, a new primordium typically originating above and between two adjacent primordia[23]. It is also relevant to note that primordia always originate in the apical meristem at some characteristic distance below the extreme tip (or centre). This distance varies with changes in the size of the apex during the ontogenetic development, and it can be modified in characteristic ways by various experimental treatments. The overall organization of the apex, and the integrated physiological activities of its component regions, must, therefore, also be given due consideration in the analysis of organogenesis and phyllotaxis.

It will be noted that while ideas relating to growth-centres, or to the helix-leaf-generating centres of the French school, may be stated in different terms according to the individual investigator's approach, there appears to be a considerable measure of agreement on several points, notably, that growth-centres have a real existence as loci of special physiological activity, that they are formed at some characteristic distance below the tip of the meristem, and that they are characteristically spaced around the apex. In my view, however, a growth-centre is a discrete physiological unit occupying a particular position in the meristem, so that there are as many growth-centres as there are leaves, whereas in Plantefol's theory, each leaf-generating centre retains its pristine physiological properties and moves acropetally around the apex, giving rise at intervals to leaf primordia. The latter collectively constitute a foliar helix.

Snow[7,8,24] has shown that the theory of multiple helices is open to criticism on several grounds. We may also note that Plantefol's theory brings its own difficulties when he attempts to explain floral ontogenesis[25]; for whereas the sepals are regarded by him as foliar members arising on the vegetative helices, the petals, which in many flowers also have the form and structure of leaves, are considered not to be homologous with leaves but organs *sui generis*. Camefort[10] has not attempted to answer Snow's criticisms, and, indeed, states (p. 102) that the only causal theory of phyllotaxis that attributes a direct role to the vegetative apex in the positioning of leaves is that of Plantefol. In this, he appears to overlook the results of experimental investigations in which the self-determining nature of the apex in organogenesis has been demonstrated and duly emphasized[26–28], as well as views based on Turing's theory[13,17–19].

When considered in terms of the underlying physiological mechanism, the theory of multiple helices raises new problems of great complexity. This, of course, is not in itself an argument against the theory, and, indeed, we may recognize that the investigation of apical organization and organogenesis not only bristles with difficulties, but also that these may well increase rather than decrease with new accessions of knowledge. As I have indicated above, the postulated acropetally moving leaf-generating centres of the French school must have their beginning in a pattern of growth-centres. If, therefore, the concepts (*a*) of the inception of discrete growth-centres in the sub-distal region, as determined by genetical and other factors and relationships, (*b*) of the regulative effects of existing primordia on new ones, and (*c*) of the functioning of the shoot apex as a regulated and integrated whole, are taken together, the theory of phyllotaxis advanced by Plantefol appears to be unnecessary, while the new facts ascertained by the French workers can be assimilated to other views on apical growth and organization.

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TECHNOLOGY OF ANCIENT GLASS AND METAL

THE general theme chosen by Section H (Anthropology and Archæology) of the British Association for the Sheffield meeting was entitled "Technology of Ancient Glass and Metal".

Dr. D. B. Harden, in discussing "Ancient Glass Furnaces", complained that the archæological evidence is very poor. Sir Flinders Petrie recorded an Egyptian furnace dated to 1350 B.C., and in general the Near East seems likely to produce valuable material, as it has done in the past. But, in north-west Europe, there is scarcely any evidence earlier than A.D. 1000, and most of the data refer to much later periods. This situation is in strange contrast to the many pottery-making sites of various periods which are known. Our knowledge of ancient glass-making still depends too much on documentary sources such as Theophilus and Agricola. The discovery of a Late Saxon glass-working site at Glastonbury Abbey in Somerset last year is therefore important. Mr. Ralegh Radford has to date found remains of two furnaces there, as well as fragments of furnace pots with glass adhering and evidence of glass-blowing. The furnaces appear to have been built on a mortar floor laid in a pit, and against the clay sides of the pit. The upper parts were probably domed over with clay stiffened by re-used Roman tiles, and buttressed with stones. It seems that heat was supplied by external fires piled over the roof. The smaller of the two furnaces was possibly for annealing, and the larger for the pots.

Prof. W. E. S. Turner, in reviewing our knowledge of "Raw Materials and Composition of Ancient Glasses"[1], directed attention to the constancy of recipes with regard to the main constituents: sand (or crushed silica rock) and ash (or glassmaker's salts). By 1700 B.C., the time of the earliest known reference, glassmaking was well established in Babylon: four different glazes are described, containing saltpetre, lime, copper, lead and, as the main constituent in each instance, a glass of which no details are given. Although lead occurs in this recipe, fewer than 10 per cent of 500 glasses analysed, ranging from 1500 B.C. to A.D. 1700, contained more than 0·5 per cent of lead oxide. The great majority were of the alkali – lime – magnesia – alumina – silica type. Lime, again, appears in the Babylonian text but the quantities (from 5 to 12 per cent) found by analysis in ancient glasses are far greater than any prescribed. In general, the composition of the glasses is very complex; ten to twelve constituents were found in many of the earliest specimens.

Alkali is first noted on Assyrian tablets of the seventh century A.D., as ash from the plant *Salicornia*. Soda could have been obtained from the natron lakes of Egypt or, with potash, by burning plants or trees. Coastal or desert plants give more (reactive) soda than potash, inland plants more potash, and all types also have lime and magnesia in their ash, in some cases (for example, beechwood) more of these than of the alkalis. Until the Middle Ages, glass always contained much more soda than potash.

Lime would enter glass also with the sand, where it can be present as shell detritus in amounts larger than 10 per cent. Similarly, magnesia and alumina would be transferred in quantity, and the lowest iron oxide content of eight samples of sand from possible glassmaking sites was found to be 0·15 per cent.

Lead glasses were mainly opaque and coloured. Large quantities of barium have been found in Chinese beads of about 200 B.C. but in no other case. Black glasses coloured with iron oxide are known from the second century B.C., and manganese is common even in early specimens, sometimes exceeding 5 per cent. The earliest coloured glasses are blue; usually copper, but sometimes cobalt, is found to be the cause, throughout the whole period. Cuprous oxide (up to 12 per cent) is present in the sealing-wax red glasses. Antimony occurs occasionally but arsenic scarcely ever, and then only in traces.

"The Analysis of Ancient Glasses" was considered by Mr. E. M. Jope who, like Prof. Turner, stressed the difficulties involved in, and yet the necessity of, carrying out complete chemical analyses. Even then the results give no indication of the intentions of the ancient glassmakers, although we can judge their powers of selecting raw materials and their knowledge of colouring agents. In order to appraise their skill we must, furthermore, know the workability of their material. The development of quantitative spectrometry in this connexion would greatly benefit research despite the limitations of the method.

For example, copper is easily incorporated into soda glass, the cupric ion giving a green or blue colour according to the value of the soda/silica ratio. On the other hand, cuprous oxide presents considerable difficulties: if about 10 per cent is present in glass frit it can give either the desired red, opaque enamel or glass, or a colourless or faintly green glass, according as the temperature is kept below, or allowed to rise above, about 1,030° C. The presence of lead in such red glasses, as early as the second millenium B.C. in Egypt, suggests that its fluxing value was already appreciated at that time.

Similarly lime, alumina and magnesia affect the properties in various ways. The composition is thus a precise index of the problems of the ancient glass-worker, and the manner of their solution, in making some of the remarkable pieces which have survived. The greatest achievement was clearly to bring high enough temperatures to bear precisely where required, and to carry out a complex operation rapidly in the short time available. The excellence of some ancient techniques can be fully realized, however, only when one tries to copy them using the primitive means then available.

Mr. Jope briefly discussed the analytical values required and the methods which were suitable and available. It is important to know the refractive index and the softening and hardening range. The study of residual strains with the polariscope is profitable in the case of complicated work such as applied decoration. Newer techniques seem promising, especially when automatic and comparatively rapid or extremely sensitive, but the X-ray fluorescence method, for example, is not applicable to the study of sodium and potassium content for which flame photometry remains most useful.

These methods were also listed as aids in "A Technological Research Programme on Ancient

Glass" by Mr. Ray W. Smith, whose paper was read by Dr. Harden. Other techniques briefly described included X-ray diffraction and neutron activation, with examples of their successful application to problems of decay and composition. Microscopic examination will elucidate stains and imperfections, and manufacturing techniques in general. The study of bubble patterns will be an important factor. Although quantitative chemical analysis remains the most reliable method, spectroscopy has become an invaluable aid. X-rays appear to darken glasses, giving a smoky or even markedly purple tinge, but this is temporary and moderate heat removes it quickly.

Mr. Smith's programme suggests the collaboration of properly equipped laboratories all over the world, with the aid of adequate subsidies, on a long-term project for clarifying the composition and properties of ancient glass. After a preliminary phase when methods are critically examined, a selection of the most useful techniques is to be generally accepted so that results can be compared. The first phase of the work will determine the general nature of a number of specimens from well-known areas and periods. This will establish about a hundred normal, 'standardized' groups classified according to age and location. The second phase is to study raw materials, particularly major constituents and such of the minor elements as appear to be distinctive.

The third phase will collect deviations from the norm and examine special aspects. The whole project is designed to produce a set of criteria for dating glass on technological grounds.

In the course of the discussion, Dr. E. T. Hall said that the Research Laboratory for Archæology, at Oxford, is prepared to consider constructive proposals about analysis of glasses. In each case there will have to be a definite research problem, and a scheme of work together with full discussion is required.

Prof. W. G. Fearnsides began the session on ancient metal with a paper on the "Distribution of Metalliferous Ores" in the British Isles. At the start of the Bronze Age the dense vegetation cover made mineral discovery difficult except on steep slopes, cliffs and beaches. The distribution of finds shows an obvious preference for chalk hills, limestone plateaux and gravel terraces, and bears little relation to the pattern of metal-bearing areas.

The Trias sandstones of Alderley Edge are the youngest deposits to have been exploited for copper. In the Carboniferous Limestone cliffs and caves along the Derwent valley, the North Wales coast and inland to Oswestry, numerous lead veins are accessible, in some places also copper and zinc; and very early lead workings are known in the limestone dales of West Yorkshire, in high Teesdale, and in tributary valleys of the Tyne. Lead is similarly present in limestone around the South Wales coalfields and the Forest of Dean (with iron), and in the Mendips (with zinc and silver).

By far the richest area lies in a ten-mile wide belt stretching from west of Penzance to east of Tavistock; here veins from Cornish and Dartmoor Carboniferous granites cut across Devonian sediments. Having escaped glaciation, this area presented to early man a typical weathered surface rich in coloured and easily accessible deposits, similar to conditions in Spain and the Middle East, and quite different from Wales and most of Ireland. Also, a large quantity of heavy minerals including tin had been washed into river valleys by Tertiary weathering.

There has always been much more copper than tin in this area. The enrichment zones could have produced all the copper and alloying metals found in British early bronzes. But Prof. Fearnsides' practical experience has convinced him that it would be impossible here to hand-pick even a hundredweight of ore which would smelt to a Bronze Age alloy of the proper proportions. He feels sure that for centuries before any tin bronze was made in Cornwall, there was export of Cornish alluvial cassiterite to metallurgically more advanced centres in the Mediterranean area and Middle East. No tin occurs in Wales, the Lake District or Scotland, and very little in Ireland where, however, some bright weathered copper deposits could have been seen and got without much digging.

The iron ores first used were evidently clay ironstones from the Lower Cretaceous Wealden forest area in Kent and Sussex, some of the Jurassic weathered oolites (that is, limonites) outcropping under Oolitic Limestone between Oxfordshire and Lincoln, Lower Lias south of the Humber, and Middle Lias of the Cleveland Hills—all low-grade deposits but more manageable than better ores. There is evidence of working, in all the cases mentioned, by Roman times, when also hæmatite in the Carboniferous Limestone of the Forest of Dean and the Vale of Glamorgan, near Barrow-in-Furness and in Cumberland was used on a large scale.

Prof. F. C. Thompson next dealt with "Mining, Extraction, Refining and Casting", mainly of copper, and the production of alloys. Antler picks and wooden shovels would be sufficient for mining soft, weathered deposits; in other cases, fire-setting (alternate heating and water-quenching of an ore face) is known to have been used in 2000 B.C. The advantages of concentration by hand-picking, crushing and washing would have been seen quite early.

Simple carbonate ores are directly reducible by heating with charcoal at a dull red heat; lead, also, is easily obtained in this way whereas iron and tin are more difficult; this explains why copper was the first metal obtained by smelting. Copper approaching native metal in purity can be obtained from carbonates, but the spongy mass produced is not easy to deal with until melting is achieved; this requires some form of blast.

Sulphide ores are first roasted in air; although this may be done on a simple platform of fuel and, once started, is self-continuing, success requires skilful and constant control. Simple sulphide ores are thereby converted to the oxide which, like the carbonate but *not* the sulphide, is reducible with charcoal. Complex sulphide ores usually contain much iron, which must be removed completely, as well as arsenic, antimony, zinc, nickel, etc., which will enter the copper metal in proportions depending on conditions. Arsenic and antimony, for example, are partly volatilized on roasting, but their higher, more stable oxides will also be formed, and will afterwards be reduced with the metallic oxides. There is thus no direct correlation, for such impurities, between the contents in an ore and in the metal obtained from it. Far too much importance has been attached by archæologists to variations in composition which are often only to be expected from normal practice in early times.

Roasting replaces sulphur by oxygen, which on smelting preferentially attaches itself to the iron, and

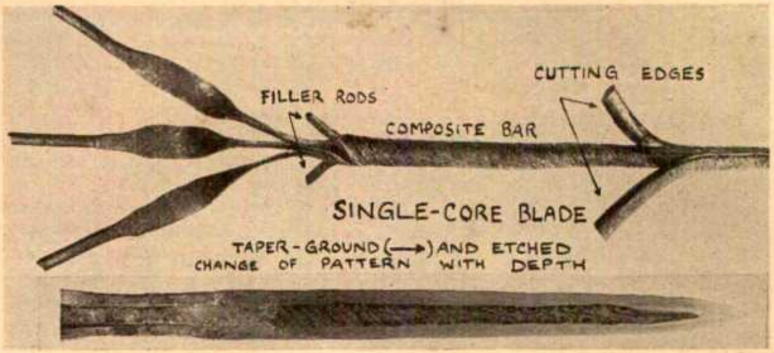

Fig. 1. Modern pattern-welded sword: experiment No. 7. (See "Technology of Ancient Glass and Metal": contribution by J. W. Anstee)

the resulting iron oxide can be slagged off by adding sand to the molten mass. If much iron is present, the roasting and smelting may have to be repeated several times before the final product is free enough from iron, can be dead-roasted to copper oxide, and finally reduced with charcoal to the metal. But all the operations are well within the means of primitive man, and it is obvious that sulphide ores were smelted successfully before 2000 B.C.

As the quality of ores deteriorated, impurities in the metal increased, but sometimes also gave a product that was harder and easier to cast. This gradually led to deliberate alloying attempts, as for example in an object with about 7 per cent of arsenic and all other impurities less than 0·05 per cent, and ultimately in the true tin bronzes.

At a certain stage there is a change that suggests the use of fire-refining which, with poleing, could make copper from impure ores as pure as that won from hand-picked malachite. The pure tin bronzes of this and later periods could have been made only by smelting tin ore with such refined copper and not, like earlier bronzes, from mixed ores.

Mr. H. Maryon followed with an account of the development in the "Fashioning of Metal Artefacts"[2]. Observation of the earlier mobility of some (that is, the more impure) metals during a melting run may have suggested the process of soldering. Hard soldering (above 550°) dates back to 3400 B.C. and was common practice in Ur; soft soldering was known before 2500 B.C. Extremely fine granulation work was produced by the Greeks and Etruscans in the sixth century B.C. Often wrongly described as 'welded', non-ferrous metal joints were invariably soldered, with the exception of a set of small gold boxes (Early Iron Age) showing cold lap welds. Repairs were often made by 'burning (or running) together': the fracture was, in effect, enveloped in a clay mould and fresh metal was cast on.

The oldest metal statues were made of copper sheets either riveted or nailed to wooden cores, and riveting was also common in domestic ware and for decoration. Bowls were made from early times by sinking (hammering on the inside) or raising (from thin sheet by hammering on the outside), and there are thousands of early examples of repoussé, chasing and engraving, as well as of work done with tracer or punch, or in high relief. All these processes require much annealing and the products show that this was well understood. Other methods of decoration were 'inlay', that is, the tracing of a recess into which a piece of another metal was inserted and fixed, and 'overlay', which involves attachment by cold flow to a surface that is merely roughened and not recessed.

Ferrous (true) welding is in evidence from the beginning, as in a tiny model head-rest of Tutankhamen (1360 B.C.). Warriors of Asshur-nazir-pal had iron swords (ninth century B.C.), and the Luristan finds (1200–900 B.C.) show some steel containing 0·5 per cent of carbon, demonstrating that forging and carburization developed quickly. Ultimately welding also came to be used successfully in massive structures such as the Colossus of Rhodes (280 B.C.; 7½ tons of iron frame) and the Delhi pillar (A.D. 310; 6 tons), as well as in delicate work, involving the 'piling' of many sheets into a composite laminate, and developing into pattern-welding.

Mr. H. W. M. Hodges, in his "Studies of Ancient Metal-working Techniques", put forward evidence suggesting the influence of other technologies in the Bronze Age, with examples from Northern Ireland. The finishing of sandstone or steatite moulds harked back to Neolithic stone working, and the form of cast implements was dictated by the limitations of carving in stone. Clay moulds usually consist of an inner (fine) and outer (coarse) sheath. Particle size and mineral analysis of moulds (for swords) found in Lough Eskragh has shown that the clay in both sheaths came from the same deposit, but that the inner sheath had been made of levigated material, as used in making slips and thus showing the potter's hand. The patterns for such moulds were often made of wood (as found at Tobermore, Co. Derry). Wood grain is evident in some bronze implements, and casting is here dependent on wood-carving technique. Casting in two-piece moulds made of bronze, and running-on, appear to owe nothing to other technologies, although bronze shields and early cauldrons, for which there are no bronze prototypes on the Continent, may be copies of leatherwork.

Mr. J. W. Anstee described a series of nine experiments to determine the essential features of a method of making "Pattern-welded Iron Swords". All the work was carried out single-handed under primitive conditions, using a small forge with Chinese-type box bellows, hammer, tongs, vice and a crude anvil. Supplies of home-made charcoal were insufficient (about two hundredweight would be required for one sword) and coke was used in all cases except three.

The first six experiments served to eliminate various points of technique as being impossible or unnecessary. No. 7 produced a specimen sword in which the various stages were left unfinished to show the details of the method (Fig. 1). No. 9, a similar but fully finished sword, was produced as follows. Three rods of good, Victorian wrought iron, each 0·22 in. in diameter, were forged out into strips in which the ratio of width to thickness was 9 : 1. The strips were laid flat one on the other and forge-twisted into a two-start screw, two 'filler rods' of square section being at the same time incorporated into the valleys. The resulting composite bar was flanked on either side by a straight packing rod, and by another composite bar of opposite twist the units of which had undergone a home-made case-hardening treatment. This assembly was forge-welded together, using a sliding wire-clip and proceeding in inch-heats, to give a triple band of characteristic herring-bone pattern, tapering to a point at one end where it had been gripped by the tongs.

Cutting edges were welded on to this core by doubling a forged half-inch rod around the point. Fullering, final forging, and grinding completed the sword blade for which a hilt, scabbard and belt fittings were also made. The total working time was seventy-five hours, of which forty-three had been spent on the blade, involving 128 separate forging and welding heats. The finished blade weighed 1 lb. 10 oz.; 1 lb. 3 oz. had been removed from the rough forging by grinding, and the total cross-sectional area of the original core-assembly had been reduced by 70 per cent. The work showed that any of the patterns observed on ancient swords could be produced in this manner by twist-welding and grinding.

Two speakers dealt with "Scientific Evidence about Metalworking Techniques". Mr. L. Biek showed how Mr. Anstee's research had been suggested by observations made while cleaning the Westminster Sword (ninth century) on the change of pattern with distance from the surface (Fig. 1), and how (*a*) radiographic examination, and (*b*) metallographic study (at the National Physical Laboratory), had helped at various stages. Most pattern-welded swords are so corroded that (*b*) is not possible; on the other hand, a sound sword does not lend itself to (*a*). It is thus difficult to obtain a good correlation, especially as the methods are most useful at different magnifications.

The Westminster Sword has, however, been examined in both ways, and a direct metallographic comparison with Mr. Anstee's No. 7 has been made. The older specimen is homogeneous and contains about 0·2 per cent of carbon, while the other is virtually free from carbon but carries slag inclusions which are responsible for the pattern seen on the polished and etched surface. Pattern can thus be produced even when there is no alternate layering of wrought iron and steel.

Dr. E. Voce demonstrated the value of interpreting the metallographic record[3], left on copper and bronze objects, of the manner in which they had been produced. In some cases, particular combinations of structural features allow one to give detailed descriptions of certain points in an object's history that cannot be determined on any other basis. Thus a Scottish celt which has clearly been cast shows an annealed structure but no evidence of any working. It appears therefore to have been heated, after manufacture and for no metallurgical reason, possibly in a ritual fire. Again, cuprous oxide inclusions in the wrought and annealed structure of a ring from Azarbaijan prove that it could not have been made from unmelted native copper.

Mr. H. H. Coghlan described the results of recent spectrographic and chemical analyses of artefacts and ores[4], made in an attempt to provide "Scientific Evidence about Provenance of Early Implements". The analysis of more than a hundred British artefacts has shown, as previous workers had found elsewhere, that the results fall into groups which are sufficiently well defined to justify the work within the chosen limits. Although, as Prof. Thompson said, the figures must not be taken too literally, whole series of analyses show better agreement than is required by many modern specifications. This is an inescapable fact which suggests that the control of operations may have been better than we imagine.

Broadly speaking, in the large majority of implements, arsenic, antimony and silver are significant impurities, present in uniform quantity and accompanied by certain minor elements which are also fairly constant. Within this group there may be a subdivision into halberds and axes, arsenic and antimony being much lower in the latter while silver remains the same. There are also a small number of artefacts containing more than 99 per cent of copper, evidently not made from native copper but of metal from pure carbonate ore, and some isolated but 'standard' 10 per cent tin bronzes.

A start has been made with likely ore specimens from Ireland and southwest England. The few results so far available suggest that the two areas are distinct in some ways useful for this purpose, while the quantities of arsenic and antimony found in implements are well within the limits of theoretically possible transfer from ore to metal.

Prof. V. Gordon Childe discussed the "Archæological Significance of Metalworking Techniques". The early development of the saw directly affected carpentry, stone-working, architecture and, by making wheels possible, revolutionized transport and thereby other industries. Though wheels and ploughs could have been made with stone tools, neither is known before the beginnings of metalworking. Ashlar masonry was probably impossible without a saw, and seals were normally engraved using metal drills and gravers. Nearly as old is the cauldron, which made possible cooking by suspension.

Later, though still in the Bronze Age, came nails, wire, springs, hinges and adjustable compasses. With the Iron Age came tongs, shears, scythes, horseshoes, tyres and ploughshares. Metal further encouraged the specialization of tools, but the general spread of its influence was limited by cost. Thus flint sickles were usual until the Late Bronze Age and log-cabins do not appear in Europe until after the cheap socketed celt. No intensification of forest clearance is noticed until the Iron Age when, in Norway for example, the first smelting of bog iron ore is followed by a great expansion in this respect. Food production was then also greatly affected by the introduction of iron scythes and other agricultural implements.

Mr. T. W. Farrer concluded with a consideration of "Scientific Evidence from Ancient Artefacts as related to Conditions of Burial". The rate of corrosion of buried metals is dependent on a number of factors which may vary considerably both in space and in time, so that no estimate of age is possible from corrosion products. But as their nature is a reflexion of conditions of burial, it is sometimes possible to tell where a change in these conditions has taken place, from such features as the adhesion of the corrosion products, or the peculiar tuberculation of iron objects associated with fresh-water. Perhaps the greatest single factor is the oxygen concentration, and there is marked difference between the states of preservation of metals according as they are found in well-aerated or waterlogged deposits.

In recent years, corrosion in anaerobic deposits has been closely studied in both archæological and industrial contexts, to great mutual advantage. Thus the protection of buried iron pipes from bacterial attack by the use of tannins, now carried out on an industrial scale, was suggested by well-preserved Saxon ironwork found with leather[5]. Other finds have confirmed industrial research on peaty soils, where similar inhibition appears to be due to the presence of antibiotic substances. On the other hand, this has led to a better understanding of the archæological conditions causing, for example, bright blue patches of vivianite, or particular types of film on metal objects, found in such deposits.

Introducing the general discussion, Mr. L. Biek listed some features common to both technologies: high temperatures, often carefully controlled or applied at selected spots; use of refractories and charcoal; casting, sintering, annealing and soldering, including glass-to-metal joints. Possibly both materials owe their discovery to the same cause—a major fire. The same analytical techniques are used, and variety of approach is needed, including the crucial test of 'doing it yourself'. It is thus most valuable to consider glass and metal together. As a result of the preceding papers and discussion, excavators will know better what to look for, and analysts where methods can best be perfected. They have shown, once again, the great value of such study in revealing not only the astonishing level of some ancient skills, but also points of interest to modern research.

The following emerged from the discussion. Various laboratories analysing early copper implements are in touch with one another, and their results can be compared within the chosen limits of accuracy. Study of isotopic ratios in lead, for example, is not likely to be useful in suggesting provenance as regards the British Isles. Analysis by neutron irradiation is extremely sensitive but not uniformly so. Several speakers stressed the importance of testing archæological hypotheses by scientific analysis and experiment, and the need for provision of more facilities by the larger institutions.

L. BIEK

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[2] *Amer. J. Archæology*, **53**, No. 2, 93 (April–June, 1949).

[3] See Coghlan, H H., "Notes on the Prehistoric Metallurgy of Copper and Bronze in the Old World", Occasional Papers on Technology, No. 4 (Pitt Rivers Museum, Oxford, 1951)

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OBITUARY

Sir Francis Simon, C.B.E., F.R.S.

THE death on October 29 of Sir Francis Simon, barely a month after taking up his new appointment as Dr. Lee's professor of experimental philosophy and head of the Clarendon Laboratory at Oxford, has come as a tragic shock to his very many friends and colleagues.

Simon was born in Berlin in 1893 and studied at the Institut fur Physikalische Chemie there. Later he became professor extraordinary at Berlin and professor and director of the Laboratory of Physical Chemistry at Breslau. When he came to England at the invitation of Lord Cherwell in 1933, he was already known internationally for his work on the physics of low temperatures, and particularly on the heat theorem of Nernst, his former teacher. During the years leading up to the War he then built up a small but powerful school of low-temperature physics at Oxford with the help of his former students, Mendelssohn and Kurti. The accommodation and facilities of the old Clarendon Laboratory being extremely primitive, the activities of this school depended largely on the use of miniature helium liquefiers based on the 'expansion' method which Simon had already developed in Germany. Perhaps the most notable success of the period was his work with Kurti on magnetic cooling, in which the temperature-range below 1° K. was systematically studied.

At the beginning of the War, many foreign-born scientists found themselves left out of the then existing scientific war projects. It is ironic to realize how much the development of nuclear energy owes to this. Simon was one of the chief instigators of the project and, with Peierls, was mainly responsible for the development of the diffusion method of separating the isotope uranium-235, later realized in the enormous diffusion plant at Oak Ridge in the United States. With his wife and two young daughters evacuated to Canada, Simon worked with great energy in the direction of a group at Oxford and on government committees, and made several visits to the United States.

After the War, Simon re-started low-temperature work under the greatly improved conditions of the new Clarendon Laboratory, and quickly built up a school which, by comparison with the pre-war school, can best be described as large and powerful. The range of work of this school in recent years has been outstanding, covering almost every branch of low-temperature physics and linking up with workers in nuclear physics and radio-frequency physics in most fruitful ways. A few years ago their collaboration resulted in the first reported experiments on the orientation of atomic nuclei. Only a few months ago it was reported in *Nature* that Simon, Kurti and their collaborators had achieved a nuclear cooling, reaching temperatures of about twenty millionths of a degree absolute for the first time. This was a project squarely in the low-temperature tradition, and had been close to Simon's heart for more than twenty years since its original proposal by Gorter.

In recent years Simon became a considerable public figure as a vigorous campaigner for the proper development and use of science, which he advocated in books, newspaper articles, on the radio and in public lectures. He was well known on government committees and took a particular interest in fuel policy, about which he campaigned (as it now appears) with some effect. A Fellow of the Royal Society since 1941 and holder of the Rumford Medal, he was made C.B.E. in 1946 and was knighted in 1954. He was honoured by many other scientific societies in Britain and abroad.

Simon's position at Oxford was as reader and later professor of thermodynamics. In his case the title was exactly appropriate. His outlook was essentially thermodynamic and he saw scientific problems simply and as a whole. It is perhaps significant that in his recent Guthrie Lecture to the Physical Society he returned to his first love, the Nernst heat theorem, now elevated to the status of the Third Law of Thermodynamics. A great deal of the work which came from his laboratory was inspired by this Law, and many of our existing ideas about the solid state started as 'anomalies' in the specific heat – temperature curves of Simon and his students. It is interesting to note that although some of the detailed results of his school were later improved upon by workers with more highly developed techniques, his 'hunches' and his interpretations of the results were in almost every case proved correct. His thermodynamic sense extended beyond physics and he would apply the same approach in discussing, say, world fuel or food policy, as to the design of a helium liquefier. He was sometimes old-fashioned in his insistence upon simple methods, and many of his more electronic colleagues have heard him beg, "Can't you do it with d.c. ?". It is perhaps not entirely inappropriate that his last and greatest achievement was an experiment done with direct current.

Simon relied generously on his closest colleagues, many of whom stuck to him for very long periods. It was an exciting experience to take part in a project with him, and the pattern was usually that Simon provided the simple idea and the energy and his collaborators filled in the details. His school expanded so much in recent years that international conferences on low-temperature physics began to take the form of reunions for scores of his former collaborators now working in very many countries, and he fell easily into the role of doyen of low-temperature physics.

Many who did not know Simon assumed that he would be somewhat Teutonic in outlook and expected pedantry and pomp from him. Nothing could be more wrong. His friends and collaborators knew that he was mischievous, mercurial, generous and warm-hearted, always approachable, impossible to offend. Although he still maintained that the English were mad in some respects, particularly in their love of sport and of cold rooms, he identified himself completely with them, and took part with great enthusiasm in college life at Oxford. Generations of research students and hundreds of visiting scientists enjoyed the hospitality which he and Lady Simon offered in their home. He was always delighted when any of his colleagues or his secretaries married each other, as frequently occurred. Whenever he travelled he would send postcards to his colleagues and he kept closely in touch with all who left Oxford, helped them whenever he could do so, and kept each one up to date about what was happening to others. He had many endearing eccentricities, particularly connected with the temperature of his surroundings, and during a long conversation with him a visitor might find that at one time Simon would be wearing cap, muffler and sweater, and that at another time he would have taken them all off and opened the window.

He was a unique figure, and all who knew him are deeply saddened by his death. G. O. Jones

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NEWS and VIEWS

The Forestry Commission :

Mr. A. H. H. Ross, O.B.E.

Mr. A. H. H. Ross, director of forestry for Scotland since July 1953, is due to retire from the Forestry Commission in March. Mr. Ross obtained a diploma and degree in forestry at Oxford in 1920 and was for some time in the Indian Forest Service. He joined the Forestry Commission early in 1925 as a district officer, serving successively in different areas under the then assistant commissioner for England and Wales. During the War he was engaged on timber supply duties and was with the North German Timber Control. Following his return to the Forestry Commission, Mr. Ross was promoted to conservator of forests for north-west England, with headquarters at Chester, where he remained until his appointment as director of forestry for Scotland. In that office, Mr. Ross has played an important part in the more recent development of forestry in Scotland and is at present in charge of nearly half a million acres of Commission woodlands.

Mr. A. Watt

Mr. A. Watt, who is at present serving as a conservator of forests at the headquarters of the Forestry Commission in London, has been appointed to succeed Mr. Ross. He obtained his degree in forestry at Oxford in 1931. He was appointed a district officer at Aberdeen in 1934 and afterwards served in south, north and west Scotland and became conservator of forests for west Scotland, with headquarters at Glasgow, in 1946. He was transferred to the office of the Director of Forestry for Scotland in 1948, and moved to London some three years later.

New Zealand Research Award : Dr. P. Whittle

The research medal awarded by the New Zealand Association of Scientists for outstanding research work (principally in New Zealand) for those under forty years of age has been made this year to Dr. P. Whittle, of the Department of Scientific and Industrial Research, Applied Mathematics Laboratory. Dr. Whittle's work has been concentrated mainly around the theory of time series and stochastic processes, a modern development in the mathematical theory of probability which makes it possible to understand and interpret data such as economic, biological and geophysical measurements which, while they possess a certain tendency to regular changes, are so subject to random shocks that this tendency is largely obscured.

Perkin Centenary Trust Awards

The following awards for educational purposes relating to the manufacture or the application of colouring matters have been announced by the Perkin Centenary Trust: the Perkin Centenary Fellowship is to be offered for postgraduate study at a university or technical college; two Perkin Centenary Scholarships will be offered to enable candidates employed in the appropriate industries to receive an education at a university or technical college. Two Perkin Exchange Lectureships are also to be created. The first, of short term, is intended to enable a senior teacher at a university, or technical college, to visit some similar establishment overseas in order to deliver a short course of lectures. In return, a visit to a British institution by some overseas scientist will be arranged. The second appointment contemplated will permit a similar exchange of lecturers for a period of up to one year.

The Perkin Centenary Trust was established in January 1956 to administer the funds subscribed to commemorate the discovery of the first synthetic dyestuff by Sir William Perkin in 1856. The secretary to the Trustees is Mr. J. R. Ruck Keene, to whom inquiries should be addressed, at the Chemical Society, Burlington House, London, W.1.

Further Education in Science and Technology in Britain

In a written answer in the House of Commons on December 12, the Minister of Education, Sir David Eccles, gave the number of full-time day students studying engineering in establishments of further education in England and Wales in 1954–55 as 7,455, compared with 6,944 in 1953–54; of these, 1,355 were on sandwich courses (compared with 746 in 1953–54), and there were 146,221 part-time day students (131,376 in 1953–54). For science the figures were 3,173 in 1954–55 and 3,526 in 1953–54, of whom 71 and 69 were on sandwich courses, and 11,010 part-time day students (10,791 in 1953–54). Enrolments in evening classes in mathematics and natural sciences totalled 429,282 in 1954–55 and 410,400 in 1953–54; for engineering and allied industries the corresponding figures are 278,466 and 269,564. In grant-aided establishments of further education 1,209 full-time and 1,128 part-time day students of engineering were recorded as studying for university degrees in 1954–55, 2,229 full-time and 68,115 part-time for National Certificates; 185 full-time and 43,184 part-time for City and Guilds examinations and 2,199 full-time and 3,454 part-time for other examinations. For science the corresponding figures are 2,279 full-time and 5,184 part-time day students for university degrees; 74 full-time and 10,829 part-time for National Certificates; 444 part-time for City and Guilds examinations; and 1,298 full-time and 4,262 part-time for other examinations.

Technological Education in France

The Paris Academy of Sciences, supporting proposals made by the Association des Professeurs de Mathématiques, the Union des Physiciens and the Union des Naturalistes, has submitted to the French Government a resolution in favour of certain reforms in scientific education (*C.R. Acad. Sci., Paris*, 243, 1811; 1956). The Academy, disturbed by the grave situation created by the growing shortage of scientists, engineers and technologists, and the inadequate number of young men embarking on a scientific career, points out the necessity for recruiting not only men with a vocation for the abstract sciences and mathematics, but also those with an aptitude for observation and experiment. The Academy therefore proposes that, in order to satisfy this dual requirement, matriculation examinations should not be such as to discourage from scientific careers young men not especially gifted in mathematics. It is also proposed that secondary schools should be less concerned with detailed instruction than with laying a firm foundation of basic principles; and that every effort be made to attract pupils to science by introducing them at an early age to the experimental method, by practical exercises and characteristic examples, to be reinforced at a later stage by more predominantly scientific instruction. Finally, it is proposed that every initiative be encouraged toward recruiting competent teachers even without diploma, and accepting students even without competitive examination, in view of the urgency of the need.

Imperial College of Science and Technology, 1954–55

The forty-eighth annual report of the Governing Body of the Imperial College of Science and Technology (London) for the year 1954–55 (from the College) notes that appointments were made to the new chairs of applied science, with special reference to engineering, soil mechanics, heavy electrical engineering, physical chemistry, instrument technology, statistics, parasitology, applied geophysics and aeronautical structures, and to readerships in applied geochemistry, physical chemistry, mining and chemical engineering. A strong expansion committee has been appointed from among members of the Governing Body, and the physical expansion of the College is gathering momentum. An additional story over the Goldsmiths' Company Extension to the City and Guilds College and the Royal School of Mines was completed in April 1955 and, besides relieving congestion due to the increased intake of engineering students, provides new accommodation for applied geophysics and applied geochemistry. A further extension of chemical engineering in connexion with a new aeronautics building was scheduled for occupation by the latter in October 1956, and by chemical engineering in December 1956. Rebuilding of the Imperial College Union was expected to be complete in September 1956, and an alteration in the Bessemer Laboratory of the Royal School of Mines to serve as a temporary house for the Mechanical Engineering Workshop and Materials Laboratory is already complete. Two stories are also being added to the single-story part of the Chemistry Department. These beginnings have all been made on sites already in possession of the College, and any further expansion by building awaits acqusition by the College of other parts of the 'island site' at present occupied by other institutions. Details of staff changes are appended to the report together with a list of publications and brief notes on departmental research. Of the 2,282 students (including 412 part-time) in 1954–55, 1,840 were from the United Kingdom, 256 from the British Commonwealth and 186 from other parts of the world. Of the total, 1,019 were postgraduate, 229 were from London and 870 from the Home Counties.

Atom

Atom, the monthly bulletin of the United Kingdom Atomic Energy Authority, is distributed to the staff of the Authority, to similar organizations overseas, to industrial firms concerned with the exploitation of nuclear energy, to the Press and to those to whom a record of information on the work of the Authority may be useful. The first issue (November), consisting of twenty-four pages, contains a report of the events of October 17, when Her Majesty Queen Elizabeth II pressed the switch that allowed power from the Calder Hall nuclear power station to pass into the national grid. The report includes the Queen's speech and technical details of Calder 'A' station. Apart from short notes dealing with diamond irradiation, the new reactor school at Harwell, and LIDO, and abstracts of patents, the main contents are devoted to the addresses given by Sir Edwin Plowden and Sir John Cockcroft at the meeting of the International Bank for Reconstruction and Development held on September 27. Sir Edwin spoke on the development of the nuclear power programme in Britain and compared British plans with likely trends of development in other countries. Sir John referred to the economic background against which the United Kingdom programme is progressing and undertook in his speech the speculative and difficult task of looking five or ten years beyond the United Kingdom programme as planned until 1960. He concluded by stating that "it is certain that, with the great power of creative technology to-day, development will be rapid and capital costs of nuclear power projects will fall rapidly. In spite of this, I think it will be a long time before nuclear power is competitive with 4-mill hydroelectric power".

Limiting Atomic War

A PAMPHLET, "On Limiting Atomic War", issued by the Royal Institute of International Affairs (London, 1956; 2s. 6d. net), is the outcome of discussions on the problems of defence policy in the nuclear age between Rear Admiral Sir Anthony Buzzard, Prof. P. M. S. Blackett, Denis Healey, M.P., and Richard Goold-Adams in the summer of 1956. It puts the arguments in favour of trying to draw distinctions between the tactical and strategic use of atomic weapons. Written by Richard Goold-Adams, it presents the case for graduated deterrents, arguing that if a start were made now, distinctions between tactical and strategic nuclear weapons would be both desirable and practicable; that it is similarly possible to draw a line between tactical and strategic targets; and that the area of almost any future war outside Western Europe could be limited. The argument turns on the facts, first, that it is only a relatively recent trend, confined almost entirely to this century, that major war should tend to spread into world war; and secondly, that it is only in world war that the generals are able to dominate the politicians. If, however, it is disputed that distinctions between big and little nuclear wars are practicable, the present costly policy of developing large quantities of small-scale nuclear weapons is already wrong. The time has already passed when any British government can afford not to find out whether the argument in this pamphlet is right or wrong. Until it does so it has no clear line of defence policy around which to rally public opinion and may continue to spend resources, which our economy can ill afford, on tactical nuclear equipment which will be largely wasted and provide no proper defence shield in return.

Oil Flax Seed

THE spectacular rise in fibre flax cultivation and the consequent increased demand for sowing seed during times of national emergency are common knowledge in the United Kingdom. The trend of cultivation of oil flax in the countries of northern Europe seem to follow a somewhat similar pattern. During and for some little time after the Second World War, when oil flax was being grown on a large scale in Sweden, a programme of research designed to improve the seed yield of this crop was undertaken at the Plant Breeding Station, Gullåkers, by Rolf Manner. The results of Manner's work, which has now been concluded, are published in monograph form entitled "Studies on Seed-setting and Seed Yield in Oil Flax" (Meddelande från Gullåkers Växtförädlingsanstalt, No. 12. Hammenhög: Gullåkers Växtförädlingsanstalt, 1956). In the course of a thorough and detailed study of the problem, the author has investigated intra-plant variability, the influence of environmental conditions and the genetical variation in seed-setting and seed yield. After remarking that increased seed production may be effected by a changed environment such as would be brought about by increased manuring (nitrogen and potassium) and plant husbandry and suggesting that such improvements may be immediately utilized, he points out that improvements in other ways and, in particular, by plant breeding must be exploited in full. The breeding work which he undertook indicates that even greater progress can be achieved in this way than by the provision of changed environmental conditions. The question of heterosis in flax breeding is examined in some detail, and the possibilities of obtaining increased yield by sowing F_2 seed are believed to be very real, although it is admitted that many problems remain to be solved before this becomes a practical possibility. The monograph contains an excellent review of foregoing literature and the publication has been ably translated by C. Montagu Evans. It is pleasing to note that the author hopes, in spite of the fact that much of the work may not assume importance under Scandinavian conditions, that he has been able to contribute some results which may be applicable beyond the frontiers of northern Europe. It is a monograph which will be welcomed by all who are interested in the problems of flax breeding.

Dedication of Woodlands in Great Britain

THE fourth edition of the Forestry Commission pamphlet, entitled "The Dedication of Woodlands: Principles and Procedures" (Booklet No. 2: pp. 60. London: H.M.S.O., 1956; 2s. 6d. net), has been issued with a foreword by Lord Radnor, chairman of the Forestry Commission, and Major Sir R. Proby, chairman of the United Kingdom Forestry Committee. The dedication scheme was first introduced in 1948, with the object of assisting in the replanting and proper maintenance of privately owned woodlands, and it is for this assistance that it is recommended to all owners who have not yet come into the scheme. Steady progress has been made since its introduction. By September 30, 1955, the total area covered by completed dedication deeds was 410,000 acres, with another forty thousand acres in preparation. Owners who have had several years of the working of the scheme say that in practice it allows them greater freedom than before. A plan of operations, drawn up by the owner himself, is helpful in dealing with the management problems. In the early stages after dedication, Forestry Commission officers pay visits and assist with advice. These visits are helpful; but they are made with the knowledge that both the responsibility for them and management of the woods remain with the owner and that any rigidity in working the plan will defeat the objects aimed at. The pamphlet gives a full description of the dedication scheme with examples of the deed covenant for England and Wales, and a separate one for Scotland

Nitrogen and Root Metabolism

IN further studies of the respiration of barley plants, E. W. Yemm and A. J. Willis (*New Phytol.*, 55, 2, 229; 1956) have investigated the nature of the products formed during the assimilation of inorganic forms of nitrogen by excised roots. Some new analytical methods are described. They have observed that under all conditions of rapid assimilation there is a marked increase of glutamine, and the experiments with nitrogen-15 show that glutamine arises as a result of primary synthesis. When ammonium salts are supplied, more than 80 per cent of the nitrogen metabolized during the initial period of rapid assimilation can be recovered as glutamine. With nitrate, somewhat smaller quantities of glutamine are formed, together with asparagine and amino-acids. The data from experiments with different sources of nitrogen are consistent with the view that nitrate is converted to nitrite and hydroxylamine, and there is evidence that the step from nitrate to nitrite is relatively slow. The synthesis of amino-acids and amides is closely associated with high rates of respiration and rapid losses of carbohydrates from the tissues. Evidence is presented that both the carbon skeleton of the amides and the respiratory carbon dioxide result from the breakdown of carbohydrate. The regulatory mechanisms which may operate during the assimilation of different forms of nitrogen are discussed. No marked increase of tissue proteins occurs in the excised roots ; but an extensive incorporation of nitrogen-15 into these proteins could be detected. There is no evidence that the operation of a continuous protein cycle plays an important part in regulating the rate of respiration in these roots.

Zoological Nomenclature

THE International Commission on Zoological Nomenclature will start voting as from March 28, 1957, on the following cases involving the possible use of its plenary powers ; full details have already been published (*Bull. Zoo. Nom.*, 12, Pt. 9 ; September 1956) : (1) Rafinesque, 1814–1818, names published by, for genera and species in the orders Decapoda and Stomatopoda (cl. Crustacea), suppression ; (2) *cruentatus* Linnaeus, 1758, *cubicus* Forskål, 1775, and *novemdecos* Sulzer, 1776, all published in combination with the generic name *Cancer* (cl. Crustacea, order Decapoda), suppression ; (3) Urinatoridae Vieillot, 1818, suppression of, in favour of Gaviidae Coues, 1903 (cl. Aves) ; (4) *Peltura* (emend. of *Peltoura*) Milne Edwards (H.), 1840 (cl. Trilobita), validation. Comments should be sent as soon as possible to Francis Hemming, 28 Park Village East, Regent's Park, London, N.W.1.

Insecticidal Effect of Nigerian Diatomite

COMPARATIVE tests have been made by E. A. Parkin and Enid I. C. Scott, of the Pest Infestation Laboratory of the Department of Scientific and Industrial Research, and E. R. Varley, of the Mineral Resources Division of the Colonial Geological Surveys, on the insecticidal efficiency of a colloidal silica preparation and several particle-size fractions of a Nigerian diatomite to assess the potentiality of the latter for local use in the protection of infestable stored produce (*Col. Plant and Animal Prod.*, 5, No. 3 ; 1956). The tests were made with *Calandra granaria*, *C. oryzae* and *Tribolium castaneum*. The finest fraction of the diatomite had a good insecticidal effect at 25° C. and 70 per cent relative humidity when used as a dry dust, although it was not so effective as the colloidal silica. However, when applied as an aqueous suspension to bricks, the dry deposit of colloidal silica was insecticidally efficient, whereas that of the diatomite failed completely because of caking. It would have been particularly advantageous in the groundnut storage areas of Northern Nigeria if the diatomite could have been used in aqueous suspension to avoid excessive losses during application of dry dusts in the local high winds.

Electron Physics Tables

THE National Bureau of Standards, Washington, D.C., has recently prepared "Electron Physics Tables" (Circular No. 571 ; pp. 83. Washington : Government Printing Office, 1956 ; 50 cents), which replace the out-of-print and partly obsolete tables published in 1941 as Part 2 of "Miscellaneous Physical Tables. Planck's Radiation Functions and Electron Functions. U.S. National Bureau of Standards. Mathematical Tables 17". The calculation of the tables was carried out on the Bureau's automatic digital computer, SEAC, and the eight tabulated quantities, each given to eight significant figures, are : the potential difference in absolute volts required to impart a kinetic energy E expressed in electron volts to an electron initially at rest ; the effective relativistic potential difference ; the product of magnetic field strength in œrsteds and the radius of curvature of electron path in centimetres ; the de Broglie wave-length of the electron ; the momentum of the electron measured in units of m_0c, where m_0 is the rest mass of the electron and c is the velocity of light ; the kinetic energy of the electron measured in units of its rest mass energy, m_0c^2 ; the total energy of the electron measured in units of the rest energy ; and the ratio of the electron velocity to the velocity of light. The electron energies quoted range from 0·206 eV. to $3 \cdot 353 \times 10^{12}$ eV. The values of the fundamental constants adopted in the computation of the tables are those given by J. W. M. Dumond and E. R Cohen (*Rev. Mod. Phys.*, 25, 691 ; 1953).

Photometric Theory of Lunar Eclipses

THE sixteen lunar eclipses between October 16, 1921, and July 15, 1954, are discussed by F. Link in a paper, written in Czech but with an English summary, entitled "Catalogue of Eclipses of the Moon, 1921–1954. 2 : Measurements of the Density of the Shadow" (Pub. Č 29, Nak. Česk. Akad. Věd, Praha ; 1956). In 1933, Link had established a photometric theory of lunar eclipses, based on contemporary knowledge of the terrestrial atmosphere and directed specially to the exploration of the upper atmosphere (*C.R. Acad. Sci., Paris*, 196, 251 (1933), and *Bull. Astron.*, 8, 77 (1933)). Since then the numerical results of his theory have served for comparison with measurements of the density of the Earth's shadow, and the object of the present paper is to give a summary of these comparisons in view of a proposed revision of the earlier theory. Many precautions are necessary in measuring the density of the terrestrial shadow thrown on the Moon, and certain disturbing factors intervene—in particular, the light scattered in the instrument used for the measurements or in the Earth's atmosphere, and then the atmospheric absorption and its variations, which are all likely to vitiate considerably the measurements. Fortunately, the photometer described by A. Danjon (*Ann. Obs. Strasbourg*, 2, 1 ; 1928) provides results in which systematic errors are automatically eliminated. There is now a long series of measurements of this nature which were made between 1921 and 1954, and the work under consideration contains the results of this series. In addition to sixteen pages of tabular matter showing the densities of the shadows, there are sixteen curves—one for each eclipse—showing the densities as functions of the angular distance from the centre of the shadow, and other curves and diagrams supplying additional information. A detailed discussion has been reserved for the future, but the following provisional deductions have been made. In the shadow and in the green and red parts of the spectrum, there is normally a deficiency of light with regard to the Rayleigh atmosphere, but in the blue—and in exceptional circumstances in the green and red—there is an excess of light with reference to the Rayleigh atmosphere. In that part of the penumbra which is close to the geometrical limit of the umbra, there is often an excess of light which is difficult to explain by any known phenomena. In both the umbra and the penumbra there is often a marked dissymmetry between the increasing and decreasing phase, and it is suggested that the above facts should serve as a starting-point in the future for revising existing theories of lunar eclipses.

Bibliography of Seismology

No. 15 of the valuable "Bibliography of Seismology" (Vol. 14 in "Publications of the Dominion Observatory, Ottawa"), edited by W. E. T. Smith and covering the period January–June 1954 (Items 8547–8772), includes 326 items in pure and applied seismology, culled from some twenty countries and taken from seventy-seven journals. Particularly interesting is the present use of explosions employing very large masses of explosive, in order to determine deep-crustal structure. Such experiments by H. Reich and O. Fortsch in southern Germany (Items 8600, 8703 and 8704), by a group of seismologists in Japan (Items 8705, 8706), and by H. E. Tatel, L. H. Adams and M. A. Tuve in the United States (Item 8746) are listed. The work of M. N. Hill and A. S. Laughton on seismic observations (using explosives) in the eastern Atlantic and of M. Hayakawa and K. Mori on seismic prospecting on the sea bottom near Sakito, Nagasaki Prefecture, are noted.

University of Birmingham

The following appointments have been made in the University of Birmingham: J. W. Glen, to be lecturer in physics; C. R. Patrick and G. H. Whitham, to be lecturers in chemistry.

The Huxley Lecture will be delivered on March 7 by Prof. C. D. Darlington, Sherardian professor of botany in the University of Oxford.

The Sir Josiah Mason Lectures will be delivered in the session 1957–58 by Sir Solly Zuckerman, Sands Cox professor of anatomy and director of the Department of Anatomy in the University; the lectures are to be entitled "Control of Population Growth".

The Night Sky in January

New moon occurs on Jan. 1d. 02h. 13m., U.T., full moon on Jan. 16d. 06h. 21m. and new moon on Jan. 30d. 21h. 24m. The following conjunctions with the Moon take place: Jan. 9d. 09h., Mars 3° S.; Jan. 20d. 20h., Jupiter 6° N.; Jan. 26d. 00h., Saturn 0·4° N.; Jan. 28d. 16h., Mercury 2° S. In addition to these conjunctions with the Moon, Mercury is in conjunction with Venus on Jan. 21d. 16h., Mercury being 2·8° N. Mercury is unfavourably placed for observation. Venus is a morning star, visible very low in the south-east just before sunrise. Mars sets at 0h. 35m., 0h. 30m. and 0h. 20m. on January 1, 15 and 31, respectively; its stellar magnitude decreases during the month from + 0·3 to + 0·9, its distance from the Earth increasing from 98 to 124 million miles. Mars continues to move eastwards, being near δ Piscium at the beginning of the month, and passing into Aries on January 27. Jupiter rises at 23h. 20m., 22h. 30m. and 21h. 20m. at the beginning, middle and end of the month, respectively, and is near η Virginis; its stellar magnitude is about – 1·7, its distance in the middle of the month being 460 million miles. Jupiter is stationary in right ascension on January 17, and subsequently begins to move westward among the stars. Saturn is now in Ophiuchus, and rises at 5h. 40m., 4h. 50m. and 3h. 50m. on January 1, 15 and 31, respectively; its stellar magnitude is + 0·7 and its distance from the Earth is approximately 1,000 million miles. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: Jan. 17d. 20h. 53·9m., ω Leo. *m* (*R*); Jan. 22d. 6h. 27·5m., 68 Vir. (*R*). *R* refers to reappearance. The Quadrantid meteors will be active on January 3, but maximum activity is expected during daylight and conditions for observation are not favourable. The Earth is in perihelion on January 3, its distance from the Sun being 91·3 million miles.

Announcements

Dr. Albert Parker, director of fuel research in the Department of Scientific and Industrial Research since 1943, is retiring on December 31, after twenty-eight years service with the Department. Dr. A. C. Monkhouse, at present deputy director, has been appointed acting director of fuel research.

Dr. W. M. Elsasser, formerly professor of theoretical physics at the University of Utah, has joined the staff of the University of California, Scripps Institution of Oceanography, as research physicist.

The Children's Lecture of the Manchester Federation of Scientific Societies will be given by Prof. C. E. H. Bawn in the Chemistry Lecture Theatre in the University, Oxford Road, Manchester, on January 3 and 4 at 3 p.m.; Prof. Bawn will speak on "Progress of Plastics". Admission is by ticket from one of the societies comprising the Manchester Federation.

A principal theme of the national sectional meetings of the National Union of Teachers to be held at the Friends House, London, N.W.1, during January 2–4 will be "The Place of Mathematics and Science in the Curriculum at all Stages of Education". Dr. J. Bronowski is opening the proceedings with a paper on "The Purpose of a Scientific Education". The teaching of mathematics at various ages and the expansion of technical education will be discussed at other sectional meetings being held at Church House, Caxton Hall and the Institute of Education (University of London).

The second International Congress of Surface Activity will be held in London during April 8–12, with Lord Brabazon of Tara as the president of honour and Sir Eric Rideal as the president. Membership of the Congress is open to all on payment of a fee of £4. Inquiries should be addressed to the Honorary Secretary, Second International Congress of Surface Activity, 14 Belgrave Square, London, S.W.1.

The Bradford Chemical Society, in conjunction with the Department of Chemistry and Dyeing of the Technical College, Bradford, and the Yorkshire Council for Further Education, is to hold a symposium on "Recent Developments in the Chemistry of Fibrous Linear Polymers" at the Technical College on February 15 and 16, 1957. There will also be an exhibition of chemical apparatus and of fibres and fabrics. There is no fee for attendance at either lectures or exhibitions, but inquiries about either may be addressed to Dr. W. R. Moore, Department of Chemistry and Dyeing, Technical College, Bradford.

HIGH-SPEED PHOTOGRAPHY

THERE has been an increasing interest in the techniques of high-speed photography and in their application. In October 1952 the Society of Motion Picture and Television Engineers of New York organized an International Congress on High-Speed Photography and held it in conjunction with its annual meeting in Washington. The number of people who attended and the extent of the interest were such that it was decided to hold other meetings, the next in Europe. The Second International Congress on High-Speed Photography was held under the auspices of the Association Française des Ingénieurs et Techniciens du Cinema in Paris in September 1954. A great deal of material was submitted to this Congress and has been published recently*. These proceedings are an impressive indication of the breadth of the subject and of the extent of its applications. Sixty-eight papers were presented, and the proceedings are extensively illustrated, by some 650 illustrations, many of which include a number of separate pictures, so that the whole number of illustrations runs into the thousands.

As many major advances have been made in Britain, it was decided to hold the next Congress here. The Department of Scientific and Industrial Research agreed to sponsor the Congress, which was held in London during September. It is a measure of the extent to which the Congress was truly international that of the 330 members who attended, ninety-six were from overseas, representing fourteen different countries.

The papers for presentation were submitted to the editorial committee some months before the Congress. There was severe restriction of the length of the papers and of the numbers that could be accepted. Papers describing work which had been published elsewhere were automatically rejected. This strict editorial policy meant that papers presented and to be published in the proceedings are of a high standard, and describe new and original techniques and applications that are nowhere else available in the published technical literature. The papers were all preprinted and copies made available to members before the opening of the Congress. They were therefore not read *in extenso*, but each author gave a résumé of his work and indicated what advances there had been in recent months. Ample time was thus left for discussion and comment on each of the papers. One of the most valuable features of the whole Congress was the vigour of the discussion and the attention that could be given to individual problems, inquiries and suggestions. Summaries of the discussions will be included with the proceedings.

The main topics discussed at the different sessions of the Congress are indicated briefly below.

Flash light sources. There were considerable advances in the detailed study of sources and in the efficiency of conversion of energy for single-shot work (E. P. Tawil; D. P. C. Thackeray; M. Laporte; J. S. T. Looms and R. J. North; P. Devaux; I. S. Marshak); and in the development of equipment that could produce a series of short flashes at high rates (H. E. Edgerton; F. Früngel). Valuable work was also reported on the production of rectangular pulses of light suitable for illuminating an event while a whole sequence of pictures was taken (D. P. C. Thackeray). Analyses were also presented of the light source requirements, and how these could be met, for work in wind tunnels (L. H. Tanner; J. S. T. Looms and R. J. North).

Image-splitting and image-dissection techniques. New techniques were described which allow fast photography through a microscope with very simple equipment (J. S. Courtney-Pratt and D. P. C. Thackeray; J. S. Courtney-Pratt). A combination of image-converter and image-dissection techniques was described which allows a high throughput of light and which has already been used to take a sequence of fifty pictures at a rate of 5×10^7/sec. (G. H. Lunn). This technique is likely to be of far-reaching importance as already it gives very high rates and yet is nowhere near the limit to which it can be pressed. Further development work will be required but should be amply repaid, as fundamental limitations are unlikely to be restrictive for speeds higher still by a factor of 100 or 1,000.

Inertialess shutters. The use was described of image converters for taking single-shot pictures with an exposure of 3×10^{-9} sec. (R. F. Saxe), and an assessment presented of the efficiency of present-day converters and the extent to which their efficiency may be increased (R. A. Chippendale). It would seem that one may hope eventually to get an intensification of the image by a factor of 100 or so. Advances in the use of Kerr cells were described, and a valuable new method of switching the light beam from one path to another so that a short series of pictures can be taken at speeds up to the maximum operating speed of these switching cells (E. W. Walker). A combination of image dissection and Kerr cell aperture-scanning was described (J. L. Viard). As in this equipment the Kerr cells are of very small dimensions, the equipment can give a qualitative study of an event at even higher rates.

Applications in industry and biology. Two papers were presented on machine and combustion analysis (R. O. Painter; J. G. G. Hempson), and a paper was presented describing a study of the flow of blood corpuscles *in vivo* (A. M. P. Brookes and P. A. G. Monro). This paper described new techniques of much wider application than simply to the particular project for which they had been developed. A cathode-ray tube was used as a repetitive source, and it was shown that one could estimate the velocity of mean flow of a stream in which randomly distributed particles are transported, by a method similar to the stroboscopic study of consistently repetitive events. The authors likened the pattern that could be seen to raindrops on a windscreen. The pattern would show no drift if the frequency of flash was equal to the mean rate of passage of particles.

Application to ballistics and explosives. A large proportion of the development and use of high-speed photography has always been in the military field. A number of papers were presented in this and other sessions that described cameras developed for use in guided-weapon trials (R. Herden; P. B. N. Nuttall-Smith), in supersonic flight (J. S. Rinehart), in proof-range work (R. Herden; M. B. Prudence; J. H.

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* "Actes de 2e Congrès International de Photographie et Cinématographie Ultra-rapides" (Dunod, Paris, 1956).

Waddell; M. Sultanoff; T. Uyemura and T. Morishige; P. Devaux; J. S. Rinehart; J. L. Viard; E. W. Walker; H. F. Hills; T. Uyemura; L. Zernow and G. E. Hauver), and in studies of safety hazards of the ignition of explosives and of gas mixtures (A. Berthmann and H. Käufer; M. Giltaire).

Instrument aids. Two papers were presented on more precise time measurement (P. Fayolle; W. Baur and K. Pfister), and a camera was described with a system that allowed the separation of pictures taken with different colour pass-bands (R. L. Aspden). A number of authors pointed out that similar means could be used to increase the framing rate, to increase the number of pictures in a sequence, or to differentiate between different features of an event (J. S. Courtney-Pratt and D. P. C. Thackeray; N. Dombrowski; W. D. Chesterman). A paper was presented in this session which described a method for studying the fracture process within a solid (F. Kerkhof). In the simplest case of brittle failure in tension, a straight fracture front will generate a plane fracture surface in a solid. If ultrasonic waves are present, the instantaneous direction of movement of the fracture front can be a little affected. After fracture, the ripples in the surface show how far the fracture front had advanced between successive maxima of the ultrasonic wave. This is a powerful method, as it allows one to study the shape and movement of a fracture front inside even an opaque material, whereas the ordinary photographic methods are restricted to a study of the movement of the crack at the surface.

Photographic materials. A number of papers were presented on the behaviour of ordinary and colour emulsions, with reference particularly to their behaviour at short exposure (R. J. North and N. A. North; J. Eggert and R. von Wartburg; R. von Wartburg; J. Castle, W. Woodbury and W. A. Shelton). Many emulsions show reciprocity failure by a factor of 2 or 3 for exposures between 10^{-3} and 10^{-5} sec. It used to be thought that there might be even greater reciprocity failure at shorter times still; but most of the evidence produced at this Congress indicates that the sensitivity of the emulsions is not much further reduced for exposure times as short even as 10^{-9} sec. (H. Hoerlin).

X-rays. Papers were presented on ciné-radiography of biological subjects at rates up to 125 frames per sec. (S. A. Weinberg, J. S. Watson and G. H. Ramsey), and on a study of the movement of shock waves in solids by the use of flash X-ray bursts of duration between 10^{-6} and 10^{-7} sec. (R. Schall). There was also a valuable paper describing a critical study of the role and influence of gas in X-ray tubes (R. F. Thumwood). It was shown that the efficiency could be greatly increased by controlling the pressure of gas with an optimum at pressures in the range 10^{-3} to 10^{-4} mm. mercury.

Film evaluation. Papers were presented describing methods of reading films, and of data processing (B. S. Benson; W. N. McJilton; J. Rieck). This is a problem of growing importance, as with the increase in speed the number of frames to be measured has made this the most laborious operation of the whole investigation; so much so that considerable increase in the complexity of recording equipment is amply justified if it can lead to a more direct means of assessment.

Optical techniques. Contributions were made describing installations that made use of the Cranz–Schardin system, of interferometric and schlieren techniques (H. F. Hills; H. Schardin; J. Dyson), and of an optical system that combined some of the advantages of phase-contrast and schlieren systems (R. Bouyer and C. Chartier). There was also an elegant new method described for extending the range of schlieren systems utilizing the moiré patterns that can be obtained by the use of two separated grids (T. Fromme).

Rotating mirror cameras. Several new cameras were described (B. Brixner; A. E. Huston; T. Uyemura; L. Zernow and G. E. Hauver; J. Tchernyi), and there was a vigorous discussion of the limitations of such systems from considerations on one hand of diffraction limits and the ultimate strength of materials, and on the other by the technical difficulties of manufacture of components of sufficient quality. Prof. H. Schardin showed that for rotating-mirror framing cameras and streak cameras the product of the framing-rate and the number of lines resolved across the frame in the direction of movement of the image could not with present materials be made higher than 4 × 10^{9} sec.$^{-1}$. One thus has a valuable criterion for assessing the performance of a camera by seeing how nearly this limit is approached. It became evident from the discussion that one might considerably surpass this limit if one took advantage of the principles of image dissection or the increased sweep-rate with image-converter cameras, and might well go even further by combinations of dissection and image converters.

Medium repetition-rate cameras. Cameras were described that showed considerable advances in resolution, and consistency of operation even under adverse conditions (B. W. Allwood, J. R. Bouffler, B. B. E. Death and D. Jones; J. H. Waddell; R. Herden; P. B. N. Nuttall-Smith); and also a system that allowed rapid acceleration of a loop of film to avoid the long delay and film wastage that often occurs in more conventional equipment (M. B. Prudence).

Applications to fluid dynamics. Papers were presented describing installations for studying flow in wind tunnels and in water (H. P. Liepman and J. B. Cooper; F. Früngel, E. Baillitis and W. Thorwart), in shock tubes (H. Schardin), and water entry tanks (E. G. Richardson). Methods were described for studying droplet formation (J. G. A. de Graaf; R. P. Fraser and N. Dombrowski) and jet disintegration (Y. Kumano). An interesting series of pictures was presented which showed the extraordinary differences in the detail that were visible with different methods of illumination (R. P. Fraser and N. Dombrowski). This was a salutary reminder that one must not assume that things are not there if they cannot be seen on a photograph. Attention to the details of the technique can perhaps make them evident.

Review papers. Colonel P. Naslin opened the technical sessions of the Congress by presenting a paper on the state of the art. As his main topic he drew an analogy between the practices and principles of high-speed photography on one hand, and the developments in control and information theory on the other. One may record continuously the variation of amplitude of one or another of the parameters, or one may sample the value of a number of parameters at a given instant (as in ordinary intermittent-movement ciné cameras). One may, however, sample in other dimensions, and dissection systems are typical of this. One might also sample, quantize, code, or multiplex other variables, so that one could raise to the maximum the rate of recording of those features of the incoming information that are most relevant. A consideration, then, of the similar advances in communication theory can stimulate advances in the whole field of high-speed photography.

A review of the work of the Congress was presented on the last day (J. S. Courtney-Pratt). Advances in particular techniques were commented upon. Trends of design were indicated. A summary was given of the emergence of principles of assessment with emphasis on the contributions, mentioned above, of Colonel Naslin and Prof. Schardin.

An exhibition was held in conjunction with the Congress, and a review has been prepared by A. R. Michaelis. This was by far the most comprehensive display of equipment for use in high-speed photography that has ever been held in Britain, and included exhibits from commercial firms, from government departments, and from universities, ranging from equipment that could be bought 'off the shelf' to research equipment that is in the process of development. It was significant that equipment that was described for the first time at the Congress in Paris is now in use at a number of laboratories and was on display at this Exhibition.

The published Proceedings of the Congress, including the review papers and summaries of the discussion and a brief description of the Exhibition, will be available from Butterworths Scientific Publications, London, in January 1957.

At the Congress the range of topics covered indicates the growth and breadth of the subject. Photographic methods are among the most powerful of the tools we have. The study even of processes we think of as slow requires short exposures and high repetition-rates when the interest is in the fine detail; and more and more we must rely on the techniques of high-speed photography. For studies on the microscopic scale the problem is accentuated, and we must take advantage of the most advanced and elaborate of the new techniques, and also must apply research and development effort to the improvement of these techniques. The ever wider use of high-speed photography in research and industry is a foregone conclusion, and it is as certain, too, that this will contribute to more rapid progress in science and technology.

J. S. COURTNEY-PRATT

THEORETICAL CONSIDERATIONS ON GRINDING

A SYMPOSIUM consisting of five papers on various aspects of grinding was held by the Institution of Chemical Engineers at the Royal Institution on November 7, under the chairmanship of Mr. A. S. White.

The first paper, by Dr. H. E. Rose (King's College, London), dealt with an attempt to predict the principal features of ball-mill behaviour from purely theoretical considerations. The basis of the method is to use suitable probability functions to compute the probability of a particle entering a 'zone of operation' around a contact point between a pair of balls and to compute the probability of occurrence of some process after the particle has entered this 'zone'.

From this reasoning it is possible to predict a number of features of ball-mill performance which, although they have been observed in practice, have not, so far as is known, been predicted theoretically. From such considerations it was suggested that, in certain circumstances, the ball-wear may be reduced by the use of softer metal; that the rate of grinding may be increased by the use of a reduced powder charge in the mill, although this can only be accomplished at the expense of increased rate of metal wear; and that the relationship between the surface produced and the time of milling is a function of the relative hardness of the balls and the material being ground.

A second paper by Dr. Rose was an attempt to analyse the performance of a vibration mill, by the application of the method of dimensional analysis; the justification of this paper being that the vibration mill appears to offer the possibility of very rapid milling of certain classes of materials which are otherwise difficult to pulverize.

The treatment has led to the conclusion that the rate of grinding in a vibration mill varies as a fairly high power of the frequency and of the amplitude of the vibration; furthermore, the exact relationship between the rate of grinding and the frequency and amplitude depends upon whether the energy to produce new surface or the limiting stress in the particle is the criterion for comminution.

By analysis of the published data, it was shown that the rate of grinding is proportional to the density of the ball material, and that the maximum rate of grinding is achieved when the powder in the mill is just sufficient to fill the space between the balls.

A paper dealing with the application of the principle of similarity to mills and to the grinding process was presented by Prof. A. H. M. Andreasen (Royal Technical University, Copenhagen).

In this paper it was shown that geometrically similar jaw crushers, cone crushers and similar machines, in which the stressing of the particle is brought about by mechanical means, will operate at the same efficiency regardless of size, but the throughput will vary as the cube of the size. For edge-runner mills, however, in which the stressing of the particle arises from gravitational forces, the throughput and energy consumption both vary as the square of the linear dimensions when the peripheral speed is constant; and as the cube of the size when the speed of rotation is fixed. With hammer mills, the condition for similarity is that the peripheral velocities must be constant irrespective of size and, under this condition, the production will vary as the square of the size of the mill.

For mills in which the inertial forces are produced by gravity, for example, the ball mill, the condition for similarity is that the densities of the grinding media shall vary inversely as the scale ratio of the machines. Since such materials are not available, true similarity cannot be maintained, and this is probably the reason why very small ball mills are not usually very successful.

When dealing with the principle of similarity applied to the crushing process, Prof. Andreasen showed that his experiments gave rise to orthogonally affine undersize curves for the product and, furthermore, it was shown that such curves would be predicted from an analysis of the fracture pattern obtained when solid bodies are crushed in a press.

From the results of experiments and considerations of similarity, it was shown that the expression $E = C \ln F_A/F_0$ is the relationship connecting the energy input to the particle and the increase of fineness; E being the energy expended, C is a constant depending on the material, and F_0 and F_A are the fineness before and after crushing, respectively. This expression is, of course, identical with that usually known as 'Kick's Law'; but Prof. Andreasen suggested that the theoretical basis of the expression is not sufficiently well established to justify its designation as a 'law'.

In the fourth paper, Mr. J. A. Holmes (Atomic Energy Research Establishment, Harwell) introduced a new law of comminution based upon a modification of Kick's Law. As a basis for this work, Mr. Holmes explained that materials which are milled commercially are rarely homogeneous and that, since in such materials the forces resisting disruption of the particle range from weak van der Waals forces to strong chemical bonds, the strength of a particle will depend upon the type of forces operative; the strong chemical bond being operative in the small particles, whereas van der Waals forces hold the particles together in a heterogeneous material. This would suggest that a modified form of Kick's Law would be $B = kD^{1-r}$; and this in turn leads to the equation

$$W = W_i\left[1 - \left(\frac{1}{R}\right)^r\right]\left(\frac{100}{a}\right)$$

where W is the work input necessary to reduce the feed from size F to a product of size a, W_i the work input necessary to reduce material from an infinite size of feed to a product of 100 micron size, R is the reduction ratio, and r is an index which depends upon the characteristics of the material and the crushing system. When $r = \frac{1}{2}$, this equation reduces to that of Bond's third theory of comminution.

It was then shown that, for grinding tests in a ball mill, the value of the work index, W_i, as calculated by the proposed formula is more nearly independent of the size of the material undergoing grinding than is the case when the calculation is based on Bond's equation. The value of the index r, however, varies from one material to another.

The fifth paper, by Mr. J. A. Holmes and Mr. S. W. F. Patching (Atomic Energy Research Establishment, Harwell), was introduced by Mr. Holmes, who explained that it dealt with a preliminary investigation into the differential grinding of mixed minerals. It has been shown that the specific rates of reduction of the components of a mixed feed are lower when the components are ground together than when they are ground separately. The ratio of the specific rates of reduction of the two components when ground together is not, however, greatly different from that when the materials are ground separately.

Equations have been developed by means of which the circulating load of each component in a two-component mixture, undergoing grinding in a ball mill, may be computed from the total circulating load, the ratio of the specific rates of reduction of the components and their proportions in the feed.

It was suggested that a useful field of application of these equations is in the determination of the specific rates of reduction from analyses of the circulating load fractions.

When opening the discussion, Dr. H. Heywood (Imperial College, London) stated that in tests upon ball mills of various sizes he has found that the maximum rate of grinding occurs when 80–90 per cent of the space between the balls was filled with powder, this result being roughly in accord with the result deduced by Dr. Rose in his first paper. Dr. Heywood also showed that the results of recent investigations on crushing of various materials suggest that the energy necessary to produce unit increase of specific surface depends upon the energy density in free crushing and upon the type of crushing device employed.

Mr. W. F. Carey emphasized that the crushing process is complicated and cannot well be dissociated from the type of crushing plant used. In this connexion he pointed out that the new equation for crushing, developed by Mr. Holmes, gives slightly more consistent values of the work index than does that of Bond; but the new equation is based on tests on ball-mills only, whereas that of Bond was developed from tests on a wide range of crushing machinery.

Mr. Carey also suggested that experimental verification of the assumptions underlying the theory of the ball mill, developed by Dr. Rose, would be of value since, although the validity of some of the basic assumptions is open to doubt, the theory appears to lead to a number of interesting conclusions.

Mr. E. J. Pryor also emphasized that the crushing process must be studied in connexion with the type of crushing apparatus used and that, in common with those of other workers, his own experiments to deduce a law of comminution have produced results which are so complicated as to defy analysis. He showed that some of the energy supplied to a mill may be expended in bringing about chemical changes in the material being ground; examples of copper ore in which the copper compound has been changed to one having a higher energy-level at the points where the balls rub the material being shown.

It was also considered that undue claims have been made for the vibration mill, and that an accurate assessment of the potentialities of these machines is necessary.

Mr. W. C. Peck pointed out that in some applications the superiority of the vibration mill lies not in increased rates of milling over the conventional mill but in some incidental advantages. For example, in the milling of tungsten carbide, the cobalt is more evenly distributed over the particles, which leads to an improved product, while some pigments give a 'stronger' tint when so milled.

Mr. R. M. E. Sullivan said that he has carried out experiments on the crushing of glass spheres by use of a drop-hammer, and he could confirm the statement of Mr. Pryor that the results are of such complexity as to defy analysis, and also the findings of Prof. Andreasen that the product undersize curves are orthogonally affine. He is therefore of the opinion that the problem of comminution requires detailed fundamental investigation.

Mr. Sullivan also said that he has re-calculated some results of tests on a vibration mill, quoted by Bachmann, and found that they confirm the deduction, made by Dr. Rose, that the rate of milling varies as the fifth power of the frequency of vibration. This result shows that, at least for limestone, the critical stress is the criterion for comminution.

Dr. G. A. H. Elton asked whether the theory of the ball mill, proposed by Dr. Rose, would be valid for the milling of a polydisperse material composed of non-spherical particles, and, in reply, Dr. Rose pointed out that some of the theoretical conclusions are supported by published results relating to the milling of chert and dolomite, both of which are non-spherical and polydisperse, and so, at least as a first approximation, the theory appears to be applicable to such materials.

Mr. R. L. Brown showed that, by the use of matrix algebra, the performance characteristics of a closed-circuit milling installation may be deduced from the relatively simple performance characteristics of the elements of the system. Such methods, however, demand an accurate knowledge of the performance characteristics of the elements, and in this connexion accurate laws of comminution are desirable. The existence of an inter-relationship between the various elements of a mill installation at once raises the question of the extent to which the 'laws' found by experiment are dependent upon the nature of the material undergoing treatment and upon the characteristics of the plant involved.

REACTIONS AND STRUCTURE IN CARBOHYDRATES

A SYMPOSIUM on "Newer Interpretations of Reactions and Structure in Carbohydrate Chemistry" was held under the auspices of the Chemical Society on November 1, in the Chemistry Department of University College, London. There was a large and interested audience composed mostly of the younger chemists. It was a particular pleasure to note the presence of Prof. C. K. Ingold, host to the meeting, and of Prof. E. L. Hirst, president of the Chemical Society.

Dr. G. R. Barker, the organizer of the symposium, was in the chair for the afternoon session, when the opening speaker was Prof. E. J. Bourne (Royal Holloway College, London), who discussed some physical methods used in the determination of carbohydrate structures. He first outlined the contributions which infra-red analysis recently carried out in the University of Birmingham can make to the solution of many problems encountered in carbohydrate chemistry. Among the applications are the direct comparisons of unknown samples with authentic specimens, analyses of mixtures, determinations of hydrogen bonding and degrees of crystallinity, detection of substituents and of water of crystallization, etc. In suitable cases, infra-red techniques provide information on configuration, conformation, ring size, anomeric state and positions of glycosidic linkages in polysaccharides. The assignment of the more important vibrations was considered. Preliminary results in studies of the Raman spectra of ring systems in carbohydrates and their derivatives were presented. Reference was made to Dr. D. H. Whiffen's theoretical interpretation of optical activity in carbohydrates and to its possible applications in future work.

Dr. J. C. P. Schwarz (University of Edinburgh) then spoke on conformational ideas applied to tosyl esters and three-membered oxide rings. In certain carbohydrate derivatives, equatorial hydroxyl groups are tosylated more readily than axial hydroxyl groups. Replacement reactions of primary sulphonyloxy groups (for example, tosyl esters) with sodium iodide, sodium hydroxide, lithium aluminium hydride, and other reagents probably proceed by S_N2 mechanisms with carbon–oxygen fission. In the absence of participation of neighbouring groups, carbohydrate derivatives containing secondary sulphonyloxy groups attached directly to a ring are generally much less reactive than primary sulphonyloxy compounds, and sulphur–oxygen fission is usually involved in their reactions with sodium hydroxide or lithium aluminium hydride.

The relative reactivities of various tosyloxy compounds are influenced by two types of steric effect, namely, hindrance encountered by the incoming group and changes occurring in the non-bonded repulsions between substituents as the molecule passes from its initial state to the transition state. The first type is illustrated by the behaviour of the 2 : 5-di-O-tosyl-1 : 4-3 : 6-dianhydro hexitols, and the second is important in elimination and cyclization reactions which involve groups attached to a neighbouring carbon atom. The migration of three-membered oxide rings was discussed at some length.

Dr. A. B. Foster (University of Birmingham) then followed with a paper on conformational aspects of the formation and reactions of certain cyclic derivatives of carbohydrates. A number of reactions in carbohydrate chemistry are amenable to conformational analysis. Those particularly discussed were: (i) preferential formation of certain cyclic acetals in the reactions of aldehydes and polyalcohols in the presence of acid; (ii) the position of the equilibrium established in aqueous acid between a hexose and its 1 : 6-anhydro-pyranoside derivative; (iii) the remarkably facile isomerization undergone in the presence of acid by derivatives of certain 3 : 6-anhydrohexopyranosides; and (iv) a number of novel steric effects which have been encountered in the study of the reaction of borate ions with pyranoside derivatives. Some of these were explained by postulating the participation of boat forms of the carbohydrate in the reaction with borate ions. The discussions of the two papers were taken together. The speakers, particularly Dr. Schwarz, were bombarded with questions, and conformational analysis was evoked to explain various other reactions, including some biochemical changes.

The chairman for the evening session was Prof. M. Stacey. Dr. W. G. Overend (Birkbeck College, London) gave a valuable paper on the hydrolysis of glycosides. The acidic hydrolysis of O-glycosides and glycosylamines was discussed from the point of view of various factors such as the variation of the glycosidic substituent; configurational change at the glycosidic centre; variation of substituents on the glycopyranosyl residue and alteration in the size of the sugar ring. Conformational and mechanistic aspects of glycoside hydrolysis were outlined, and consideration given to the formation and hydrolysis of glycosyl phosphates and to the transglycosylation reaction.

The final comprehensive paper was given by a distinguished guest from Ottawa, Dr. R. U. Lemieux (University of Ottawa), who discussed reactions at the anomeric centre of acetylated glycopyranosyl acetates and halides. The reactions appear almost invariably to involve participation of either the ring-oxygen atom or the C(2)-substituent. The participations strongly affect the stereochemical route of reaction and appear to impose the half-chair conformation on the pyranose ring of the intermediate state. A consideration of the interactions between non-bonded atoms in the half-chair conformation of the intermediate state appears to be more fruitful in the rationalization of observed effects of configuration on reactivity than are similar considerations based on the conformation of the reactant in the ground state.

The use of proton magnetic resonance spectroscopy for establishing the conformations of sugar acetates was briefly discussed.

The symposium altogether was a lively and stimulating affair, and in the closing remarks the chairman commented on the increasing importance of applications of these newer interpretations of carbohydrate reactions in the ever-widening field of biochemistry.

ASSOCIATION OF SCHOOL NATURAL HISTORY SOCIETIES

EIGHTH ANNUAL EXHIBITION, 1956

THE eighth annual exhibition of the Association of School Natural History Societies was held at the British Museum (Natural History) on October 20. Mr. Eric Hosking, who is a founder-member of the Association, gave a lecture on "Birds in Action" before an audience of 150 children. This was illustrated by a selection of magnificent photographs of birds, for which Mr. Hosking is rightly famous. By means of electronic flash and occasionally with the use of a specially designed photo-electric camera release, some remarkable pictures had been obtained.

After the lecture, the exhibition was opened to members and to the public. A notable feature of this year's exhibition was the reduction in the number of charts and diagrams coupled with an increase in live exhibits. While it is true that the tabulation of results and their presentation in graphic form is an admirable, if not essential, way of summarizing field work, it is also true that this practice often makes a dull exhibit. Nine out of the twelve items displayed by Bishop's Stortford College were living exhibits, including an elaborate reconstruction of a portion of a refuse dump. In another exhibit were specimens of the white-lipped hedge snail (*Cepea nemoralis*), showing the many variants of shell-marking. African clawed frogs, reared at the school, made an interesting contrast to familiar British amphibians. Other examples of living freshwater animals were shown by Oundle School, Felsted School and Lord Wandsworth College, Hants. The latter school displayed also a home-made portable instrument for the field measurement of salinity in salt marshes. This operated by measuring the electrical conductivity of the water contained in a long polythene tube. The study of the natural history of mammals is a subject which has been sadly neglected by the majority of naturalists. It was therefore encouraging to see that Kimbolton School, Hunts, had begun a scheme of trapping and marking small mammals. A number of living small rodents was displayed.

Marine studies had been undertaken by Dulwich College, which displayed a large collection of marine algae and a shore transect illustrating the zonation of these species on the sea-shore. Similar work was described by Ackworth School, Yorkshire.

A pupil of Bishop's Stortford College had prepared a model to illustrate the trapping of moths at a mercury-vapour light trap. A relief model of an area of countryside, above which bird flight-lines were indicated, showed that whereas some species of bird preferred to fly along the valleys, other species tended to fly in a direction perpendicular to the contour lines. Limehurst Natural History Society (Garendon School, Loughborough, Leics.) displayed models, photographs and charts which described their island nature reserve and the wild life found there.

Lepidoptera were not so prominent in the exhibition as they were last year. Several schools showed a few in connexion with their other exhibits, but the collection shown by Tonbridge School was the most comprehensive.

Geology was represented by a soil profile across an area of poor fen, exhibited by Cranbrook School, and a selection of rock samples and fossils from an ironstone cutting brought by Uppingham School. Also included in their exhibits were owl pellets and kestrel pellets, whole and dissected. Owl pellets were featured in the displays by Oundle School, and the William Grimshaw School, London. The latter school had prepared a complete demonstration of the various stages in the dissection of a pellet, culminating in the 'reconstruction' of most of the skeleton of an individual vole from bones found in a single pellet.

It was announced that further exhibitions have been arranged in Leicester (November 24) and Leeds (May 11, 1957). Other meetings are being planned to take place in Exeter and Manchester. Further details of these meetings can be obtained from O. N. Bishop, Hon. General Secretary, A.S.N.H.S., 115 Shelly Road, Exmouth, Devon. A special edition of the Exhibition Catalogue is available (10*d*., including postage), which contains a full list of exhibits, a list of members and their addresses, and the annual reports of the committee.

In addition to those displays put on by member schools there were a number of guest exhibitors. The Amateur Entomologists' Society, the Royal Society for the Protection of Birds, the School Nature Study Union and the Universities Federation for Animal Welfare displayed their publications. The Children's Centre showed material illustrating their Saturday morning activities; a scale-model of a small portion of Epping Forest was particularly noteworthy.

O. N. BISHOP

EXPEDITION TO THE SALMON AND LEDUC GLACIERS

AN expedition to the Salmon and Leduc Glaciers was organized in 1956 by the University of Toronto under the leadership of Prof. J. A. Jacobs at the request of the Defence Research Board and the National Research Council of Canada. Eleven men took part, and the expedition lasted from the middle of May until the end of August.

The Salmon and Leduc Glaciers, which are situated near the coast of British Columbia opposite the southern tip of Alaska (approximately lat. 56° 10′ N., long. 130° 15′ W.), were chosen since they lie between the glaciers from the Juneau ice field to the north and those of the Washington Cascade and Olympic Mountains to the south, on which a considerable amount of work has already been done. The area is also interesting since the Granduc ore body lies in the mountains surrounded by these and other glaciers.

The objectives of the expedition, which forms part of Canada's glaciological programme in the International Geophysical Year, were two-fold: to train men and test equipment for use on the Canadian expedition to Northern Ellesmere Island next year, and to obtain information about British Columbia glaciers.

The whole area around the Salmon Glacier was surveyed and a map of the glacier and surrounding terrain is being prepared by Mr. K. Arnold. The main part of the programme was given over to extensive seismic and gravity surveys. The seismic programme was organized by Dr. R. R. Doell (Massachusetts Institute of Technology) and Mr. J. R. Weber (University of Alberta). In all, 354 profiles were shot, the work being greatly facilitated by the Granduc Mining Company, which provided air-borne support and the loan of a 'sno-cat' tractor. The depth of ice was generally found to be about one-half the width of the glacier, amounting to 2,000–2,400 ft.

Dr. F. S. Grant (University of Toronto) organized the gravity work. At first the survey was carried out in loops tied to a chained and levelled base-line which extended over twenty miles along the Salmon glacier and adjoining snowfields with stations every 600 ft. As the firn line receded, severe crevassing made the work difficult and a survey was carried out using two transits located on adjacent mountains, controlled by a system of visual signals. The survey was accurate to about 2 ft. in 10,000 ft.

Absolute movement of the glacier surface was determined from the movement of stakes and was of the order of 8 in. a day. Samples of ice at various depths down to 80 ft. were collected for an analysis of their tritium content. Mr. G. Falconer (University of Toronto) also carried out geomorphological studies. The rest of the party was made up of graduates and undergraduates from the Universities of British Columbia and Toronto. The results of the various projects are being prepared and will be published in detail later. A second expedition is planned for the summer of 1957, to extend the present investigations and also to undertake other glaciological studies, including micro-meteorology.

THE RADIO RESEARCH STATION

REPORT FOR 1955

THE Radio Research Organization of the Department of Scientific and Industrial Research has for many years past been the main centre of research in Britain on the propagation of radio waves; and both civilian and defence users of telecommunications look to the Radio Research Station increasingly for advice. The work is not, however, confined to the study of propagation, and during recent years attention has been given to investigations of materials used in radio components and equipment, and to the development of accurate methods of measuring power and field-strength at increasingly high frequencies. The report on this and the related work carried out during the calendar year 1955* comprises a general review made by the Radio Research Board, signed by the chairman, Sir Noel Ashbridge, together with a more detailed report on the work by Dr. R. L. Smith-Rose, director of radio research in the Department of Scientific and Industrial Research.

The report describes, with the aid of a plan, the new building which has been under construction at the Radio Research Station, Ditton Park, Slough, and has been occupied during the present year. This provides improved facilities for research and development of the laboratory type, while retaining some two hundred acres of agricultural land for field work. In addition to this central establishment, the organization maintains other observatories for measurements on the ionosphere and on atmospheric noise at Inverness, Singapore and at Port Stanley in the Falkland Islands. The latter station also works in close co-operation with a similar observatory at Port Lockroy, Graham Land, which is staffed by the Falkland Islands Dependencies Survey. Some of the work on wave propagation and also on the properties of materials is carried out, by contract arrangements or otherwise, with various research workers at University College, Ibadan, and with university groups at Cambridge, Edinburgh, London, Manchester and Swansea.

Research on wave propagation. The work conducted on radio wave propagation has been extended over a very wide range of frequencies, from about 10 kc./s. to several thousand megacycles per second. At the low-frequency end of the range, investigations are being conducted into the time and space variations of the phase and amplitude of the field received from a transmitter, since a detailed knowledge of these is essential to the development and full exploitation of long-distance radio navigational aids. At the other end of the spectrum, from a few hundred to several thousand megacycles per second, much research is in progress on the propagation of waves along the ground and through the lower atmosphere. This work is of great importance in connexion with the development of television, and also in view of the realization that the scattering of radio waves by turbulent portions of the troposphere has a practical application to communication by very short waves over distances well beyond the normal horizon. Intermediate between these extremes, the transmission of high-frequency waves (3–30 Mc./s.) by way of the ionosphere is still being actively pursued. Progress has been made in the use of the back-scatter technique in this connexion, whereby radio waves are returned from a distant point by scattering from the ground, having undergone reflexion at the ionosphere on both the outward and return journeys. During the year under review, it was found that, in the winter months, echoes were received which apparently corresponded to long hops much greater than the usual maximum of 4,000 km. for a single-hop reflexion from the ionosphere. With the view of exploring this and some associated phenomena, preparations are well advanced for the experimental comparison of this type of back-scatter with the measurement of the field-strength of signals from radio transmitters at various distances along the same great-circle path.

Research on materials. The behaviour of germanium in the form of rectangular monocrystalline filaments and in the form of commercial diodes and transistors has received a great deal of attention at the Radio Research Station. The noise characteristics of germanium are of particular interest; and observations have been made of the spectral density of noise in filaments and in point-contact and junction rectifiers biased in the reverse direction. Detailed investigations have also been made of some of the physical processes involved in the behaviour of transistors.

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* Department of Scientific and Industrial Research. Report of the Radio Research Board with the Report of the Director of Radio Research for the Year 1955. Pp. iv+56+1 plate. (London: H.M.S.O., 1956.) 3s. 6d. net.

Some of the work which has been carried out under contract at the Imperial College of Science and Technology, London, includes research on the preparation and on properties of ferromagnetic materials. Single crystals of certain ferrites are in demand for fundamental measurements at extremely high frequencies, and a crystallization technique has been developed for the production of small single crystals. Other work at the College has included the study of artificial dielectrics which, when used in a prismatic form, can be applied to the development of an antenna system from which the direction of the radiated beam can be rapidly swung over an arc of some 15°. A greater beam swing is desirable for the purposes of radar scanning, and work is now being done on the development of materials which will make this possible.

Publications. The results of the research work described in the present report have been published in the technical press or in the journals of scientific and technical institutions; and a list of forty-one references to these publications is given in an appendix to the report. In addition, a section of the staff has surveyed all the published literature of interest to radio research workers and engineers, and nearly four thousand abstracts and references concerning work in the radio and allied fields have been published in the *Wireless Engineer* in Britain and in the *Proceedings of the Institute of Radio Engineers* in the United States.

THE QUESTION OF CORRELATION BETWEEN PHOTONS IN COHERENT LIGHT RAYS

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A RECENT article by Brannen and Ferguson[1] casts doubt on our experimental demonstration[2] that the times of arrival of photons, defined as the times of ejection of photoelectrons, are correlated in two coherent beams of light. These authors quote the null result obtained by Adám, Jánossy and Varga[3] and describe in detail an experiment which they have performed themselves and which also gave a null result. They state that the existence of such a correlation would call for "a major revision of some fundamental concepts in quantum mechanics".

This last statement is in direct contradiction to our own conclusions; however, further argument should perhaps be left until our analysis, based on quantum mechanics, has been published. In the present communication we are concerned only to show that the results of Brannen and Ferguson, together with those of Adám *et al.*, are to be expected, and that they are not inconsistent with our own experiment.

The optical system described by Brannen and Ferguson was practically identical with our own, but they used a different method of detecting the correlation. A beam of light from a pinhole was divided by a half-silvered mirror into two coherent beams which illuminated independent photomultipliers. The rate of coincidence in time between the photoelectrons emitted from the two photocathodes was measured by conventional coincidence counters and compared with the random rate. It was found that the measured rate did not differ significantly from the random value, and that less than 0·01 per cent of the photons in the two beams could be in true time coincidence. On the basis of a similar experiment, Adám *et al.*[3] concluded that there was no evidence for correlation of photons and that less than 0·6 per cent could be in true coincidence.

The theoretical coincidence-rate for these two experiments does not appear to have been evaluated, and so we have derived it as follows. The average number N_0 of photoelectrons emitted by a photocathode in unit time is given by:

$$N_0 = \int_0^\infty \alpha(\nu) n_0(\nu) \mathrm{d}\nu = B\alpha(\nu_0) n_0(\nu_0) \qquad (1)$$

where $\alpha(\nu)$ is the quantum efficiency of the cathode surface at a frequency ν; $n_0(\nu)$ is the number of quanta of frequency ν incident on the cathode in unit time and unit band-width; ν_0 is the frequency of the light at which $\alpha(\nu)n_0(\nu)$ has its maximum value; B is the equivalent band-width of the light in cycles per second. If τ is the resolving time of the equipment and $2\tau N_0 \ll 1$, a condition which must apply to this technique, then the average number of random coincidences $\overline{C}_R$ to be expected in a time T_0 is given by:

$$\overline{C}_R = 2\tau N_0^2 T_0 \qquad (2)$$

When the light beams are correlated we have shown (unpublished work) that, under practical conditions, there will be an additional average number of coincidences C_S, where

$$C_S = \frac{T_0}{2}\int_0^\infty \alpha^2(\nu) n_0^2(\nu) \mathrm{d}\nu \,.\, \Phi(\theta D/\lambda_0) \qquad (3)$$

and where θ is the apparent angular diameter of the source viewed from the photocathodes; the photocathodes are squares of size $D \times D$; λ_0 is the mean wave-length of the light; it is assumed that the light is unpolarized and that $B \gg 1/\tau$. The quantity $\Phi(\theta D/\lambda_0)$ is a function which represents the degree of coherence of the light over the area of the photocathodes and is equal to unity when $(\theta D/\lambda_0) \ll 1$.

It is convenient to introduce a parameter σ, the spectral density of the light, defined by:

$$\alpha(\nu_0) n_0(\nu_0) \sigma = \int_0^\infty \alpha^2(\nu) n_0^2(\nu) \mathrm{d}\nu \Big/ \int_0^\infty \alpha(\nu) n_0(\nu) \mathrm{d}\nu \qquad (4)$$

where σ usually lies in the range of $0{\cdot}5 < \sigma < 1$. We may now write the expected number of true time coincidences, which is independent of τ, as

$$C_S = \frac{N_0{}^2 T_0 \sigma}{2B} \cdot \Phi(\theta D/\lambda_0) \qquad (5)$$

It should also be noted that the ratio of the number of true coincidences to the random rate is given by:

$$C_S/\overline{C}_R = \frac{1}{4\tau B} \cdot \sigma \cdot \Phi(\theta D/\lambda_0) \qquad (6)$$

and is independent of the total number of incident quanta. The fractional number of *photoelectrons* in true coincidence δ_c is given by:

$$\delta_c = \frac{N_0 \sigma}{2B} \cdot \Phi(\theta D/\lambda_0) \qquad (7)$$

and is linearly proportional to the number of incident quanta per unit band-width.

The root mean square fluctuation c_R in the number of random coincidences is defined as:

$$c_R{}^2 = \overline{C_R{}^2} - (\overline{C}_R)^2 \qquad (8)$$

and, neglecting fluctuations introduced by the photomultiplier itself, it is given by

$$c_R = N_0 (2\pi T_0)^{1/2} \qquad (9)$$

Thus the ratio of the true coincidences to the root mean square fluctuations in the coincidence-rate, which we shall refer to as the signal-to-noise ratio, is given by:

$$C_S/c_R = \alpha(\nu_0) n_0(\nu_0) \sigma \frac{1}{\sqrt{2}} \cdot \Phi \frac{\theta D}{\lambda_0} \left(\frac{T_0}{4\tau}\right)^{1/2} \qquad (10)$$

or alternatively,

$$C_S/c_R = \frac{\int_0^\infty \alpha^2(\nu) n_0{}^2(\nu) d\nu}{\int_0^\infty \alpha(\nu) n_0(\nu) d\nu} \cdot \frac{1}{\sqrt{2}} \cdot \Phi \frac{\theta D}{\lambda_0} \left(\frac{T_0}{4\tau}\right)^{1/2} \qquad (11)$$

Equation (11) can be compared directly with equations (1) and (2) of our previous paper[2], which refers to the alternative technique of correlating the fluctuations in the anode currents of the two photomultipliers by means of a linear multiplier. It can be shown that the effective resolving time of a linear system with a band-width b is given by $\tau \simeq 1/\pi b$, and, if this substitution is made in our original equations, a comparison shows that the two techniques give approximately the same signal-to-noise ratios. In making this comparison, it must be remembered that the equations given for the counting technique are only valid for the condition $2\tau N_0 \ll 1$.

We shall now substitute the parameters of the two coincidence-counter equipments into the equations given above. The values which have been taken for these experiments are shown in Table 1. The band-width of the light is not stated by Brannen and Ferguson, and so we have assumed that their high-pressure mercury-arc lamp, when viewed through an interference filter, gave a line-width of at least 10 A. at 4358 A. The value of $\Phi(\theta D/\lambda_0)$ depends in detail on the geometry of the equipment, and its calculation is too long to give here. In the case of Adám *et al.*, we have taken the same values for B and $\Phi(\theta D/\lambda_0)$ as those assumed for Brannen and Ferguson; this is probably an optimistic estimate, and in practice their equipment was probably even less sensitive.

Table 1. A COMPARISON OF THE THEORETICAL PERFORMANCE OF THREE EQUIPMENTS USED TO TEST THE CORRELATION BETWEEN PHOTONS IN TWO COHERENT BEAMS OF LIGHT

		Brannen and Ferguson (ref. 1)	Adám, Jánossy and Varga (ref. 3)	Hanbury Brown and Twiss (ref. 2)
Total number of photoelectrons incident per sec. on each cathode	N_0	5×10^4 ($\alpha = 0{\cdot}1$)	100 ($\alpha = 0{\cdot}003$)	3×10^9 ($\alpha = 0{\cdot}15$)
Resolving time of the equipment (sec.)	τ	5×10^{-9}	2×10^{-6}	10^{-8}*
A factor which expresses the degree of coherence of the light over each cathode	$\Phi \frac{\theta D}{\lambda_0}$	0·1	0·1 ?	0·5
Effective band-width of the light (c./s.)	B	$\geqslant 1{\cdot}5 \times 10^{12}$ ($\sigma = 1$)	$\geqslant 1{\cdot}5 \times 10^{12}$ ($\sigma = 1$)	10^{13} ($\sigma = 0{\cdot}5$)
Fractional number of photons to be expected in true time-coincidence	ρ_c	$\leqslant 1{\cdot}7 \times 10^{-8}$	$\leqslant 10^{-9}$	$2{\cdot}5 \times 10^{-4}$*
Time of observation to obtain a significant correlation (3 times r.m.s. fluctuation)	T	$\geqslant$ 1,000 years	$\geqslant 10^{11}$ years	5 min.

* A coincidence counter was not used in this experiment. The correlation was measured in a linear multiplier, using a band-width of about 30 Mc./s.

The fraction $\rho_c \simeq \delta_c/\alpha(\nu_0)$ of *photons* to be expected in true time-coincidence was found from equation (7). Brannen and Ferguson found that less than 10^{-4} were in coincidence, while Adám *et al.* found less than $0{\cdot}6 \times 10^{-2}$. It can be seen from Table 1 that the corresponding expected values are $1{\cdot}7 \times 10^{-8}$ and 10^{-9}.

We have also calculated, from equation (10), the time T_0 for which counts would have to be observed to obtain a significant correlation; a significant result has been defined as an excess of coincidences amounting to at least three times the root mean square fluctuation in the random coincidence-rate. The time for which Brannen and Ferguson would have to count is 1,000 years, while Adám, Jánossy and Varga would have to count for 10^{11} years.

In our own experiment a significant result was obtained in about 10 min. This confirms the value of 5 min., shown in Table 1, which was calculated from the equations given in our previous paper[2]. A further confirmation that our analysis is quantitatively correct is given by our recent measurements[4] on the star Sirius *A*.

We conclude that the results obtained by Brannen and Ferguson, and by Adám *et al.*, are to be expected theoretically and are not in conflict with our own. Their equipment was too insensitive to detect a significant correlation by at least four orders of magnitude. In the case of Adám *et al.*, the equipment was too insensitive by at least seven orders of magnitude.

[1] Brannen, E., and Ferguson, H. I. S., *Nature*, **178**, 481 (1956).
[2] Hanbury Brown, R., and Twiss, R. Q., *Nature*, **177**, 27 (1956).
[3] Adám, A., Jánossy, L., and Varga, P., *Acta Physica Hungarica*, **4**, 301 (1955).
[4] Hanbury Brown, R., and Twiss, R. Q., *Nature*, **178**, 1046 (1956).

Brannen and Ferguson[1] have reported experimental results which they believe to be incompatible with the observation by Hanbury Brown and Twiss[2] of correlation in the fluctuations of two photoelectric currents evoked by coherent beams of light. Brannen and Ferguson suggest that the existence of such a correlation would call for a revision of quantum theory. It is the purpose of this communication to show that the results of the two investigations are not in conflict, the upper limit set by Brannen and Ferguson being in fact vastly greater than the effect to be expected under the conditions of their experiment. Moreover, the Brown–Twiss effect, far from requiring a revision of quantum mechanics, is an instructive illustration of its elementary principles. There is nothing in the argument below that is not implicit in the discussion of Brown and Twiss, but perhaps I may clarify matters by taking a different approach.

Consider first an experiment which is simpler in concept than either of those that have been performed, but which contains the essence of the problem. Let *one* beam of light fall on *one* photomultiplier, and examine the statistical fluctuations in the counting-rate. Let the source be nearly monochromatic and arrange the optics so that, as in the experiments already mentioned, the difference in the length of the two light-paths from a point A in the photocathode to two points B and C in the source remains constant, to within a small fraction of a wave-length, as A is moved over the photocathode surface. (This difference need not be small, nor need the path-lengths themselves remain constant.) Now it will be found, even with the steadiest source possible, that the fluctuations in the counting-rate are slightly greater than one would expect in a random sequence of independent events occurring at the same average rate. There is a tendency for the counts to 'clump'. From the quantum point of view this is not surprising. It is typical of fluctuations in a system of bosons. I shall show presently that this extra fluctuation in the single-channel rate necessarily implies the cross-correlation found by Brown and Twiss. But first I propose to examine its origin and calculate its magnitude.

Let P denote the square of the electric field in the light at the cathode surface in one polarization, averaged over a few cycles. P is substantially constant over the photocathode at any instant, but as time goes on it fluctuates in a manner determined by the spectrum of the disturbance, that is, by the 'line shape'. Supposing that the light contains frequencies around ν_0, we describe the line shape by the normalized spectral density $g(\nu-\nu_0)$. The width of the distribution g, whether it be set by circumstances in the source itself or by a filter, determines the rate at which P fluctuates. For our purpose, the stochastic behaviour of P can be described by the correlation function $\overline{P(t)\,P(t+\tau)}$, which is related in turn to $g(\nu-\nu_0)$ by[3]

$$\overline{P(t)P(t+\tau)} = \overline{P}^2(1+|\rho|^2),$$

$$\text{where } \rho = \int_{-\infty}^{\infty} g(x) \exp 2\pi i\tau x \, dx \qquad (1)$$

For the probability that a photoelectron will be ejected in time dt, we must write $\alpha P dt$, where α is constant throughout the experiment. It makes no difference whether we think of P as the square of an electric field-strength or as a photon probability density. (In this connexion the experiment of Forrester, Gudmundsen and Johnson[4] on the photoelectric mixing of incoherent light is interesting.) Assuming one polarization only, and one count for every photoelectron, we look at the number of counts n_T in a fixed interval T, and at the fluctuations in n_T over a sequence of such intervals. From the above relations, the following is readily derived:

$$\overline{n^2_T} - \overline{n}^2_T = \overline{n}_T(1+\alpha\overline{P}\tau_0) \qquad (2)$$

$$\text{where } \tau_0 = \int_{-\infty}^{\infty} |\rho|^2 d\tau$$

and it has been assumed in deriving (2) that $T \gg \tau_0$. Now $\alpha\overline{P}$ is just the average counting-rate and τ_0, a correlation time determined by the light spectrum, is approximately the reciprocal of the spectral bandwidth $\Delta\nu$; in particular, if $\Delta\nu$ is the full width at half intensity of a Lorentzian density function, $\tau_0 = (\pi\Delta\nu)^{-1}$, while if $\Delta\nu$ is the width of a rectangular density function, $\tau_0 = \Delta\nu^{-1}$. We see that the fractional increase in mean-square fluctuation over the 'normal' amount is independent of T, and is about equal to the number of counts expected in an interval $1/\Delta\nu$. This number will ordinarily be very much smaller than one. The result, expressed in this way, does not depend on the counting efficiency.

If one insists on representing photons by wave packets and demands an explanation in those terms of the extra fluctuation, such an explanation can be given. But I shall have to use language which ought, as a rule, to be used warily. Think, then, of a stream of wave packets, each about $c/\Delta\nu$ long, in a random sequence. There is a certain probability that two such trains accidentally overlap. When this occurs they interfere and one may find (to speak rather loosely) four photons, or none, or something in between as a result. It is proper to speak of interference in this situation because the conditions of the experiment are just such as will ensure that these photons are in the same quantum state. To such interference one may ascribe the 'abnormal' density fluctuations in any assemblage of bosons.

Were we to carry out a similar experiment with a beam of electrons, we should, of course, find a slight suppression of the normal fluctuations instead of a slight enhancement; the accidentally overlapping wave trains are precisely the configurations excluded by the Pauli principle. Nor would we be entitled in that case to treat the wave function as a classical field.

Turning now to the split-beam experiment, let n_1 be the number of counts of one photomultiplier in an interval T, and let n_2 be the number of counts in the other in the same interval. As regards the fluctuations in n_1 alone, from interval to interval, we face the situation already analysed, except that we shall now assume both polarizations present. The fluctuations in orthogonal polarizations are independent, and we have, instead of (2),

$$\overline{\Delta n_1^2} = \overline{n_1^2} - \overline{n}_1^2 = \overline{n}_1(1+\tfrac{1}{2}\overline{n}_1\tau_0/T) \qquad (3)$$

where n_1/T has been written for the average counting-rate in channel 1. A similar relation holds for n_2. Now if we should connect the two photomultiplier outputs together, we would clearly revert to a single-channel experiment with a count $n = n_1 + n_2$. We must then find:

$$\overline{\Delta n^2} = \bar{n}\,(1 + \tfrac{1}{2}\bar{n}\tau_0/T) \qquad (4)$$

But $\overline{\Delta n^2} = \overline{(\Delta n_1 + \Delta n_2)^2}$

$$= \bar{n}_1(1+\tfrac{1}{2}\bar{n}_1\tau_0/T) + \bar{n}_2(1+\tfrac{1}{2}\bar{n}_2\tau_0/T) + \overline{2\Delta n_1\Delta n_2} \qquad (5)$$

From (4) and (5) it follows that:

$$\overline{\Delta n_1\Delta n_2} = \tfrac{1}{2}\bar{n}_1{}^2\tau_0/T \qquad (6)$$

This is the positive cross-correlation effect of Brown and Twiss, although they express it in a slightly different way. It is merely another consequence of the 'clumping' of the photons. Note that if we had separated the branches by a polarizing filter, rather than a half-silvered mirror, the factor 1/2 would be lacking in (4), and (5) would have led to $\overline{\Delta n_1\Delta n_2} = 0$, which is as it should be.

If we were to split a beam of electrons by a non-polarizing mirror, allowing the beams to fall on separate electron multipliers, the outputs of the latter would show a negative cross-correlation. A split beam of classical particles would, of course, show zero cross-correlation. As usual in fluctuation phenomena, the behaviour of fermions and the behaviour of bosons deviate in opposite directions from that of classical particles. The Brown–Twiss effect is thus, from a *particle* point of view, a characteristic quantum effect.

It remains to show why Brannen and Ferguson did not find the effect. They looked for an increase in coincidence-rate over the 'normal' accidental rate, the latter being established by inserting a delay in one channel. Their single-channel rate was 5×10^4 counts per sec., their accidental coincidence rate about 20 per sec., and their resolving time about 10^{-8} sec. To analyse their experiment one may conveniently take the duration T of an interval of observation to be equal to the resolving time. One then finds that the coincidence-rate should be enhanced, in consequence of the cross-correlation, by the factor $(1 + \tau_0/2T)$. Unfortunately, Brannen and Ferguson do not specify their optical band-width; but it seems unlikely, judging from their description of their source, that it was much less than 10^{11} cycles/sec., which corresponds to a spread in wavelength of rather less than 1 A. at 4358 A. Adopting this figure for illustration, we have $\tau_0 = 10^{-11}$ sec., so that the expected fractional change in coincidence-rate is 0·0005. This is much less than the statistical uncertainty in the coincidence-rate in the Brannen and Ferguson experiment, which was about 0·01. Brown and Twiss did not count individual photoelectrons and coincidences, and were able to work with a primary photoelectric current some 10^4 times greater than that of Brannen and Ferguson. It ought to be possible to detect the correlation effect by the method of Brannen and Ferguson. Setting counting efficiency aside, the observing time required is proportional to the resolving time and inversely proportional to the square of the light flux per unit optical band-width. Without a substantial increase in the latter quantity, counting periods of the order of years would be needed to demonstrate the effect with the apparatus of Brannen and Ferguson. This only adds lustre to the notable achievement of Brown and Twiss.

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[3] Lawson, J. L., and Uhlenbeck, G. E., "Threshold Signals", p. 61 (McGraw-Hill, New York, 1950).

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A CYTOCHEMICAL REACTION FOR NUCLEOPROTEIN

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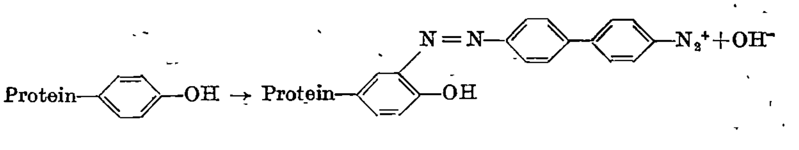
WE have recently completed a study of a cytochemical reaction for protein which appears to be specific for protein in a special form of combination with nucleic acid.

When a diazonium hydroxide is applied to a tissue section, the following components may react: (1) tyrosine and histidine and perhaps tryptophan side-chains in proteins, for example:



(2) some aliphatic —NH_2 and —NH— groups to give triazenes; (3) phenols, certain bases and similar compounds of low molecular weight; (4) some doubt has existed in the past as to whether the nucleic acid bases might couple. They do not appear to do so *in vitro*; but the possibility exists that they might do so in the peculiar physico-chemical conditions prevailing in a tissue section.

If, before the diazonium hydroxide is applied, the section is treated with benzoyl chloride, all components capable of reacting with diazonium hydroxides should react with the benzoyl chloride, so that subsequent reaction with diazonium hydroxide should be blocked. Consequently, pretreatment of sections with benzoyl chloride should entirely eliminate the formation of chromophores. In fact, it does not: after benzoylation there is a residual (mainly nuclear) reaction[1].

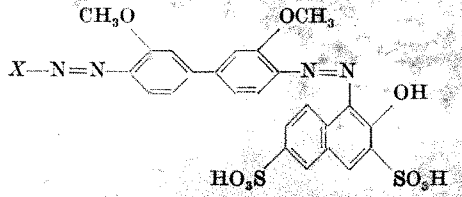
The nature of this tissue reactant which is able to react with diazonium hydroxide after benzoylation has been the object of our present study. This reaction sequence was first tried by Mitchell[2], who found that some reaction persisted, which he attributed to nucleic acid. The results of his reaction, using benzoyl chloride in aqueous sodium hydroxide, were not very satisfactory, but indicated that some interesting effects might exist.

To develop this procedure into a satisfactory cytochemical process the following steps were necessary: (1) to find conditions under which benzoylation and coupling with diazonium hydroxide give reproducible coloration of the section; (2) to determine, by fractionation, which major tissue components displayed the reaction; (3) to identify, by analysis, the nature of the groupings which were responsible for the coloration of the reactant; (4) to determine the cellular distribution of the reactant; (5) to determine the significance of the reaction.

1. *Cytochemical routine.* The method is normally applied to frozen-dried tissue, embedded in wax and sectioned. After removal of wax, the sections are fixed in absolute alcohol, washed in acetonitrile, and benzoylated for about three hours at room temperature in dry acetonitrile containing 10 per cent (w/v) benzoyl chloride and one equivalent of pyridine. Benzoylation in this medium always goes uniformly and reproducibly, provided all the materials are dry. The sections are washed in alcohol, taken down to water and coupled with a solution of tetrazotized dianisidine in sodium veronal buffer (*p*H 9) at about 4° C. for 12 min. They are washed thoroughly with buffer, 0·05 *N* hydrochloric acid and water, and then to enhance the colour are coupled further with a solution of a naphthol, for example, β-naphthol (0·1 per cent in 0·5 per cent sodium carbonate) for 12 min., all operations being carried out in the ice-bath. After washing in sodium carbonate solution and in water, the sections are taken up to absolute alcohol and mounted in balsam.

2. *Fractionation studies.* To identify the tissue component responsible, tissue was treated in bulk using conditions comparable to those encountered in the sections. 2-Naphthol-3,6-disulphonic acid was used as the naphthol for conferring water-solubility and on account of its chemical stability. Isolated chicken erythrocyte nuclei were found to possess several advantages as a test material. Smears of the final product showed discrete nuclei similar in appearance to those in a treated chicken blood smear. Fractionation of this material involved solvent extraction of lipid followed by the removal of nucleic acid by hot trichloracetic acid or by boiling *N* hydrochloric acid. Neither the lipid nor the nucleic acid extracts contained any of the dye component, although the acid extracts appeared to contain all the purines and pyrimidines present. Brief extraction of the residue with alkali gave a highly coloured solution, leaving a final residue containing very little dye. Selective precipitation of the extract, using the polyelectrolyte properties of the dye-containing component, separated the latter from some non-coloured proteins present. The dye-containing compound was readily soluble in slightly alkaline solution. It appeared to be macromolecular, and on reduction of the dye and hydrolysis a typical amino-acid mixture was obtained. The dye residue thus appeared to be linked chemically to a protein component of the nucleus, or at least to be very strongly associated with such a component. We have not been able to find lipoid, nucleic acid or polysaccharides which have reacted to give a coloured product. Thus it remained to determine which protein components were responsible for the reaction.

3. *Identification of the active group* (*X* in the structure):



Hydrolysis of the coloured protein fraction to yield the dye-containing molecule was sought. Proteolytic enzymes proved ineffective, presumably owing to the benzoyl[3] and dye groups present. Acid hydrolysis under the usual conditions destroyed the dye residue, as did alkaline hydrolysis, although more slowly (compare observations of Rowe and Dangerfield[4]). The only medium found to give satisfactory hydrolysis of the peptide bonds with conservation of the azo links was a solution of cetyl trimethyl ammonium bromide (0·015 *M*) in 0·3 *N* sodium hydroxide solution, under reflux. This method was suggested by the work of Steinhardt and Fugitt[5], who used anionic detergents in dilute acid for catalytic hydrolysis. Here we may be observing a combination of catalytic and protective effects, the latter probably due to binding of the cationic pole by the sulphonic groups of the dye residue. Ion-exchange resin chromatography of the hydrolysate removed the detergent and separated the dye component from the normal amino-acids. Paper chromatography of the dye fraction in two solvents gave one main spot and a weaker one which appeared to arise from a small amount of destruction of the major component. The main spot was unchanged on further hydrolysis. Identification of this bis-azo compound by paper chromatography was difficult owing to the size and nature of the residue attached to *X*, the group derived from the tissue. The two azo links were therefore reduced with sodium hydrosulphite to give amino derivatives (after purification of the dye solution by alumina column chromatography). Paper chromatography of the reduction products separated dianisidine, an amino derivative of 2-naphthol-3,6-disulphonic acid, and an unknown ninhydrin-positive compound, having R_F 0·18 in butanol/acetic acid/water (4 : 1 : 5). Extraction of the latter compound from the paper and examination of its ultra-violet spectrum (in distilled water) showed strong absorption only below 2350 A., a spectrum incompatible with a derivative of tyrosine or tryptophan. Synthesis and separation on paper of 4-amino-tyrosine and 2- and 4-amino-histidines and comparison of their R_F values in different solvents and of their ultra-violet spectra gave results confirming the exclusion of tyrosine and consistent with a derivation from histidine.

Prof. W. C. Price and his group at the Wheatstone Physics Laboratory, King's College, kindly agreed to examine eluates from paper chromatograms by infra-red spectroscopy. Eluate solutions were evaporated to deposit samples on silver chloride disks. Identification was complicated by two factors: (1) the tendency of histidines (but not of tyrosine) to combine with a fraction from the paper, and (2) the tendency of amino-histidine to polymerize. Details of these complications will be dealt with in another communication. However, the behaviour of the compound suspected of being amino-histidine was identical with that of synthetic amino-histidine. Hence all the evidence examined appears to lead to the conclusion that the coupling reaction in the nucleus after benzoylation is given by histidine residues in a protein fraction.

4. *Distribution of the reactant.* Sections of a considerable number of animal tissues having structures and activities of various types have now been subjected to this blocked tetrazonium reaction. The tissues include rat liver, kidney, intestine, pancreas, stomach, lung, trachea, skeletal and cardiac muscle, spleen, skin, cerebellum, bone marrow, ovary, testis, adrenal, pituitary, thyroid and Walker rat sarcoma; mouse ascites cells; avian erythrocytes and other avian tissues. The nuclei are always consistently positive, showing an intranuclear distribution of stain which appears to be very similar to that after a Feulgen reaction on similar sections. Rat pancreas sections in which the blocked tetrazonium stain was photographed and then removed by titanous chloride reduction, and which were subsequently reacted by the Feulgen method and re-photographed, showed a superimposable localization of the two stains in the same nucleus. Although the cytoplasm is negative after benzoylation in many cases, there are certain sites in which it remains positive, although less intensely so than with coupling alone. These include the cytoplasm of exocrine cells in the pancreas, which contrast with neighbouring endocrine and connective tissue cells. Goblet cells in the intestinal mucosa (Fig. 2) are strongly positive, although extracellular mucus appears to be negative. Certain other extranuclear structures in specific sites also appear to react to some extent, but an accurate evaluation is awaiting quantitative measurements.

5. *Significance of the reaction.* It remains to inquire why the histidine residues implicated are not benzoylated, as they are *in vitro*, and in the cytoplasm in most cases. A clue to this problem may lie in our discovery that brief exposure to water, for times of the order of one minute, prior to benzoylation abolishes the later coupling reaction. The positive reaction is shown by frozen-dried sections fixed and benzoylated in anhydrous media; if this condition is not observed, unsatisfactory results may be obtained. Deliberate taking down to water and renewed hydration after embedding in wax and before benzoylation give a uniformly negative result, which is not due to the removal of any substance at that stage. We have interpreted the reaction in terms of 'protective bonds', which after dehydration exist between certain imidazole groups and other groups presumed to be normally in some particular relation to them. These bonds protect imidazole rings from reaction with benzoyl chloride in anhydrous medium. In more polar conditions this bond is labile, hence coupling can occur in aqueous solution. Benzoylation only occurs at this site if the imidazole group is first exposed by water treatment. Since the effect is not re-established by a second dehydration, we presume the elements involved were initially related to each other in a specific way.

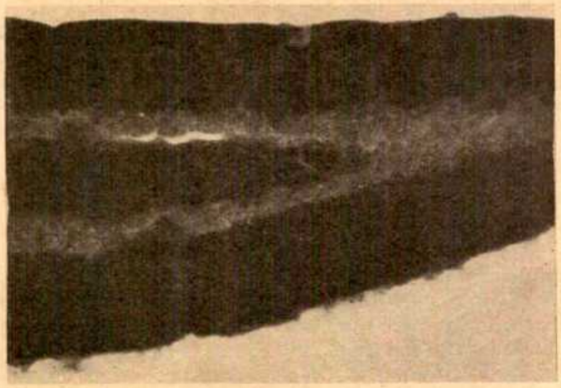


Fig. 1. Rat intestine, tetrazonium coupled

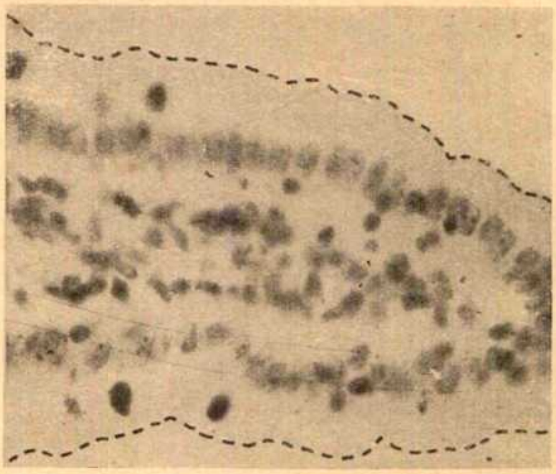


Fig. 2. Rat intestine, benzoylated and tetrazonium coupled

The close association shown above between this nuclear component and deoxyribonucleic acid suggests that a protein naturally associated with the acid is involved. Histidine residues could form bonds with nucleic acid in at least four ways: (1) with phosphate groups in the manner usually suggested for arginine and lysine (it is interesting to note that phosphate groups on imidazole may in some cases be readily transferred[6]); (2) by hydrogen bonding on to suitable partners; (3) by chelation through a metal, using the specific complexing properties of the imidazole ring (evidence has been claimed for metal bridges in nucleoproteins[7]); (4) by combination with the pentose due to the ability of histidine to form strong bonds (perhaps as a special case of (2)) with carbohydrate in certain circumstances[8]. It is not possible to predict at present which of these bonds would have the properties found here, but the particular environment concerned could well confer such properties even if model systems did not show them (cf. evidence adduced by Fraenkel-Conrat[9] for stabilization by protein structures of otherwise unstable bonds including some involving imidazole). Some simple chemical properties of the imidazole ring of histidine are known to be greatly affected by changes at the α-carbon such as incorporation into a peptide chain[10].

The cytoplasmic reactions mentioned, although not yet analysed biochemically, appear to be associated usually with synthetic activity and high content of ribonucleic acid (for example, pancreas) or with muco-protein secretion (goblet cells). Both these may well involve bonds of the type discussed, and can thus be fitted into the same scheme. We appear to be observing cytochemically an indication not of the stoichiometric amount of a particular substance or group present (an aim probably not often achieved) but the extent to which a particular type of bonding is present. The facts that the reaction appears normally to be limited to nucleoprotein, that the shielding of the histidine from benzoylation is readily destroyed after fixation, and that the relationship between protein and nucleic acid is specific, and cannot be readily reproduced by mixing proteins and nucleic acids, lead us to believe that the reaction detects an interaction between nucleic acid and protein which may well be of major importance in the biological activity of the cell. It may be that information is derivable by these methods on such important consequences of nucleic acid–protein relationships as the genic structure of the cell and protein synthesis. To this end further investigation into the precise nature of the interactions concerned is being pursued.

In conclusion, we should like to direct attention to the fact that the complex physico-chemical conditions prevailing in tissues make it impossible to predict with certainty which tissue components will react with any chemical reagent. Thus in the evaluation of all chromogenic techniques it is necessary to identify, by analysis, the tissue components which actually do react with the reagents used. In dealing with the very small amounts of material of this type that can reasonably be prepared, it may be found useful in other cases to combine ion-exchange and paper chromatography with ultra-violet and infra-red spectroscopy, and to find methods of protecting sensitive residues during the often drastic degradation procedures necessary.

We thank Dr. L. G. Bell for valuable help. We are indebted to Prof. W. C. Price, Mr. R. Bradbury, Dr. M. A. Ford and Dr. G. R. Wilkinson for carrying out the infra-red measurements. One of us (E. A. B.) acknowledges financial assistance from the British Empire Cancer Campaign and from the Nuffield Foundation.

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MORPHOLOGY OF RESTING VACCINIA VIRUS

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IN previous electron microscopic studies it was shown that pepsin treatment of vaccinia elementary bodies discloses a nucleus-like inner body[1], which contains deoxyribonucleic acid[2,3]. If digestion is performed after Chabaud-fixation, this body has an annular shape caused by a central depression. With regard to its ring-like arrangement, it was concluded that the material containing deoxyribonucleic acid could not be identified with the area of higher density in the centre of untreated particles[4,5]. This conclusion could further be supported by studies on the influence of other fixatives combined with pepsin or papain, respectively, on ultra-thin sections and on material prepared by the critical point method. Suspensions of virus particles collected from rabbit skin and purified by differential centrifugation were used.

In this stage of development the elementary bodies of vaccinia virus are brick shaped. Material prepared by the critical point method[6] usually revealed virus particles attached to the film in a vertical position. These demonstrated more contrast (Fig. 1) than those attached in the usual horizontal manner. The outline of vertically orientated particles revealed a central thickening. A stereoscopic study of inclined particles proved the identity of the thickening and the central elevation previously seen in shadowed elementary bodies[5]. Occasionally vertically orientated particles are also found in material prepared in the conventional manner[1]. It is important, therefore, to keep in mind that variations of internal structures of enzyme-treated particles may represent elementary bodies of different positions. The ratio of vertically orientated particles increased when drying during the different steps of treatment was avoided.

Enzymatic digestion was performed under varying conditions of enzyme concentration, digestion time, salt solution and particularly pH value. The pepsin-resistant annular structure was best preserved by fixation with ethanol–acetic acid (15 : 1) (Fig. 2*a*). It could also be demonstrated after treatment with buffered formaldehyde (pH 7·2) and occasionally in the unfixed state. In some virus particles which happened to be prepared vertically, this structure exhibited its lateral aspect, thus showing a bar- or bean-shaped outline. Buffered osmic acid (pH 7·2), the commonly recommended fixative for electron-optical purposes, rendered the elementary bodies resistant to pepsin treatment. This obstacle could be overcome by performing the pepsin treatment in a reducing medium like cysteine or thioglycolic acid. In spite of a more condensed shape of the inner body, the central depression was usually preserved (Fig. 2*b*). In view of the following results, it is assumed that some shrinkage of the inner body generally occurred, due to the influence of acid medium and pepsin-

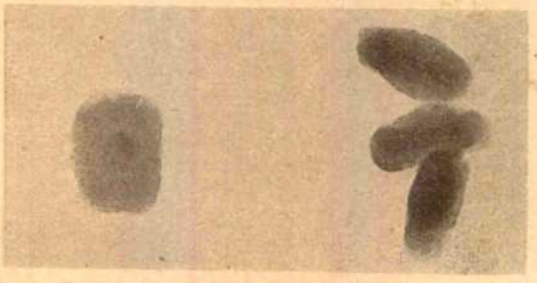

Fig. 1. Vaccinia elementary bodies fixed by osmic acid prepared by the critical point method (× 50,000)

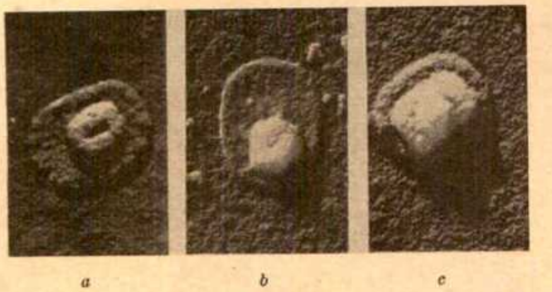

Fig. 2. Elementary bodies after pepsin treatment, uranium shadowed (× 50,000). *a*, ethanol-acetic acid fixation (15 min.), cryst. pepsin (0·02 per cent, *p*H 1·5, 37°, 2 hr.); *b*, osmic acid fixation (*p*H 7·2, 15 min.), cryst. pepsin (0·02 per cent, *p*H 2·0, 37°, 2 hr.) in presence of cysteine (0·1 mol.); *c*, ethanol-acetic acid fixation (15 min.), cryst. pepsin (0·02 per cent, *p*H 3·5, 37°, 2 hr.) activated by cysteine (0·1 mol.). Note the shadow outline

induced structural destabilization. This effect was more pronounced after osmic acid treatment. This may be explained by the fact that osmic acid does not cause precipitation as the aforementioned organic fixatives do.

In studies on unfixed or ethanol–acetic acid fixed particles it was found that addition of cysteine extended the *p*H range of peptic digestion up to *p*H 4·5. From *p*H 2·5 onwards—to a maximum at *p*H 3·5—increasing numbers of elementary bodies were observed showing an additional distinct structure at the site of the central depression (Fig. 2*c*). In previous studies this body could only be demonstrated irregularly after incomplete enzymatic treatment[5]. Due to its position at the centre of the annular body, this structure represents a constituent of the central opaque area of untreated particles. The comparison of Figs. 2*a*, 2*b* and 2*c* demonstrates that shrinkage of the annular inner body decreases with increasing *p*H.

In contrast to pepsin, papain offered the advantage of a more neutral reaction. Activated crystallized papain (Worthington) did not attack the structure of untreated elementary bodies. After previous denaturation (fixation with ethanol–acetic acid or buffered osmic acid), however, a reaction took place at *p*H values above 3·2. Papain exhibited optimum efficiency in a citric acid medium. Up to *p*H 4·8 an annular inner body was demonstrated (Fig. 3*a*) similar to that known from pepsin treatment. It was rod- or bean-shaped when exposed from its lateral aspect. With the increased *p*H value a lesser degree of inner body shrinkage was observed. The ring-like structure proved to be resistant to pepsin, and conversely the pepsin-induced inner body resisted papain treatment at *p*H 4·2. This is taken as a proof of their identity. Parallel to previous work with pepsin[2,3], the presence of deoxyribonucleic acid in this structure could be demonstrated by the combined action of deoxyribonuclease (*p*H 6·0) and papain (*p*H 4·2), which accordingly led to almost empty membranes.

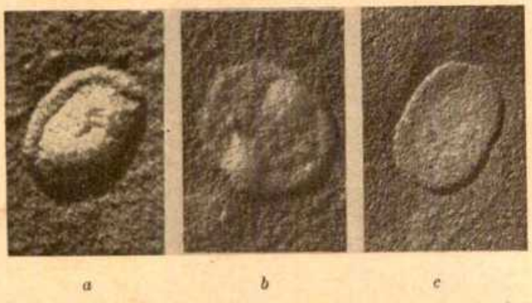

Fig. 3. Elementary bodies after papain treatment, uranium shadowed (× 50,000). *a*, ethanol–acetic acid fixation (15 min.), cryst. papain (0·2 per cent, *p*H 4·2, 37°, 2 hr.) activated by thioglycolic acid (0·1 mol.) in citrate (0·1 mol.); *b*, osmic acid fixation (*p*H 7·2, 15 min.), cryst. papain (0·02 per cent, *p*H 7·0, 37°, 20 hr.) activated by thioglycolic acid (0·1 mol.) in pure water; *c*, osmic acid fixation (*p*H 7·2, 15 min.), cryst. papain (0·2 per cent, *p*H 6·0, 37°, 20 hr.) activated by cysteine (0·1 mol.) in citrate (0·1 mol.)

Among papain-treated virus particles, some were always found showing the distinct structure at the site of the central depression. Their number increased with decreasing *p*H values. At *p*H 3·4, in addition to some intact particles, only such elementary bodies were demonstrated. The picture was the same as that seen after digestion with activated pepsin at *p*H 3·5 (Fig. 2*c*). Obviously, so far, there is good agreement between the results gained by pepsin and by papain treatment.

From *p*H 5·0 to about *p*H 9 the material containing deoxyribonucleic acid was not protected against papain digestion. Almost empty membranes resulted (Fig. 3*c*). A few of those, however, contained some material at the centre or two distinct small bodies, respectively, arranged at opposite sites of the membrane along its shorter axis. These structures were regularly demonstrated when particles fixed with osmic acid were treated with papain at a low concentration and *p*H 7·0 (Fig. 3*b*). They appear to be identical with the aforementioned distinct structure which is assumed to participate in the central opaque zone of untreated particles. Horizontally orientated elementary bodies exhibited this material within the centre. In the vertical position, however, it appeared to be separated into two bodies at the rim of the membrane.

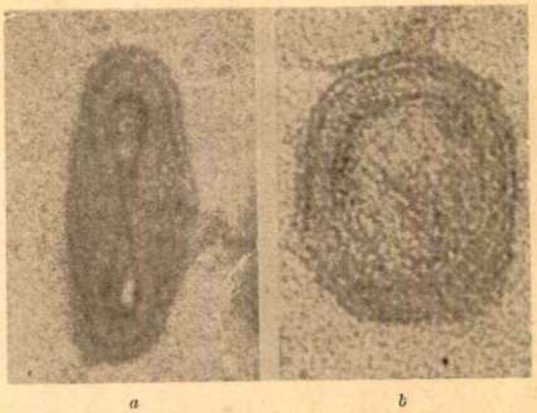

Fig. 4. Sectioned elementary bodies, fixed in osmic acid (*p*H 7·2, 4 hr.), methacrylate-imbedded, prepared on carbon film (× 130,000). *a*, vertical section; *b*, horizontal section. Note the double outline around the core

These results agree with the aspect of ultra-thin sections of virus particles derived from the same suspensions embedded in methacrylate. When examined by this method, the overall structure of the elementary bodies appeared the same independent of the mode of fixation (Figs. 4 and 5). This seemed to prove that the essential morphological details of this material have not been changed artificially by fixation in ethanol–acetic acid, which has been used extensively in our work with enzymes. A schematic drawing (Fig. 6) demonstrates our present knowledge.

The double contour of the surrounding membrane already discerned by Morgan *et al.*[7] in extracellular virus particles was best demonstrated after fixation with buffered osmic acid and less clearly with buffered formaldehyde. Pretreatment with ethanol–acetic acid, however, produced only a single contour. The membrane enclosed different structures. The most impressive picture was gained from vertical trans-sections (Figs. 4*a* and 5*a*). A rectangular core with rounded edges was found surrounded by a rim of high opacity and with an area of lower density at the centre. Oval, bar- or dumbbell-shaped outlines were observed, as previously described in connexion with vaccinia, fowl pox, ectromelia and molluscum contagiosum[7-9]. In horizontal sections (Figs. 4*b* and 5*b*) this material occupied the central spaces of the particles, its outlines following the outer membrane. This core appears to be identical with the nucleus-like annular body, which evidently contains deoxyribonucleic acid and protein, as shown in our studies with enzymes. Within this core and situated at the four corners distinct opaque round bodies were seen, measuring 5–12 mμ in diameter. These structures, which are omitted in the diagram in Fig. 6, are supposed to indicate the satellite bodies of untreated elementary bodies, first described by Green *et al.*[10]. In sections fixed by osmic acid the core containing deoxyribonucleic acid was often surrounded by a double-lined membranous structure, measuring about 15 mμ in total thickness (Fig. 4*b*). This structure was less frequently observed after formaldehyde and seldom after ethanol–acetic acid treatment. It is suggested that this structure which separates the core from an outer layer is possibly related to a nuclear membrane.

The outer layer with a thickness of about 20–25 mμ followed the outlines of the core. It was filled with a homogeneous material of moderate electron-optical density. This material appears to be identical with the peripheral protein part of the virus which, in contrast to the core containing deoxyribonucleic acid, is hydrolysed by pepsin, or by papain at acid reaction. Up to now there is no indication of the presence of nucleic acid in this zone. In its exterior part this material is in contact with the enclosing membrane. In the central region, however, two bodies of equal size are arranged in spaces between the protein layer and the outer membrane, thus producing the central elevation previously seen in shadowed untreated particles[5]. A connexion between these two bodies is still questionable. It is suggested that this material represents the enzymatically disclosed central structure which is resolved into two separated bodies in vertically prepared virus particles. The chemical nature of these bodies obviously is subject to variation. The susceptibility to protease digestion points towards a protein constituent which seems to be more or less protected against digestion in different elementary bodies of the same suspension.

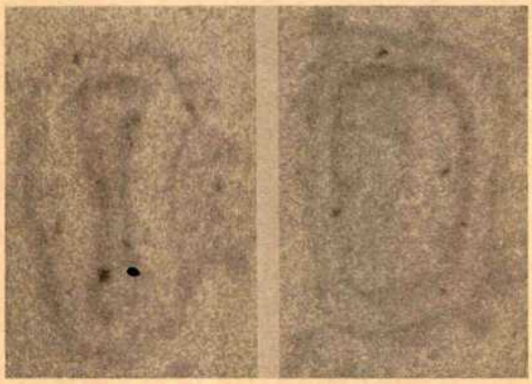
a *b*

Fig. 5. Sectioned elementary bodies, fixed in ethanol–acetic acid (2 hr.), methacrylate-imbedded, prepared on carbon film (× 130,000). *a*, Vertical section ; *b*, horizontal section

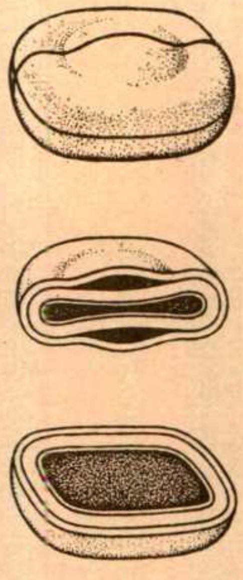
Fig. 6. Schematic drawing showing vertical and horizontal trans-sections (× *c*. 90,000)

A comparison of these results demonstrates that all morphological details disclosed by enzymes could also be identified in sectioned material. Further support for the correctness of the concept was gained from particles prepared by the critical point method[6]. Using 100 kV., it was possible to penetrate the vertically attached particles so far that diffuse inner structures could be observed. These corresponded to the outlines seen in vertical sections (Fig. 1), since a dumbbell-like opaque core surrounded by a zone of lower density could be discerned.

It is important to point out that these results apply only to a stage of virus development which predominates in suspensions after differential centrifugation. Working on infected tissue, Morgan *et al.*[7], and later Flewett[11], differentiated between an intracytoplasmic form of particle, enclosed by a single membrane, and another one found near the surface of the host cell and in extracellular spaces, which is characterized by a double membrane. The latter one seems to be identical with the stage described in this work. Since we know that elementary bodies of this type prevail in suspensions which retain infectivity for a long time, it seems reasonable to interpret these particles as resting ones.

Details will be published elsewhere. This work was supported by grants from the Deutsche Forschungsgemeinschaft. The technical assistance of Rudolf Geister is gratefully acknowledged.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Excitation of Luminescence in Gases by 2–4 keV. Lithium Ions

THE excitation of part of the auroral spectrum by the passage of fast protons from the Sun through the upper atmosphere[1], together with recent applications in nuclear physics of gaseous scintillators[2] for the detection of heavy particles, has made the excitation of luminescence in gases by heavy particles one of increasing interest and importance. While a reasonable lower limit on the rate of excitation is the rate of ion-pair production[3,4], detailed information is not generally available on excitation processes and on the spectral character of the resulting radiation. The purpose of this communication is therefore briefly to report upon some experiments in which 2–4 keV. lithium ions (Li^+) were employed to excite luminescence in nitrogen, oxygen, argon and air, and to compare the spectral composition of the luminescence with that reported by other workers who have used faster particles[5,6].

A thermionic ion source, with a lithium aluminium silicate-coated anode, was designed, with the aid of a rubber-sheet gravity analogue, and constructed. The source produced a collimated ribbon-like beam of lithium ions which was used to bombard nitrogen, oxygen, argon and air over a pressure-range of 5–40 microns mercury and over an energy-range of 2–4 keV. The luminosity produced in the gases by the ion beam was observed spectrographically (both along and perpendicular to the beam) and photographed at a camera aperture of $f/2$ and at a reciprocal dispersion of 130 A./mm. at λ 4000 A. and 1400 A./mm. at λ 8000 A. Analysis of the microphotometer traces of the spectra enabled positive identification of the main spectroscopic features to be made. They are summarized in Table 1, together with comparable observations of workers previously cited. More detailed information on our experiments will be published elsewhere shortly.

The strongest spectral features were lines of neutral lithium, together with lines of the neutral and ionized atomic nitrogen in the case of nitrogen, lines of neutral atomic oxygen in the case of oxygen, and of a combination of these features in the case of air. Lines of neutral and ionized argon also appeared in the case of argon. Evidently, the relatively slow collisions between lithium ions and the target nitrogen molecules resulted in (*a*) charge transfer in which the lithium ion captured an electron from the molecule to become an excited lithium atom which radiated, and (*b*) spontaneous dissociation of the resulting molecular ion into excited atomic and ionic components which also radiated:

for example, $Li^+ + N_2 \rightarrow Li^* + N^* + N^{+*}$

$$Li^* \rightarrow Li + h\nu$$
$$N^* \rightarrow N + h\nu$$
$$N^{+*} \rightarrow N^+ + h\nu$$

The absence of lines of ionized atomic oxygen in the case of oxygen may possibly be explained by the predominance of the mechanism: $Li^+ + O_2^- \rightarrow Li^* + O^* + O^*$ over the mechanism $Li^+ + O_2 \rightarrow Li^* + O^* + O^{+*}$. For it is well known that O_2^- ions are readily formed by oxygen in the presence of slow electrons (of which there must have been many in the source) owing to the extremely small electron affinity of the ion.

In contrast to these observations, Carleton[6] excited predominantly bands of N_2^+ and the lines of atomic hydrogen by bombarding nitrogen with protons of 2·5 keV. energy, while Fan and Meinel[5] excited predominantly N_2 bands (together with a few weaker N^+ lines) by bombarding air with a variety of particles (H^+, D^+, He^+, Ne^+) at higher energies. They also observed N_2 bands which were attributed to secondary excitation processes associated with electrons. In these experiments, charge transfer without dissociation was assumed to be a predominant mechanism. Evidently there was a negligible change in the molecular internuclear separation during the collision. Thus a change in only the electronic configuration of the molecule resulted. On the other hand, in our experiments the collision time was not negligible compared to the period of internuclear vibration. A sufficiently violent perturbation of the internuclear motion resulted as to cause dissociation as well as electronic excitation. The influence of collision time, measured by the parameter $f = (2M/V)^{1/2}$, is seen in Table 1. f measures the number of half-periods of internuclear vibration during which the ion crosses the molecular diameter. (M is the

Table 1

Particle	Energy (KeV.)	$f=(2M/V)^{1/2}$ half-periods per molecular diameter	Target gas	Spectroscopic features		Workers
				Primary	Secondary	
Li^7 II	2–4	0·1–0·06	Nitrogen	Li I, Na I, N I, N II, N III lines	(N_2^+ bands)	Pleiter and Nicholls (1956)
			Oxygen	Li I, O I lines		
			Air	Li I, O I, N I, N II, N III lines	(N_2^+ bands)	
			Argon	Li I, A I, A I, A II lines		
H^1 II	2·5	0·03	Nitrogen	H I lines, N_2^+ bands		Carleton (1956)
	40–230	0·008–0·003	Air	H I, N II (feeble) lines, N_2^+ bands	(N_2 bands)	Fan and Meinel (1953–55)
D^2 II	75–320	0·02–0·004	Air	D I, N II (feeble) lines, N_2^+ bands	(N_2 bands)	
He^4 II	150–450	0·007–0·005	Air	He I (none)*, N II (feeble) lines, N_2^+ bands	(N_2 bands)	
Ne^{20} II	400	0·01	Air	Ne I (none)*, N II (feeble) lines, N_2^+ bands	(N_2 bands)	
He^4 III (Po α-particles)	5,300	0·0012	Air	N_2^+ bands N II lines, N_2^+ bands	(N_2 bands) (N_2 bands)	Huggins (1903–6) Ortner and Salim (1952)

* Note the absence of He I and Ne I lines was ascribed by Fan and Meinel (see ref. 5) to the formation of these atoms in their ground-state by the charge transfer process.

ionic mass in atomic weight units, and V is the ionic energy in eV.). When $f \sim 0{\cdot}1$, dissociation and charge transfer predominate, and a predictable atomic spectrum results; while when $0{\cdot}01 < f < 0{\cdot}001$, charge transfer alone results, and the predominant spectrum of the molecular ion and the neutralized atomic ion is seen.

In the experiments of Huggins[5] and of Ortner and Salim[5], spectra of the luminescence produced in air by very energetic α-particles from radioactive sources were reported. Here $f \sim 0{\cdot}001$ and the predominant primary radiation appeared to be the N_2^+ bands, and a few N^+ lines. Bands of N_2 were also observed which were probably due to secondary excitation from the energetic electrons produced in the ion-pair production along α-particle tracks. It should therefore be possible to predict the rough spectral composition of the scintillations produced in monatomic and diatomic gases by energetic fast particles from a knowledge of ion energy, gas composition, energy-levels of significant atoms, molecules and ions involved, and a rough idea of the relative oscillator strengths of the possible radiative transitions. Spectroscopic studies of such scintillations are in progress.

This work has been performed with the assistance of Contract *AF* 19(604)1718 with the Air Force Cambridge Research Center.

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Radon Content of the Air

In recent years it has become a practice to deduce the radioactivity of the air (that is, its radon content) from the sampling and measurement of the short-lived radon daughter products. This method dates from the beginning of the present century[1]. The unique difference between the early measurements and the recent ones consists in the method of sampling the active deposit of radon; while nowadays deposition on filter paper is almost exclusively used, in the early experiments the transmutation products of radon were collected on the electrode by a strong electric field.

As for the filter-paper method, it has been shown by Harley[2] that even a molecular filter does not retain all airborne dust particles of submicroscopic size. On the other hand, the experimental results of Wilkening[3] indicate that most of the natural radioactivity in the atmosphere attaches itself to particles having diameters of 0·001–0·04 micron, and that a predominant grouping of the activity occurs in the vicinity of two particle diameters, namely, 0·009 and 0·018 micron. Hence it is not surprising that the radon values for the atmosphere as deduced from the filter paper method are too low. Thus Dawson[4] finds for January 1950 and on the roof of St. Bartholomew's Hospital in London a mean value of $0{\cdot}94 \times 10^{-16}$ curie radon/ml., and for May of the same year $0{\cdot}28 \times 10^{-16}$ curie radon/ml. Dawson's values were used very recently[5] as representative of the radioactivity of London's atmosphere. Anderson *et al.*[6] have found by the filter-paper method on the roof of the Physics Department of the Royal Cancer Hospital in London on sunny dry days values as low as $0{\cdot}02 \times 10^{-16}$ curie radon/ml.; but by comparing the filter-paper measurements to the direct determination of radon content of the air by the ionization method, they find that filter-paper values correspond only to 2–3 per cent of the true value of radon content. It is evident that in the free atmosphere radon is not in equilibrium with its daughter products and that variable fractions of the whole amount of the active deposit are attached to the dust or smoke particles and can be collected by the filter paper. We have found the same results for the radon content in closed rooms.

The experiments were carried out in a laboratory where concentrated radon solutions are prepared. The volume of the air in this laboratory is 39 m³. Air samples were examined simultaneously by the Schleicher–Schüll 589 filter-paper and in ionization chambers calibrated by a radium standard solution. About 140 litres of air were drawn during 15 min. with an average speed of 9·3 litre/min. through the filter paper, which was afterwards rolled on a Geiger–Müller tube with glass walls penetrable to β-rays with energy greater than 0·5 MeV. An interval of 10 min. was also allowed between the end of the air sampling and the first counts. Measurement of the active deposit was usually prolonged to 2 hr. The curves obtained correspond almost exactly to the equilibrium of radium A, B and C during the time of air sampling. The results of four sets of experiments are summarized in Table 1.

Table 1

10^{-9} curie/litre	N (counts/min.)	N^* (counts/min.)
1·40 ± 15 per cent	25,690	18,350
0·59 ± 10 ,,	7,060	11,980
2·80 ± 10 ,,	48,000	17,150
1·30 ± 15 ,,	12,790	9,830

The first column gives the content of radon determined by direct ionization measurement, the second the number N of counts 10 min. after the end of the sampling of the active deposit on the filter paper, and the third the values of the second column reduced to the content of 1×10^{-9} curie/litre and designated by N^*. From the values of N^*, it is clear that even in closed rooms there is no constant ratio between the active deposit collected on the filter paper and the radon content of the air. From these experiments and the results of Anderson *et al.*[6], it is evident that there is no reason for assuming this ratio to be a constant equal to or less than 1, as is frequently done.

We thank Mr. J. Kočí for technical assistance.

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Spectroscopic Indications of an Internal Spiral Arm in the Galaxy

SPIRAL structure within our galaxy has been detected by three methods: (*a*) space-plotting of stellar associations[1], (*b*) multiple structure in the *H* 21 cm. radiation[2], (*c*) multiple structure in the interstellar lines of Ca II and Na I in distant stars[3]. The radio method (*b*) has the advantage over the two optical methods in that it will penetrate to the limits of the galaxy. On the other hand, the interpretation of the radio profiles for directions within 90° of the galactic centre is greatly complicated by the superposition of radiation from regions at very different distances which have the same angular velocity. By contrast, method (*c*) can reveal unambiguously the presence of one, two or more spiral arms within a light-path limited by a distant star. The limited light-paths used in method (*c*) are of advantage in the internal regions of the galaxy.

In the course of work at the Radcliffe Observatory on velocities of southern *B* stars, certain stars with distances probably greater than 3 k.parsecs were selected for study at a dispersion of 19 A./mm. at 3933 A., with the view of possible resolution of the interstellar *K* line into components due to spiral arms. Among the five stars listed below, three have been found to have two well-separated *K* lines, whereas in the other two *K* is seen to be resolved with a separation which cannot be reliably measured but which is of order 25 km./s.

Stars with double *K* line

HD	m_v	*l*	*b*	Velocities (km./s.)		
				Star	K_1	K_2
142,468	8·1	295·6	− 1·8	− 40	− 14	− 84:
142,565	9·0	295 7	− 1·8	− 25	− 12	− 75
147,331	8·9	299·8	− 3 0			
148,546	7·8	311·1	+ 5·9			
173,987	9·0	354·6	− 3·7	+ 54:	+ 1:	+ 43:

Four stars in the longitude range 273°–289°, namely, *HD* 114,340, 122,324, 125,241, 136,239, have also been examined with the same dispersion but failed to show doubling of the interstellar lines, despite the fact that these stars are probably as distant as those with double lines and lie in longitudes more favourable for resolving components due to differential galactic rotation.

Of the five tabulated stars with double *K*, four lie south of the galactic centre. In each case the low-velocity component must correspond largely to the Sagittarius arm. The high-velocity component presumably corresponds to an interior arm which might be called the Scutum-Norma arm from the constellations in which it is probably seen tangentially. The radio work has already indicated that this arm is seen tangentially in longitude 3° at a distance of about 5 k.parsecs from the centre[4]. No details concerning radio observations at longitude 295° seem to be available at present[5].

The negative evidence from the four stars with $l = 273°–289°$ (some of which have been suggested by E. Smith[6] as belonging to a distant arm) might be taken as supporting the view that the Scutum-Norma arm does not extend beyond 290°. However, these stars might lie on the near side of the arm behind an undetectably small amount of the gas associated with the arm.

The observed *K* velocities in the three stars *HD* 142,468, 142,565 and 173,987 can be used to derive $\Delta\omega(R)$ on the assumption of circular motions. The calculations are rather sensitive to the assumed longitude of the galactic centre and to the corrections for solar motion. But if the standard values are assumed, we find a value of 3·5 km./s./k.parsec for the low-velocity components (consistent with the predictions of the radio model for the combined effects of the Sagittarius arm and of gas still nearer the Sun) and for the high-velocity components 16 ± 3 km./s./k.parsec in agreement with the model for the more distant arm suggested by the radio observations at $l = 3°$. It is difficult to avoid the conclusion from these observations that in the Scutum-Norma arm the value of $\Delta\omega(R)$ is greater at $l = 295°$ than at $l = 355°$. Interpreted literally, this would imply that the Norma branch is nearer than the Scutum branch to the centre of the galaxy, that is, that this arm is opening out in the direction of rotation. It would be weighting the meagre data too heavily to deduce that this is a property of the arm as a whole. A more plausible suggestion is that in front of the two stars *HD* 142,468, 142,565 we are observing a peculiar stream motion of the Ca II gas.

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Radioactive Sulphur produced by Cosmic Rays in Rain Water

ISOTOPES of carbon, hydrogen and beryllium arising from interactions of primary and secondary cosmic-ray particles with the oxygen and nitrogen nuclei of the atmosphere have been recorded[1]. Two isotopes of phosphorus due to spallation of atmospheric argon have also been found[2]. We can now add to the list sulphur-35.

Sulphur-35 is a beta-emitter ($E_{\text{max.}} = 167$ keV.) with a half-life of 87 days. Because of the low decay-energy, self-absorption of electrons is serious and it is necessary for detection to have samples of high specific activity. As is well known[3], rain water often contains appreciable amounts of stable sulphur partly due to ocean spray, and partly to industrial contamination. Samples collected in Bombay have, on the average, large amounts of stable sulphur (about 0·7 mgm. per litre). In order to reduce such contamination and thereby obtain samples with higher specific activity, we have used rain water from Banaras and from Kodaikanal. In samples from Banaras, which is far distant from the sea, the sulphur contents were low, although still about 0·27 mgm per litre, and detection was comparatively easy. Further improvement was achieved by obtaining a sample from Kodaikanal, which is well inland, 7,500 ft. above sea-level and with much less industrial pollution. This sample contained 0·08 mgm. of sulphur per litre. The results for all the samples are given in Table 1. Since our counter is not yet calibrated for soft beta-radiation, the absolute number of atoms may be in error by as much as a factor of two. The counts per hour have been converted into disintegrations/min. and atoms per litre, by taking account of counter geometry, window absorption, self-absorption, estimated chemical efficiency and decay.

Table 1

Sample	*V*1	*V*2	*V*3	*K*1
Place	Banaras	Banaras	Banaras	Kodaikanal
Date of rainfall	22.7.56	23.7.56	25.7 56	19.8.56
Size of sample (litres)	185	118	300	150
Total sulphur content (mgm.) (calculated from $BaSO_4$ precipitate)	53·2	51 8	71 4	12 2
Sulphur deposited for counting (mgm.)	11·4	2·2	5·4	3 2
Counts per hr. (above background)	64±8	85±9	74±7	75±11·5
Disintegrations/min. per litre	0 8	6·5	1·35	0·55
Atoms of sulphur-35 per c.c. of water	145	1,175	244	100

To extract sulphate from rain water we employed ion exchange columns containing the anionic resin, 'Amberlite *IRA*-400', in chloride form. Sulphate was precipitated as barium sulphate from the eluate. The barium sulphate was heated in a stream of hydrogen[4] and the hydrogen sulphide evolved was bubbled through ammoniacal water; sulphur was recovered from it, as a pale yellow precipitate, by adding dilute nitric acid. This sulphur was deposited on a 1-in. diameter brass holder by sublimation and counted on a heavily shielded end-window counter which is surrounded by rings of anticoincidence counters. The background of the counter was 62 ± 2 counts per hour.

To ascertain the nature of the activity, transmission measurements were made for each one of the samples by using aluminium absorbers of different thickness. The results, with their statistical errors, are shown in Fig. 1. All the samples give absorption spectra identical with that of artificial sulphur-35 in the same geometry.

Further purification of sample *V*1 by sublimation showed no change in specific activity. The values, corrected for self-absorption, were 7·3 ± 0·8 counts per hr. per mgm. before, and 7·7 ± 0·9 counts per hr. per mgm. after, resublimation.

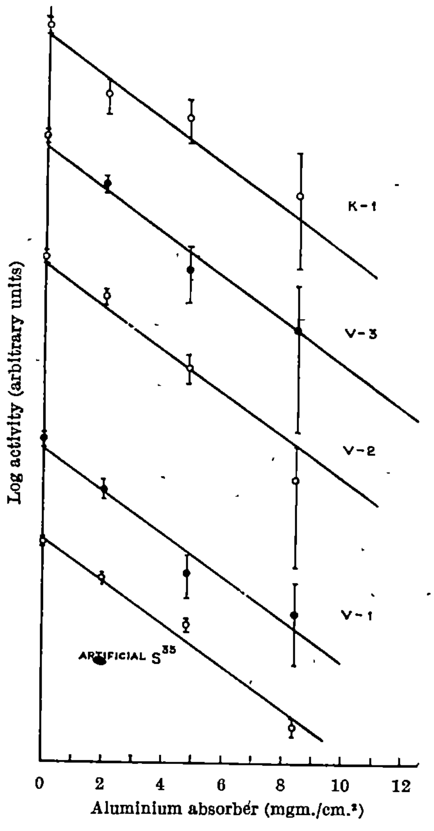

Fig. 1. Absorption spectra of sulphur samples

In order to test the chemicals and equipment for possible contamination, a reagent blank was prepared by precipitating sulphate ions of dilute sulphuric acid as barium sulphate and reducing it to sulphur in the same apparatus. No activity was found.

Since the activity is obtained after a chemical procedure highly specific for sulphur and the beta-ray absorption spectrum is identical with that of artificial sulphur-35, we conclude that the activity is due to that isotope.

The mean concentration of 1·9 disintegrations/min. per litre for sulphur-35 obtained here is comparable to the value of 1·4 obtained for phosphorus-32 by Lal *et al.*[2]. This is to be expected if the isotope is produced by cosmic radiation in atmospheric argon in the same way as phosphorus-32. However, the possibility that some of the activity is due to sulphur-35 produced by nuclear explosions cannot be ruled out. In order to check on possible contamination by such explosions, long-term observations are needed.

I am much indebted to Prof. B. Peters for his interest and many suggestions during this work. I thank also Mr. N. Narasappaya for help in counting the samples, and Dr. G. K. Das, Physics Department, Banaras Hindu University, and Mr. T. S. G. Sastry, of the Physical Research Laboratory, Ahmedabad, for their co-operation in collecting the samples from Banaras and Kodaikanal respectively.

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Rate of Transformation of Rhombohedral Graphite at High Temperatures

The hexagonal modification of graphite (common graphite) is composed of identical layers of stacking sequence *ABAB* . . . , while in the rhombohedral modification the sequence is *ABCABC* . . . , the latter modification being confirmed by Lipson and Stokes[1]. The occurrence of this modification and the enhancement and weakening of the X-ray diffraction lines belonging to it by chemical, mechanical and thermal treatments have been described by Hofmann[2], who states that it is transformed to the hexagonal modification in a graphitizing oven in an atmosphere of carbon monoxide at 3,000° C. In the course of experiments on the thermal expansion of graphite by X-ray diffraction[3], I observed that the corresponding lines were markedly weaker at much lower temperatures *in vacuo*. The rates of transformation were measured using the following improvements in technique. (1) Plate specimens were used in place of rods; to achieve a definite degree of orientation of crystals, 21 mgm. of powder of Ceylon graphite of average diameter 0·05 mm., purified with hydrochloric and hydrofluoric acids, was compressed to a plate 0·5 mm. thick and 6 mm. in diameter with a

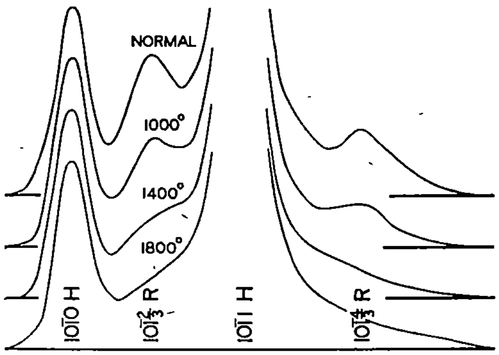

Fig. 1

pressure of 40 kgm. without adding any adhesive substances. (2) The plate was mounted on a Debye–Scherrer camera 20 cm. in diameter so as to bisect the angle between the incident and diffracted rays and oscillated about this angle with a half-amplitude of 30°. (3) Since, with cobalt K-radiation, the curvatures of the diffraction lines were not large, a stepped absorber made by piling aluminium foils was placed in front of the photographic film so that the blackening of each line was graded by known ratios, permitting more accurate determination of the intensities than by the use of intensity marks photographed on one side of a film.

The heat treatments of the specimen plates were performed at 1,000°, 1,200°, 1,400°, 1,500°, 1,600°, 1,700° and 1,800° C. and for 20 min., 1 hr., 3 hr. and 10 hr. Use was made of a small resistance furnace consisting of a Ringsdorff carbon tube just permitting the insertion of the plate, and evacuated with an oil diffusion pump backed by a booster pump. Before use the furnace was run at a temperature of 1,800° C. for 10 hr. For each heating-cycle no fluorescence was observed in a discharge tube for vacuum testing after several minutes.

The intensity curves of the diffraction patterns obtained with the specimens heated for 1 hr. are shown in Fig. 1, where scales are reduced to the true intensity. The integrated intensities of the 10$\bar{1}\frac{2}{3}$ line of the rhombohedral graphite were estimated from these curves and the percentages of the original content are plotted against temperature in Fig. 2. It will be seen that the decrease is linear in the observed range. An attempt was also made to obtain the rate of isothermal transformation as a function of time by the decreases of intensity of the line, but the dependence on time was found to be smaller than that on temperature, and the accuracy of the intensity measurements was not large enough for a definite trend to be determined.

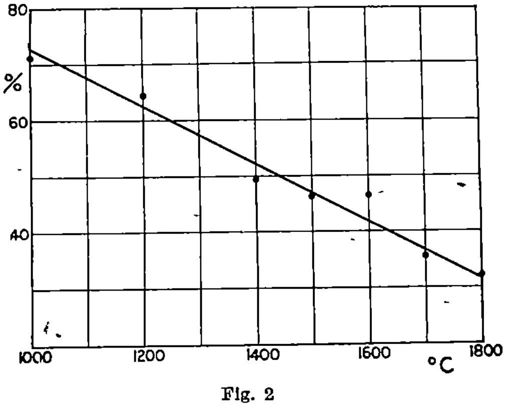

Fig. 2

With Madagascar graphite flakes of 0·5–1 mm. diameter similar results were obtained.

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Dielectric Properties of Solid Alkyl Polymethacrylates

WE have investigated the dielectric properties of methyl-, ethyl-, *n*-butyl- and *iso*butyl-polymethacrylates in the solid state, at temperatures ranging from − 30° C. to + 150° C., that is to say, above and below the transition temperature T_g from the glassy to the rubbery state. We have measured the dielectric constants and losses at frequencies varying from 500 c./sec. to 14 Mc./sec., by means of a special Scherring bridge up to 500 kc./sec. and a twin T apparatus for the higher frequencies.

With the methyl-polymethacrylate we confirmed the results obtained by Deutsch, Wolf and Reddish[1]: the dielectric dispersion appears below the glass temperature T_g and is prolonged through the transition temperature without any discontinuity.

With the ethyl, *n*-butyl and *iso*butyl compounds, the dielectric dispersion appears in the transition region. Above T_g, the critical frequency f_c corresponding to the maximum value ε_m'' of dielectric losses was of the order of a few kilocycles/sec. and could be detected with our apparatus. If the dispersion exists below T_g, the critical frequencies must be much lower than 500 c./sec.

By plotting log f_c as a function of $1/T$, straight lines were obtained. The activation energies ΔH calculated from the slopes of these straight lines were considerably lower than the apparent activation energies ΔH_a determined by the Williams, Landell, Ferry equation[2], as can be seen from Table 1.

Table 1. ACTIVATION ENERGIES FOR DIELECTRIC PROPERTIES

Alkyl group	Glass temperature	ΔH (in k.cal.)	ΔH_a ($T = T_g + 50°$) (in k.cal.)
Methyl	105° C.	23	73
Ethyl	47° C.	24	55
n-Butyl	17° C.	30	46
*Iso*butyl	67° C	43	61

Moreover, as the temperature is raised, the shape of the dispersion curve changes; a narrowing of the reduced dielectric losses curves ($\varepsilon''/\varepsilon_m''$ against log f) is found.

The dielectric dispersion appearing above T_g for ethyl-, *n*-butyl- and *iso*butyl-polymethacrylates must therefore not be considered as a primary dispersion region. It is probably due to an electrically dominant secondary mechanism, presumably the orientation of the dipolar side groups independently of the main polymer chain.

These results will be published in detail elsewhere.

I wish to acknowledge my indebtedness to Prof. L. de Brouckère, under whose supervision this work was carried out.

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Conductance of Concentrated Solutions of Strong Electrolytes

Numerous attempts have been made to extend the Debye–Huckel theory to electrolyte solutions of higher concentrations than 0·1 *N*. The attempts of Falkenhagen and Leist[1], Robinson and Stokes[2], Wishaw and Stokes[3], and Leist[4], are the most notable contributions in recent times in this direction.

Based on thermodynamical reasoning, we have evolved a new concept of 'concentration potential' (C_p) of an electrolyte solution, which may be defined as the ratio of moles of the electrolyte per 1,000 gm. of water at a given molality to the moles of the electrolyte per 1,000 gm water at saturation at the same temperature. The 'concentration potential' at any molality other than at saturation, being a fraction, may be visualized as representing in magnitude by the same fraction as the sum total of the effects due to hydration, ion-solvent interaction, quantum-mechanical forces of attraction, ion-pair formation, dielectric constant, etc., which tend to a limit at saturation. I. Bencowitz[5] found empirically that by using the ratio of any molality of an electrolyte solution to that at saturation, which he called the 'degree of saturation', instead of the molal concentration, vapour pressure lowerings even at high concentrations were explained by simpler relationships.

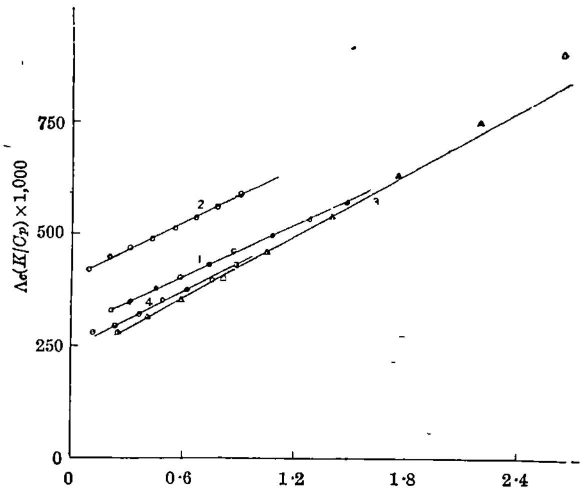
Similarly, we have introduced a new viscosity term, potential viscosity (η_p), which may be defined as the ratio of the viscosity of the electrolyte solution of a given molality to that at saturation at the same temperature.

Applying these new concepts, we have formulated the equation:

$$\Lambda_c = \Lambda_s + A\,(1 - C_p)/\eta_p \qquad (1)$$

where Λ_c is the specific conductance $K \times 1{,}000/C_p$. Hence, Λ_s is specific conductance at saturation $K_s \times 1{,}000$.

C_p and η_p have been defined above and A is a constant the properties of which have to be elucidated. The proportionality of Λ_c with $(1 - C_p)$ is introduced for the following main reasons. At saturation, $C_p = 1$. At concentrations other than at saturation, C_p is a fraction which may be assumed to be the same as that of the sum total of the internal effects at saturation. Since the equivalent conductance decreases progressively as the concentration increases towards saturation, Λ_c at any molality must be proportional to the 'concentration potential difference' between the concentration potential at the particular molality (C_p) and that at saturation (unity). Λ_c at any molality is therefore proportional to the concentration potential difference at that molality. At infinite dilution the concentration potential difference will be a maximum and therefore Λ_c at infinite dilution will be a maximum. The concentration potential difference at saturation will be zero and therefore the conductance Λ_s at saturation must be a minimum. These results agree with experiment.



1, Sodium chloride; 2, potassium chloride; 3, sodium nitrate; 4, potassium nitrate

The important part played by viscosity at higher concentrations was brought out by Wishaw and Stokes[3]. Though various workers observed qualitatively that conductance varies inversely as the bulk viscosity, there has been no agreement regarding a quantitative formulation of the relationship. Since the non-thermodynamic property viscosity tends to a maximum at saturation, we believe that conductance variation may be assumed to be related inversely to the ratio of viscosity at any molality to that at saturation. The relative viscosity of a solution hitherto considered has been that relative to the solvent. An expanded form of equation (1) will indicate that Λ_c at infinite dilution tends to a constant.

We have measured the conductance and viscosity of aqueous solutions ranging from 1·00 molal to about the saturation concentration at temperatures of 30°, 35°, 40°, 45°, 50° and 55° C. for potassium chloride and nitrate, and sodium chloride and nitrate. At all temperatures for the above electrolytes, a plot of Λ_c against $(1 - C_p)/\eta_p$ was found to be linear. Results obtained at 30° are represented in Fig. 1. A plot of Λ_c against temperature gave perfectly straight lines at all concentrations for solutions of sodium chloride and nitrate, and potassium chloride. Only for potassium nitrate solutions were non-linear curves each forming part of a parabola obtained. The parameter A is a function of temperature.

A detailed account of this work will be reported elsewhere.

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Thermal Conduction and Gas Analysis

GAS analysis based on thermal conduction was first introduced by Daynes and Shakespear[1] and depends on the principle that the thermal conduction loss in a particular mixture depends uniquely upon the composition of the mixture, and consequently, if we know the conductivity, the composition can be determined. Since then this principle has been utilized by a number of workers to analyse both the steady state and also the approach to steady state of non-uniform gas mixtures under various conditions. Unfortunately, the procedure adopted has not always been free from objections, and in the present report I propose to discuss the use of a thermal conductivity apparatus for which the theory is now completely understood and the various corrections are exactly calculable. The general design of the thermal conductivity cell is based on the conventional hot-wire type of cell introduced by Kannuluik and Martin[2] and since then has been widely used by a number of workers. Two simple designs for the construction of such cells have been recently made by Srivastava and Saxena[3].

Until now most workers have used this thermal conductivity apparatus more or less in an empirical fashion and obtained calibration curves in terms of galvanometer deflexions against concentration when the same current is passed through the helix of the conductivity cell. This procedure involves several discrepancies as the galvanometer deflexion does not give directly the thermal conductivity, though the latter depends uniquely upon the composition alone. This calibration for a particular gas mixture is correct only at the actual experimental points, and any interpolation is subject to errors arising out of the different accommodation coefficients, wall effects and convection effects with varying composition of the mixture unless the katharometer is so designed as to eliminate or correct precisely for the above effects. The theory of the hot-wire cell using a thick wire has been given by Kannuluik and Martin[2] and seems now to be complete. The corrections to be usually applied in a hot-wire type of apparatus are: (*a*) convection effects; (*b*) wall effects; (*c*) radiation correction; (*d*) radial flow correction; (*e*) the temperature jump correction. The conductivity cells used by us[3] were found to be free from convection and had a negligible temperature jump effect for a considerable range of pressures (6–20 cm. of mercury). We have therefore taken the observations at a pressure of 10 cm. of mercury. For our metal body cells, calculations showed that the wall effect is of the order of 0·01 per cent for gases like helium and neon while for gases of low thermal conductivity like argon, krypton and xenon, etc., the correction is negligible. The correction due to radiation amounts to the reduction in the conductivity value by a fixed amount and is independent of the nature and composition of the gases. The radial flow correction for a given cell and for a fixed value of the current uniquely depends upon the value of the conductivity and therefore upon ($R - R_0$) approximately. Here R represents the resistance of the cell wire for a certain current I, and R_0 for zero current.

In view of the above remarks about the corrections to be applied to the conductivity values measured by a hot-wire cell, it follows from the theory of Kannuluik and Martin[2] that for a given mixture the change in resistance $R - R_0$ of the cell wire will depend uniquely upon the composition of the mixture provided the same current is passed through the cell wire. Consequently, if we first perform an experiment with a mixture of known composition and plot a graph of $R - R_0$ versus composition of the mixture for practically a fixed value of the current, then we can use these plots to find the unknown composition from a knowledge of $R - R_0$ only.

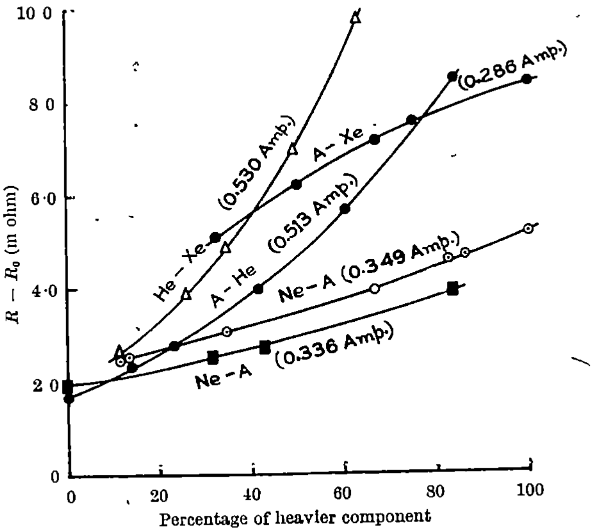

Fig. 1. Plots of $R - R_0$ vs. composition for some inert gas mixtures

Srivastava and Saxena[3] and Saxena[4] have recently obtained results of this type for a number of inert gas mixtures and utilized it to calculate the thermal conductivity. In Fig. 1 are shown the plots of $R - R_0$ versus composition for some mixtures. The experimental currents to which the data refer are recorded for each curve within brackets. These plots can now be utilized with fair accuracy for the purpose of gas analysis.

I am grateful to Prof. B. N. Srivastava for his kind interest and supervision throughout the progress of the work presented here and to the Council of Scientific and Industrial Research, New Delhi, for financial support.

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Free Radical Salts of Halogenated Quinones

IT has been shown[1] that bi-radical molecular compounds can be formed from quinones (O—*Q*—O) and aromatic diamines (*D*), and that these compounds are of the ionic form O—*Q*—O]$^-$*D*$^+$.

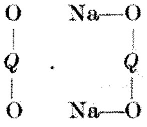
Highly electropositive aromatic diamines can form stable solid paramagnetic salts with simple anions[2], for example, the perchlorate of Wurster's ion, $(CH_3)_2$ N—⬡—N$(CH_3)_2]^+$ ClO_4^-, and it was interesting to see if there also existed stable salts of quinones with simple cations:

$$O—Q—O]^{-}Na^{+}$$

(I)

These should also be free radicals.

As long ago as 1912, Torrey and Hunter[3] studied the highly coloured salts produced by the reaction of tetrahalogenated quinones with sodium iodide. They showed that these solids contain one sodium atom per quinone molecule and they postulated the structure



$$\begin{array}{ccc} O & & Na—O \\ | & & | \\ Q & \cdot & Q \\ | & & | \\ O & & Na—O \end{array}$$

(II)

It seemed to us, however, that such a structure is improbable and that the product of their reaction is more likely to be, instead of (II), the simple salt of the semiquinone (I). The latter has an odd number of electrons and should therefore be paramagnetic.

We have tested four of Torrey and Hunter's coloured substances for paramagnetism by means of the paramagnetic resonance method[4]. The measurements were made at a wave-length of 3 cm. on powdered samples at 90° K. The substances (Table 1) all showed paramagnetic resonance with a single line a few gauss wide and g-value nearly equal to the free electron value. Such resonance is typical of a free radical.

Table 1

	g-value	Line-width (gauss)
Sodium tetrachloro p-quinone	$2·0044 \pm 0·0008$	10
Sodium tetrabromo p-quinone	$2·0068 \pm 0·001$	20
Sodium 2 : 6 dichloro 3 : 5 dibromo quinone	$2·0063 \pm 0·0007$	20
Sodium tetrabromo o-quinone	$2·0077 \pm 0·0008$	30

These results indicate that, as we have proposed, solid stable free-radical salts of quinones do exist, and that the coloured salts of Torrey and Hunter are of this form.

We are indebted to the British Council for the award of a scholarship (H. K.), the University of Oxford for the award of a Pressed Steel Co., Ltd., research fellowship (D. B.) and the Department of Industrial and Scientific Research for a maintenance grant (A. C. R.-I.) during the 1954 tenure of which these researches were carried out.

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Surface Structure of Blowholes in Cast Iron

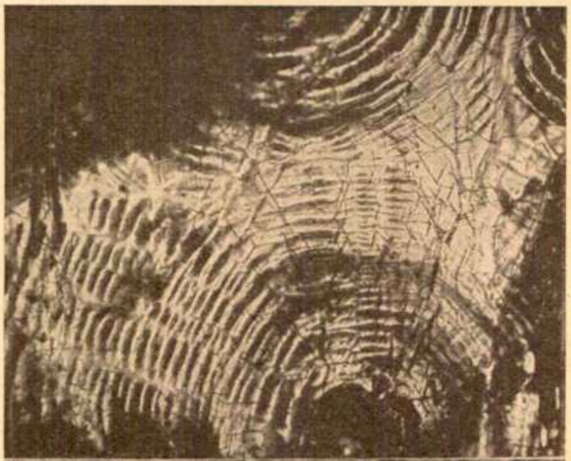
BLOWHOLES caused by evolution of gas are relatively seldom encountered in cast iron. Recently, however, cavities evidently produced by hydrogen gas have been recorded[1-3]. The surface of the blowholes exhibited a peculiar pattern of concentric circular waves or wrinkles. This pattern was imprinted not only on the graphite shell covering the walls of the blowholes but also on the underlying matrix[3]. In the following some complementary observations will be given and a suggestion as to the formation of the structure is advanced.

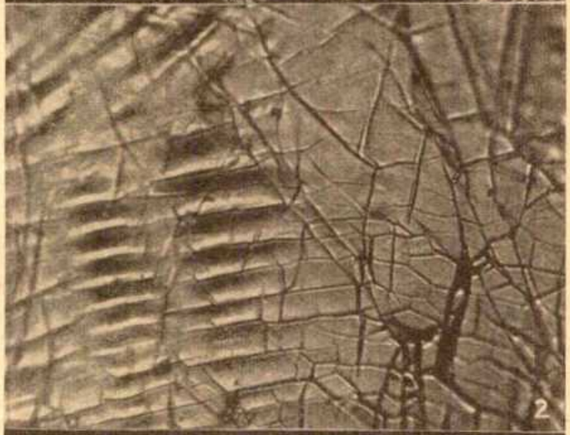
The blowholes examined occurred in cast iron to which magnesium had been added. Water was poured upon the iron in the ladle. The object of this double treatment was to introduce hydrogen into the liquid metal by reaction between the magnesium and the water. It is believed that the blowholes were caused by the evolution of hydrogen or possibly hydrocarbons during cooling. The holes were either approximately spherical or had an elongated shape with the axis perpendicular to the outer surface of the casting. A thin scale or shell of the same metallic material as the matrix, as shown by examination of sections in the microscope, could be removed from the walls of the blowholes.

Fig. 1 shows the surface structure as observed from the interior of a cavity towards the wall. The surface is covered with circular 'waves', seemingly emanating from a few different centres. Within each group of concentric waves there are flat areas with radial extensions. This gives the impression that the groups consist of interfering wave systems with adjacent centres. Closer examination shows (Fig. 2) that the waves can be described as ridges running between U-shaped valleys, as is also seen from polished sections perpendicular to the wall (Fig. 3). On the top of each ridge there runs a marked ditch. Ditches are also seen to traverse the valleys and the flat areas. Sometimes they develop into crack-like formations, sometimes they become more vague. Near the centre of a group of waves the cracks are more pronounced, outlining 'grains' with hexagonal symmetry. In the central part of each wave group there is a pyramid of six-fold symmetry, built up of triangular sectors or 'shields'. The tops of the pyramids are directed towards the interior of the cavities. The shields, which do not fit closely together, have surface markings like arrow-heads pointing towards the top angle.

In a section perpendicular to the wall of the cavity (Fig. 3), the metallic matrix is found to be pearlitic near the wall of the blowhole, changing to a mottled ledeburitic-graphitic cast iron structure in the interior of the metal.

It is tentatively suggested that wrinkles of the kind observed could be produced by compression of a (surface) layer by forces parallel to the surface, the wave crest at any point being perpendicular to the compressive force. The circular form of the wave groups points to common centres from which the forces have radiated. In the central area where the ultimate reason for the deformation should be sought, small cavities, believed to be hydrogen blowholes, were once observed. Evolution of gaseous hydrogen at this position at a stage during cooling when there is a still deformable surface layer around the larger blowhole could well provide the expansion required for the deformation mechanism proposed. Evidence for a secondary evolution of gas is also given by the





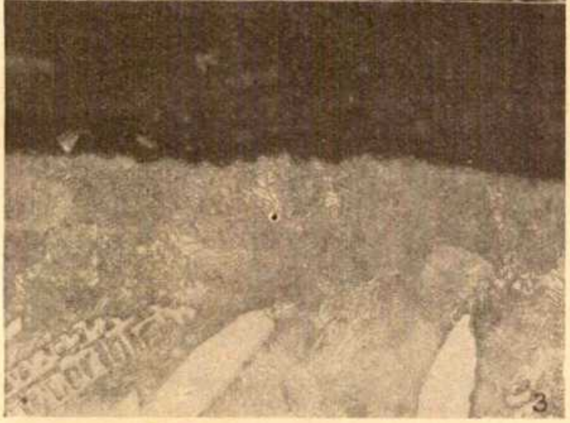


Fig. 1. Surface pattern. × 300
Fig. 2. Surface pattern at higher magnification. × 1100
Fig. 3. Section of blowhole, etched with 'Nital'. × 450

form of the space separating the above-mentioned scale from the main body. As regards the ditches and cracks mentioned above, they are believed to be the result of deformation at a lower temperature where the iron is less ductile.

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Polymerization of Tobacco Mosaic Virus from Electric Birefringence Studies

It has been reported[1] that the addition of methylene blue to aqueous solutions of tobacco mosaic virus produces increases in viscosity which can be interpreted in terms of conversion of the monomeric units to end-to-end dimers and possibly higher polymers. The suggestion was made that the association may be the result of interactions between a given methylene blue molecule and sites on the nucleic acid chains of different macromolecules. The production of end-to-end aggregates by an association of this type is in accord with the structural investigations of tobacco mosaic virus[2], which place the nucleic acid at the core of a relatively compact helix. It therefore was of interest to determine whether or not the suggestion of end-to-end aggregate formation by methylene blue could be substantiated independently with a well-characterized monomeric preparation, and by a method particularly sensitive to such aggregates.

Evidence for the presence of rigid end-to-end dimers in some untreated tobacco mosaic virus solutions was found in transient electric birefringence studies[3]. The rotational diffusion constants which are observed in such experiments are greatly decreased upon end-to-end association; for example, by a factor of six upon formation of a tobacco mosaic virus dimer. The experiments reported here were carried out on the preparation designated tobacco mosaic virus I, which was shown to contain no detectable concentration of end-to-end polymers in the previous study[3].

The experimental technique, which involved oscillographic recording of the birefringence transients produced by rectangular pulses, has already been described[3,4]. All solutions were prepared by dilution with distilled water from tobacco mosaic virus I stock[3], which contained 37·5 mgm. of the virus per c.c. and a low concentration of phosphate buffer, of *p*H 7, introduced at an early stage during the preparation.

A solution containing 0·5 mgm. tobacco mosaic virus per c.c. and 10^{-5} *M* methylene blue was allowed to stand for about 15 hr. at 0° C. before warming up to 25° C. for a birefringence measurement. Analysis of the build-up and decay curves gave the same single relaxation time as an untreated preparation (0·5 msec.) within the experimental accuracy ($\sim$ 5–10 per cent). Afterwards, a solution containing 17·7 mgm. tobacco mosaic virus per c.c. and 10^{-2} *M* methylene blue was allowed to stand at 0° C. for 72 hr. before making dilutions, photographing the birefringence transients, and measuring *p*H. The results are summarized in Table 1, which lists the relaxation intervals τ_0, τ_1 and τ_2, in msec. (The term 'interval' is substituted for the formerly used 'time' to reduce the possibility of confusion of $\tau_0, \tau_1, \ldots \tau_i$ (arbitrarily defined[3]) with the relaxation times of the various components.) For the first solution in Table 1 the birefringence did not reach the steady state during the applied pulse, which was of 15 msec. duration. This and the values of τ_0 and τ_1 indicate the presence of species higher than dimers. The conclusion is independent of the particular mode of association since the end-to-end polymers will give longer relaxation times than any other possible forms.

For the second solution, a steady state was approached in about 5 msec. An additional experi-

Table 1

Tobacco mosaic virus conc.	Methylene blue conc.	τ_0	τ_1	τ_2	*p*H
0·5 mgm./c.c.	$2·8 \times 10^{-4}$ *M*	5·0	21·0	—	6·4
0·1 mgm./c.c.	$0·56 \times 10^{-4}$ *M*	0·8	1·0	1·8	6·0

ment with a shorter polarizing pulse (0·7 msec.) was performed, to decrease the contribution from the slower component and permit more accurate evaluation of the relaxation time of the faster component. The two curves for birefringence decay were plotted on semi-log paper and analysed according to the method illustrated in Fig. 5 of a preceding publication[3]. After subtracting the contribution of the slower component, which had a relaxation time of about 3 msec., the remainder exhibited a relaxation time of 0·5 msec. From this it is concluded that the experimental results, at 0·1 mgm./c.c. tobacco mosaic virus and $0·56 \times 10^{-4}$ *M* methylene blue, are adequately explained by the presence of a mixture of monomer and end-to-end dimer[3]. However, the more concentrated solution, obtained from the same sample, consisted of more aggregated species, which confirms the suggestions[1] that the degree of polymerization increases with methylene blue concentration, and that the polymerization is to some extent reversible.

The results are of interest in that they illustrate how the interactions of biological macromolecules and small ions may be studied to determine the location of interacting groups on the macromolecule. Secondly, they suggest a possible cause of the aggregation, which is often troublesome in investigations of the physical chemical properties of such species as tobacco mosaic virus, namely, interaction of a given molecule having two or more cationic sites with negative sites on the nucleic acid chains of different molecules. Although the methylene blue cation carries a single positive charge, it is distributed equally between the substituted amino groups by resonance, so methylene blue molecules may interact simultaneously with two macromolecules. The commonly observed aggregation of tobacco mosaic virus might be caused in a similar manner by multiply charged cations or possibly by partially hydrolysed peptide chains carrying two or more positive charges, and might be prevented by the use of complexing agents. (In a private communication, W. Ginoza has reported that aggregation may be reduced by the use of versene to aid in clarifying the virus during isolation.) Finally, a method for controlling the distribution of lengths of the macromolecular units in a biological preparation offers interesting possibilities for further studies of electric polarization and birefringence in macromolecular systems.

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Separation of Oxidized from Non-Oxidized Corticotropin A_1 by Chromatography on Carboxy-Methyl Cellulose

Dedman, Farmer and Morris[1] have shown that corticotropins can be oxidized by hydrogen peroxide to yield products which are inactive in the adrenal ascorbic acid depletion bioassay of Sayers, Sayers and Woodbury[2], and that the biological activity can be completely restored by reduction with thiol compounds. The process is unaccompanied by any change in the amino-acid composition of the corticotropin (Dedman, Farmer and Morris, unpublished observations). Dixon and Stack-Dunne[3] have confirmed this reaction, and have reported a separation of the oxidized and non-oxidized hormones by chromatography on the carboxylic acid cation exchange resin 'Amberlite' *XE*-64 (*IRC*-50).

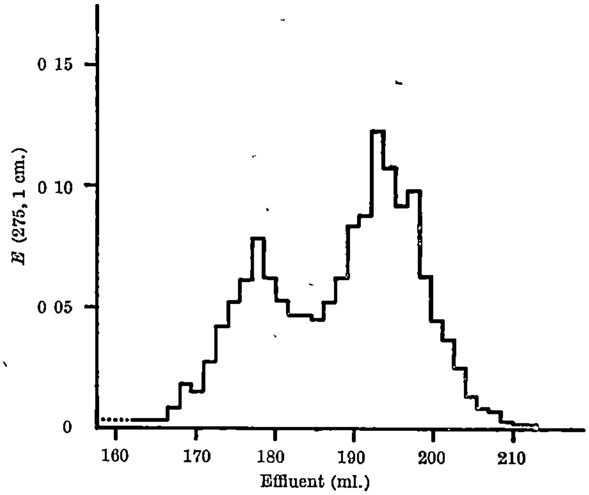

Fig. 1

The present communication describes an alternative chromatographic system for the separation of oxidized and non-oxidized corticotropin A_1, using as the stationary phase carboxy-methyl cellulose prepared by the method of Peterson and Sober[4].

The column was prepared from 1·5 gm. of carboxy-methyl cellulose which had been equilibrated with 0·1 *M* phosphate buffer at *p*H 5·56, and packed under pressure to give final dimensions of 66 cm. × 0·35 cm. A mixture of 1·7 mgm. of corticotropin-A_1 (91 I.U./mgm.) and 1·8 mgm. of corticotropin A_1 oxidized by hydrogen peroxide (27 I.U./mgm.) was dissolved in 0·5 ml. of the phosphate buffer and applied to the column. Development was carried out with 0·1 *M* phosphate buffer, *p*H 5·56, at 19° at a flow-rate of 2·1 ml./hr. 1·5-ml. fractions were collected automatically, and the corticotropin content determined by measurement of the ultra-violet absorption at 275 mμ. The course of the separation is shown in Fig. 1.

Table 1

Material	Treatment	% original A_1 potency
Corticotropin A_1	None	100
Corticotropin A_1	Oxidized with H_2O_2	23 (13–40)
Fraction 1	None	<17
Fraction 1	Reduced with thioglycollic acid, 18 hr., 78°	102 (95–117)
Fraction 2	None	172 (91–300)

The eluate, 171–180 ml., was bulked to give fraction 1, and 186–204 ml. to give fraction 2. The biological potencies of these fractions, together with the potency of fraction 1 after reduction, are given in Table 1. Values in parentheses are fiducial limits of the potencies at $p = 0 \cdot 95$.

It is evident that oxidized corticotropin A_1 forms the faster moving zone (fraction 1) in the chromatogram, and that it can be completely separated from corticotropin A_1 under these experimental conditions. This, together with the earlier separation by Dixon and Stack-Dunne[3], demonstrates that the oxidized form of corticotropin A_1 is a chemically distinct species.

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Mutagenicity of Sarkomycin

Since the discovery of Auerbach and Robson[1], various substances have been added to the list of chemical mutagens. It is generally accepted that many strong mutagens have also clear inhibitory actions against neoplasms. It is therefore of special interest to determine whether sarkomycin, an antibiotic with anti-tumour effect, found by Umezawa and his colleagues, has also mutagenic ability. Yamamoto *et al.*[2] and Umezawa *et al.*[3] have shown that sarkomycin induces chromosomal aberrations in Yoshida sarcoma cells and in Ehrlich ascite tumour cells.

Recently, Satô[4] has also pointed out that sarkomycin has a radiomimetic effect upon root tip cells of *Tradescantia paludosa*.

Tests were made on the production of the same mutations which have been used before[5,6]. In the silkworm, *pe* and *re* are located on chromosome V at 0·0 and 31·7, and w_2 on chromosome X at 3·4; all of them control the colour of the egg (and also the colour of the eye). Whereas the normal colour is black, *pe/pe* and w_2/w_2 eggs are white and *re/re* eggs red. Eggs homozygous for both *pe* and *re* are also white (the eye of *pere/pere* is green). The sarkomycin was extracted from *Streptomyces* as the sodium salt and was a viscous syrup light-brown in colour. It was diluted in physiological saline solution for silkworms to a final concentration of 7·5 unit/ml. (unit used here is a special effective value as antibiotic), and the *p*H was adjusted to 6·8 with sodium bicarbonate. 0·05 ml. of this solution was injected into the abdomen of wild male or female moths. 10–60 min. after the injection these moths were mated to double recessive *pere/pere* or w_2/w_2 partners. Eggs from these matings were examined as to egg colour, and the mutation-rates were estimated as the percentages of aberrant eggs in total pigmented eggs.

This method makes it possible not only to deal with many samples but also to compare the results of those obtained with the other chemical mutagens, such as nitrogen mustard or nitromine (Nakao, Y., unpublished data).

Table 1

No. of experiment	Sexes of treated moths	No. of tested eggs (total pigmented eggs)	Aberrant eggs	
			No.	Percentage
C_1		3,333	1	0·030±0·030
C_2	♂	4,074	0	—
1	♂	1,535	6	0·391±0·159
2	♂	4,485	3	0 045±0 032
3	♂	3,364	13	0·386±0·107
4	♂	1,192	4	0·336±0·168
C_3	♀	2,818	3	0·106±0·061
5	♀	1,234	0	—
6	♀	4,629	0	—
C_4	♂	2,636	0	—
C_5	♂	5,045	0	—
7	♂	2,362	3	0·127±0 073

(1) Partners in matings of the first nine are *pere/pere*, and those of the last three (C_4, C_5 and Exp. 7) are w_2/w_2. (2) Doses of sarkomycin are 0·05 ml. of 7·5 unit/mol. solution except Exp. 7 (0 05 ml. of 17·4 unit/ml.). (3) Intervals between the injection and the mating are 10–60 min.

The experiments were repeated several times, and the results have been summarized in Table 1. The mutation-rates in the control series were generally small except in the case of control 3. No aberrant eggs were obtained when the female moths were treated (Exp. 5 and 6). After treatment of males some aberrant eggs occurred in three experiments (Exp. 1, 3 and 4) but not in all. The numbers of aberrant eggs were, however, small and mosaic eggs formed the bulk, as after treatment with nitrogen mustard or nitromine.

Since the spontaneous mutation-rates at the *pe* and *re* loci sometimes reach quite high values (control 3) (Nakao, Y., unpublished data) and the differences between control and experimental rates were small, we used also the w_2 locus in which spontaneous mutation-rate is always low[7] (controls 4 and 5 and exp. 7). The results support the view that sarkomycin has slight mutagenic power for the silkworm.

The variability of the results may be due to the difficulty of obtaining sarkomycin samples of uniform effectiveness by extraction from *Streptomyces erythrochromogenes*.

It is very interesting that substances like sarkomycin produced by a living organism have slight but probably real mutagenic effect. But there have been such precedents. Mustard oil tested by Auerbach and Robson[8] is an example.

We wish to express our sincere gratitude to Dr. C. Auerbach not only for her kind criticisms and advice, but also for her kindness in reading the original manuscript.

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Effect of Chloramphenicol in maintaining the Viability of *Escherichia coli*

THERE is ample evidence that cultures of non-sporing bacteria tend to die on prolonged storage. A widely held belief, supported by much less evidence, is that the presence of bacteriostatic antibiotics increases the tendency of bacteria to die. Thus Wilson and Miles[1] state that "... although by definition they [bacteriostatic antibiotics] inhibit growth without killing the cell, they are in fact slowly bactericidal", but the evidence for this statement is conflicting[2–8]. An explanation of this conflict may lie in the finding of Valentine[8] that the tendency of bacteria to die under conditions of bacteriostasis induced by chloramphenicol varies from species to species.

The experimental results given below indicate that under certain conditions of bacteriostasis chloramphenicol, instead of increasing the tendency of *E. coli* to die, has the reverse effect. It may, in fact, prevent bacteria from dying. An analogous situation is presented by the drying of bacteria; slow drying causes death of many species whereas freeze-drying is an accepted way of maintaining viability.

The organism used in the present experiments was *E. coli* (N.C.T.C. 9001), and cells were harvested from 24-hr. cultures in meat extract broth and resuspended in broth or in broth containing chloramphenicol. Total counts were determined by the Spekker absorptiometer calibrated by direct counts in a Petroff–Hausser chamber. Viable counts were determined by a modification of the method of Miles and Misra[9] in which 100 drops instead of 6 of each dilution were taken, giving about a six-fold reduction in the error of estimation. The variables were temperature of incubation and concentration of chloramphenicol. In the first instance experiments were carried out at a low temperature with a high concentration of cells in order to make conditions as inimical as possible to cell multiplication. Later, it was found that the results were more striking when the incubation temperature was raised to 22° C.

It can be seen from Tables 1 and 2 that, instead of hastening the death of bacteria, chloramphenicol may, under the conditions of the experiment, act in such a way that the viability of the culture is maintained. Thus the viable count of the control suspension stored at 5° C. fell to about half its original value by the end of three weeks, whereas in the presence of 10 or 100 μgm. per ml. of chloramphenicol it remained unchanged. When similar suspensions were stored at 22° C. the effect was even more marked. The viable count of the control suspension fell to about one-eighth of its original value within one week, but with 100 μgm. chloramphenicol per ml. it showed only a slight decrease, and with 10 μgm./ml. it was still more than half the original value.

Table 1. CHANGES IN THE TOTAL AND VIABLE COUNTS OF SUSPENSIONS OF *E coli* STORED AT 5° C. IN THE PRESENCE AND ABSENCE OF CHLORAMPHENICOL

Period of storage (days)	Total count cells per ml. × 10^7			Viable count cells per ml. × 10^7		
	Concn. of chloramphenicol μgm. per ml.			Concn. of chloramphenicol μgm. per ml.		
	0	10	100	0	10	100
0	780	700	700	410	400	390
1	720	630	630	400	385	375
2	800	650	600	420	395	375
5	750	550	510	390	395	405
8	850	650	650	410	410	370
12	820	630	570	395	405	365
21	660	580	550	225	420	415

Table 2. CHANGES IN THE TOTAL AND VIABLE COUNTS OF SUSPENSIONS OF *E. coli* STORED AT 22° C. IN THE PRESENCE AND ABSENCE OF CHLORAMPHENICOL

Period of storage (days)	Total count cells per ml. × 10^7			Viable count cells per ml. × 10^7		
	Concn. of chloramphenicol μgm. per ml.			Concn. of chloramphenicol μgm. per ml.		
	0	10	100	0	10	100
0	680	640	660	470	400	430
1	1,050	580	570	530	410	435
2	1,220	660	620	535	425	435
4	960	520	500	220	390	415
7	510	550	520	60	250	350
11	480	350	550	20	60	250

It would seem, therefore, that a bacteriostatic agent such as chloramphenicol need not necessarily increase the tendency of bacteria to die under conditions of bacteriostasis, but may instead help them to survive. Whether death is encouraged or prevented probably depends on the interplay of a number of factors such as species of bacterium, temperature, concentration of chloramphenicol and cell numbers. Differences in these conditions probably explain why Gray[7] and Valentine[8] found that chloramphenicol exerted a bactericidal action on *E. coli.* Work is now proceeding with the view of determining whether, for any given species, at any chosen temperature, there is a critical concentration of chloramphenicol per cell which will retard death.

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Evidence for β-Oxidation in the Metabolism of Saturated Aliphatic Hydrocarbons by Soil Species of *Nocardia*

MEMBERS of the genus *Nocardia* can use certain long-chain saturated aliphatic hydrocarbons (C_{10}–C_{18}) as sole carbon and energy source[1], but very little information is available about the mechanism by which these compounds are broken down by micro-organisms[2]. In the present work the breakdown of 1-phenyldodecane, 1-phenyldecane, 1-phenyloctadecane, 3-phenyleicosane and 1-(α-naphthyl)hendecane by *N. opaca* (strain T_{16}) and *Nocardia* spp. (strain P_2) has been shown to give substituted fatty acids. The shorter-chain ethyl, *n*-propyl and *n*-butyl benzenes were not attacked. In the following the methods detailed by Webley, Duff and Farmer[3] were used.

Phenyldecane, phenyldodecane and phenyloctadecane. An experiment with strain T_{16} was set up with about 100 mgm. of 1-phenyldodecane (Eastman Chemicals) in place of the ω-phenyl-substituted fatty acids used previously[3]. Other conditions remained the same except that the phosphate buffer concentration was increased to $0 \cdot 033\ M$. After seven days incubation *o*-hydroxyphenylacetic acid was detected, as formed by strain T_{16} from phenylacetic acid and other ω-phenyl-substituted fatty acids with an odd number of methylene groups[3]. Strain P_2, which does not attack phenylacetic acid, was used in the following experiment. Phenyldodecane (103 mgm.) was added aseptically to 340 mgm. (dry wt.) washed cells (grown for 14 days on glucose (1 per cent (w/v)–nutrient broth at 25°) in phosphate buffer (100 ml.)). The conversion of phenyldodecane to phenyl-substituted fatty acids was estimated by the increase in absorption of acidified 5-ml. aliquots (after removal of cells) at 210 $m\mu$, using phenylacetic acid as a standard. A conversion of 67 per cent was found after 40 hr., increasing to 85 per cent in 6 days. No further change occurred and the experiment was concluded after 12 days. Benzoic acid, if formed, did not exceed 5 per cent of the starting material. Ether extraction of the solution (after removal of cells) gave a solid product the infra-red spectrum of which (after recrystallization) was identical with phenylacetic acid. The R_F value on the paper chromatogram was the same as that of the authentic material.

It was shown similarly that phenylacetic acid was formed from phenyldecane and phenyloctadecane by strain P_2.

3-*Phenyleicosane.* By analogy[3] 3-phenyleicosane was expected to give phenylethylacetic acid, which is not attacked by *N. opaca*. Spectrophotometric analysis showed that after 13 days about 26 per cent of the hydrocarbon appeared as aromatic acids. A fresh batch of washed cells of *N. opaca* was added aseptically to the flask and incubation continued for a further 7 days to give about 56 per cent of the 3-phenyleicosane as aromatic acids. A 5-ml. aliquot examined by paper chromatography showed a spot corresponding to phenylethylacetic acid, but at least two other acids were present.

The remaining contents of the flask were centrifuged, the supernatant sterilized by filtration and a fresh batch of washed cells added. After a further 11 days the cells were removed and the supernatant extracted as before. Paper chromatographic analysis of the oily residue revealed only one spot the R_F of which corresponded to phenylethylacetic acid. The infra-red spectrum also showed that the principal component was phenylethylacetic acid, together with traces of unidentified impurities.

1-(α-*Naphthyl*)*hendecane.* Experiments were performed using both *N. opaca* (T_{16}) and *Nocardia* spp. (P_2) in the manner described for 1-phenyldodecane. After incubation for 10 days (P_2) and 13 days (T_{16}) the ether extracts yielded crystalline products the infra-red spectra of which showed 2-(α-naphthyl)-propionic acid to be the major component and not the expected α-naphthoic acid. Impurity bands showed the presence of some 2-(α-naphthyl)acrylic acid by comparison with a synthetic specimen. Ultra-violet absorption indicated about 17 per cent of this compound. As 2-phenylpropionic acid is rapidly converted by way of cinnamic to benzoic acid[3] by both strains, the failure of the corresponding step with 2-(α-naphthyl)propionic acid may be ascribed to an electronic or steric effect of the larger nucleus.

These results show that $(\omega - 1)$ oxidation[4] is not an important mechanism in the breakdown of substituted long-chain hydrocarbons by these organisms, since this initial step followed by β-oxidation would have led to benzoic acid formation from phenyldecane and phenyldodecane[3]. Initial attack at any of the $(\omega - 2n)$ carbon atoms ($n = 0$, 1, 2 etc.), followed by β-oxidation of the resulting acid, can account for the products obtained, but ω-oxidation ($n = 0$) seems the most probable route.

We are indebted to Dr. J. A. Dixon, of the Pennsylvania State University and the American Petroleum Institute, for specimens of 1-phenyldecane, 3-phenyleicosane and 1-(α-naphthyl)hendecane; to Prof. R. L. Wain, Wye College, for a speciman of 2-(α-naphthyl)-propionic acid; and Dr. Treccani (University of Milan), for the culture of *Nocardia* spp. strain P_2.

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Isolation and Characterization of a Naturally Occurring Stimulator of Citrulline Biosynthesis

THE synthesis of citrulline by preparations from mammalian liver requires the addition of ornithine, ammonia, bicarbonate ion, magnesium ion, adenosine triphosphate, and an appropriate derivative of glutamic acid[1]. Synthetic compounds which have been shown to be active in the latter capacity are the N-carbamyl, N-formyl, N-acetyl and N-chloroacetyl derivatives of L-glutamic acid[1]. These compounds have been shown to be catalytically active in the synthesis of carbamyl phosphate, an intermediate precursor of the carbamyl group of citrulline[1-3].

It was desired to ascertain which, if any, of these glutamyl derivatives is the naturally occurring stimulator of citrulline synthesis. Observation of the occurrence of such a stimulator and preliminary progress in the purification of this substance has been previously reported[4]. A concentrated hot-water extract of beef liver, generously provided by the Armour Co., Chicago, was found to contain material which would stimulate citrulline synthesis, and this concentrate proved to be a more convenient starting source for purification than fresh liver. It was further found that Difco Bacto-Yeast Extract (Difco Laboratories, Inc., Detroit, Michigan) and fresh brewer's yeast are potent sources of a similar or identical material. The stimulators from liver and from yeast were purified by chromatography on anion exchange resins and by preparative paper chromatography employing several solvent systems. During purification, the desired material was located and assayed by its ability to stimulate citrulline synthesis in the absence of added glutamyl derivatives.

Both the liver and the yeast stimulator were obtained as crystalline compounds. Both materials moved on chromatograms in a manner identical with authentic N-acetyl glutamic acid. The activity of both stimulators in the citrulline-synthesizing system was virtually identical on a weight basis with that of N-acetyl glutamic acid. Infra-red spectroscopy provided further evidence for their identity.

Acid hydrolysis of both stimulators gave rise to a single ninhydrin-reactive material, which was identified as glutamic acid by paper chromatography in three solvent systems. The yield of glutamic acid from weighed samples of the stimulators was determined by the quantitative ninhydrin method[5]. These yields were in reasonable agreement with the theoretical yield from N-acetyl glutamic acid, the values being 97 per cent of theory in the case of the liver stimulator, and 106 per cent of theory in the case of the yeast stimulator.

It has been reported that N-acetyl glutamic acid is an intermediate in the synthesis of ornithine in *Escherichia coli*[6]. However, this compound has not, to our knowledge, been isolated previously from natural sources. N-acetyl glutamic acid appears to be present in fresh liver in a concentration of about three parts per million, and in Difco Bacto-Yeast Extract to the extent of about 200 parts per million.

Details of the isolation and characterization of these materials will be published elsewhere.

This investigation was supported in part by research grants from the National Institutes of Health and the Wisconsin Alumni Research Foundation.

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α-Mannosidase and Other Glycosidases in the Tissues of the Mouse and the Rat, with Special Reference to the Sex Organs

α-Mannosidase, an enzyme previously obtained from sources such as lucerne seed[1], snails[2] and limpets[3], has been found to be widely distributed in the body of the mouse and the rat (Table 1). On the whole, values for infant organs tended to be somewhat higher than the corresponding adult values. The figure for adult mouse uterus was drastically reduced, sometimes to zero, by ovariectomy, and was restored to the normal level by œstrone administration.

Adult epididymis, both caput and cauda, displayed by far the highest α-mannosidase activity observed, in both mice and rats; but the figure for epididymis in immature animals was very much lower, depending on the age. Experiments are in progress to determine whether the high activity in adults is derived from the epididymis itself or from the ripening spermatozoa. It is interesting to note in this connexion that α-mannosidase is strongly inhibited by mannonolactone[3].

Table 1. The α-Mannosidase Activity of Mouse and Rat Tissues
Results expressed as μgm. p-nitrophenol liberated per gm. moist tissue from 0·002 *M* p-nitrophenyl-α-mannoside in 1 hr. at 37° and pH 4 6. (*M*, male; *F*, female; *i*, infant)

Tissue		Rat				Mouse			
		M	*F*	*iM*	*iF*	*M*	*F*	*iM*	*iF*
Liver		899	1,033	2,056	1,782	883	728	1,825	
Spleen		670	808	1,740		1,508	966	1,320	
Kidney		3,028	1,770	5,561	5,466	2,638	2,225	8,311	
Intestine		998	1,020	—	—	1,106	1,057	—	—
Adrenals		646	352	—	—	—	Nil	—	—
Heart		122	Nil	—	—	170	116	—	—
Lung		460	436	—	—	382	316	—	—
Muscle (leg)		Nil	Nil	—	—	92	—	—	—
Brain		162	175	—	—	238	158	—	—
Preputials		1,121	1,092	590	1,232	1,485	1,025	—	—
Prostate		2,973	—	2,100	—	320	—	—	—
Epididymis	Caput	13,975	—	2,703	—	12,657	—	1,679	—
	Cauda	30,410	—	1,435	—	16,477	—		—
Testis		614	—	1,068	—	1,685	—	691	—
Seminal vesicle		611	—	2,618	—	2,889	—	—	—
Ovary		—	590	—	616	—	Nil	—	—
Uterus		—	279	—	1,183	—	1,124	—	—
Vagina		—	164	—	813	—	1,389	—	—

While the possible function of α-mannosidase in the body remains a matter for speculation, mannose is known to occur in several mucoproteins, such as ovomucoid[4] and urinary mucoprotein[5]: the concentration of the latter is higher in male than in female urine[5]. One cannot, however, exclude the possibility that the natural substrate may be quite a small molecule.

The distribution of α-mannosidase in the body and the effect of œstrogen on the uterine level is very reminiscent of β-glucuronidase, an extensively studied mammalian glycosidase[6,7]. Epididymis had not hitherto been studied for β-glucuronidase activity. The figure found was not, however, particularly high in mice and rats, nor did it vary markedly with age. On the other hand the enormous β-glucuronidase activity of female rat preputial-gland[8], which we have confirmed, was not reflected by α-mannosidase.

β-N-Acetylglucosaminidase activity[9] was found to be much higher in adult rat epididymis than in any other tissue examined for this enzyme, but was reduced about 15-fold in infant animals. This enzyme, it should be noted, was shown to be distinct from α-mannosidase: it was not, for example, inhibited by mannonolactone.

Glucuronic acid is present in the acid mucopolysaccharides, hyaluronic acid and chondroitin, while N-acetylglucosamine is present in the former and also in many mucoproteins. There is evidence for the participation of both β-glucuronidase and β-N-acetylglucosaminidase in mucopolysaccharide metabolism[10]. In the case of β-glucuronidase, great emphasis has been placed on its possible role in the metabolism of steroid glucuronides, since the activity of the enzyme in many organs can be altered by sex-hormone administration. It would appear, however, that there are two other glycosidases in animal tissues that may be under the control of sex hormones, and that in common with β-glucuronidase may play some part in mucoid metabolism.

One of us (J. F.) is in receipt of a grant from the Medical Research Council.

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Reversal of Relaxing Mechanism in Muscle Fibre Systems by Hydrostatic Pressure

It is an old observation[1,2] that intact muscle subjected to a hydrostatic pressure of a few thousand pounds per square inch goes into contracture. Further, it was shown by Brown[3] that in the range where contracture is still small, pressure greatly increases the tension of an electrically stimulated twitch, and that this effect occurs if the pressure is maintained only up to the end of the latent period. Thus pressure is promoting a precursor reaction which has been loosely called activation.

The discovery of an *in vitro* contraction cycle by Goodall and A. G. Szent Györgyi[4] provides a model of activation which works simply through small changes of *p*H. It is of interest, therefore, to see how far this system resembles intact muscle in its reaction to pressure.

First the dependence of relaxation on *p*H has to be characterized. It was found by one of us (M. C. G.) that fibres, active not only in the creatine phosphate system but also in the presence of adenosine triphosphate alone, can be obtained if one adds to the 50 per cent glycerol–water extraction fluid 5 m*M* histidine and 2 m*M* sodium cyanide to *p*H 6·8; in which medium they retain their remarkable activity for several weeks. With these the *pK* of equation (2) below is a function:

$$pK = 6{\cdot}45 + 2 \log_{10} [CP]/10 \qquad (1)$$

of the creatine phosphate concentration $[CP]$ (millimolar) provided that the adenosine triphosphate concentration $[ATP]$ is less than $[CP]$, which is the case of physiological interest; and $n = 3$. Similar results hold for adenosine triphosphate alone, for which case the dependence of tension y on *p*H is given in Fig. 1. More complete details will be given elsewhere.

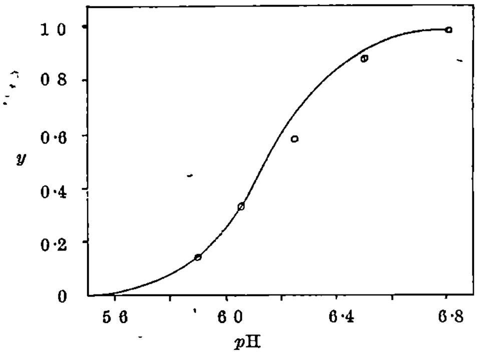

Fig. 1. Dependence of tension (y) on *p*H of extracted muscle fibre (rabbit psoas) in the presence of 10 m*M* adenosine triphosphate, 5 m*M* magnesium chloride and 0·125 sodium succinate buffer. Temperature, 22° C. Curve through points is relation (2) with $P = 0$, $n = 3$, $pK = 6{\cdot}15$

To study the pressure effect a small fibre bundle developing about 1·5 gm. tension was mounted in a pressure bomb designed for rapid access without disturbing the optical recording system. A solution containing the substrates 5 m*M* magnesium chloride and 0·125 *M* sodium succinate buffer to measured *p*H was added. The fibre developed tension and relaxed to a value depending on *p*H. Pressure P was applied in increments of 1,000 lb./sq. in. and the steady state tension y noted. In all cases tension increased reversibly with pressure in accordance with a relation of the form:

$$pY = \log_{10}\left(\frac{y}{1-y}\right) = \frac{P\Delta V}{2{\cdot}3RT} + n(pH - pK) \qquad (2)$$

Fig. 2 shows pY plotted as function of pressure for three typical cases including an intact muscle.

The fact that the slope $\Delta V = 350$ c.c./mol. is the same in all cases confirms the view that the system is a model of intact muscle, since this high value is quite unique for protein transformations[5]. So it is reasonable to use the relation $pH = pK - \frac{1}{n}\, pY(0)$, where $pY(0)$ is obtained by extrapolation to $P = 0$, to estimate the *p*H of intact muscle on the basis of a known intracellular concentration of creatine phosphate. For the slow tonic muscle of Fig. 1, a probable value is $[CP] = 10$ m*M*, giving $pH = 5{\cdot}8$.

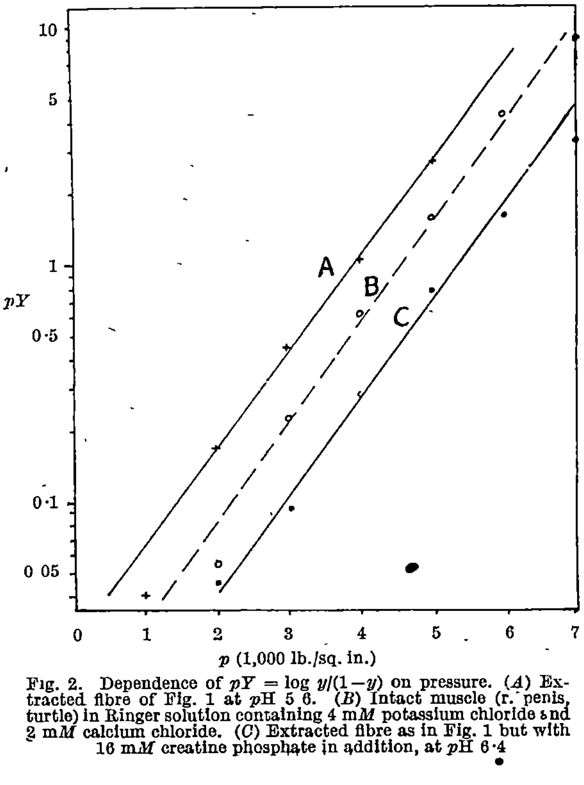

Fig. 2. Dependence of $pY = \log y/(1-y)$ on pressure. (*A*) Extracted fibre of Fig. 1 at *p*H 5·6. (*B*) Intact muscle (r. penis, turtle) in Ringer solution containing 4 m*M* potassium chloride and 2 m*M* calcium chloride. (*C*) Extracted fibre as in Fig. 1 but with 16 m*M* creatine phosphate in addition, at *p*H 6·4

Equation (2) implies that involved with increase of one positive unit charge is a volume increase of $\Delta V/n = 117$ c.c./mol., which is in the normal range for protein transformations[5]. Since volume increase is invariably associated with loss of net charge, we must suppose that the protein is negatively charged. Further, if we accept the view[6] that relaxation is essentially the dissociation of actomyosin (AM) into actin (A) and myosin–adenosine triphosphate complex (M^{nATP}), then the factor 2 in (1) suggests that the overall reaction is something like :

$$AM^{nAMP-} + n\text{H}^+ + 2n \sim P \rightleftharpoons A + M^{nATP} \quad (3)$$

Confirming this view, we found that addition of adenosine monophosphate to 5 mM lowered the pK by 0·5 unit. The function of magnesium, which is essential for this reaction in the concentration used, would be then to inhibit the further splitting of the myosin – adenosine triphosphate complex.

Adequate stirring throughout was necessary to prevent accumulation of products, presumably mainly adenosine monophosphate having the same result as above.

This work was aided by grants from the Horace H. Rackham School of Graduate Studies, University of Michigan, and from the Muscular Dystrophy Associations of America, Inc.

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Adaptation of Yeast to Maltose Fermentation

Certain strains of baker's yeast (*Saccharomyces cerevisiae*) have been shown in this laboratory to be capable of fermenting maltose without prior exposure to this sugar provided that the growth conditions are suitably controlled. The fermentation tests were carried out for one hour in the Warburg apparatus under nitrogen, strict precautions being taken to remove all traces of dissolved oxygen from the yeast suspension and substrate solution, and only glucose-free maltose being used, because traces of both oxygen and glucose are known to enable yeast to become adapted rapidly to maltose fermentation[1,2].

This ability to ferment maltose rapidly is a very labile characteristic of the yeast. Early experiments on growing the yeast in the laboratory in a defined medium of glucose or sucrose, salts, vitamins and 'Difco Casamino' acids failed to produce a yeast which on harvesting fermented maltose unless maltose had been included in the growth medium. It was then discovered that a harvest of yeast which would ferment maltose with no appreciable lag at a rate comparable to glucose fermentation could readily be obtained in the absence of maltose in the growth medium, provided that the supply of assimilable nitrogen in the growth medium was restricted. The effect of limited nitrogen could be enhanced by simultaneously restricting the sugar supply (usually glucose).

Table 1

Treatment	Maltose fermentation (μl. CO_2/hr / 10 mgm. yeast)	Yield (mgm. wet weight)
Inoculum	183	(100)
0·014 M amino-N	18	182
0·0036 M amino-N	156	171
0·0011 M amino-N	374	156
0·0004 M amino-N	483	150

Basal medium: 0·425 gm. KCl, 0·246 gm. $CaCl_2.6H_2O$, 0·125 gm. $MgSO_4.7H_2O$, 2·5 mgm. $MnSO_4.4H_2O$, 4·2 mgm. $FeCl_3.6H_2O$, 0·6 gm. KH_2PO_4, 2·5 mgm. pyridoxine, 2·5 mgm. calcium pantothenate, 20 mgm. inositol, to 1 litre with water.

Table 1 contains the results of one of many such experiments, in which inocula of 100 mgm. of yeast (wet weight) were seeded into 200-ml. aliquots of a basal medium as indicated, containing varying amounts of 'Difco Casamino' acids and 0·028 M glucose. After 3 hr. growth at 30° C., with aeration at 500 ml./min., the yeast from each flask was harvested, washed twice with isotonic saline, and samples were immediately examined in the Warburg apparatus.

It will be seen from Table 1 that the decrease in maltose fermentation rate in the 0·014 M amino-nitrogen medium cannot be accounted for by dilution of the intracellular level of existing enzyme by growth; with the two lowest levels of nitrogen there was an overall increase in fermentation activity.

In experiments carried out over 24 hr., yeast of high maltose-fermenting activity was seeded into an aerated synthetic medium containing 0·11 M sucrose and 0·014 M amino-nitrogen (as 'Difco Casamino' acids), with vitamins and salts as before. Aliquots were withdrawn at intervals of 1 hr. and the yeast was spun down, washed and tested immediately in the Warburg for maltose fermentation.

The yeast sample withdrawn after the first hour had one-third of the maltose fermentation rate of the original seed, the latter evolved 272 µl. carbon dioxide/hr./10 mgm. yeast (wet weight), whereas the sample withdrawn at one hour evolved 76 µl. By the third hour the rate had fallen to zero and there was no activity until the ninth hour, when a low rate of 21 µl. was recorded. The rate then steadily increased until by the twenty-fourth hour of growth the activity was 283 µl. The loss of ability to ferment maltose when seeded into a fresh medium containing ample nitrogen is quite reproducible, as is the induction of the maltose-fermenting system in media containing little nitrogen and sugar. Similar results were obtained using media where the sole nitrogen source was DL-asparagine or ammonium sulphate; but the degree of response was always less than for casein hydrolysate.

Moreover, if the rate of growth was restricted by other means, for example, by supplying galactose as sole sugar, or omitting vitamins, or severely reducing the glucose level in the medium, then even in the presence of excess nitrogen maltase synthesis was induced. Table 2 contains results of one such experiment. It has not yet been determined whether the effect is due to the overall diminished growth activity, or to a restriction of nitrogen uptake per cell arising from this diminished activity, although determination of the nitrogen content of harvested yeast cells by a modification of Conway's procedure[3] shows only a weak inverse correlation between maltose fermentation and nitrogen, with a much stronger

Table 2

Treatment	Maltose fermentation (μl. CO_2/hr./ 10 mgm. yeast)	Yield (mgm. wet weight)
Inoculum	109	(100)
0·014 *M* amino-N, 0·056 *M* glucose	31	197
0·014 *M* amino-N, 0·056 *M* galactose	747	140
0·014 *M* amino-N, 0·0056 *M* glucose	658	169
0·014 *M* amino-N, 0·056 *M* glucose, omitting vitamins	556	193

inverse correlation between yield and fermentation rate.

The maltose-fermenting system of these yeasts must be considered as adaptive owing to its extreme lability. Yet such activity can be induced in the absence of maltose or a substrate analogue by altering the cultural conditions in one of several ways to restrict growth. In view of the current interest in enzyme adaptation it is obviously of importance to ascertain whether other of the known adaptive enzyme systems will respond in this way. Recently, White[4] has described experiments on yeast from which he concluded that ability to ferment maltose, and glucose, often proved to be a function of the stage of the harvesting of the yeast crop. The likelihood is that the variations found were a function of the concentration of sugar or nitrogen in the medium at the time of harvest.

It is hoped to publish a full account of this work with experimental details elsewhere.

We would like to thank our colleagues in this Department for their help and criticism, and also the Directors of the Distillers Company, Limited, for permission to publish this work.

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A Factor influencing the Protozoal Population in Sheep

THE quantitative importance of the protozoa in ruminal digestion has not yet been positively assessed. The recent work of Sugden and Oxford[1] and Sugden[2] shows unequivocally that various protozoa digest both starch and cellulose and also utilize a number of soluble carbohydrates[3]. Furthermore, McNaught *et al.*[4], using rats, showed that the protozoa yield a protein of higher biological value than the ruminal bacteria.

The concentration of the ruminal protozoa is strongly influenced by diet[5], but from the results of a number of experiments in this laboratory, it became apparent that the composition of the diet may be overshadowed by other factors. One such factor has been observed in an experiment designed to determine the influence, on ruminal metabolism, of feeding, in five different ways, a simple ration of roughage and sheep cubes to Merino sheep. The 700-gm. daily ration was palatable and eaten avidly as soon as presented. The five treatments were used in a 5 × 5 Latin square design. These, together with the mean protozoal counts, are shown in Table 1.

Table 1

Ration No.	Treatment	Protozoa × 10^6/ml. (Mean of 5 sheep)	
4	$\frac{1}{4}$ ration fed at 09.00, 11.00, 13.00 and 15.00 hr.	3·14	
3	$\frac{1}{2}$ ration fed at 09.00 and 17.00 hr.	2·26	2·29
1	Roughages fed at 09.00 hr., sheep cubes at 17.00 hr.	2·34	
5	Sheep cubes fed at 09.00 hr., roughages at 17.00 hr.	2·26	
2	Whole ration fed at 09.00 hr.	1·15	

L.S.D. 5% = 0·666
1% = 0·93
0·1% = 1·32

Rumen samples were taken by stomach tube on the final day of each 4-week period, immediately before feeding. Counts were made by a modification of the method outlined by Adam[6].

A sharp division of the protozoal counts into three levels is apparent, notwithstanding the fact that the same diet was used throughout. Treatment 4 is significantly higher than all other treatments ($P < 5$ per cent). No significant difference exists between treatments 3, 1 and 5, but these are all higher than treatment 2 ($P < 1$ per cent).

The relationship of these data to ruminal conditions awaits assessment, but they show clearly that the eating habit of the animal can be an important factor in determining the level of the protozoal population.

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Use of the Cervical Mucus Smear in assessing Ovarian Activity in the Ewe

PAPANICOLAOU[1,2] noted that when the cervical mucus of women was spread to dry on a glass slide a characteristic "crystallization" took place. This phenomenon has been investigated by Zondek[3]. Its use as a simple test for determining ovarian function has been extended recently to domestic animals, notably the cow[4-8]. So far we are not aware of any such studies with the ewe.

The complexity of the external orifice of the cervix, particularly in aged ewes, presents a difficulty in the collection of a cervical specimen uncontaminated with vaginal mucus. With experience mucus was readily obtained through use of a 'Coldite' vaginal speculum and glass rod, or directly from slaughtered animals. Smears on a clean glass slide were examined microscopically under low power when dry. It was found necessary to warm slides before examination in cold weather. The fern-like patterns disappeared fairly rapidly on cooling again. Cervical mucus was recovered from Romney ewes running with raddled

Table 1. "CRYSTALLIZATION" IN CERVICAL MUCUS SMEAR DURING THE ŒSTROUS CYCLE OF THE EWE

Day of cycle	−7	−6	−5	−4	−3	−2	−1	0	+1	+2	+3	+4	+5	+6
No. showing positive	0	3	4	6	12	18	25	33	21	6	0	2	0	0
Total smears	9	13	15	25	27	28	27	33	33	30	19	9	5	2
Per cent showing positive	0	23	27	24	44	64	93	100	64	20	0	22	0	0

teasers during anœstrus and the breeding season. Mucous secretions of the cervix from pregnant ewes and from castrated and hysterectomized animals were observed, as well as cervical mucus from ewes receiving injections of œstrogens, progesterone and the gonadotrophin from pregnant mare serum.

During the œstrous cycle the fern-like patterns were present in association with œstrus as shown in Table 1. No such "crystallization" occurred in specimens taken in late pregnancy, in anœstrus or from uninjected ovariectomized ewes. Toward the end of the breeding season when the phenomenon of 'silent œstrus' is not uncommon the cervical mucus suggested ovulation unaccompanied by œstrus in several ewes. Ovulation in some instances was confirmed by recovering the ova a few days later. Likewise, patterns were seen when ovulation was induced with pregnant mare serum in five anœstrous ewes. Three hysterectomized ewes were available for study. Negative mucus persisted for several months during the breeding season, indicating perhaps that the life of the corpus luteum had been prolonged[9]. While none of these ewes has been in œstrus since, it is interesting to note that the negative mucus was superseded by fern-like patterns before the end of the breeding season and these positive smears have continued. The ovaries of one animal are being examined histologically.

In thirty-seven œstrous cycles a single injection of œstradiol benzoate was given to study the inhibiting effect of progesterone on pattern formation during the luteal phase. On the third day post-œstrus both 100 μgm. and 50 μgm. œstradiol benzoate induced a positive mucous smear. These same levels of œstrogen on the sixth day resulted in one positive response only in four animals treated at each level. Administration of $\geqslant$ 150 μgm. was completely successful. From the ninth to twelfth day $\geqslant$ 50 μgm. always caused pattern formation, as did several injections of 20 μgm. This greater sensitivity in the late luteal phase may reflect a reduced inhibitory effect, lower progesterone secretion or an increase in endogenous œstrogens.

Another phase of the work, using ovariectomized ewes, was to study the quantitative relationship of progesterone to œstrogens when the hormones were injected simultaneously. It is known that progesterone pretreatment in the ewe results in a marked increase of sensitivity to œstrogen[10]. When 10 mgm. progesterone was administered daily for three days prior to the simultaneous injection of œstrogen and 10 mgm. progesterone we noted that 20–25 μgm. œstradiol benzoate caused "crystallization" and $\geqslant$ 50 μgm. led to œstrous behaviour. The marginal levels when œstrogen was given as a single injection 40 hr. after the progesterone priming were 15 μgm. and 25 μgm. respectively.

These results show a high degree of sensitivity on the part of the cervical mucus smear to œstrogen and progesterone, and therefore suggest its suitability in determining the quantitative production of the ovarian hormones in the ewe.

One of us (M. F. M.) is indebted to the New Zealand Wool Board for a scholarship.

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Manganese Deficiency in *Chlorella* under Heterotrophic Carbon Nutrition

IN the course of an investigation of the effect of manganese on nitrogen metabolism in *Chlorella*, limitations in growth of *Chlorella* due to lack of manganese have been obtained under autotrophic, mixotrophic and heterotrophic conditions of carbon nutrition with both nitrate and ammonium as nitrogen sources. In the recent report of Pirson and Bergmann[1], it is stated that for *Chlorella vulgaris*, "manganese deficiency has no influence upon growth in heterotrophic culture in darkness".

Chlorella vulgaris var. *viridis* has been grown in a solution of purified nutrients in an apparatus[2] devised for the rapid growth of *Chlorella* under normal and micronutrient deficient conditions. No measurable growth took place in the purified nutrient solution without the addition of manganese. In this study, normal culture solutions were supplied with 0·4 p.p.m. of manganese, and deficient solutions, except autotrophic cultures, were supplemented with 0·004 p.p.m. of manganese. The nitrate autotrophic culture received 0·003 p.p.m. of manganese and the ammonium autotrophic culture, 0·008 p.p.m. of manganese. Glucose, purified by passage through a mixture of 'Dowex 50' and 'Dowex I', was included in mixotrophic and heterotrophic cultures at a concentration of 1 per cent.

Growth of *Chlorella* (Table 1) was limited when manganese was deficient under all conditions of carbon nutrition. This is in contrast with the experience of Pirson and Bergmann[1]. Manganese, as a contaminant in their nutrient solutions, may account for the failure of these workers to obtain manganese-deficient effects under heterotrophic conditions.

Table 1. TERMINAL GROWTH OF *Chlorella* UNDER VARIOUS CONDITIONS

Carbon nutrition	Packed cell volume ml /l.		Dry weight mgm /ml.	
	Mn-sufficient	Mn-deficient	Mn-sufficient	Mn-deficient
	Nitrate as nitrogen source			
Autotrophic	11	4	3·2	1·4
Mixotrophic	13	6	3·5	2·2
Heterotrophic	23	14	5·5	7·3
	Ammonium as nitrogen source			
Autotrophic	8	4	3·0	1·5
Mixotrophic	11	5	3·5	1·9
Heterotrophic	16	12	5·0	3·8

Table 2: THE MANGANESE STATUS OF *Chlorella* CELLS GROWN IN THE PRESENCE OF LOW LEVELS OF MANGANESE

Carbon nutrition	Nitrogen source	Growth per added Mn μl./μgm.	Manganese content		Manganese* recovered in cells per cent
			Packed cell volume basis μgm./ml.	Dry wt. basis μgm./gm.	
Autotrophic	Nitrate	1,300	2·0	5·6	114
Mixotrophic	,,	1,600	0·6	1·7	46
Heterotrophic	,,	3,500	0·4	1·3	64
Autotrophic	Ammonium	475	2·0	4·8	63
Mixotrophic	,,	725	0·2	0·6	14
Heterotrophic	,,	3,000	0·3	1·0	45

* Manganese content of nutrition solution was found to be 0·003 p.p.m.

These results show that for the same amount of manganese, growth under heterotrophic conditions was greater than in the light. This is in accord with the observations of Pirson and Bergmann[1]. The point is more clearly demonstrated when the growth data were calculated as microlitres of *Chlorella* produced per microgram of added manganese (Table 2). However, when the manganese content of the cells was determined[3], the striking difference was shown to be between the presence and absence of added glucose, and not between light and dark.

If manganese requirement is based on its level in the manganese-limited cell when growth ceases, such a requirement is clearly several times higher for photosynthesis than for other functions.

The quantity of manganese recovered in the cells (Table 2) suggests an explanation for the apparent difference in manganese requirement based on growth response as compared with manganese content. Thus, the recovery of manganese was less under mixotrophic conditions than under autotrophic or heterotrophic conditions, indicating that in the presence of both photosynthesis and glucose metabolism, manganese absorption was impaired. Unfortunately, it was impossible to confirm this further by analysis of the residual solution.

Since manganese is involved in so many enzymatic processes[4] it is not surprising to find that it is required under heterotrophic conditions. However, it is clear that most of the requirements under autotrophic conditions are for photosynthesis. The requirement of manganese for photosynthesis has been shown[5] previously. It is now suggested that the apparently high requirement of *Chlorella* for manganese under mixotrophic conditions is due to restricted manganese absorption and that the low requirement for manganese under heterotrophic conditions has obscured the actual need for this element.

Note added in proof. Eyster, Brown and Tanner (*Arch. Biochem. Biophys.*, **64**, 240 (1956)) have reported that there is no Hill reaction in manganese-deficient *Chlorella* cells and that photosynthesis is 25 per cent of normal.

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A Phosphate Requirement for Nitrate Reductase from *Neurospora crassa*

THE enzyme nitrate reductase which catalyses the reduction of nitrate to nitrite in some bacteria[1], fungi[2–4] and green plants[5] has been shown to be a flavoprotein[6] containing molybdenum[2–4]. During enzyme action the micronutrient undergoes a valence change[7] involving Mo^{6+} and Mo^{5+}.

This communication reports that further purification of nitrate reductase from *N. crassa* has shown it to have a requirement for phosphate which can be replaced completely by arsenate, tellurate or selenate and partially so by silicate or sulphate.

N. crassa wild type 146 (microconidial type) was grown in a modified Fries medium containing ammonium nitrate as the source of nitrogen[2]. The media were dispensed in 200 ml. amounts in 1-litre Erlenmeyer flasks sterilized for 10 min. at 10 lb. per sq. in., cooled and inoculated with a spore suspension of the fungus. After four days growth at 28° C. in the dark, the felts, harvested in a Büchner funnel, were well washed with distilled water and frozen for 3 hr. at – 15° C. They were ground in a pestle and mortar with three times their weight of cold 0·1 *M* phosphate buffer (*p*H 7·5) and then in a Ten Broeck glass macerater. The homogenates were centrifuged at 3,000*g* for 15 min. at 0° C. The supernatant was fractionated with ammonium sulphate, calcium phosphate gel and carbon adsorption procedures as summarized in Table 1.

The final enzyme preparation was dissolved in distilled water and represented an 84-fold purification of the enzyme. Protein was determined by the Folin method[8].

The enzyme was assayed as follows: 0·1 ml. enzyme (100 μgm. protein/ml.); 0·1 ml. 0·1 *M* potassium nitrate; 0·02 ml. boiled, *tris*(hydroxymethyl)amino-methane extract of acetone powder of pig heart (*p*H 7·5); 0·05 ml. 2 × 10^{-3} *M* reduced triphosphopyridine nucleotide and 0·1 *M* *tris* buffer (*p*H 7·5) to a final volume 0·5 ml. In the control tubes reduced triphosphopyridine nucleotide was omitted. After 10 min. incubation at 25° C., nitrite

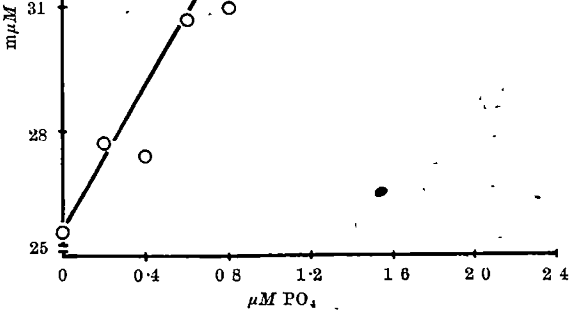

Fig. 1. Enzyme assay as in text, phosphate (*p*H 7·5) added to 0·1 ml. of enzyme (110 μgm. protein/ml.)

Table 1. PURIFICATION OF NITRATE REDUCTASE FROM *Neurospora*

		Total units	Total protein mgm.	Specific activity units/mgm. protein	Per cent recovery
Fraction I	Crude extract	23,900	1,300	18·4	
II	0–43 per cent ammonium sulphate ppt. of I	7,600	185	40·5	31·8
III	24–46 per cent ammonium sulphate ppt. of II	4,660	94	50	19·5
IV	Calcium phosphate gel treatment of III; 0·2 *M* pyrophosphate eluate	880	5·4	162	3·7
V	0–100 per cent ammonium sulphate ppt. of IV (washed four times with saturated ammonium sulphate solution)	800	4·1	195	3·3
VI	Aqueous solution of V treated with 'Darco *G*. 60' carbon* slurry; centrifuged at 3,000 *g* for 15 min. Activity of supernatant	200	0·13	1,539	0·84
	Total purification 84-fold				

* 'Darco *G*.60' carbon (30 mgm added/ml. enzyme) obtained from Darco Corporation, 42nd East Street, New York.

Table 2. THE SUBSTITUTION OF OTHER ANIONS FOR PHOSPHATE IN NITRATE REDUCTASE (FRACTION VI)
(Values as per cent)

Anions	PO_4'''	P_2O_7''''	ATP	AsO_4'''	BO_2'''	SiO_3''	VO_3'	MoO_4''	MoO_3''	WO_4''	SO_4''	SeO_4''	TeO_4''
Exp. 1	100	0	0	97	0	48	0	0	0	0	42	100	100
,, 2	100	0	0	120	0		0	0	0	0	91	100	100
,, 3	100	0	0	62	0	35				0	62	100	100
Mean	100	0	0	93	0	42	0	0	0	0	65	100	100

Anions dispensed in 0·05 *M tris* buffer (*p*H 7·5). Enzyme assay as in text; plus anion in 0·1 ml. at a final concentration of 10^{-2} *M*.

was determined by adding sulphanilamide and N-(1-naphthyl)-ethylenediamine reagents[7].

Reduced triphosphopyridine nucleotide was prepared by reducing triphosphopyridine nucleotide with isocitric dehydrogenase extracted in 0·1 *M tris* buffer (*p*H 7·5), from acetone powder of pig heart.

The effect of adding graded amounts of phosphate *in vitro* to 0·1 ml. of the purified enzyme (fraction VI) containing 110 μgm. protein/ml. is shown in Fig. 1. Maximal activity was obtained when 2·5 μ*M* phosphate was added to 0·1 ml. of the enzyme. Adenosine triphosphate at either 10^{-2} or 10^{-3} *M* did not substitute for inorganic phosphate. The enzyme was not inhibited by uncoupling reagents, for example, dinitrophenol at 1×10^{-5} and 10^{-4} *M*; aureomycin at 5×10^{-4} *M* or sodium arsenite at 1×10^{-2} *M*, so that there is no evidence, in these experiments, for a phosphorylation mechanism during nitrate reductase action.

The results in Table 2 show that the phosphate requirement can be replaced completely by selenate, tellurate or arsenate and to a lesser extent by sulphate or silicate, each at a final concentration of 10^{-2} *M*.

It is likely, therefore, that one of the roles of phosphate in nitrate reductase is to bind the molybdate to the apoenzyme, as the replacement anions which have similar atomic radii to phosphate (2·76 A.), being within the range 2·4–2·8 A., also form complexes with molybdates.

A full account of this and related work will appear elsewhere.

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Thiamine-deficiency of *Prototheca*, a Yeast-like Achloric Alga

IN 1894, Krüger[1] described two micro-organisms isolated in Germany from mucous flux of *Tilia* and *Ulmus* spp., namely, *Prototheca moriformis* and *P. zopfii*. Although the generic diagnosis indicated the micro-organisms to be fungi, they could not be connected with the Saccharomycetes nor with the lower Phycomycetes. Chodat[2] showed that the genus should be referred to the achloric strains of the alga *Chlorella*; this was confirmed later on by Printz[3]. Ashford *et al.*[4], isolating *P. portoricensis* and its variety *trispora* from cases of human sprue in tropical areas, confirmed the ability of this genus to grow also on chemically defined media, although best growth was always obtained in peptone-containing media. Negroni and Blaisten[5] reported that it was impossible to cultivate *P. ciferrii*, isolated from potato skin, in the absence of peptone. More recently, Butler[6] induced by radiation a number of chlorophyll-less mutants of *Chlorella pyrenoidosa* that, in his opinion, could be referred to the genus *Prototheca*. The achloric strains can grow on chemically defined media and do not require vitamins or other growth factors.

Investigations under way in this Institute showed that, in the presence of peptone as nitrogen source, four species of *Prototheca* (*P. zopfii*, *P. portoricensis*, *P. port.* var. *trispora* and *P. ciferrii*), grew well utilizing a wide variety of carbon substrates. On the contrary, all the species failed to grow in media containing glucose, inorganic salts and amino-acids. The vitamin requirements of *P. portoricensis* var. *trispora* are shown in Table 1.

The results were confirmed when thiamine or peptone or their mixture were added to a chemically defined vitamin-free medium (Table 2).

A more extended investigation, including Butler's achloric strains of *Chlorella pyrenoidosa*, is now being made; it will be reported in detail elsewhere. But it may be concluded that some nutritional requirements of *Prototheca* and *Prototheca*-like *Chlorella* strains are quite different. The absence of vitamin-deficiencies of the achloric mutants of *Chlorella* indicates a metabolism still autotrophic while natural

Table 1. Growth determined turbidimetrically (Optical Density ×10)

Vitamin or growth factor	Peptone	Basal medium* plus Na nitrate	Arginine	Proline
None	28·0	0·9	1·5	1·4
B_1	—	5·0	55·5	62·0
B_2	—	3·2	11·8	7·2
B_6	—	3·0	15·0	8·0
Biotin	—	3·5	17·0	8·8
Folic acid	—	3·3	10·3	11·5
Calcium pantothenate	—	1·1	1·4	1·5

* Basal medium: glucose, 34 gm.; KH_2PO_4, 5 gm.; $MgSO_4.7H_2O$, 2·5 gm.; $FeSO_4$, 0·01 gm.; water, 1,000 ml.

Table 2

Medium	Growth* (gm.)	Increase over basal medium (per cent)
Basal medium†	0·040	—
Basal medium + peptone	0·049	22·5
Basal medium + B_1	0·056	40·0
Basal medium + peptone + B_1	0·058	45·0

* Dry cells weight. Each result is the average of three experiments.
† Basal medium as in Table 1 with 2·05 gm. of L-proline.

Protothecae have already a heterotrophic metabolism, like certain fungi and bacteria.

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Thorium-bearing Minerals in New Zealand

In the course of a comprehensive study of the opaque mineral sands of New Zealand, the occurrence of thorium-containing minerals of medium density has been noted in the Westport area. Dr. C. O. Hutton, of Stanford University, California, has identified the principal minerals responsible as thorium-bearing sphene and the epidote allanite (private communication).

That part of a fairly crude magnetically separated fraction that sank in bromoform, s.g. 2·8, but which floated in methylene iodide, s.g. 3·3, analysed 0·1 per cent thorium oxide by chemical methods. (Analysis of the thorium oxide was carried out by the Dominion Laboratory.) The ratio of the weight of this fraction in the sample studied to the weight of ilmenite contained was approximately 1 : 7.

D. S. Nicholson[1] has roughly estimated that from surface indications there could be some 90 million tons of sand containing some 5 million tons of ilmenite in the area. It is assumed, but has not been established, that the thorium-containing minerals occur throughout the deposits.

It is understood that neither mineral is a commercially acceptable source of thorium to-day.

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A Through-conducting System co-ordinating the Protective Retraction of *Alcyonium* (Coelenterata)

Although Milne-Edwards[1] and Hickson[2] report the existence of co-ordination between the polyps of *Alcyonium*, there is very little to be found in the literature beyond this bare record. Kassianov[3] comes to the conclusion that there is no colonial nervous system in *Alcyonium*. Kukenthal[4] states that in Alcyonaria the existence of a colonial nervous system must be inferred from (presumably mechanical) stimulation experiments. On the other hand, Hyman[5] concludes that "in most Alcyonarians a nervous plexus seems to be absent from the wall of the anthocodia and the general coenenchyme", except that "the occurrence of such a plexus in the coenenchymal epidermis has been verified for *Veretillum* and may be expected in many Pennatulacea".

The use of electrical stimulation has recently revealed a through-conducting system which co-ordinates the protective retraction of polyps in several groups of Octocorallia. In *Alcyonium*, *Solenopodium*, *Tubipora* and some colonies of *Heteroxenia*, a single electrical stimulus produces no contraction of the polyp columns, though tentacles anywhere on the colony may respond with a jerk. A second stimulus applied anywhere relative to the first initiates a wave of contraction of the tentacles and columns of all the polyps of the colony. This experiment shows that the first stimulus produces a state of excitation over the whole colony, though without a visible reaction. By progressively shortening the interval between the two shocks until the second produces no effect, the refractory period of the through-conducting system has been measured in some instances. For the following Red Sea species at 25°–26° C. the refractory periods were: *Heteroxenia*[6], 0·08 sec.; *Tubipora*[7], 0·02 sec.; *Solenopodium*[8], 0·05–0·1 sec. In the cold-water species *Alcyonium digitatum* it was 0·15–0·2 sec. at 16°–17° C.

However, there could be a localized effect of successive stimuli in addition to the above straightforward through-conduction. To test this possibility in *Alcyonium*, a comparison has been made between the contraction of the polyps in response to eight shocks at 1-sec. intervals applied to the same point, and eight shocks at 1-sec. intervals applied to widely separated points. Eight shocks are a convenient number because they produce a large but incomplete retraction. A difference in degree of contraction over the colony would have implied a summation at the one point, but in fact no difference has been found in twenty-five to thirty small colonies tested. The same experiment carried out on *Sarcophytum* has quite a different result. Summation of several electrical stimuli at one point is there essential before through-conduction is initiated[7]. In large colonies of *Alcyonium* (greater than 15 cm. long) through-conduction may not be complete, because it has been noted that even in small colonies through-conduction sometimes fails between lobes.

The histological basis of the through-conducting system of *Alcyonium* has not been identified directly. An old controversy concerning the existence of nerve cells in the mesoglœa appears to have been settled by Kassianov[3], who describes a nerve net only in the walls of the endodermal tubules, not in the mesoglœa or the ectoderm of the syndete. There is no indication that this histological endodermal net entirely corresponds with the physiologically observed through-conducting system. The ectodermal muscle sheets and associated nerve nets, which are well developed in the individual polyps, apparently have no connexions between polyps[3]. This agrees with the sharp localization of the feeding responses of individual polyps, which can be referred mainly to the ectodermal musculature. When a very small electrode, carrying condenser shocks at 5/sec., is brought up to a polyp disk or tentacle, a feeding reaction or a slow retraction can be elicited from this one polyp alone; but if the through-conducting system is excited, then distant polyps retract no less than neighbouring ones.

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Arterio-Venous Anastomoses in the Teat of a Cow

RECENT studies of the circulation in the skin of cattle have shown that arterio-venous anastomoses occur in the ear of the calf and also in the skin of the forehead and cheek[1,2] but not in the skin of the general body surface[2]. Since they might possibly occur in the skin of other extremities the following investigation was carried out.

At autopsy the tip of a teat of an Ayrshire cow and pieces of skin from the end of the tail and from immediately above the hoof of an Ayrshire calf were obtained. They were fixed in 5 per cent formol-saline and embedded in paraffin. Serial sections of the blocks were cut and stained by Masson's trichrome method.

On examination of the sections no arterio-venous anastomoses were found in the skin of the tail and the leg. They were present, however, in the teat, where they could be recognized by the epithelioid cells in their media. In the serial sections it was possible to trace their course from artery to vein. All were apparently in the contracted state. Their outer diameters ranged from 60 to 150µ. Some were short and unbranched while others were tortuous and branched. A typical arterio-venous anastomosis is shown in Fig. 1. It has been sectioned at a bend in its course, as can be seen from the shape of its lumen.

The presence of arterio-venous anastomoses in the teats of any species has not been previously reported. It is possible[3,4] that they may help to control local temperature in conditions of extreme heat and cold. However, they may also be associated with the mechanism of erection of the teat. Although it has been found[5] that the most essential factor in the erection of the human nipple is the contraction of the smooth muscle core, yet some vascular engorgement of the small sinus-like vessels in the dermal papillæ may also occur. Similar sinus-like vessels occur in the dermal papillæ of the cow's teat. It seems possible that the arterio-venous anastomoses may control the flow of blood through these sinuses just as the arterio-venous anastomoses in the tongue of the dog, the sheep and the goat may control the flow of blood through the capillaries of the papillæ[6,7].

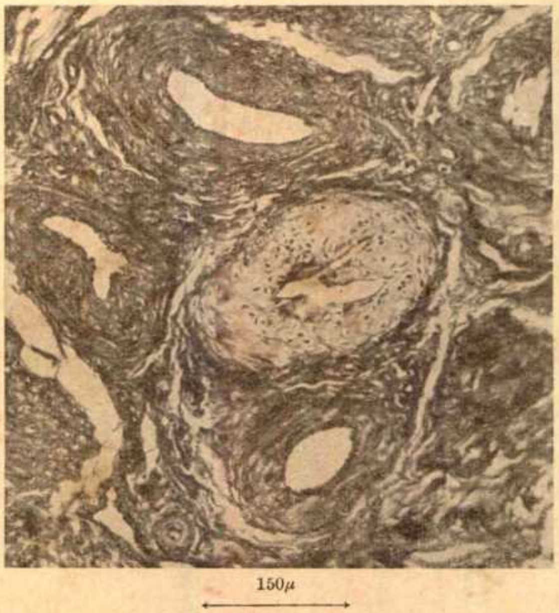

Fig. 1. An arterio-venous anastomosis cut obliquely at a bend in its course. Note the epithelioid cells in its thick wall. Beneath it lies the artery from which it arises, while above it and to the left lie the veins into which it drains

It is proposed to examine the human nipple and the teats of other animals to find if the occurrence of arterio-venous anastomoses in this location is common in mammalia. Examination of latex casts of the blood vessels of the teat may indicate whether the arterio-venous anastomoses control the blood supply to the sinus-like vessels in the dermal papillæ.

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Root Dissection: a Method of studying the Distribution of Active Mycelia within Root Tissue

THE presence of saprophytic micro-fungi in the decomposing cortex of roots of rye-grass[1] has been studied by a simple modification of a technique, described by Harley and Waid[2], which was developed to study the active mycelia of root surfaces. Roots at various stages of decomposition, characterized by the colour and condition of the cortex, were selected from rye-grass (*Lolium perenne* L.) growing under field conditions. The roots were washed by agitation in ten changes of 10 ml. of sterile water, and were then cut into 2-mm. fragments from which the outer cortex was dissected, leaving the central cylinder comprising the inner cortex and stele. Dissection was carried out in dishes of sterile water using sterile forceps and scalpel; with practice this could be done by eye. The 2-mm. fragments of outer and inner

Table 1. FUNGI ISOLATED FROM ROOTS OF RYE-GRASS WITH DECOMPOSING CORTEX TISSUES
Number of isolations of various kinds of mycelia, July 26, 1954

Fungal species	Intact roots "Root surface population"*	Dissected roots	
		Outer cortex†	Inner cortex‡ and stele§
	100 fragments	100 fragments	100 fragments
Rhizoctonia sp.	17	2	1
Penicillium spp.	24	7	0
Mucor spp.	12	9	3
Fusarium culmorum	20 (33)‖	17 (24)	1 (3)
Other sporing mycelia	23	18	9
Sterile mycelia—dark coloured	19 (19)‖	8 (28)	21 (44)
Sterile mycelia—hyaline	5 (4)‖	14 (7)	18 (23)
Total mycelia	120	75	53
Ratio, sporing/sterile mycelia	4·00	2·41	0·36

* In the sense used by Harley and Waid (ref. 2).
† 3–5 cell layers, 39–97μ thick, forming about 35 per cent of the total dry wt. of an intact root.
‡ 2–4 cell layers, 19–68μ thick.
§ 184–232μ in diameter.
‖ Percentage of root fragments inhabited by these fungi in samples of 386 root-surface, 393 outer-cortex and 543 inner-cortex fragments.

cortex and of intact roots were placed on three separate series of plates of Czapek–Dox agar and incubated for a period of three weeks at 25° C. The results, summarized in Table 1, demonstrate the differences which occurred between the composition of the mycelial populations of the root surfaces of intact roots and those of the outer and inner tissues of the cortex of dissected roots. Some of the sterile species of fungi isolated from the inner cortex were rarely isolated from intact roots, presumably because they could not compete in mixed culture with such surface-inhabiting species as *Trichoderma viride* or *Mucor* spp.

The technique can be used to determine the spatial relationships of different fungal species within plant tissue. An interesting example is the distribution of the mycelium of *Fusarium culmorum* in decomposing roots of rye-grass. In samples of 486 fragments, this fungus occurred in 135 outer and 24 inner cortex fragments. Generally, several consecutive fragments of outer cortex were infected with *F. culmorum*. Eighteen of the records from the inner cortex occurred on fragments which had been surrounded by an outer cortex that was infected with *F. culmorum*. Three of the remaining six records from the inner cortex were located in fragments which were adjacent to regions of infected outer cortex. The observations indicate that the ability of *F. culmorum* to infect the inner cortex was dependent upon its initial establishment in the outer cortex. This is in contrast to the distribution of some of the more abundant species of sterile fungi from the inner cortex which were isolated infrequently from the outer cortex (Table 1). I suggest that similar techniques might be developed to follow the course of infection by pathogenic fungi in diseased plant structures.

Attempts have been made to isolate the mycorrhizal fungi associated with beech (*Fagus sylvatica* L.). Microscopic inspection showed that the outer layers of the hyphal mantle which encloses the cortex of infected roots of beech consisted of the hyphæ of several species of fungi, some of which were non-septate and some septate with dark-coloured hyphal walls. This meant that the isolation of the ectotroph would be subject to contamination by the non-mycorrhizal fungi which inhabit the mantle surfaces. To avoid such contamination the mycorrhizal roots were washed in sterile water and the mycorrhizal mantle was then removed by dissection. Several kinds of sterile mycelium were isolated from the root cortex in various types of culture media, and it is possible that they had occupied the intercellular spaces of the outer cortex, that is, the region of the Hartig net. Fungi isolated from the hyphal mantle were mainly sporing forms.

I wish to thank Dr. J. L. Harley and the Director of the Grassland Research Institute, Dr. William Davies, as well as Mr. T. E. Williams, for their encouragement, also the Agricultural Research Council for a training grant during the tenure of which the studies on beech were made.

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Some New Observations on the Development of the *Proteus* Group of *Amoebae*

FOR no member of the *proteus* group of *Amoebae* is there any published account of what takes place between the hatching of the spore and the attainment of adult size. (Throughout this communication Jepps[1] has been followed in the use of the terms spore, cyst and *proteus* group.) The technique[2] of removing mature *Amoebae* from their culture to a dilute inorganic fluid (KCl, 0·006 gm.; $MgSO_4.8H_2O$, 0·002 gm.; $CaHPO_4$, 0·004 gm.; 1,000 ml. Glasgow tap water), thereby changing the *p*H of their environment, has facilitated the elucidation of these stages and therefore of giving some explanation of why 4–6 months are occupied by the juvenile stages. When adult they divide by fission once in three days—a striking contrast.

All mature *Amoebae* of this group contain some spores. For the sake of simplicity the species *A. lescherae* will be used to portray the new knowledge acquired. It is needless to emphasize the precaution of dealing with a culture of *A. lescherae* uncontaminated with any other amoeba species.

Introduce into a Petri dish (4 in. diam.) half-filled with inorganic fluid about 20 mature *A. lescherae*. The *Amoebae* are killed, spores released and bacterial decomposition sets in. After about a week (60° F.) hatching amoebulae, 5–6μ, may be studied with a 4·4-mm. water immersion lens *in situ*. These feed and then encyst (? digestive cysts). After a varying period of time, not less than a week, excystation takes place. It is a beautiful sight to see the creatures emerging through a minute opening and freeing themselves from the cyst wall. When half-way through, they look like balloons tied round the middle. These creatures feed, and their growth is accelerated if minute flagellates are added. Once more, these now larger amoebulae encyst. Encysted amoebulae can always be distinguished from spores by their possession of food vacuoles.

After a varying period of time, even so long as a month, excystation again takes place. So the story goes on: a feeding stage, followed by encystment, excystation feeding and consequent growth. The largest cysts after three months measure 39μ. The *Amoebae* emerging from these large cysts grow rapidly to adult proportions, but they are almost transparent.

Thus during the juvenile stage a much longer time is spent in cysts than in active stages. What induces excystation, an excystment factor[3] or a favourable environment, has still to be investigated. A fuller account of this work will be published elsewhere.

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Tagging Green Turtles, 1951–56

ON three little islands off the south-west coast of Borneo, the Sarawak Turtle Board annually collects for sale or replants for hatching more than a million eggs of the green or edible turtle (*Chelonia mydas* Linn.)[1]. In 1951 we commenced marking experiments on this population. By 1953 we had settled on polished, monometal, hard-steel, 'cow-ear' type tags—one side with an inset code-number; "SARAWAK MUSEUM: REWARD" on the other. These are punched and locked through the inner rear trailing edge of one forward flipper on an adequate sample of laying turtles.

First 1953 returns showed repeated laying in following weeks of the 'season'[2]. But no 1953 turtle repeated in 1954; and so through 1954–55, until 1956 (about 4,000 tagged). It is unlikely that tags could be regularly overlooked at these three small beaches, where every female is numbered in, flagged, clocked and the clutch-size recorded on an all-night rota, by trained Malay watchers.

The first proved 'over-season' repeat came on July 4, 1956, from a turtle initially tagged on July 30, 1953. By the end of July, fourteen had been recorded, *all* tagged in July or early August 1953. This trend has continued increasingly to date. Many of the 1953+56 recoveries have repeated several times in the latter year, as in the former: *B* 1544 has now laid well over 1,000 eggs on eleven recorded visits, five in 1953 and six in 1956.

The immediate result is a proved method of tagging sea-turtles, durably and harmlessly. Only one number has been eroded. No turtle has been visibly injured. Previous attempts, notably by Schmidt[3] and Moorehouse[4], only succeeded over short periods. Prof. A. Carr is now using these tags on Atlantic green turtles; he already reports significant results[5]. I shall be pleased to correspond with others interested.

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A Selective Medium for the Isolation of Coliform Soft Rot Bacteria from Plant Tissue

DURING further studies on black leg disease of potato, difficulty was experienced in isolating the appropriate pathogens, which were identified as *Erwinia atroseptica* (van Hall) Jennison syn. *Bacterium atrosepticum* (van Hall) Burgwitz. Even using the screening methods of Noble and Marshall[1], namely, seeding plates of meat infusion agar with contaminated material from infected stems and tubers, selection of the organisms was difficult owing to the growth of many other types of bacteria. MacConkey's lactose bile-salt neutral red agar was found to be more selective, but *Pseudomonas* spp. could not now be identified by fluorescence in ultra-violet light, although a number still grew on the plates. The selective pectate gels of Rudd-Jones[2] and others were also tried, but proved to be difficult to prepare especially with limited facilities, and were often too soft to use for plating.

One of the characters of the coliform soft rot bacteria is their ability to grow and produce an acid reaction in salicin basal-salt media. A solid medium was therefore devised which would be selective and would allow this reaction to take place as an aid to identification.

The constituents are as follows:

Salicin	10·0 gm.
Sodium taurocholate	5·0 ,,
Ammonium dihydrogen phosphate	1·0 ,,
Magnesium sulphate ($MgSO_4 7H_2O$)	0·2 ,,
Potassium chloride	0·2 ,,
Bromthymol blue (water soluble)	0·05 ,,
Agar	20·0 ,,
Distilled water	1 litre

The ingredients are mixed in a flask and dissolved by steaming. The *p*H is corrected to 7·0, the medium tubed and sterilized by bringing the pressure in the autoclave to 15 lb. momentarily, then switching off. In preliminary experiments sodium pectate was substituted for salicin in the medium, but growth was unsatisfactory.

Erwinia spp. and *Aerobacter* spp. produce roughly circular, entire, finely granular, yellow to yellowish-orange colonies about 1 mm. in diameter after four days at 26° C. Colonies should be removed to meat infusion agar slopes as soon as possible because they quickly loose viability on the medium. To differentiate between *Erwinia* spp. and *Aerobacter* spp., slices of potato tuber should be inoculated in the usual way.

Although the medium is highly selective, at times pectinase-producing *Pseudomonas* spp. have occurred on the plates. However, they form circular, entire, colourless or very pale yellow colonies, and do not grow in liquid salicin basal-salt media. On one occasion, an organism of the *Bacillus mascerans-polymyxa* group was obtained from the plates.

The medium has been used principally in black leg investigations; but isolations of soft rot coliforms from tomato, celery, etc., have been made successfully.

Studies by one of us (D. C. G.) have recently shown that while *E. atroseptica* always produces alkali in the ethyl alcohol peptone medium of Noble and Marshall[1], this reaction is not specific to the black leg organisms. Certain isolates, identified by other biological and biochemical tests as *E. carotovora* and *E. aroideae*, give the alkaline reaction also. Micro-tests, using washed suspensions in weak phthalate buffer plus 5 per cent ethyl alcohol, were carried out. These showed that acid production in the ethyl alcohol peptone was perfectly correlated with acid production in ethyl alcohol alone. A full report will be published elsewhere.

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Seed Dressings for the Control of Frit Fly in Oats

Gough and Woods[1] have shown that the use of a seed dressing of an appropriate insecticide can give good control of damage caused by wheat bulb fly (*Leptohylemyia coarctata* Fall). Moreover, Bradbury and Whitaker[2] have shown that such insecticides as benzene hexachloride, when applied to the roots of a cereal seedling, are taken up systemically by the plant to a marked degree. Cunliffe and Hodges[3] showed that under dry conditions in the spring, the number of eggs of the frit fly (*Oscinella frit* Linn.) laid in the soil around the plant was several times those found on the plant, and this has been confirmed by us using a new technique for recovering eggs. This is being described by one of us (D. P. W.) elsewhere. It seemed, therefore, that an insecticide suitably placed around the roots of the young oat plant might kill some of these eggs or the young emerging larvæ and help to reduce the damage caused by this pest.

Commercial seed dressings of gamma-B.H.C., used for wireworm control, are normally applied at the rate of about 600 μgm. of pure insecticide per gram of cereal seed, but Gough and Woods[1] used dressings of three times this strength (40 per cent gamma-B.H.C. at 3 oz. per bushel). A small pilot trial was laid down by us on April 26 at this centre using oat seed of variety S84 previously treated with a commercial dressing containing an organo-mercurial fungicide. To different lots of this was added further dressings containing gamma-B.H.C., aldrin and dieldrin, each at normal, twice normal and four times normal strength, that is, 600, 1,200 and 2,400 μgm. of pure insecticide per gram of seed. Each plot consisted of 25 ft. of drill sown by hand.

Samples of fifty plants were taken at random from each treatment on June 25, when the very heavy frit fly attack had reached its maximum, and all shoots examined for damage by frit fly. The results (Table 1) indicate the percentage of attack on the primary shoots and on tillers formed later. In a late-sown crop of this type, secondary tillers are produced too late to form a head of grain of any useful size, so the saving of the primary shoot is of major importance in production of a grain crop. These results show that under certain conditions an excellent control of the attacks on primary shoots can be obtained by the higher rates of dressing, especially of dieldrin, and that these shoots can go on to produce a reasonable yield even in late-sown crops.

Table 1

Dressing rate	Insecticide	Primary shoots attacked (per cent)	Tillers attacked (per cent)	Heads per 25 ft. of drill	Yield (cwt. per acre)
	Untreated	94	48	0	0
Normal	Aldrin	52	69	245	6·5
	Dieldrin	32	76	264	9·0
	B.H.C.	60	64	76	2·6
Twice normal	Aldrin	50	73	207	8·4
	Dieldrin	16	68	376	17·8
	B.H.C.	74	74	173	4·8
Four times normal	Aldrin	24	59	350	18·0
	Dieldrin	20	60	346	18·1
	B.H.C.	28	64	246	9·7

Germination at all rates of dressing had been reasonably good, but as the untreated plants rapidly disappeared owing to frit fly attack, a comparison of germination was difficult. It is, however, known that gamma-B.H.C. and aldrin can be phytotoxic in the presence of mercury.

On July 6 a further trial of the same type was sown, but this time using gamma-B.H.C. and dieldrin dressings at four times and eight times normal. Again the untreated control plots were practically destroyed by frit fly attacks, but the dieldrin plots gave substantially the same results as the four-times normal dressing previously used. Severe phytotoxic symptoms were apparent with the eight-times normal gamma-B.H.C. and to a lesser extent with the four-times normal.

In the present trials, seed was sown by hand at a depth of about 1 in. Since under field conditions the seed and dressing might be placed at a much greater depth than this, the insecticides may be less effective against larvæ hatched from the eggs which are laid near soil-level. This aspect is being looked into.

We are indebted to Mr. J. D. Thomas for the original suggestion which gave rise to this work and for reading this communication in draft.

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Performance of Telephone Operators relative to Traffic Level

One of the important problems involved in the efficient running of a telephone exchange is to decide on the number of operators required to deal with the expected volume of traffic. Calls arrive at an exchange at approximately random time intervals, so that the longer subscribers wait for their calls to be answered, the less respite will there be for the operators. To provide a service where subscribers rarely wait would require so many operators or trunks that they would be idle for a very large proportion of their time. In practice, a balance is struck between subscriber waiting and operator/equipment waiting.

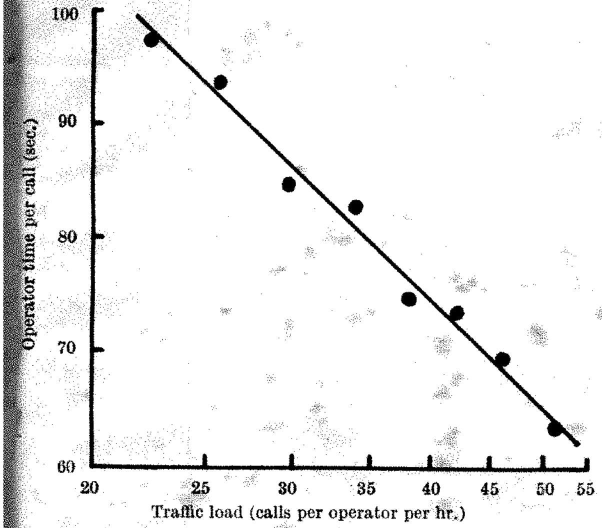

Fig. 1. Relationship between operator performance and traffic level

The mathematics involved in solving this problem for automatic exchanges were first developed by Erlang (Brockmeyer, Halstrom and Jensen)[1]. Subsequent extensions[2] provide a basis for calculating subscriber delay, given the traffic-level, the number of operators available to deal with it, and the operator handling time per call. Theoretically, therefore, one can predict how subscriber delay would be affected if the number of operators at an exchange were to be varied, if one can assume that operator time per call is independent of traffic-level. With the co-operation of the General Post Office this assumption has been tested at a cordless auto-manual exchange by experimentally varying the traffic load per operator during a four-week period. Operator waiting time was measured by Tippett's[3] snap-reading method, and from it, operator time per call was calculated. The result is shown in Fig. 1.

It will be seen that over the range considered, for all practical purposes operator time per call varies inversely as the logarithm of the traffic load on the operator. An assumption of independence is clearly invalid.

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Missing Values in Factorial Experiments

Methods of estimating missing values have been discussed by Goulden[1]. Some applications to factorial experiments were presented by Cochran and Cox[2], but they do not give a general formula. If there is one replication of an $a \times b \times c \times \ldots f$ factorial experiment, with n factors $A, B, C, \ldots F$ at $a, b, c, \ldots f$ different levels respectively, then it may be shown by minimizing the highest-order interaction sum of squares that a suitable estimate, y, of a missing value is given by:

$$\begin{aligned}(-1)^{n-1}(a-1)(b-1)(c-1)\ldots(f-1)y = {} & (G)-a(A)-b(B)-c(C)\ldots \\ & +ab(AB)+ac(AC)+\ldots -abc(ABC)-\ldots \\ & \ldots+(-1)^{n-1}\,bc\ldots f(BC\ldots F)\end{aligned}$$

where (G) is the sum of the available observations, that is, the incomplete grand total, (A) is the sum of the $bc \ldots f-1$ observations for the level of A which contains the missing value, or the incomplete A total, (AB) is the incomplete $A \times B$ total, ... and $(BC \ldots F)$ is the sum of $a-1$ observations. There will be 2^n-1 terms on the right-hand side. For two factors this reduces to the well-known randomized-block formula:

$$(a-1)(b-1)y = a(A) + b(B) - (G)$$

The purpose of this communication is to point out that the above estimate has a property which, except for the 2 × 2 table (see ref. 1, p. 310), has not been recorded. The estimate is identical with that obtained by equating to zero a particular component of the highest-order interaction. This is the component, with one degree of freedom, which measures the interaction of the comparisons of the level of each factor in which there is a missing value, with all other levels of the factor. The relation may be verified in any particular case by expanding the above estimation equation in terms of individual observations. This alternative estimate, which will in general be more laborious to calculate, may be obtained by expanding the function:

$$\{(a-1)A_m-\sum_{i\neq m}A_i\}\{(b-1)B_n-\sum_{j\neq n}B_j\}\ldots\{(f-1)F_t-\sum_{k\neq t}F_k\}=0$$

where the product $A_xB_yC_z \ldots F_w$ represents the observation at levels $x, y, z, \ldots w$ of the factors; i, j, etc., run from 1 to a, b, etc., respectively; and where observation $A_mB_nC_o \ldots E_t$ is the one missing.

A more detailed account of these results is being prepared for submission to the *New Zealand Journal of Science and Technology*.

G. M. Wright

Crop Research Division,
Department of Scientific and Industrial Research,
Christchurch, New Zealand.
July 17.

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[1] Goulden, C. H., "Methods of Statistical Analysis", 2nd. edit., 318 (Wiley, New York, 1952).

[2] Cochran, W. G., and Cox, G. M., "Experimental Designs", 202 (Wiley, New York, 1950).

A Mesolithic Burial Tumulus from Ceylon

Stone age burials that have yielded more or less complete skeletons lying in the postures in which they were buried are extremely rare and this is particularly so of Ceylon and India.

Pitted pebble hammers were recorded from Ceylon in 1942 [1], and recently what appears to be a kitchen midden cum burial tumulus yielding more or less complete skeletons of the makers of these artefacts has been discovered at Bellanbandi Palessa at lat. 6° 31′ N., long. 80° 48½′ E., about two miles west of the Valave River. A ridge of reddish earth about 4 ft. high extends across a flat exposure of limestone and contains these bones of humans and of the animals eaten by them, together with stone and bone artefacts, all of the same age and occurring regularly from the surface down to the limestone. This has been eroded to a depth of 4 ft. by a former stream, now represented by a series of temporary pools. The area was divided into 6 ft. × 6 ft. squares and ten of these yielded six more or less complete skeletons. The fragments of about another ten individuals lay either upon or underneath them, together with the remains of the animals utilized as food, numerous stone implements, unworked pebbles, ten pitted pebble hammers and one pitted anvil-cum-grindstone, all akin to those in Fig. 1 of the original article of 1942[1], and with them lay an abundance of microliths with crescents. Most of the pebbles bore scars of impact at either end or along the perimeter. The hammers and anvil-cum-grindstones being of granulite gneiss, amphibolite and basic igneous rock disclosed heavy patination and incipient disintegration; but the quartz and chert artefacts were more or less unaffected by age. Some of the bone artefacts resembled (*i*), (*n*) and (*o*) in Fig. 2 of the previous article[1], and there were also large obliquely pointed digging sticks, spoon-like scoops of bone and deer antler and cells of elephant bone and of antler.

Fig. 1 shows one of these skeletons from square *B* 2. With it are three pebbles and also a bag of thirteen smaller ones, probably sling stones, that had evidently been placed in a bag within reach of the corpse.

The diet of this race consisted of the water snail *Paludomus*, the land snail *Cyclophorus*, the arboreal snail *Acavus*, the reptiles *Testudo* and *Varanus*, mammals such as squirrels, porcupine, hare, monkeys, pole-cat, bear, civet cat, fishing cat, pig, chevrotain spotted deer, sambhur, buffalo and possibly the now extinct gaur.

Materials employed as pigment were lumps of hæmatite and molybdenum worn smooth through friction. The entire skeletons were flexed, the majority facing east or south-east, a few faced north-west, while other skeletons or fragments of such lay above or beneath them. They rested either upon the bedrock or on a rock slab, and were often covered over with another slab. The surrounding limestone had been affected by the decomposing corpse and distintegrated into yellow fragments.

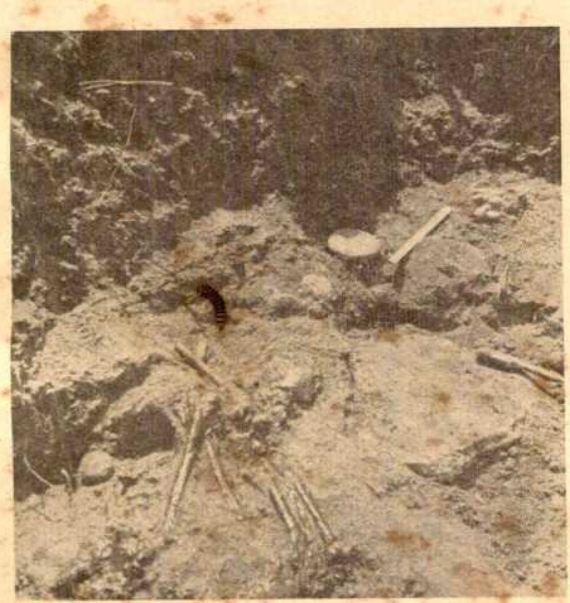

Fig. 1. Flexed skeleton from square *B* 2 lying upon its left side. Pelvis at lower left of figure, a bag of sling-stones near upper or right end of foot ruler

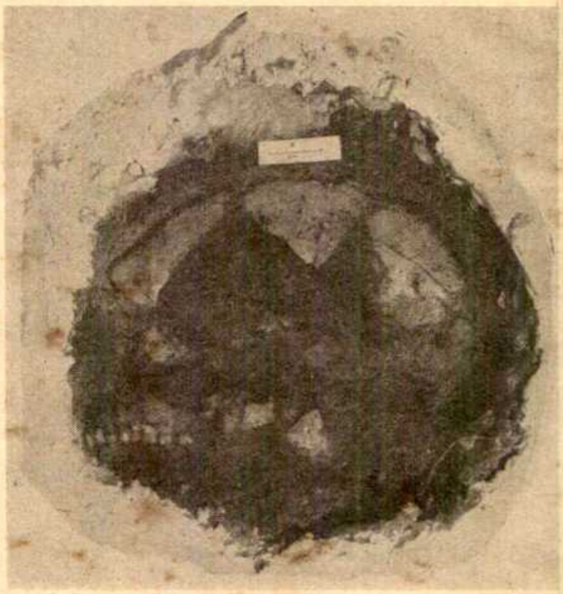

Fig. 2. Left surface of a skull plaster jacketed and lifted from square *B* 2. Its glabellar-occipital length, 223 mm.

The skulls (Fig. 2) were dolichocephalic and prognathous with males possessing heavy diffuse brow ridges and markedly receding foreheads. The bite was of the edge-to-edge type. The skull bones were 8–9 mm. thick. The horizontal mandibular body was noticeably deep.

The teeth were badly worn at an early age, doubtless due to sand in the diet, and the third molars which were usually as large as or larger than the second ones were well worn. Traces of the *Y*-shaped mark generally termed the Dryopithecus pattern were also present in some of the molars.

The abundance of broken bones and human mandibles without calvaria that occurred both loose in the earth and as bone breccia suggests that this site was the kitchen midden of a cannibal tribe that had also ceremoniously slain and interred individuals within it. Fire was known; but its traces were scarce.

The absence of potsherds, the abundance of microliths together with crescents, the unpolished nature of the artefacts, the pebbles with pits produced by conical drilling, the advanced mineralization of the bones, the marked change to aridity of an area that had once been traversed by a large stream from which the aquatic snail *Paludomus* and the arboreal *Acavus* had disappeared, and also the disintegration of some varieties of rock, all indicate sufficient age to support the view that this culture is Mesolithic.

A detailed communication will appear in the Ceylon National Museums Bulletin, *Spolia Zeylanica*.

P. DERANIYAGALA
(Director of National Museums)

Colombo, Ceylon.
Sept. 28.

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[1] Deraniyagala, P. E. P., *Nature*, **149**, 384 (1942).

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Tuesday, January 1

Institution of Electrical Engineers (at Savoy Place, London, W.C.2), at 3 p.m.—Mr. J. F. Coales: "The Evolution of Automation". Christmas Lecture for Older Schoolchildren. To be repeated on Wednesday, January 2, at 3 p.m.)

Tuesday, January 1—Friday, January 4

Geographical Association (at the London School of Economics, Houghton Street, London, W.C.2).—Annual Conference.

Wednesday, January 2

Institute of Fuel (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Mr. W. A. D. Baker: "Approval Tests for Coke Burning Domestic Appliances".*

Institute of Petroleum (at 26 Portland Place, London, W.1), at 5.30 p.m.—Symposium on "Staff Training".

Institution of Mechanical Engineers, Applied Mechanics Group (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p.m.—Discussion on "New Techniques in Photo-Elasticity".

Thursday, January 3

Physical Society (joint meeting with the Institute of Refrigeration, at the Junior Institution of Engineers, 14 Rochester Row, London, S.W.1), at 5.30 p.m.—Mr. M. J. Hickman: "The Thermal Properties of Heat Insulation at Low Temperatures".

Institute of Metals, London Local Section (at 17 Belgrave Square, London, S.W.1), at 6.30 p.m.—Dr. H. K. Hardy: "The Metallurgical Challenge of Nuclear Power".

Friday, January 4

Institution of Mechanical Engineers, Applied Mechanics Group (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6 p.m.—Dr. J. M. Alexander and Prof. Hugh Ford: "An Experimental Investigation of the Process of Expanding Boiler Tubes".

Saturday, January 5

British Interplanetary Society (in the Tudor Room, Caxton Hall, Caxton Street, London, S.W.1), at 6 p.m.—Dr. Michael W. Ovenden: "Astronomy and Earth Satellites".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Neutron Spectrometer Assistant (at least 27 years of age, and with G.C.E. in four subjects at "O" level, including the English language and a mathematical or scientific subject, or equivalent qualifications) in the Nuclear Physics Division, to assist in the carrying out of slow neutron cross-section measurements on radioactive samples—The Establishment Officer, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting Ref. 678/34 (January 1).

Chemist (with a good first- or second-class honours degree) at the Central Laboratory, Chiswick—The Recruitment and Training Officer (F/EV.613), London Transport, 55 Broadway, Westminster, London, S.W.1 (January 5).

Superintendent of the Chemistry Laboratories—The Registrar, The University, Sheffield (January 7).

Experimental Officer (preferably with a knowledge of chemistry, routine tests used in clinical pathology, and ability to handle farm animals) in the Radio-Biological Laboratory—The Secretary, Agricultural Research Council's Field Station, Compton, Newbury, Berks (January 14).

Lecturer in Anatomy at the University College of the West Indies—The Secretary, Senate Committee on Colleges Overseas in Special Relation, University of London, Senate House, London, W.C.1 (January 15).

Experimental Officer (with G.C.E. (advanced) in physics and one other scientific subject, or H.N.C. in applied physics or engineering with a good reading knowledge of Russian and one other foreign language) at the National Physical Laboratory, Teddington, Middlesex, for translating and abstracting from scientific journals—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.423/6A (January 19).

Professor and Head (with high academic qualifications in mechanical engineering, and wide experience in research and teaching in internal combustion and automobile engineering, and in industrial testing and development work) of the Department of Internal Combustion Engineering—The Registrar, Indian Institute of Science, Bangalore 3, India (January 20).

Senior Laboratory Technician (over 35 years of age, and preferably with previous experience in histology and/or microbiology) for basic research in microbiology involving biophysical techniques—The Secretary, Grassland Research Institute, Hurley, near Maidenhead (January 25).

Research Fellow (astronomer, with experience in Milky Way research by observational methods) in the Department of Astronomy, Research School of Physical Sciences, Australian National University—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, January 28).

Research Scholars (with a Master's degree or equivalent research experience) in the Departments of Astronomy, Geophysics, Nuclear Physics, Particle Physics, Radiochemistry and Theoretical Physics, Research School of Physical Sciences, Australian National University, Canberra, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (January 28).

Chair of Physics in the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (January 31).

Senior Lecturer in Veterinary Medicine (specific and contageous diseases and epidemiology) at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, January 31).

Lecturer or Assistant Lecturer in Crop Husbandry, at Makerere College (University College of East Africa)—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (April 8).

Assistant Professor (with an honours degree in mathematics and preferably some postgraduate experience in research or teaching) in the Department of Mathematics—Head of the Department of Mathematics, University of New Brunswick, Fredericton, N.B., Canada.

Biochemist, Basic grade (with experience in steroid chemistry)—The Group Pathologist, The Mental Hospital's Group Laboratory, West Park Hospital, Epsom, Surrey.

Biochemist (with a first- or second-class honours degree or equivalent) to assist in research on amino-acids in animal nutrition; and a Bacteriologist (with a first- or second-class honours degree or equivalent) to assist in work on nutritional significance of micro-organisms of the digestive tract—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire.

Chemist (with at least a four years university degree, and preferably specially trained in physico-chemistry); and a Bacteriologist (preferably with a university degree, and well trained in industrial microbiology) at the Sugar Milling Research Institute, Durban—The Director, Sugar Milling Research Institute, University Private Bag, King George V Avenue, Durban, South Africa, and to the South African Scientific Liaison Officer, Africa House, Kingsway, London, W.C.2.

Demonstrator in the Department of Physics, University College of Rhodesia and Nyasaland—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1.

Demonstrator (with a good first-class degree in science or engineering or equivalent qualification) to teach experimental aerodynamics and to participate in the expanding wind tunnel research activities; and an Assistant Wind Tunnel Engineer (with experience of the operation of large-scale plant involving powers of around 1,000 kW., and sound relevant knowledge of mechanical and electrical engineering techniques) for the operation of a 9 in. by 9 in. continuous supersonic tunnel and an 8 ft. by 6 ft. general purpose low-speed tunnel, and ancillary equipment—The Recorder, College of Aeronautics, Cranfield, Bletchley, Bucks.

Laboratory Technician (A.I.M.L.T. or equivalent qualifications) to assist with research work in bone histology—The Pathology Department, Institute of Orthopaedics, 234 Great Portland Street, London, W.1.

Laboratory Technician (male or female, with A.I.M.L.T. or equivalent)—North London Blood Transfusion Centre, Deansbrook Road, Edgware.

Physicist in Charge at the Northern Ireland Radiotherapy Centre—The Secretary, Northern Ireland Radiotherapy Centre, Purdysburn, Belfast.

Principal Scientific Officer (with a first- or second-class honours degree in physics or electrical engineering, and at least three years postgraduate research experience in one or more of the following fields: (*a*) spark or arc discharge process; (*b*) generation of high energy high voltage pulses; or (*c*) capacitor development) to conduct a programme of research into certain aspects of weapon design—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting Ref. B/1000/34.

Research Assistants (honours graduates in chemistry) in the Department of Applied Science, Wolverhampton and Staffordshire College of Technology—The Clerk to the Joint Education Committee, Education Offices, North Street, Wolverhampton.

Science Graduate (with a good degree in physics or equivalent, and preferably with previous experience in research) in the Physics Department, for research on the measurement and suppression of dust—The Assistant Secretary, British Coal Utilization Research Association, Randalls Road, Leatherhead, Surrey, quoting Ref. C.84.

Scientist (female, with a first- or second-class honours degree and some research experience) at the National Coal Board's Scottish Divisional Laboratory, Edinburgh, for work mostly concerned with studying the physical characteristics of fine coal and clay suspensions in water and high temperature reactions associated with brick making—The Divisional Chief Staff Officer, National Coal Board, 8 Eglinton Crescent, Edinburgh 12.

Sleeping Sickness Control Officer (preferably single, with a good general education and agricultural training, or knowledge of surveying, mapping, entomology or botany) in the Northern Nigeria Government, Medical Department—The Crown Agents, 4 Millbank, London, S.W.1, quoting M.3A/43728/NF.

Spectrographic Chemist, Research Officer (with at least a university degree with first- or second-class honours, and preferably some experience with spectrographic equipment and methods), with the Australian Atomic Energy Commission, Lucas Heights, Sydney, Australia, to organize a range of spectrographic analytical services and to carry out research on spectrographic analysis generally—The Australian Atomic Energy Commission Liaison Office, Australia Ho[illegible] Strand, London, W.C.2.

Technician in the Chemistry Department—Th[illegible] Royal Holloway College, Englefield Green, Surrey.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Physics in Medicine and Biology. Vol. 1, No. 1 (July, 1956). Edited by Prof. J. E. Roberts. Pp. 102+1 plate. 20*s*.; 3 dollars. Annual subscription: 70*s*. per volume (4 parts); 10.50 dollars in U.S.A. and Canada. (London: Taylor and Francis, Ltd., 1956.) [1710

British Electrical and Allied Industries Research Association. Technical Report L/T 321: The Effects of Small Discharges on Some Insulating Materials—1. By N. Parkman. Pp. 14+11 figures. 12*s*. 6*d*. Technical Report L/T 343: Ultra-High Frequency Breakdown in Irradiated Parallel Plate Gaps. By W. A. Prowse and P. E. Lane. Pp. 6+11 figures. 12*s*. 6*d*. Technical Report L/T 350: A Study of Ionization Coefficients and Electrical Breakdown in Hydrogen. By A. Wilkes, W. Hopwood and N. J. Peacock. Pp. 18+5 figures. 12*s*. 6*d*. (Leatherhead: British Electrical and Allied Industries Research Association, 1956.) [1710

Birkbeck College (University of London). Calendar for the year 1956–57. (134th Session.) Pp. 137+xv. (London: Birkbeck College, 1956.) [1710

Central Electricity Authority. Eighth Report and Statement of Accounts for the year ended 31st March, 1956. Pp. viii+244+8 plates. (London: H.M. Stationery Office, 1956.) 10*s*. 6*d*. net. [2510

Institution of Metallurgists. The Fatigue of Metals. (Lectures delivered at the Institution's Refresher Course, 1955.) Pp. 148+16 tables. (London: Institution of Metallurgists, 1956.) 25*s*. [2510

Imperial College of Science and Technology (University of London). Research Report of the Royal College of Science, 1953–56. Pp. iv+63. (London: Imperial College, 1956.) [2510

Tinplate Handbook: Facts about Tinplate for Buyers and Users. By Dr. W. E. Hoare. Third, revised edition. Pp. 44. (Greenford, Mddx.: Tin Research Institute, 1956.) [2510

Scottish Society of the History of Medicine. Report of Proceedings, Session 1955–56. Pp. 34. (Edinburgh: Scottish Society of the History of Medicine, 1956.) [2510

Royal Institute of Chemistry. Lectures, Monographs and Reports, 1956. No. 3: Coal as a Raw Material. By W. Idris Jones. Pp. ii+22. (London: Royal Institute of Chemistry, 1956.) 4*s*. net. [2510

Scientific and Engineering Manpower in Great Britain. Pp. ii+28. (London: H.M. Stationery Office, 1956.) 1*s*. 6*d*. net. [2510

Piezoelectric Ceramics. Pp. 16. (Towcester: Technical Ceramics, Ltd., 1956.) [2510

Association of Universities of the British Commonwealth. United Kingdom Postgraduate Awards (Fellowships, Scholarships, Grants, etc.), 1956–57. List of Awards tenable at Universities in the United Kingdom. Short list of Awards tenable Overseas. Pp. 130. (London: Association of Universities of the British Commonwealth, 1956.) [2610

Ministry of Labour and National Service. Method of Construction and Calculation of the Index of Retail Prices. Pp. 40. (London: H.M. Stationery Office, 1956.) 1*s*. 9*d*. net. [2610

Ministry of Education. List of Special Schools for Handicapped Pupils in England and Wales (including Boarding Homes for Handicapped Pupils, and Establishments for Further Education and Training of Disabled Persons). (List 42, 1956.) Pp. 72. (London: H.M. Stationery Office, 1956.) 3*s*. 6*d*. net. [2610

Flora of Tropical East Africa. Edited by W. B. Turrill and E. Milne-Redhead. Menispermaceae. Pp. 32. (London: Crown Agents for Oversea Governments and Administrations, 1956.) 3*s*. [2610

Higher Education in the United Kingdom: a Handbook for Students from Overseas. Pp. 203. (London: Longmans, Green and Co., Ltd., 1956. Published for the British Council, and the Association of Universities of the British Commonwealth.) 5*s*. net. [711

The Religious Philosophy of Dean Mansel. By Dr. W. R. Matthews. (Friends of Dr. Williams's Library, Tenth Lecture, 1956.) Pp. 24. (London: Oxford University Press, 1956.) 3*s*. 6*d*. net. [711

Proposals for the Development of the Manchester College of Science and Technology. By Dr. B. V. Bowden. Pp. viii+140. (Manchester: Manchester College of Science and Technology, 1956.) 5*s*. [711

Memoirs of the British Astronomical Association. Vol. 37, No. 3: Edmund Halley, 1656–1742: Papers to Commemorate the Tercentenary of his Birth. Pp. 39+2 plates. (Hounslow West, Mddx.: British Astronomical Association, 1956.) 5*s*. [711

Colonial Geology and Mineral Resources. Supplement Series, Bulletin Supplement No. 1: The East African Rift System. By Dr. F. Dixey. Pp. iv+71+7 plates. (London: H.M. Stationery Office, 1956.) 7*s*. 6*d*. net [711

Aluminium Development Association. Directory of Members. Pp. vi+18. List of Publications. Pp. 31. (London: Aluminium Development Association, 1956.) [711

Empire Cotton Growing Corporation. Progress Reports from Experiment Stations, Season 1955–56. Cotton Research Station, Namulonge, Uganda. Pp. 50. 9*d*. Aden Protectorate. Pp. 14. 9*d*. (London: Empire Cotton Growing Corporation, 1956.) [711

Other Countries

New Zealand. Thirtieth Annual Report of the Department of Scientific and Industrial Research. Pp. 73. (Wellington: Government Printer, 1956.) [1710

Memoirs of the Commonwealth Observatory, Canberra. No. 12: Spectral Types of Bright Southern Stars. By Mary Lee Woods. Pp. 18. (Canberra: Government Printer, 1955.) [1710

Union Observatory, Johannesburg. Annual Reports, 1953–1955. Pp. 16. (Johannesburg: Union Observatory, 1956.) [1710

Chicago Natural History Museum. Fieldiana: Geology. Vol. 11, No. 8: A Review of the Habitat of the Earliest Vertebrates. By Robert H. Denison. Pp. ii+359–458. 1.50 dollars. Fieldiana: Zoology. Vol. 36, No. 2: The Distribution of Fishes Found Below a Depth of 2000 Metres. By Marion Grey. Pp. ii+75–338. 4 dollars. [illegible] 38: Days with Birds: Studies of Habits of Some East African [illegible] By V. G. L. Someren. Pp. ii+520. 8 dollars. Vol. 39, [illegible]ew Birds from Nepal. By Austin L. Rand and Robert L. Fleming. Pp. 4. 10 cents. Vol. 39, No. 2: A New Lacertid Lizar from Angola. By Hymen Marx. Pp. 5–10. 15 cents. (Chicago Chicago Natural History Museum, 1956.) [171

Proceedings of the Symposium on the Physics of Fission held a Chalk River, Ontario, May 14–18, 1956. (Report No. ZECL 329 Pp. vi+414. (Chalk River, Ont.: Atomic Energy of Canada Limited 1956.) 5 dollars. [171

East African Meteorological Department. Pamphlet Series, No. 2 The Climate of Nairobi City. Pp. 4. (Nairobi: East African Meteorological Department, 1956.) [171

Beitrage zur Neotrophischen. 1 Band, Heft 1, 1956. Pp. 68. (Jena Gustav Fischer Verlag, 1956.) 10 D.M. [171

Council of Scientific and Industrial Research. Fuel Researc Institute, Manbhum, Bihar. Carbonization Potentialities of Certai M.P. Coals. Pp. iv+62. (Jealgora, Manbhum, Bihar: Fuel Research Institute, 1956.) [171

United States Department of Agriculture. Technical Bulleti No. 1140: Effect of Spacing on some Agronomic and Fiber Characteristics of Irrigated Cotton. By R. H. Peebles, G. T. Den-Hartog an E. H. Prellsey. Pp. ii+62. (Washington, D.C.: Government Printin Office, 1956.) 25 cents. [171

United States Department of Commerce: National Bureau o Standards. Circular 539, Vol. 6: Standard X-ray Diffraction Powde Patterns. By Howard E. Swanson, Nancy T. Gilfrich and Marlene I Cook. Pp. ii+62. (Washington, D.C.: Government Printing Office 1956.) 40 cents. [1710

Clinica Chimica Acta: International Journal of Clinical Chemistry Vol. 1, No. 1 (January, 1956). Pp. 100. Vol. 1, 1956 (6 issues), 90*s*. Vol. 2, 1957 (6 issues), 90*s*. (Amsterdam: Elsevier Publishing Company; London: Cleaver-Hume Press, Ltd., 1956.) [171

United States Department of Agriculture. Technical Bulletin No 1135: The Larvae of the Phalaenidae. By S. E. Crumb. Pp. ii+356+11 plates. (Washington, D.C.: Government Printing Office 1956.) 1.25 dollars. [171

Federation of Nigeria. Annual Report on the Department o Agriculture (Central), for the year 1953–54. Pp. 52. (Lagos: Government Printer, 1956.) 9*d*. net. [251

On the Genesis of the Ovum of Mammals and of Man. By Kar Ernst von Baer. (Translated into English by Charles Donald O'Malley). (Reprinted from *Isis*, Vol. 47.) Pp. 37+1 plate. (Cambridge, Mass.: History of Science Society, Inc., 1956.) 1 dollar. [251

Arctic Institute of North America. Technical Paper No. 1: The Plankton of the Beaufort and Chukchi Sea Areas of the Arctic and Its Relation to the Hydrography. By Martin W. Johnson. Pp. 32 (Montreal: Arctic Institute of North America, 1956.) 50 cents. [251

Indian Forest Bulletin No. 211 (New Series): Cellulose and Paper Cold Caustic Soda Pulps and Cheap Grade Writing and Printing Papers from Blue Gum (*Eucalyptus Globulus* Labill). By R. V. Bha and P.R. Gupta. Pp. ii+11. (Delhi: Manager of Publications, 1956. As. 12; 1*s*. [251

Chicago Natural History Museum. Fieldiana: Zoology. Vol. 35 No. 4: Placentation of the Pigmy Treeshrew, *Tupaia minor*. By Waldemar Meister and D. Dwight Davis. Pp. ii+73–85+plates 10–14. (Publication 803.) (Chicago: Chicago Natural History Museum, 1956.) 60 cents. [711

Proceedings of a Conference on Tissue Fine Structure held at Arde House, Harriman, N.Y., January 16, 17, and 18, 1956, under th auspices of the Morphology and Genetics Study Section, Division o Research Grants, National Institute of Health. Edited by Keith R. Porter. (Supplement, Vol. 2, No. 4, Part 2, July 25, 1956, *Journal of Biophysical and Biochemical Cytology*.) Pp. xv+454+147 plates. (Baltimore, Md.: Rockefeller Institute for Medical Research, 1956.) 5 dollars. [711

United States Department of Agriculture. Index-Catalogue o Medical and Veterinary Zoology. Supplement 6, Authors A–Z. By Mildred A. Doss, Judith M. Humphrey and Dorothy B. Segal. Pp. ii+1375–1788. (Washington, D.C.: Government Printing Office, 1956.) 1.50 dollars. [711

World Health Organization. Technical Report Series. No. 114: Toxic Hazards of Pesticides to Man—Report of a Study Group. Pp. 52. (Geneva: World Health Organization; London: H.M. Stationery Office, 1956.) 2 Swiss francs; 3*s*. 6*d*.; 60 cents. [711

Mitteilungen des Deutschen Wetterdienstes. Nr. 16 (Band 3): Vorträge über Frostschutz anlasslich der "1. Tagung der Arbeitsgemeinschaft Frostschutz" am 22 November 1955 in Bonn, und de "Sonderbesprechung über die technischen Erfahrungen des Deutschen Wetterdienstes im Frostschutz," am 26 April 1956 in Mainz. Pp. 86. (Bad Kissingen: Deutschen Wetterdienstes, 1956.) [711

Bulletin of the Florida State Museum (Biological Sciences). Vol. 1, No. 3: Freshwater Mollusks of Alabama, Georgia, and Florida, from the Escambia to the Suwannee River. By William J. Clench and Ruth D. Turner. Pp. 97–240 (9 plates). (Gainesville, Fla.: Florida State Museum, 1956.) 1.80 dollars. [711

Publikationer fra det Danske Meteorologiske Institut. Communications Magnétiques, etc. No. 22: On the Computation of Lunar Daily Variations in Geomagnetism—Two Simple Methods. By J. Egedal. Pp. 25. (København: Trykt I Hørsholm Bogtrykkeri, 1956.) [711

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